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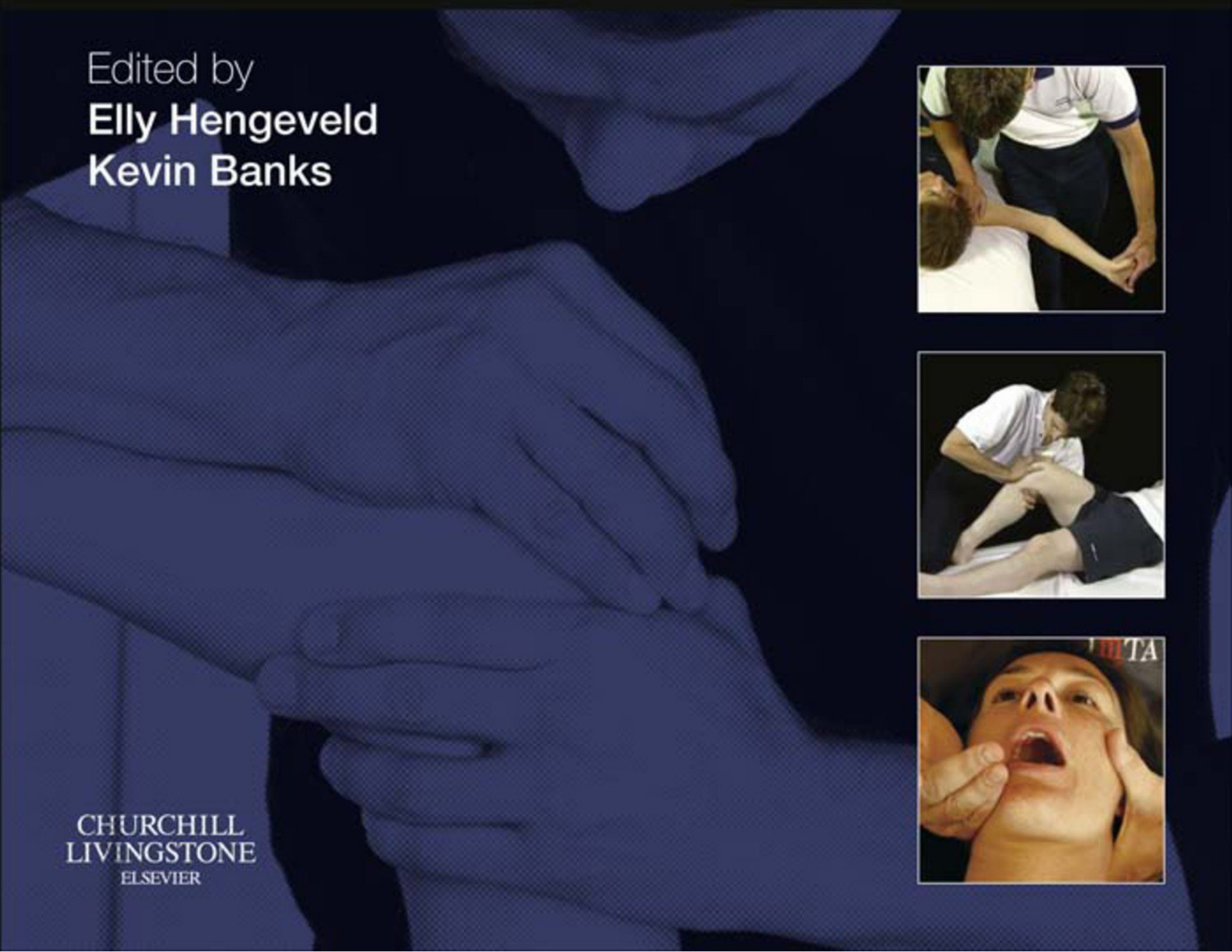
MAITLAND'S
Peripheral Manipulation

MANAGEMENT OF NEUROMUSCULOSKELETAL DISORDERS - VOLUME TWO



Edited by
Elly Hengeveld
Kevin Banks

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Maitland's Peripheral Manipulation

This book is dedicated to the memory of Geoff and Anne Maitland and the legacy they have left for us to nurture and evolve

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Maitland's Peripheral Manipulation

Management of Neuromusculoskeletal Disorders
Volume 2

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Biography

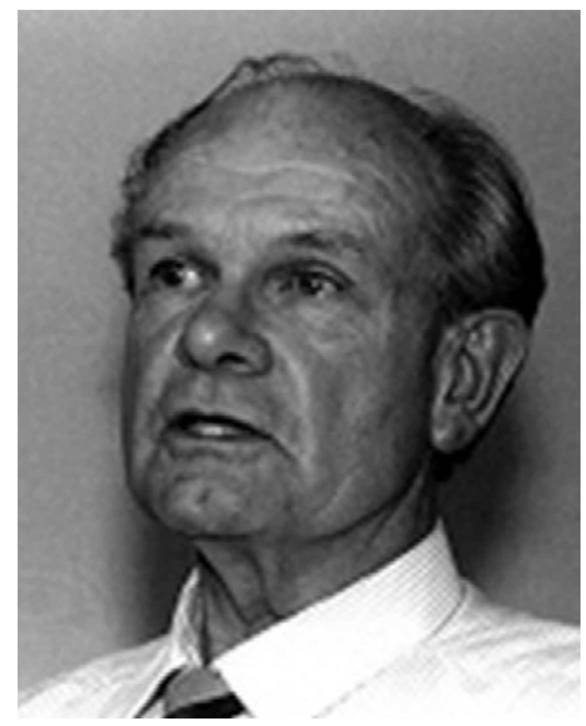
Geoffrey Douglas Maitland MBE AUA FCSP FACP (Monograph), FACP (Specialist Manipulative Physiotherapist) MAppSc (Physiotherapy)

Geoff Maitland worked initially at the Royal Adelaide Hospital and the Adelaide Children's Hospital, with a main interest in the treatment of orthopaedic and neurological disorders. Later he became a part-time private practitioner and part-time clinical tutor at the School of Physiotherapy at the University of South Australia. He continuously studied and spent half a day each week in the Barr–Smith Library and the excellent library at the Medical School of the University of Adelaide.

He immediately showed an interest in careful clinical examination and assessment of patients with neuromusculoskeletal disorders. In those days assessment and treatment by specific passive movements were under-represented in physiotherapy practice. GD Maitland learned techniques from osteopathic, chiropractic and bonesetter books as well as from medical books such as those of Marlin, Jostes, James B Mennell, John McMillan Mennell, Alan Stoddard, Robert Maigne, Edgar Cyriax, James Cyriax and many others. He maintained an extensive correspondence with numerous authors worldwide, who published work on passive mobilizations, manipulation and related topics as for example MacNab from Canada and Alf Breig from Sweden.

As a lecturer, he emphasized clinical examination and assessment. He stimulated students to write treatment records from the very beginning, as he felt that 'one needed to commit oneself to paper to analyse what one is doing'. In 1954 he started with manipulative therapy teaching sessions.

In 1961 he received an award from a special studies fund, which enabled him and his wife Anne to go overseas for a study tour. They visited osteopaths, chiropractors, medical doctors and physiotherapy colleagues whom they had heard and read about and corresponded with in the preceding years. In London, Geoff had interesting lunchtime clinical sessions and discussions with James Cyriax and his staff. From this tour GD Maitland established a friendship with Gregory P Grieve from the UK. They had extensive correspondence about their clinical experiences and this continued for many years.



G.D. Maitland (1924–2010), was born in Adelaide, Australia, trained as a physiotherapist from 1946 to 1949 after serving in the RAAF during the Second World War in Great Britain.

Maitland delivered a paper, in 1962, to the Physiotherapy Society of Australia entitled 'The Problems of Teaching Vertebral Manipulation', in which he presented a clear differentiation between manipulation and mobilization and became a strong advocate of the use of gentle passive movement in the treatment of pain, in addition to the more traditional forceful techniques used to increase range of motion. In this context it may be suitable to quote James Cyriax, a founder of orthopaedic medicine and of major influence on the development of manipulative therapy provided by physiotherapists:

> … more recently Maitland, a physiotherapist from Australia, has been employing repetitive thrusts of lesser frequency but with more strength behind them. They are not identical with the mobilizing techniques that osteopaths misname 'articulation', nor are they as jerky as chiropractors' pressures. The great virtue of

> Maitland's work is its moderation. He has not expanded his manipulative techniques into a cult; he claims neither autonomic effects nor that they are a panacea. Indeed, he goes out of his way to avoid theoretical arguments and insists on the practical effect of manipulation … The patient is examined at frequent intervals during the session, to enable the manipulator to assess the result of his treatment so far. He continues or alters his technique in accordance with the change, or absence of change, detected. These mobilizations clearly provide the physiotherapist with a useful addition to those of orthopaedic medicine and, better still, with an introduction to them. She gains confidence from using gentle manoeuvres and, if the case responds well … need seek no further.
>
> Cyriax J 1984 Textbook of Orthopaedic Medicine. Part II – Treatment by Manipulation, Massage and Injection, 11th edition. Ballière-Tindall, London. pp 40–41.

GD Maitland became a substantial contributor to the *Australian Journal of Physiotherapy* as well as to other medical and physiotherapy journals worldwide. On the instigation of Monica Martin-Jones, OBE, a leader of the Chartered Society of Physiotherapy in Great Britain, Maitland was asked to publish his work, which resulted in the first edition of *Vertebral Manipulation* in 1964, which was followed by a second edition in 1968. The first edition of *Peripheral Manipulation* was published in 1970, in which the famous 'movement diagram' was introduced, an earlier co-production with Ms Jennifer Hickling in 1965.

Over all the years of lecturing and publishing, Maitland kept treating patients as the clinical work remained his main source of learning and adapting ideas. Geoff treated patients in his private practice for over 40 years and although he closed his practice in 1988, he remained active in treating patients until 1995.

In 1965, one of Maitland's wishes came true; with the help of Ms Elma Caseley, Head of the Physiotherapy School, South Australian Institute of Technology and the South Australian Branch of the Australian Physiotherapy Association, the first three months course on Manipulation of the spine was held in Adelaide. In 1974 this course developed into the one-year postgraduate education 'postgraduate diploma in manipulative physiotherapy' at the South Australian Institute of Technology, now a master's degree course at the University of South Australia.

He was one of the co-founders, in 1974, of the International Federation of Orthopaedic Manipulative Physical Therapy (IFOMPT), a branch of the World Confederation of Physiotherapy (WCPT).

Only in 1978, while teaching one of his first courses in continental Europe in Bad Ragaz, Switzerland, did he recognize, through discussion with Dr Zinn, Director of the Medical Clinic and the Postgraduate Study Centre in Bad Ragaz, that in fact his work and ideas were a specific concept of thought and action rather than a method of applying manipulative techniques. The Maitland Concept of Manipulative Physiotherapy as it became known emphasizes a specific way of thinking, continuous evaluation and assessment and the art of manipulative physiotherapy ('know when, how and which techniques to perform, and adapt these to the individual situation of the patient') and a total commitment to the patient.

Maitland has held a long and extensive commitment to various professional associations:

- Australian Physiotherapy Association (APA) where he was on the State branch committee for 28 years in various capacities and a State Delegate to Federal Council for 11 years. In conjunction with others, he was responsible for the revision of the constitution of APA in 1964–1965 In 1977, he put forward a submission regarding Specialization in Manipulative Physiotherapy, a concept which was subsequently accepted in modified form.
- Inaugural President of the Australian College of Physiotherapists for six years and a member of the council for a further six years.
- Member of the Physiotherapy Registration Board of South Australia for 22 years.
- Chairman of the Expert Panel for Physiotherapy for Australian Examining Council for Overseas Physiotherapists (AECOP) for 11 years.
- Australian delegate to IFOMPT for five years and a member of its academic standards committee for another five years.

For his work he was honoured with several awards:

- Member of the Order of the British Empire in 1981.
- Fellowship of the Australian College of Physiotherapists by Monograph in 1970, with a further Fellowship by specialization in 1984.
- Honorary Degree of Master of Applied Science in Physiotherapy from the University of South Australia in 1986.

- Honorary Fellow of the Chartered Society of Physiotherapy (GB).
- Honorary life memberships of the South African Society of Physiotherapy, including the Group of Manipulative Physiotherapy, Manipulative Physiotherapy Association of Australia (MPAA), Swiss Association of Manipulative Physiotherapy (svomp), German Association of Manual Therapy (DVMT), the American Physical Therapy Association (APTA) and the International Maitland Teachers' Association (IMTA).
- He received an award from IFOMPT in appreciation of his service and leadership from its foundation.
- Mildred Elson Award by the World Confederation of Physical Therapy (WCPT) for his life's work in 1995.

In 1992 in Zurzach, Switzerland, the International Maitland Teachers' Association (IMTA) was founded, of which GD Maitland was a founding member and inaugural President.

All this work would not have been possible without the loving support of his wife Anne, the mother of their two children John and Wendy. Anne did most of the graphic arts in Maitland's publications, kept notes, made manuscripts and videotaped many of his courses. Their continuous feedback discipline has been one of the very strengths of the Maitlands, who have been practically inseparable since they met in England during the second World War. Anne was awarded the protectoress of the Dutch Association of Orthopaedic Manipulative Therapy (NVOMT).

Maitland's work, especially through the mode of thinking and the process of continuous assessment, has laid the foundation for the development of contemporary definitions and descriptions of the physiotherapy process. His life's work has been acknowledged by numerous authors in obituaries at the time of his passing in 2010:

> … Geoff will be remembered by countless physiotherapists in Australia and overseas. We acknowledge the passing of a truly great clinician, teacher and mentor.
>
> P Trott, R Grant, 2010, Manual Therapy. 15:297

> … Geoff Maitland's contribution to the physiotherapy profession, and in particular to musculoskeletal physiotherapy cannot be underestimated. His inspiration and collaboration with our own UK pioneers led to the development of the MACP and really set the foundations for all the extended scope roles and postgraduate physiotherapy education that we enjoy today.
>
> MACP, 2010, Manual Therapy. 15:298–299

> … Geoff was a great listener and a great communicator. He placed a great emphasis on the art and skill of listening [as opposed to just hearing]. He would hang on every word his patients would say so that he did not miss the subtle hints from the language or its tone that would help him understand, in depth, what the individual was experiencing. He would use every facet of 'the bodies capacity to inform' both verbal and non-verbal. He would spot the almost imperceptible nuances of the patient's responses to his treatment. Only he would recognise, in a room full of students, the important meaning of a patient drumming his fingers on the couch. Geoff was a visionary and an innovator. In the preface to the first edition of Vertebral Manipulation [1964] he recognises 'The practical approach to the use of manipulation is to relate treatment to the patient's symptoms and signs rather than to diagnosis' and that 'it is often impossible to know what the true pathology is … symptoms and signs [of a disc lesion] may vary widely and require different treatments'
>
> His vision was instrumental in giving us what are now established competencies, including, 'Patient-Centred Care', the use of mobilisation for pain modulation, and an awareness of 'the nature of the person' and ist impact on treatment. He highlighted the need for deep and broad theoretical knowledge to support and inform clinical practice. He advocated the discipline of evaluating everything we do to prove our worth and with this came the use of patient reported and orientated outcome measures [subjective and functional asterisks] and the demand for accurate recording of treatment and its effects. Geoff was also at the forefront of research by Physiotherapists for Physiotherapist at a time when it was seen as the role of the Doctor to report on Physiotherapy and decide which Physiotherapy modalities should be prescribed. In summary, GD Maitland supported by Anne and his close family and colleagues has established his place in our Profession's History. He is the Donald Bradman of Physiotherapists. Sir Donald, a fellow Australian, had a career Test Match batting average of 99.94 and, as with Geoff, many have aspired to reach such a standard but none, to date, have come anywhere near.
>
> Chairman and members of the International Maitland Teachers' Association, IMTA, 2010, Manual Therapy. 15:300–301

Within this context it seems suitable to conclude with a quote from Professor Lance Twomey, Vice

Chancellor, Professor of Physiotherapy, Curtin University of Technology, Perth, Australia:

> … Maitland's emphasis on very careful and comprehensive examination leading to the precise application of treatment by movement and followed in turn by the assessment of the effects of that movement on the patient, form the basis for the modern clinical approach. This is probably as close to the scientific method as is possible within the clinical practice of physical therapy and serves as a model for other special areas of the profession.
>
> Foreword in Refshauge K & Gass E, 1995, Musculoskeletal Physiotherapy. Butterworth-Heinemann, Oxford. p IX

Kevin Banks, Elly Hengeveld

Preface

The vision for this new edition of *Maitland's Peripheral Manipulation* was to bring together a group of experts in their field who have a deep and broad working knowledge of the Maitland Concept of manipulative/musculoskeletal (MSK) physiotherapy, which underpins their clinical practice.

The basic principles of this concept of MSK-physiotherapy are as valid today as they were when this special approach to clinical practice was first developed. An obituary written after the death of Geoff Maitland in January 2010 expresses the legacy, which the editors and authors of this book wish to carry on:

> … I particularly reflected on my first meeting with him in Melbourne and my first experience of hearing him as a speaker at IFOMT 1988 in Cambridge in the UK. At the congress, in front of 200 people, Geoff examined an unseen patient, a male patient, who I believe was a traveller. He was a very shy man who had had spinal problems for some time and was clearly experiencing much physical discomfort. Being in front of an audience of 200 people was probably equally discomforting and this gentleman's physical problem clearly needed some time on behalf of the therapist to unravel the real problems and to undertake a thorough clinical reasoning process. In this situation many presenters might tend to focus on the audience's needs rather than those of the patient simply because of time constraints and the objective of living up to the expectations of the audience. Geoff, however, was different. There was no question as to who the most important person was in the auditorium – it was the patient. Geoff sat with his back to the audience, close to the patient, whom he shielded from the audience. We could, however, all hear the conversation that was in flow and the careful and meaningful dialogue that ensued and we could see later the very gentle but purposeful examination that took place. The audience was transfixed, enraptured and silent. The man who advocated listening in his early textbooks really did listen and he was an exemplar in terms of patient-centred care and an example to us all. I already had a great respect for Geoffrey Maitland and knowledge of his approach changed my practice hugely, as I am sure it has for thousands of physiotherapists worldwide. Geoff's performance at the IFOMT conference was exemplary and yet so understated. It is an event that I shall remember forever and one that I think significantly influenced my clinical practice, my teaching and even my approach to research. When I met Geoffrey Maitland in Melbourne some years later he was once more very person-centred, self-effacing, humble, genuine and felt truly like someone you could trust. His position during that conversation was clear. He praised eclectic approaches to musculoskeletal therapy and he was very welcoming of new and future developments in the discipline.
>
> A P Moore, 2010. With sadness on the passing of Geoffrey Maitland 22.01.2010. Manual Therapy 15:211

Geoff Maitland always stressed that there were no such things as 'Maitland Techniques', just techniques of passive mobilization specifically designed around the individual patient's physical problems.

The chapters in this edition, therefore, are not technique driven as such. Instead, each chapter reflects an expertise and the diverse clinical domains within which the Maitland Concept operates effectively. Each chapter stands alone as a 'master class'.

Chapter 1 'The Maitland Concept as a clinical practice framework for neuromusculoskeletal disorders' by Kevin Banks and Elly Hengeveld places the Maitland Concept within an evidence-based practice domain.

Chapter 2 'The Maitland Concept: evidence-based practice and the movement sciences' by Elly Hengeveld details how a paradigm shift in the focus of healthcare by professions such as physiotherapy is gathering momentum.

Chapter 3 'Management of craniomandibular disorders' by John Langendoen reflects the emerging role that physiotherapists have in helping patients with a range of craniomandibular dysfunctions and impairments.

Chapter 4 'Management of shoulder and shoulder girdle disorders' by Matthew Newton and Phil Ackerman shows how the principles of the Maitland Concept are underpinning extended scope practice.

Chapter 5 'Management of elbow disorders' by Toby Hall and Kim Robinson reveals how physiotherapists are using knowledge and evidence from the literature to shape their clinical reasoning and recognizes that the integration of skills in manual therapy, motor control and neurodynamics is essential in practice.

Chapter 6 'Management of wrist and hand disorders' by Pierre Jeangros highlights that there is a need for more than just manual therapy skills in practice and that the bio-psychosocial impact of impaired hand function needs as much recognition.

Chapter 7 'Management of hip disorders' by Dianne Addison emphasizes the role of manual therapy within the context of the fine tuning of movement.

Chapter 8 'Management of knee disorders' by Gerti Bucher-Dollenz and Elly Hengeveld focuses the clinician's attention away from biomedical diagnosis and more towards the exploration and therapeutic recovery of functional capacity and performance of movement disorders of the knee complex.

The final chapter 'Management of foot and ankle disorders' by Jukka Kangas shows the link between clinical reasoning and the development of a clear practice framework for classification and therefore therapeutic management of restriction and control impairments of the foot.

In all cases the principles and practice of the Maitland Concept clearly underpin the integrated and diverse range of available interventions used in practice. While mobilization techniques are still central to the management of many movement-related neuromusculoskeletal disorders, in other cases they support and enhance other strategies such as recovery of motor control, restoration of healthy neurodynamics, physical reconditioning and support to patients in understanding their pain and its mechanisms.

Anti-nociception and functional gain are the clear outcomes of mobilization and manipulation techniques supported by or supporting a range of physical therapy interventions. From an individual perspective, however, these outcomes can only be achieved through collaboration with the patient (the patient at the centre), a clinical-reasoning model for decision making (the symbolic permeable brick wall), thorough and detailed assessment (examination and analytical assessment) and a means of evaluating responsiveness to therapies (reassessment).

As co-editors we hope you enjoy dipping into this text and accessing the companion website (www.maitlandsresources.com) to support the construction of your own knowledge and understanding of manipulative physiotherapy and the Maitland Concept. We hope this will give you plenty of deep and contextual learning opportunities to develop your own practice and personal learning goals.

Kevin Banks, Elly Hengeveld 2012

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Kevin would like to thank Elly for helping to bring this vision to its conclusion. Both Kevin and Elly are grateful to Sheila Black and Rita Demetriou-Swanwick from Elsevier for their support, advice and patience.

Kevin would also like to thank Robbie Blake and Peter Wells for their unwavering support and for being the best role models anyone could ever hope for. A big thank you goes to colleagues at Doncaster and Bassetlaw NHS Foundation Trust for their critical appraisal of some of the material. To Stefan Karanec, thank you for the contribution. Thanks also to all the authors of the individual chapters for entering into the spirit of things and sharing their expertise with all of us.

Last but not least, my gratitude goes to Nancy, my fiercest critic, for being there and for her friendship. I am forever in your debt.

Elly is grateful to Kevin for his thorough preparation of this book, his patience and ongoing support throughout the whole process of writing. Thanks also to all the contributors of this book, who carefully expressed their insights related to this concept of practice. A warm thank you goes to all students and colleagues: their queries during teaching and clinical practice have helped in the seeking of answers to many clinical and theoretical questions. Elly also expresses her gratitude to Matthew Newton for his invaluable help at the completion of the electronic version of this publication. Charles, my greatest friend in life: there are no words for all the things I have been able to learn and to give by living and unfolding in life with you.

In Memoriam: Kevin Banks (1959–2012)

It is with great sadness that we learned of the death of Kevin Banks. Kevin passed away on 14 November 2012 aged 53 after a short illness.

Kevin has been involved as a co-editor with Elsevier's *Maitland's Peripheral Manipulation*, *Maitland's Vertebral Manipulation* and *Maitland's Clinical Companion*. He passed away as we were completing the manuscripts for the new editions of *Maitland's Peripheral Manipulation* and *Maitland's Vertebral Manipulation*, which he will sadly not be able to see in their final versions.

Kevin was a senior teacher and founding member of the International Maitland Teachers' Association (IMTA). His enquiring thoroughness and critical input played a decisive role in IMTA's further development as an educational institute.

We have lost a friend and colleague dedicated to the teaching and further development of the principles of manipulative or neuromusculoskeletal physiotherapy as initiated by GD Maitland. Kevin saw himself as a practising Clinician and Clinical Educator. His belief that a structured yet flexible clinical practice framework, along with a detailed grounding in clinical reasoning, communication and wise action decision making, is essential for best practice was at the heart of his teaching. Kevin really was a visionary. He knew where his professional area of specialism needed to develop and how to get it there, in a way that many did not. He stated of himself: 'I am driven by the need to enhance learning in a broad and deep range of skills, knowledge and attributes within physiotherapy to ensure that patients have as good a deal as possible.' The patient and their needs were indeed the centre of all he did and strived for in his professional life.

We knew Kevin as a gentle and dedicated person. Many of us have enjoyed his often subtle and unexpected humour and most of all his friendship and kind-heartedness. Kevin has been suddenly taken from us in the prime of his life. We are proud to have been associated with him and will miss him. Our sympathy and thoughts are with wife, Nancy and his children Richard, William and Helen.

Elly Hengeveld
Sheila Black and Rita Demetriou-Swanwick (Elsevier)

Glossary

Chapter 1 The Maitland Concept as a clinical practice framework for neuromusculoskeletal disorders

Assessment – includes all procedures which are undertaken to monitor the therapeutic process throughout all encounters between the physiotherapist and the patient. Assessment procedures do not stop after the f rst examination at initial consultation in which the physiotherapist comes to a diagnosis of the movement disorder of the patient and develops collaboratively with the patient a treatment plan; assessment is an ongoing analytical process throughout all therapy sessions.

1. Analytical assessment – examination and planning at a f rst consultation.
2. Assessment during every treatment session – determines the eff cacy and duration of a technique at a particular stage in treatment.
3. Final analytical assessment – reflects on the f nal outcome of treatment and prognosis of the disorder after completion of therapy.
4. Pretreatment assessment – considers the effects of the previous treatment session.
5. Retrospective and progressive assessment – compares the effects of treatment over three or four sessions; particularly, looks back and re-evaluates treatment when progress has stopped or slowed. (Maitland 1987).

Autonomous practice – refers to a health professional who is able to work without medical referral, appropriate to their education.

Brick wall – the symbolic permeable brick wall is a unique mode of thinking advocated in the Maitland Concept which involves the separation of thinking into a theoretical and clinical compartment, so that thoughts related to the theory of the patient's disorder may guide, but should not inhibit the discovery of the f ner details of the clinical information.

Clinical reasoning – 'The thinking underpinning clinical practice.' Clinical reasoning is a process in which the therapist, interacting with the patient and signif cant others (e.g. family and other health care team members) structures meaning, goals and health management strategies based on clinical data, patient choices and professional judgement, knowledge and skills (Higgs & Jones 2000).

Evidence-based practice – the application of knowledge and skills that inform and support clinical practice and the use of research and clinical evidence to ensure the best available assessment and treatment of the individual patient and populations of patients.

Chapter 2 The Maitland Concept: evidence-based practice and the movement sciences

Bio-psychosocial perspective – it is suggested that various factors may contribute to the development and maintenance of disease, pain and disability. the illness experience is always culturally shaped and is dependent on what a society regards as appropriate behaviour, on the personal biography of the person, and on psychological processes, meanings and relationships, so that the social world is always linked with the inner experience of feeling ill. In this experience powers may exist that can either amplify or reduce suffering and disability including the behaviours of other, as relatives or clinicians (Kleinmann 1988). This notion is being supported by Pilowsky (1997), who argues that clinicians need to be aware of the influence of their behaviour on the behaviour of the patients they are treating. Furthermore, there is indication that the clinical reasoning of physiotherapists may be different, dependent on the culture in which they are active (Cruz et al. 2012), hence being to accentuate certain behaviours within themselves and their clients.

Evidence-based practice – conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research (Sackett et al. 1998).

Individual illness experience – the personal experience of bodily processes and the impact of social and cultural influences on this experience.
See Bio-psychosocial perspective.

Models of practice – various theoretical models, such as pathobiological models to bio-psychosocial paradigms, physiotherapy-specif c, movement-oriented paradigms, neurophysiological theories, client-centred perspectives, etc. used to guide clinical decision making.

Salutogenesis – a pathogenic perspective mainly focuses on causative factors and the prevention of diseases and other disorders whereas a salutogenic perspective concentrates on the reasons why people stay healthy in spite of the presence of health-risk stressors, and which factors can guide them to find a better sense of health and well-being. As stated by Antonovsky (1979) 'salutogenic factors are not necessarily the other side of the coin of pathogenic factors'. He concluded that a 'sense-of-coherence' supports a better resilience to life-stressors. This construct supports the development and maintenance of a sense of health, sense of purpose and well-being. He postulated that health is not a fixed state, but patients move on a continuum between two extremes of 'dis-ease and ease'. In the examination of patients those factors need to be evaluated which lead to a backward and forward movement on this health–disease continuum. Salutogenetic perspectives play a central role in health promotion programmes.

Neurophysiological pain mechanisms – an individual's pain experience should be ascribed to diverse mechanisms of altered nervous system processes rather than to a single neurophysiological pain mechanism (Cervero & Laird 1991) and to elements of neuroplasticity or learning processes (Loeser & Melzack 1999). The suggested neurophysiological mechanisms encompass peripheral nociceptive processes, peripheral neurogenic mechanisms, central nervous system modulatory mechanisms and autonomic nervous system mechanisms. The clinician needs to relate active nociceptive and peripheral neurogenic mechanisms to possible tissue pathology (end-organ dysfunction), which needs further medical action or serves as a specific precaution or contraindication to physiotherapeutic interventions. The clinician should also consider the ways in which the altered nervous system processing is influencing the pain experience and disability of a person and how the physiotherapeutic treatment should be adapted to these mechanisms.

Chapter 3 Management of craniomandibular disorders

Bruxism – subconsciously grinding or clenching the teeth together, usually during sleep. Bruxism is associated with stress states and results in myofascial pain and associated pain from the temporomandibular joints.

Centric relation – physiological position of the caput mandibulae in the resting position of the mandible as well as in maximum intercuspation, which is defined as maximum cephalad, maximum anterior and midway lateral-medial position of the head of the mandible in the fossa.

Craniomandibular complex – describes not only the temporomandibular joints but also the functional interrelationships between the skull, the cervical spine, the thorax, the mandible, the teeth, the tongue, the hyoid and the larynx.

Guidance, incisal and canine – physiological contact between incisives during protraction and canines during lateral movements of the mandible.

Malocclusion – misalignment of teeth and jaws, or more simply, a 'bad bite', such as an overbite, a loss of the vertical dimensions of the lower mandible in relation to the skull dimensions.

Occlusion – contact of the chewing surfaces of the teeth. More precise, it means the relationship between the maxillary (upper) and mandibular (lower) teeth when they approach each other, as occurs during chewing or at rest.

Static occlusion – contact between teeth when the jaw is closed and stationary, while dynamic occlusion refers to occlusal contacts made when the jaw is moving, as with chewing.

Parafunctional habit – involuntary use of voluntary muscles of a body part in a way that is other than the most common use of that body part. It mostly occurs in dentistry and refers to involuntary, habitual use of the mouth, tongue and jaw. Oral parafunctional habits may include bruxism (tooth clenching or grinding), tongue pressing, cheek sucking, lip tics, nail biting, even mouth breathing, and any other regular use of the mouth unrelated to biting, chewing (eating), drinking, swallowing or speaking.

Reciprocal clicking – a clicking sound occurring during excursive and incursive mandibular movements that appears to arise from within the temporomandibular joint.

Splints – devices placed on the lower or upper teeth rows to manage a number of complaints such as abrasia of the teeth due to bruxism, or to deload the temporomandibular joint surfaces and articular disc or to restore centric relation.

Trismus – sustained contraction of the jaw muscles ('lockjaw').

Chapter 4 Management of shoulder and shoulder girdle disorders

Extended scope practitioner (ESP) – defined by the United Kingdom's Chartered Society of Physiotherapy (CSP) as 'a clinical physiotherapy specialist, in any recognized speciality, with an extended scope role, e.g. requesting X-rays, scans, blood tests, nerve conduction studies etc.' Traditionally tasks such as these would have been undertaken by the medical profession, but with additional training and development they may be performed by physiotherapists with an extended role.

Diagnostic utility – the value and ability of a specific test to be diagnostically discriminatory.

Impairment-based treatment – identification of impairments, which contribute to a patient's functional limitations and possible disabilities with the aim of maximizing movement potential and quality of life. This is in contrast to the biomedical model and way of thinking, which is concerned with identifying pathology and diagnostic labels to specify a disease on which decisions are made regarding examination and treatment.

Medical diagnosis – 'The determination of the *cause* of a patient's illness or suffering by the combined use of physical examination, patient interview, laboratory tests, review of the patient's medical records, knowledge of the cause of observed signs and symptoms, and differential elimination of similar possible causes'(Mosby's Medical Dictionary 2009).

Orthopaedic special tests – medical physical examination tests which aim to test for the presence of a specific pathology or medical diagnosis.

Physiotherapy diagnosis – concerned with classifying the *consequences* of a patient's disease, injury or disorder – the impairments, functional limitations and disabilities as well as with the diagnosis of movement disorders which may precede pathobiological processes (WCPT 2007, Zimny 2004, Jette 1989, Guccione 1991).

Screening – triaging process whereby patients with specific conditions are managed according to their need for care.

Chapter 5 Management of elbow disorders

Lateral epicondylalgia – syndrome whereby pain is experienced over or around the lateral epicondyle of the elbow. Such a disorder is characterized by difficulty or loss of functional activities involving gripping because of lateral epicondylar pain.

Mobilization with movement – treatment technique combining an accessory joint glide with an active movement or activity.

Upper limb neurodynamic tests – examination procedures used to evaluate the mechanical sensitivity of the neural structures in the upper limb, in particular the radial, ulnar and median nerves.

Chapter 6 Management of wrist and hand disorders

Nonprehensile function – use of the hand for activities other than gripping, such as pushing, pulling, weight bearing and non-verbal communication.

Rehabilitation – restoration of function through therapeutic intervention and training.

Sensory and motor representation – in the sensory and motor cortex, the hand, and especially the thumb, has a much greater representation than many other body areas.

Classification of neuro-musculo-skeletal disorders

Arthritis – joint and bone disease.

Carpal tunnel syndrome – entrapment of the median nerve within the carpal tunnel at the wrist. Symptoms are experienced in the cutaneous distribution of the median nerve. Night pain is a key feature.

CRPS (Complex Regional Pain Syndrome or Sudeck's atrophy) – reflex sympathetic dystrophy of the extremities (the hand and foot), often a consequence of injury to the hand. The disorder is characterized by severe pain (Allodynia and hyperalgesia), swelling, trophic changes and progressive stiffening of the joints.

de Quervain's disease – tenosynovitis of the tendon sheath of the abductor pollicis longus and extensor pollicis brevis.

Ganglion – cyst of the wrist, tenosynovial in origin, within the anatomical snuff of the wrist. Treated conservatively, unless there is severe pain and significant loss of function.

Guyon's canal syndrome – entrapment of the ulnar nerve within the Guyon canal tunnel at the wrist. Symptoms are experienced in the cutaneous distribution of the ulnar nerve.

Dupuytren's contracture – predominantly inherited disorder of the fascia of the palm of the hand characterized by progressive flexion contracture of the little and ring fingers.

Tendinopathy – overuse or overstretching injury, involving mostly the extensor tendons around the wrist (Ashe et al. 2004). A paradigm shift should be considered: the process is more degenerative than inflammatory.

Wartenberg's disease or cheiralgia paresthetica – sensitive neuropathy involving the superficial branch of the radial nerve.

Wrist instability or ligament sprains – tendency for static or dynamic subluxation or malposition of the carpal bones.

Volkmann's ischaemic contracture – ischaemic retraction of the muscles of the anterior compartment of the forearm, resulting in pronation of the forearm, flexion of the wrist and hooked finger flexion (extension of the proximal phalanx, flexion of the middle and distal phalanx).

Chapter 7 Management of hip disorders

Flexion/adduction – functional movement of the hip, which can be used to detect and treat minor or less obvious painful restrictions.

Intra-articular disorder – movement disorder and symptoms coming from intra-articular structures. It frequently requires compression in examination or treatment procedures.

Motor control – for adequate motor control the appropriate muscle fibre type should be recruited. All human muscles contain tonic and phasic muscle fibres. For low-level activity (activities requiring approximately 25% of a maximal voluntary contraction) selective recruitment of only the tonic fibres is necessary for stability. For high-level activity maximal tonic recruitment together with phasic fibre recruitment is essential.

Multicomponent movement disorders – although some patients may be referred with a biomedical diagnosis which indicates a disorder in a certain area (e.g. osteoarthritis), frequently more movement components contribute to the disorder. Many problems in the hip area show movement dysfunctions of the hip joint in combination with the lumbar spine, sacroiliac joints, neurodynamic structures and the muscular system.

Chapter 8 Management of knee disorders

Anterior knee pain/patellofemoral pain syndrome – condition with symptoms in the area of the anterior aspect of the knee. Movements of the patellofemoral joints are frequently involved. Treatment often consists of passive mobilization and normalization of the patella tracking through the femoral groove by activation of the vastus medialis oblique (VMO) in relation to the vastus lateralis and the overall muscle chain of the pelvis and foot (McConnell 1996). Contributing factors such as foot, hip, pelvic and trunk alignment, mobility and stability dysfunctions in this area have to be addressed as well.

Extension/abduction, extension/adduction, flexion/abduction, flexion/adduction – functional movements of the joint ('functional corners') which can be used in the examination and treatment of minor or less obvious painful restrictions.

Joint stability – provided by the ligamentous structures (passive stability) and the surrounding muscles (dynamic stability).

Stabilization training – allows supporting tissues such as ligaments to heal, to strengthen surrounding musculature, and to re-establish motor control and appropriate movement patterns of the knee, including joint position sense.

Chapter 9 Management of foot and ankle disorders

Disorder – all cumulative features and anomalies resulting from presumed initial tissue pathology. Disorder refers to both pathology and effects. Pathology and effects may be physical or psychological (Elvey & O'Sullivan 2004).

Management – specific or general intervention performed by the patient under the direction of or prescribed by the clinician (Elvey & O'Sullivan 2004).

Motor control impairments of the foot and ankle – lack of motor control drives the pain disorder and results in monotonic loading patterns and pain in the foot and ankle. Motor control impairments of the foot and ankle present in a directional manner (Kangas et al. 2011).

Movement impairments of the foot and ankle – loss of normal physiological movement drives the pain disorder. Movement is lost in the direction of pain provocation. Movement impairments of the foot and ankle present in a directional manner (Kangas et al. 2011).

Treatment – specific intervention performed by the clinician (Elvey & O'Sullivan 2004).

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The Maitland Concept as a clinical practice framework for neuromusculoskeletal disorders

1

Kevin Banks Elly Hengeveld

CHAPTER CONTENTS

Key words

Framework, pillars, competencies, bio–psychosocial, research

Setting the scene – the Maitland Concept as a clinical practice framework

A quotation by the Scottish architect and designer Charles Rennie Mackintosh (1868–1928) sums up the culture within which the Maitland Concept of manipulative and movement therapies operates:

> There is hope in honest error;
> None in the icy perfections of the mere stylist.
>
> (Mackintosh (1868–1928))

The equivalent within the Maitland Concept (Maitland 1991) is that manipulative physiotherapists should be driven to:

Adapt, adopt and improve

The message here is that the Maitland Concept embraces change and advancement. Using critical appraisal, reflection upon practice and continual evaluation of the effectiveness of interventions, the manipulative physiotherapist is encouraged to look for new and innovating ways of helping patients.

The authors of each of the brand new chapters of this edition of Peripheral Manipulation: Management of Neuromusculoskeletal Disorders take the reader through a journey of 'adapting, adopting and improving'. In all cases the key features of the Maitland Concept underpin clinical reasoning and competency within a comprehensive, integrated and evolving clinical practice framework.

The editors of this edition hope that in years to come the established principles and practice of the Maitland Concept will lead to many more changes to the future editions of this text.

This chapter, therefore, details the clinical practice framework, which is grounded within the principles and practice of the Maitland Concept, and includes:

The fve pillars of clinical practice

Patient-centred practice

Patient-centred practice demands a personal commitment to understanding, entirely, the patient experiences throughout an episode of health care. Placing the patient at the centre of everything we do means giving patients choices about their health care, including them in all aspects of decision making, collaborating with them at all times and giving them responsibility for compliance in and ownership of their own health care strategies.

Clinical reasoning

Clinical reasoning refers to the decision-making process by which the clinician can safely and effectively *THINK, PLAN, EXECUTE to PROVE.* Effective clinical reasoning requires the clinician to consider all aspects of theoretical knowledge and research that may be relevant to the individual patient and all aspects of clinical evidence from examination and effects of treatment (Jones et al. 2006a, 2006b). By *reasoning in action* the clinician can apply knowledge and skills appropriately, leading to a desired outcome of intervention and by *reasoning on action* there can be a reflection and analysis of what has taken place in order that further or future management can be more effective.

Examination

The examination, should be structured in two parts. Subjective examination (or C/O – 'complains of') ensures the gathering of clinical information about the patient's experiences of their problem and the clinician's manual examination (physical examination or P/E) identifies and confirms the presence of physical impairments. The two examinations provide the detail the clinician needs to be able to plan and carry out appropriate interventions and management strategies.

Interventions

Interventions of manipulative and movement therapies should be directly linked to the patient's problems and identified physical impairments. A broad and deep range of reliable and effective interventions should be available and considered.

Assessment

Assessment is the keystone holding decision making and progression of treatment together and ultimately leads to a collaborative outcome. Assessment is the analysis of clinical data and the timely evaluation of the effects of treatment or management strategies. Assessing and analyzing changes in a patient's functional performance (C/O parameters or 'asterisks') and movement capacity (P/E parameters or 'asterisks') immediately before during and after each treatment, at regular intervals throughout the episode of care, and retrospectively when progress has slowed or stopped, supports the clinician's decision making and ultimately the pathway to a shared and successful outcome.

Professional and clinical competencies supporting physiotherapists as autonomous practitioners

International standards of manual therapy practice are determined by the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) through the federation's educational standards committee (Beeton et al. 2008). The committee has identified 10 dimensions each with associated competencies of knowledge, skills and attributes. These competencies serve to ensure effective and expert practice in the speciality of manipulative and movement therapy. The assurance of quality standards also enhances the recognition of physiotherapy as a profession that can sustain itself autonomously within a defined scope of practice and through collaborative work with other health professions and governmental organizations.

The bio-psychosocial paradigm

It is recognized that health professions such as physiotherapy operate most effectively within a bio-psychosocial paradigm rather than the traditional biomedical model of health care delivery (Bazin & Robinson 2002). This paradigm shift within the profession has taken place over the last 10–20 years and has opened up many avenues for professional development. Diagnosis and a pathological basis for patients' signs and symptoms are still very important, yet understanding the impact and health consequences of illness, disease or injury can have a profound effect on an individual's capacity to live a healthy life. The International Classification of Functioning, Disability and Health (ICF) (WHO 2001) is an ideal model on which to base an understanding of patients and their problems. The patients' experiences can be evaluated from both a biological perspective and in the context of potential psychological and social factors.

Physiotherapists can identify and make a difference to physical impairments that have their base in dysfunction (e.g. muscle weakness, joint stiffness, nerve sensitivity). Physiotherapists can identify and deal with performance and capacity issues in relation to activity limitations in life tasks and participation restrictions in life areas such as work, sport and recreation. The ICF domains also give the clinician the opportunity to identify personal and environmental mediators, which may contribute (positively or negatively) to recovery of health and assist in the broader assessment of prognosis.

The physiotherapy domain therefore is changing with the paradigm shift to one where the focus is at the health care/healthy living interface and where the physiotherapy profession has a greater role to play in public health and healthy life expectancy by advocating movement and exercise as a means to ensuring the adding of *life to years* (Middleton 2008).

Evidence-informed practice, research and the Maitland Concept

Any clinical practice framework is embraced by a demand from service users and health care peers to provide evidence for interventions and competencies. Research and increasing knowledge help to inform practice. Both qualitative and quantitative research paradigms are important to the construction of knowledge and professional advancement. All clinical practice should be underpinned by sound knowledge, theory and research and likewise all research should have a practical clinical application and support clinical practice.

The Maitland Concept as a clinical practice framework

Figure 1.1 demonstrates the design characteristics of the Maitland Concept as a clinical practice framework.

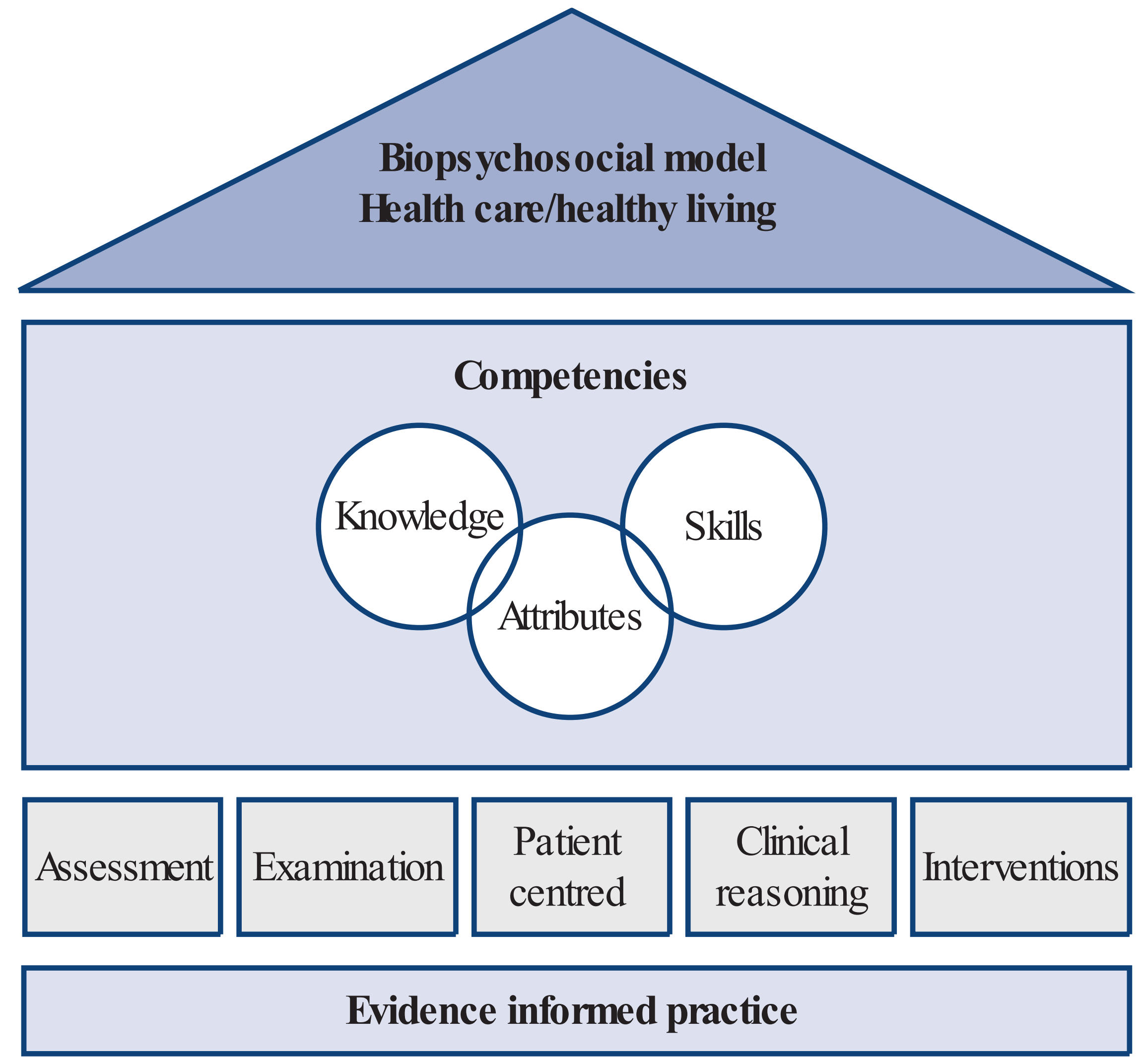

Figure 1.1 • A clinical practice framework.

The detail of each component of the framework will now be analyzed within the context of manipulative physiotherapy practice. This will then form the basis for understanding the design and presentation of each individual chapter within this edition. For example, the chapter on shoulder conditions highlights how this framework has enhanced the professional development beyond the traditional scope of physiotherapy practice. The chapter on elbow conditions shows the use of the framework to enhance a multidimensional approach to practice. The chapter on hip conditions highlights how the principles apply to any identified impairment and are not exclusive to arthrogenic disorders.

The five pillars of clinical practice

The following section will expand on the key features of the Maitland Concept as a clinical practice framework. Thinking in terms of five key pillars of support will help the clinician to form a structural base for the application of clinical competencies in manipulative and movement therapies. The design of the framework will also help the clinician to understand its place in applying a bio-psychosocial model of health care and its place within an evidence-based practice environment.

Patient-centred practice

Within each chapter of this edition you will be able to read how contributing authors maximize patient-centred practice to inform and enhance clinical decision making. A clear picture will emerge of the importance of engaging with the patient through attention to detail in questioning, clinical examination and manipulative physiotherapy treatment and reassessments. The importance of collaboration with patients will help physiotherapists to understand how inclusive decisions about assessment and treatment make for more effective outcomes. The key features to consider for effective patient-centred practice are:

- The patient and healthy living
- Analyzing the patient's individual illness experience
- Patient inclusion and participation in decision making
- Patient-centred communication
- Understanding the body's capacity to inform and adapt
- The role of collaborative reasoning.

The patient and healthy living

The key requirement, therefore, of patient-centred practice is to address *individual's* physical and mental well-being in order that they can function effectively, without deficit, in their daily life tasks and life areas (WHO 2001) (Table 1.1).

Table 1.1 Activity limitations and participation restriction

Activity limitations–life tasks	Participation restrictions–life areas
Difficulties an individual may have in executing activities (tasks). For example: • bending forwards • walking • getting in and out of bed • lifting a box • reaching up to a shelf • manual work • hitting a golf ball.	Problems an individual may experience in involvement in life situations (areas) For example: • lack of disability-friendly transport • poor access to shops or a theatre.

WHO 2001

Box 1.1

Healthy life expectancy

'Live Long Die Faster'

The increase of disability-free life expectancy

Added years of relatively good health

Disability is the loss of autonomy which older people fear and which in turn leads to dependency and its cost implications

Disability-free life expectancy should be a better measure of the well-being of an ageing population

House of Lords 2005

The ultimate outcome of interventions of manipulative physiotherapy should be to 'add life to years' (Middleton 2008). The role of physiotherapy in *maximizing movement potential* is the key to promoting healthy living, functional capacity and physical fitness (Chartered Society of Physiotherapy 2008) (Box 1.1).

Analyzing the patient experience

The demand of the Maitland Concept is that patient care is driven by the patient's own evaluation of their *main problems*, their expectations of therapeutic interventions and their personal goals. The therapeutic process, therefore, should begin with question 1 and question 2.

The physiotherapist should always start by asking the patient question 1:

'As far as *you* are concerned what is *your* main problem?' For example, *I have a painful and stiff shoulder*.

Secondly the patient should be asked question 2:

'For *you*, what would be a successful outcome of physiotherapy treatment?' For example, *I want to be able to play badminton again without any pain or stiffness in my shoulder*.

This approach gives the physiotherapist evidence to support a range of decision-making hypotheses based on the answers given, including:

- The patient's perceptions and experiences (bio-psychosocial hypothesis). For example, *I am worried that I may not be able to do my job properly*.
- The kind of disorder (pathobiological hypothesis) (Jones et al. 2006a). For example,

Adhesive capsulitis causing painful and stiff shoulder movements.

- The patient's symptoms (impairment hypothesis). For example, *It is too painful for me to put my hand behind my back and too stiff to get things down off shelves at work.*
- The impact of the disorder on the patients' life areas and life tasks (activity limitations, participation restrictions). For example, *I struggle to get dressed in the morning. I cannot sleep on my right side. I have had to stop playing badminton.*
- Contributing factors (the cause of the cause). For example, *I don't think my shoulder problem is helped by the stiffness in my neck and spine since a car crash eight years ago.*
- Ideas about management and treatment interventions. For example, pain modulation of shoulder joint pain, mobilization of a stiff joint and prevention of adaptive shortening due to protective/adaptive posture and movement. Address contributing factors in the neck and spine.
- Need for caution. For example, factors which may mediate ideal treatment. Such as cardiac capacity for exercise, medication effects on tissue viability (long-term steroids).
- Thoughts about prognosis. For example, evidence from literature which supports the natural history and shapes the extent of intervention. Knowing that frozen shoulder has a self-limiting natural history of two years (plus) helps in making decisions about expectations for interventions.

Patient inclusion and participation in decision making

Patient-centred practice in manipulative and movement therapies, therefore, is driven by an inclusive clinical decision-making process whereby patients have the opportunity to consent and participate in decisions regarding the parameters of their therapy.

The features of the Maitland Concept which underpin PROMs (patient reported outcome measures) and enhance patient participation in decision making are illustrated in the following examples of patient information:

- Patient-reported problems – Question 1/the main problem: *I am having increasing difficulty reaching to put my socks on in the morning due to groin pain and stiffness in my hip joint.*
- An attention to detail as to what the patient is experiencing and where (body chart): *deep, intermittent ache within the groin, ache radiating down the front of the thigh to the knee.*
- How the problem is affecting them in their everyday life (their functional performance): *every morning I struggle to put my socks on. I can only just reach the end of my foot with a lot of effort. My hip feels very stiff and sore in the groin. I have stopped playing five-a-side football because of the soreness afterwards and restriction during play.*
- *Their* tolerance and acceptance of movement and activity (severity, irritability): becoming severe as they start to avoid activities and recreation. Less irritable as symptoms settle quickly after activity.
- What may be mediating their responses: fear of disability leading to surgery, frustration, anger and depression at not being able to do things (Ashby et al. 2009).
- Their C/O and P/E asterisks: (emphasis on individual, specific and utility outcome measurement) (Box 1.2).
- Health and medical issues compounding their problems: Type 2 diabetes as a risk factor for peripheral vascular disease and neuropathy.
- The pathobiological nature of their condition (history) pattern: osteoarthritis of thhe hip (OA hip).
- Their physical status and functional capacity: hip flexion 85 degrees stiff ++ (1) 5/10 (VAS – visual analogue scale).
- Their physical capacity against ideal (impairments): reduced range of movement in the hip, weakness in hip muscles.

Box 1.2

Asterisks as individual outcome measures

C/O

(1) Increases when lifts knee towards chest, very stiff and sharp pain in the groin (1) settles immediately the movement stops.

P/E

Hip flexion 85 degrees stiff ++ (1) 5/10 (VAS).

- Risk factors to conditioning: poor general health and quality of life issues (social deprivation), access to support and socioeconomic priorities all contribute to compliance with healthy living options (McLean et al. 2011).
- Their body's capacity to inform (movement as a therapy and pain killer): understanding the health and pain-modulating benefits of movement and exercise coupled with an appreciation of individual movement capabilities and deficits.
- Their responsiveness and motivation to change: responders or non-responders to manipulative and movement therapies. This can be mediated by a number of extrinsic (personal and environmental) factors and intrinsic factors (pathobiology and nature of the problem).
- Their evaluation of responses to interventions: recognition of changes in symptoms and signs during and between sessions.

The primacy of clinical evidence supported and informed by research and experience-based knowledge, therefore, drives this patient-centred approach.

For example, Sims (1999a) identified that in patients with OA hip X-rays reveal a common occurrence of down-and-in and up-and-out migration of the head of the femur. This knowledge may well support the clinical response of increasing range of hip flexion in such patients when lateral or longitudinal caudad mobilizations are performed at the hip (Sims 1999b).

Patient-centred practice enhances the evidencing of movement impairment and functional deficit. It confirms the presence of functional pathology (Stucki & Grimby 2007). It supports the application of appropriate interventions (Darzi 2008) and successful patient-focused outcomes where, for example, the patient can walk without pain, they feel better in themselves and their ability to do more is evident.

Patient-centred communication

An attention to detail in obtaining reliable and meaningful answers to patient-centred questions will inform clinical practice and therapeutic decisions.

Errors in communication, however, are known to have a big impact on the accuracy of clinical decisions (Maitland et al. 2005).

As the physiotherapist tries to develop a broad and deep understanding of what is going on with the patient using thoughtful communication strategies (Higgs & Jones 2000), the role of manipulative and movement therapies should be considered. Understanding the patient's experiences will serve to make treatment decisions relevant and appropriate to individual problems.

Physiotherapists must understand the fineries of non-verbal communication to gain an understanding of how the patient is responding to the experience of pain and incapacity. The main source of information, however, comes from verbal exchanges with the patient. Care must be taken to employ strategies which ensure information gathered is as reliable and meaningful as possible and that questions asked have a single meaning and are unambiguous. These strategies, with examples, should include:

- **Reasoning behind the question to be asked:** (sufficient theoretical and clinical knowledge). For example, the patient is complaining about elbow pain which is sensitive to light touch. This suggests allodynia which is often associated with nerve injury. A common source of nerve entrapment is in the cervical spine so…
- **Wording the question:** (what the therapist needs to know.) For example, to explore the possibility that the elbow pain has a neuropathic element to it I must ask the patient: 'Have you had or do you ever have any problems with your neck?'
- **Hearing and understanding the words used in the patient answer:** (follow up questions to be certain of the meaning). For example, the patient has told me that his elbow started hurting in the spring. A key word here is 'spring' so I must find out what is the association between his elbow pain and spring. I must ask him 'What was it that made your elbow start hurting in the spring?'
- **Interpreting the answer:** (clarifies the answer to understand the patient's symptoms rather than forming assumptions). For example, the patient has told me that he had to dig over his allotment in the early spring but has never had problems before. I could assume that the amount of digging was more than usual but should qualify my question if this was the case. I must ask 'What was unusual about the digging this year?' The patient told me that he had had to dig an area which had not been dug before and this was very rocky. He felt the jarring

rather than the amount of digging had caused his pain.

- **Relating the answer to the question:** (has the question been completely answered in sufficient depth?). For example, in response to the question 'Do you ever have problems with your neck?' the reply 'No, not now' demands further explanation to determine whether any past episodes of neck pain could relate to the onset or development of the elbow pain.
- **Determining the next question:** (sufficient theoretical and clinical knowledge on which to base the next question irrespective of accuracy of patient answer). For example, to understand the significance of the neck problem, therefore, the immediate response question might be: 'When was the last time you had problems with your neck?'

In parallel with an attention to questions being asked and qualifying responses the clinician must also pay attention to ensuring that the patient is:

- **Hearing and understanding the question:** (avoid using words which the patient cannot understand and avoid using questions which are biased towards a particular answer). For example, I want to use the same words that the patient uses in my follow-up questions and I want to avoid using leading questions. So I will not ask. 'Is it right that the spondylosis in your neck was set off by the digging and this is sending pain into your elbow?' Instead to ensure the patient understands the question and it is not leading him to a particular answer, (my hypothesis), I will ask, for example, 'Do you feel your neck pain is connected to your elbow pain in any way?'
- **Considering the reply:** (the patient's thoughts will affect what the question means to them and their memory of facts may be incomplete or inaccurate). For example, I must make sure that the question I ask does not have a double meaning and is not ambiguous. I must also be sure that I use key words to prompt the patient's memory so that their recollection of events and experiences is as accurate as possible. So I will not ask 'Where did you feel your first pain?' as the patient might wonder whether I mean his neck or elbow or he might think I mean to find out whether he first felt pain at the allotment or at home. I will ask instead 'When you jarred yourself digging in the rocky area can you recall what you felt?'
- **Putting the answer into words:** (be aware that the patient may lack experience in the health care environment which may influence the response given). For example, I want to ensure that the patient has every opportunity to say what they are feeling and thinking rather than what they think they are expected to say. So I will not ask: 'What did your doctor say was wrong with you?' Instead I will ask: 'What do you feel happened to you when you jarred yourself whilst digging?'

Understanding the body's capacity to inform and adapt

Another feature of patient-driven clinical decision making is an understanding of the *body's capacity to inform* (about the experience of injury, neuromusculoskeletal conditions and disease) (Box 1.3) and *adapt* (influences of injury, disorder or disease on neuromusculoskeletal (NMS) functioning).

If these capacities are understood then they open up a vast array of possibilities in:

- Being able to understand the patient experience, and
- Being able to choose interventions which relate to those experiences.

An understanding of the patient's body's capacity to inform or adapt begins immediately the therapist

Box 1.3

The body's capacity to inform

What the patient thinks is wrong with them
Their experiences and their feelings
The localization of their symptoms
The impact on activities and participation (work and recreation)
Responses to movement
Reproducing symptoms or establishing comparable signs
Responses during treatment
Effects of treatment on symptoms and signs
Overall satisfaction with outcome

Maitland et al. 2005

meets the patient and observes them. Examples of the body's capacity to inform and adapt and therefore drive decisions are:

- **The patient's main problem:** a reflection of the whole experience (for example, a knee medial ligament sprain and how it impacts on the patient's everyday life).
- **What, for them, would be a successful outcome?**(For example, the patient is looking forward to experiencing no pain and discomfort in the knee and being able to return to playing football as soon as possible).
- **The body chart:** an expression of what the patient feels and how this is processed into symptoms (for example, soreness over the ligament, under the skin but sore to touch and intermittent pain).
- **Behaviour of symptoms:** what the patient can and cannot do because of their symptoms is a reflection of how the body informs and processes what activities and participation it is capable of based on the patient's own knowledge and frame of reference from previous experiences (for example, a sharp pain over the knee ligament when twisting the leg means that the patient avoid twisting movements because they are too painful and it feels like the ligament will break).
- **History of symptoms:** if an injury causes or predisposes to symptoms, the body informs the patient about what has been damaged and by how much. Whether the body can help to identify a link between injuries and symptoms or not is another feature of the body's capacity to inform (for example, the patient knew something had torn as soon as he was tackled from the side playing football last week. It hurt like a torn ligament and it swelled up almost straight away).
- **Medical screening questions:** usually the patient knows whether they are well or not, so questions about general health and well-being will help to inform about any personal mediators which may impact on the body's response to physical therapies (for example, the patient feels well in himself, just a bit angry at the other player. He says that he does take steroids to bulk up in the gym).
- **Observation:** recognition of protective posture is a reflection of the body's capacity to adapt to painful situations (for example, knee held in 10 degrees of flexion in standing).
- **Asking the patient to move to the first onset of pain (P1) or to the limit of available movement:** this will be a reflection of the body's capacity to inform about what is restricting movement (for example, knee extension minus five degrees due to pain and apprehension).
- **Asking the patient to show a functional movement,** which is affected by symptoms (functional demonstration), gives the patient an opportunity to use the body's capacity to inform about how and how easily symptoms can be reproduced and it also gives the therapist an opportunity to analyze movement with reference to possible therapeutic interventions (Banks & Hengeveld 2010). (For example, twisting the knee causing immediate pain and apprehension.)
- **Structural differentiation** is, in effect, the body's capacity to inform about tissue responses to movement and which tissues to influence therapeutically (for example, stabilization of the tibiofemoral joint during the knee twisting eliminates the pain and apprehension).
- **Passive testing** of joints, muscle length and neurodynamic capacity, helps the therapist to understand how the body reacts to passive movement (for example; tibiofemoral anteroposterior accessory mobilization grade II, which is soothing; quads lag present due to inhibition; saphenous nerve length test not painful).
- **Palpation:** again is the body informing the therapist about tissue responses to handling and can it inform decisions about which interventions may be more effective? (For example, swollen, thickened medial ligament of the knee.)
- **Assessment strategies** also tap into the body's capacity to inform about responses to interventions during and after treatments have been carried out (for example, since the mobilization, the pain is not so sharp when the patient twists his knee).
- **Decisions to stop treatment** are often based on the patient's feedback on whether interventions have been effective. This is often informed by the body's capacity (for example,

the patient can run and jump on the knee after several sessions; it still aches a bit but he thinks it has healed and he just needs to get fit again).

The role of collaborative reasoning

Collaborative reasoning is defined as the nurturing of a consensual approach towards the interpretation of examination findings, the setting of goals and priorities and the implementation and progression of treatment (Jones et al. 2006a).

Collaborative reasoning (Jones et al 2006a) gives the therapist a framework which utilizes the body's capacity to inform. Semistructured interviews give the patient an opportunity to impart information that is meaningful to them as individuals. Thoughtfulness in shaping semistructured questions will enhance collaboration between patient and therapist in coming to the correct (safe and effective) decisions about interventions.

Examples of semistructured interview questions for the therapist to consider are:

- *What is the problem you are having?*
- *What are you feeling and where?*
- *What effect is this feeling having on your everyday life?*
- *What seems to change the feeling you have?*
- *How did this feeling first start?*
- *Do you have any other health and well-being issues?*

To have a patient-centred meaning, collaboration should permeate all the therapeutic processes below:

- Information gathering during the subjective examination.
- Planning the physical examination – the aims of the physical examination.
- Determining what to examine and by how much – identify the source of the symptoms, the cause of the source and contributing factors.
- Choice of interventions – what are the desired effects?
- Decisions on progression – what will produce graded improvements?
- Feedback on effects of interventions – what does the patient think?
- Outcomes meaningful to the patient – has the outcome achieved its goal?

Clinical reasoning

Throughout the chapters of this edition of *Maitland's Peripheral Manipulation*, contributors will detail the evidence and research underpinning clinical practice and how clinical practice can be explained in terms of specialist knowledge and skills.

Clinical reasoning, therefore, is a process in which the therapist, interacting with the patient and significant others (e.g. family and other health care team members) structures meaning, goals and health management strategies based on clinical data, patient choices and professional judgement, knowledge and skills (Higgs & Jones 2000).

Clinical reasoning should be viewed in relation to:

- The brick wall concept
- Patient-centred practice
- Selection and progression of treatment
- The expert clinician
- Care pathways and best practice
- The clinical practice framework of the Maitland Concept.

Clinical reasoning and the brick wall concept

Physiotherapists are aware of a strong link between knowledge about the subject at hand and its application to clinical practice and how clinical practice is informed by research evidence. What this awareness is portraying is the application of the *symbolic permeable brick wall* model of thinking (Maitland et al. 2005) (Table 1.2).

Leading commentators on manual therapy (Moore & Jull 2009) recognize that clinical reasoning assessment and clinical practice skills are a *crucial nexus between the patient, the research evidence and successful clinical outcomes.*

The foundation of clinical reasoning lies in cognition – *The thinking underlying clinical practice* and metacognition – *thinking about thinking* (Jones 2012) and the ability to make decisions based on clinical evidence underpinned by a combination of research and experienced-based evidence. This is the essence of the *brick wall* concept.

Clinical reasoning also requires an ability to explain clinical evidence and responses to examination and interventions in light of current knowledge.

Table 1.2 The symbolic permeable brick wall and clinical reasoning

Theoretical knowledge and research evidence (Beeton et al. 2008)	Clinical evidence and skills
Evidence-based practice Biomedical sciences Clinical sciences Behavioural sciences Theoretical basis of neuromusculoskeletal (NMS) management The process of research	Clinical reasoning skills Assessment and management of patients with NMS disorders Communication skills enabling effective assessment and management of patients with NMS disorders Practical skills with sensitivity and specificity of handling Commitment to the development of OMT practice

The brick wall allows the clinician the luxury of being able to make safe, effective therapeutic decisions even where there is an incomplete level of supporting evidence. The primacy of clinical evidence and use of clinical facts unhindered by diagnostically restrictive protocols helps the clinician to tailor clinical reasoning to the patient's individual needs.

Cox (1999) cited in Jones et al. (2006a) summed this up nicely by stating that:

> Scientific method focuses on one variable at a time across a hundred identical … [Subjects] to extract a single, generalisable 'proof' … Clinical practice deals with a hundred variables at a time within one … [Subject] … in order to optimize a mix of outcomes intended to satisfy the particular … [Subject's] current needs and desires.

The Maitland Concept, therefore, gives us a framework for effective clinical reasoning in the form of the *symbolic permeable brick wall* model of thinking (Fig. 1.2). By forming, in our mind, a permeable brick wall, our thoughts about clinical evidence and theoretical knowledge can be kept separate and yet can still interact with each other. This gives us a model which allows us to:

- Base our decisions primarily on the clinical evidence about dysfunction without being limited only to what is 'known' from research evidence and diagnosis – *the primacy of clinical evidence*.
- Use our theoretical knowledge about the biomedical, behavioural and clinical sciences to back up clinical evidence helping to *make features fit*.
- Explain to the patient the meaning of clinical evidence from a biomedical, biomechanical, pathological or behavioural science perspective, therefore enhancing *informed consent and collaborative decision making*.
- Accommodate all our personal knowledge, skills and attributes related to manipulative and movement therapies, all available evidence that we know of and our ability to analyze all in one place.

Patient-centred clinical reasoning

Expanding on the idea of the primacy of clinical evidence and patient-centred practice, it is clear that the clinical side of the brick wall is supported by underpinning knowledge and emerging research from the theoretical side of the brick wall that

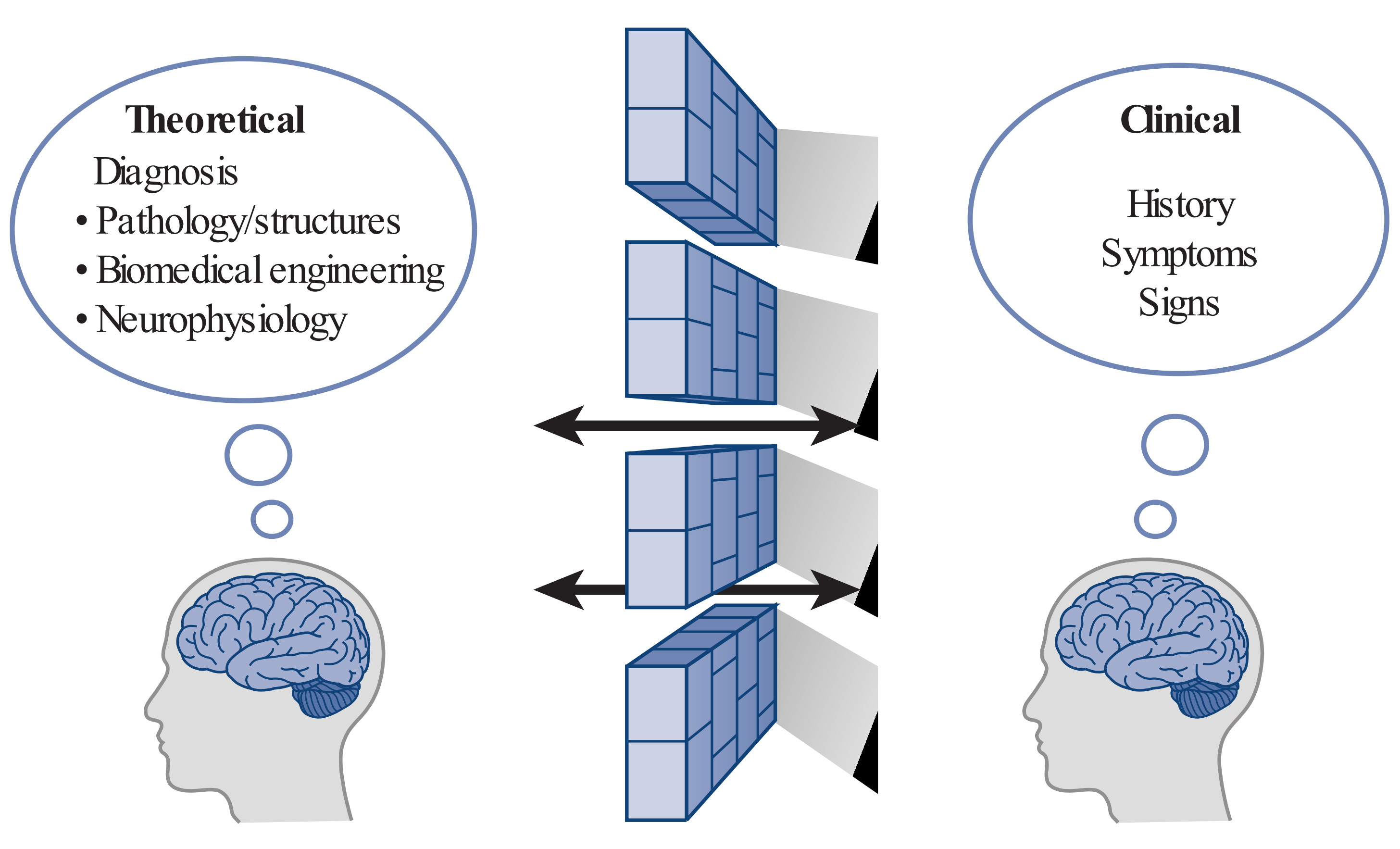

Figure 1.2 • The symbolic permeable 'brick wall': theoretical and clinical compartments. Reproduced with permission from Banks & Hengeveld 2010.

together drive clinical reasoning and decision making.

Because the clinical process in physiotherapy has become patient driven (Department of Health 2010), opportunities have arisen to develop interventions based on patient needs and what, to them, would be a successful outcome. So, for example, if a patient cannot squat down because of a stiff knee caused by osteoarthritis, the main concern is not to cure the osteoarthritis but to enable the patient to squat more easily. In this way, the knee can be mobilized to increase range of movement leading to a successful outcome.

Interventions, therefore, should be, and can be, directly linked, through clinical reasoning, to outcome needs more than ever before (Department of Health 2010). In effect, the domain of physiotherapy is no longer driven by *disease* but practice which focuses on *ease* or the desired effects of treatment (Hengeveld & Banks 2005).

Clinical reasoning and treatment selection and progression

Clinical reasoning theory and practice (Jones et al. 2006a) has demanded that a broad and deep multidimensional range of physiotherapeutic interventions be available in clinical practice. More specifically, the following examples demonstrate how a range of mobilization techniques can be selected according to clinical reasoning hypothesis:

- **The source of symptoms** – the use of compression to influence pain emanating from the intra-articular component of a knee joint disorder (Noel et al. 2000).
- **The mechanisms driving the symptoms** – neurodynamic sliders to overcome the allodynia generated from a mechanosensitive radial nerve in a patient with lateral epicondylalgia (Coombes et al. 2009).
- **Contributing factors** – the patient with weakness of shoulder lateral rotation which improves immediately after the application of C5-6 joint mobilization techniques (Wang & Meadows 2010).
- **Functional demonstration (FD)** – a patient with anterior knee pain, when stepping onto a step, which has developed because of a stiff ankle. The FD can be utilized as a treatment position, with alignment correction and an anteroposterior mobilization of the talocrural joint during step-up (Collins et al. 2004). This is illustrated in Figure 1.3.
- **Results of differentiation strategies and merging examination with treatment** – if a patient's hip flexion in supine lying increases in range beyond 90 degrees and becomes less painful when a medial glide is applied to the greater trochanter and activation of gluteus medius and maximus checks the pull of an overactive rectus femoris, then it is clear that this differentiation process also becomes the treatment of choice to achieve a shared outcome of pain relief and increased range of mobility.

Of course, addressing the physical impairments alone in clinical reasoning is not enough when dealing with patients. A clear understanding of *the nature of the person* and how their *frame of reference* for illness affects their response to treatment must also be understood and taken into account.

The context of mobilization and manipulation in supporting recovery of functional capacity and maximizing activity and participation must be understood if a clear role is to be identified. Passive mobilization and manipulation techniques can be a tool in helping clinicians to identify relevant sources, causes and contributing factors and to identify effective symptom and functional improving strategies. Such strategies can also be incorporated to prevent recurrences.

Selection of mobilization as a therapeutic intervention has to be considered judiciously and based on: sound and reliable clinical evidence; what the patient needs and expectations are; and what research has come to tell us (Sackett et al. 1996). Such attention to detail in decision making and application of mobilization techniques can only serve to support and help achieve *desired effects*.

Clinical reasoning and the expert clinician

The requirements for clinical reasoning at an expert level demand that the physiotherapist integrates but retains the independence of clinical evidence and theoretical knowledge to justify practice decisions to treat or not to treat a patient.

Effective clinical reasoning is based on clinical competency. A novice or inexperienced clinician will reason strategically because they often lack the depth of knowledge and skill to link practice to theory and vice versa. Reasoning will be

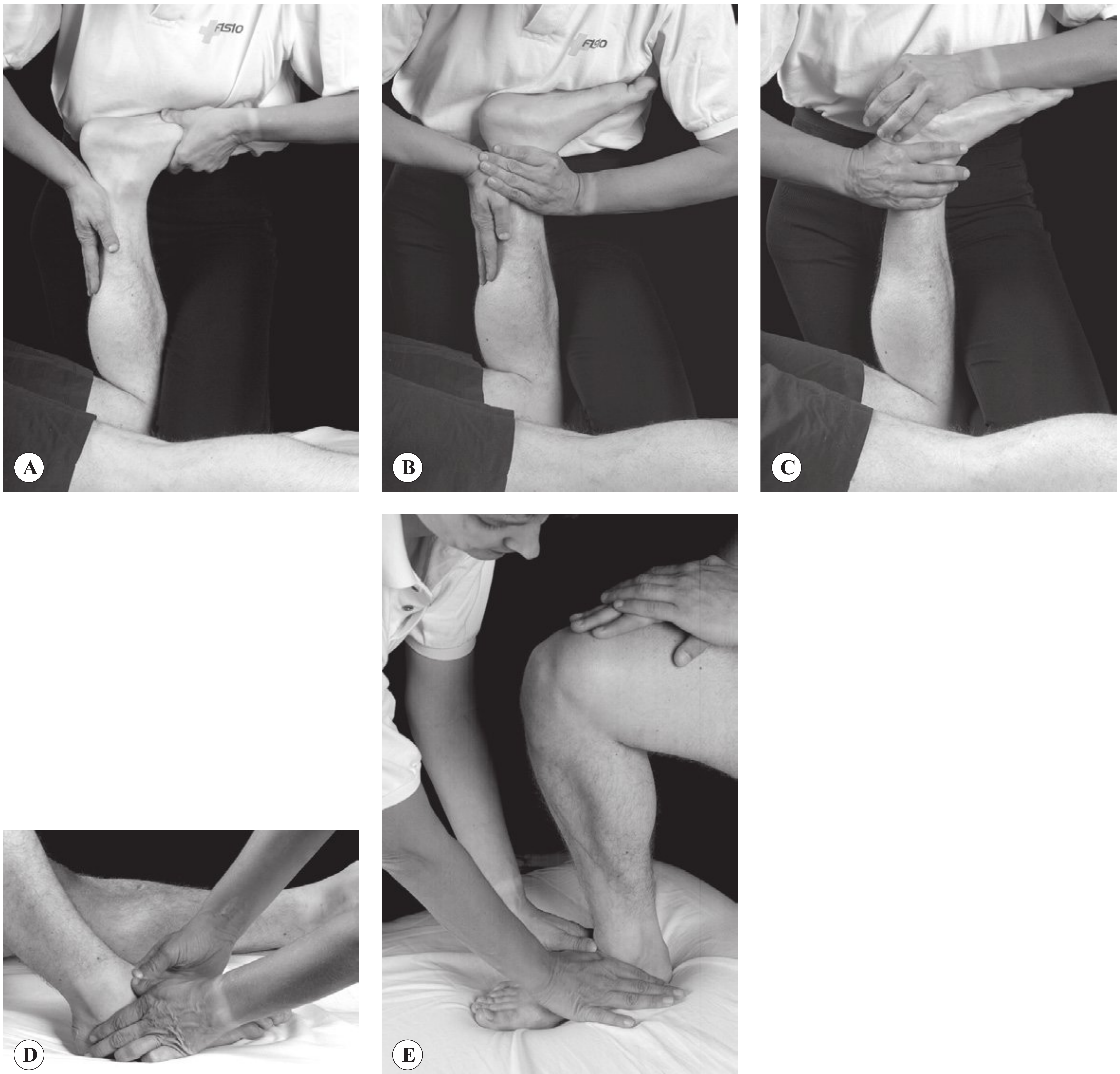

Figure 1.3 • Ankle joint: A anteroposterior movement; B more localized talocrural; C more localized subtalar; D, E localized talocrural as treatment.

hypothetico-deductive or backward and a whole spectrum of hypotheses will be tested. An expert, on the other hand, will reason analytically because they have both deep and broad knowledge and skills portfolios to draw upon. Reasoning will be more inductive and based on pattern recognition. Hypotheses will be selective based on this recognition and a deeper ability to apply knowledge and skills. This does not mean that the expert will always get it right and make the correct decision but it should give more varied options for reaching the end point more quickly. Maitland (1986) likened this process to a game of chess or contract bridge whereby plans can be made and changed as evidence emerges and until the final goal is reached.

The requirements for the transition from strategic to analytical reasoning, that is, from a novice to an expert, therefore, should include:

- An attention to detail in communication with the patient.

- A clear understanding of the context of the patient experience and their frame of reference.
- A depth of knowledge and patient mileage whereby patterns of symptom presentation can be recognized and explained from knowledge of the clinical, behavioural and biomedical sciences and current primary research.
- Decision making around measurable clinical evidence of deficit in physical and or mental capacity and performance (C/O asterisks).
- A depth and breadth of examination and intervention skills to call upon to confirm hypotheses and effect changes in functional deficit.
- Choosing reference standard screening and interventions for which there are clinical prediction rules (Beattie & Nelson 2006) or for which evidence in the literature supports their use in clinical practice (P/E asterisks and treatment).
- A broad and deep understanding of outcome measures (C/O and P/E asterisks) to ensure interventions are being evaluated at all times (assessment, reassessment).
- Attributes which enhance analysis, appraisal and reflection upon clinical practice and the evidence available to support it.

Clinical reasoning, specifc care pathways and best practice

Care pathways are commonly used in clinical practice to help guide decisions related to specific conditions. The central route of the pathway, however, should always be reserved for clinical reasoning based on individual patient needs. In this way the physiotherapist is encouraged to use his or her own experiences, knowledge and skills to come to well-reasoned decisions about patient management.

An example of a care pathway developed by a colleague of the author of this chapter highlights the pivotal role of clinical reasoning within an MSK (musculoskeletal) knee care pathway (Karanec 2010) (Fig. 1.4).

Clinical reasoning also underpins best clinical practice frameworks which have been developed to support clinicians in their decision making. One such example is the CSP guideline on subacromial impingement syndrome (Hanchard et al. 2004) where theoretical knowledge and clinical evidence are matched to produce best practice guidelines from a physiotherapeutic perspective. Such frameworks should include:

- Background to the condition including epidemiology, risk factors, diagnosis, definition and mechanisms of injury or disorder.
- Clinical features common to the condition found from subjective and physical examination.
- Effective interventions or management strategies.
- Outcome measures appropriate for the condition.
- Research supporting practice.

In effect, this supports the clinician's pattern recognition of a patient presentation as well as giving them the flexibility in practice to make individualized therapeutic decisions.

Clinical reasoning and the clinical practice framework of the Maitland Concept

The Maitland Concept, therefore, offers a clinical practice framework with clinical reasoning and decision making at the centre and consists of:

- Information gathering (C/O)
- Planning appropriate physical examination
- Physical examination (P/E)
- *Evaluation* and selection of appropriate manipulative physiotherapy or movement therapy interventions
- Application of clinical skills in movement therapy
- The delivery of meaningful patient education and information
- A deep and broad portfolio of knowledge to interpret responses and actions.

Box 1.4 details such a framework of practice underpinned by analytical reasoning.

Examination

Analytical assessment at the first consultation is based on detailed examination findings. This along with evaluation of manipulative and movement therapy is the *keystone* holding the Maitland Concept together (Maitland 1986).

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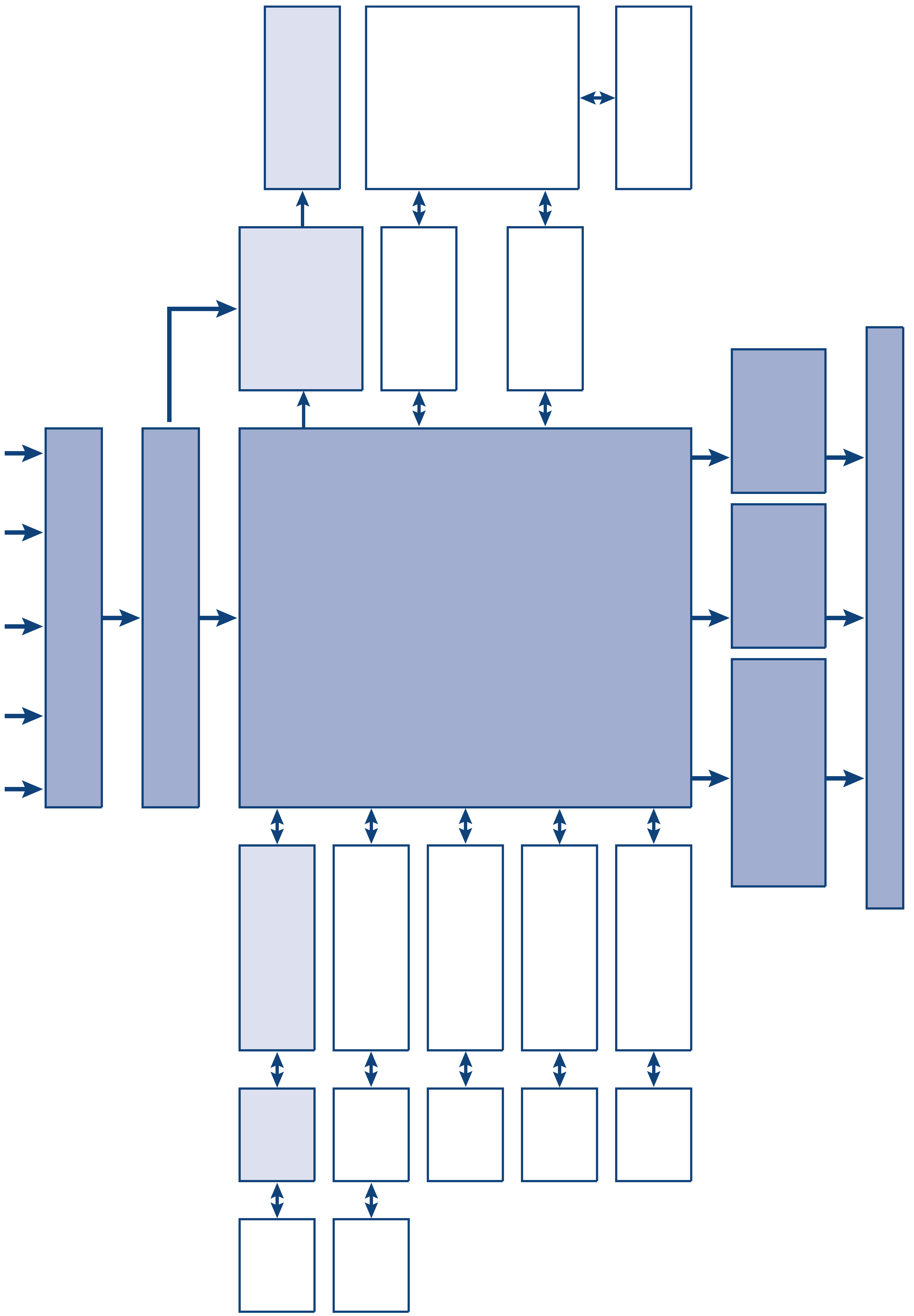


Box 1.4

A clinical reasoning form to support patient management

How to plan various stages of the therapeutic process

Although clinical reasoning is an ongoing process, with many tacit, implicit decisions, it is essential to make some elements of the reasoning process explicit in order to structure and organize the processes below. The structuring of thinking best takes place in some of the so-called *critical phases* of the therapeutic process:

- Referral
- 'Welcoming' of the patient
- First session: during the subjective examination
- First session: planning the physical examination (and frst exploratory treatment)
- Planning the second and third sessions
- Planning overall treatment (latest in the third session)
- Planning retrospective assessment
- Planning conclusion of therapy

On referral

The biomedical diagnosis may already elicit hypotheses on possible fndings for physiotherapy diagnosis by following up on the questions:

- What do I know about the disorder: the natural history, which kind of treatment objectives may be necessary?
  ……
  ……
- Prediction of possible fndings: what can I expect to fnd in subjective and physical examination?…………………
  ……
  ……
- How long does the treatment of such a disorder usually take to effect results?……………………………………
  ……
  ……
- What experiences have I had before with a (medical) referral like this? (For example, the diagnosis 'coxarthrosis' might be a movement disorder of lumbar spine (Lx), sacroiliac joint, hip, or neurodynamic systems.)……………
  ……

Welcoming the patient – information and introduction phase

This phase influences the course of the frst sessions, and is relevant in enhancing the patient's understanding of the steps to be taken by the physiotherapist.

Ask the following questions:

Did the patient expect physiotherapy as the treatment of choice for the problem?……………………………………
……

Does the patient have an understanding of the physiotherapist's specifc role in diagnosis and treatment of movement-related disorders as complementary to biomedical diagnosis?………………………………………………
……

Are there any evident issues with regard to privacy, the setting, therapy, or therapists?………………………………
……

During the subjective examination – regular summarizing of information

Whilst going through the steps of establishing the main problem – namely the body chart, 24-hour behaviour of symptoms, history and special questions – it is useful to *regularly summarize* the information provided by the patient. This serves to validate and deepen your understanding of the patient's problem, as well as enhancing the therapeutic relationship:

Main problem……………………………………………………………………………………………………
Body chart………………………………………………………………………………………………………
Symptom behaviour………………………………………………………………………………………………
History of symptoms………………………………………………………………………………………………
Medical screening questions………………………………………………………………………………………

Box 1.4—cont'd

After the subjective examination – prepare for physical examination

This is an essential reflection and planning phase.

- Reflect on the process of subjective examination:
  - Is the information comprehensive enough, particularly with regard to precautions?
  - Have you obtained useful parameters to perform an in-depth comparison of results at the beginning of the second session (reassessment)?
  - Is relevant information still missing?
  - What information can be left until the second session?
- **Hypotheses** – although certainly more hypotheses have been formed during the subjective examination, a few hypothesis categories have to be made explicit in this planning phase:
- Sources (of all movement components possibly involved; may also include possible structures involved)............
  ....
- Contributing factors (e.g. muscle imbalance, posture, adaptive/maladaptive movement strategies when pain increases)..
  ....
- Pathobiological processes:
  - Tissue pathology..
    ....
  - Stages of healing: know natural healing history of various structures (e.g. meniscus, muscle, disc, bone)........
    ....
- Neurophysiologic pain mechanisms:
  - Nociceptive mechanisms..
    ....
  - Peripheral neurogenic mechanisms...
    ....
  - Central nervous system processing...
    ....
  - Autonomic output mechanisms...
    ....
  - Affective (cognitive/emotional mechanisms..
    ....
- Contraindications to examination and treatment procedures – precautions to examination and treatment procedures as determined by the questions:

  Is the problem severe/irritable, yes or no? ....

  Are there any factors of 'nature of the problem' to be respected?..

  Pathobiological process..

  Co-morbidity...

  Stages of healing..

  Stage and stability of the disorder (Hx)..

  Nature of the person': (lack of) confdence to move...

Planning procedures of physical examination

- Anticipation and extent of physical examination:

  Do you think you will need to be gentle or moderately frm with your examination procedures?

  Do you expect a 'comparable sign' to be easy/hard to fnd? Explain why...................................

  What movements do you anticipate to be comparable?

  Are there any positions or movements that need specifc consideration during P/E (e.g. prone lying)?

Box 1.4—cont'd

Which symptoms would you like to reproduce?
Are there any symptoms which you would NOT want to produce (e.g. dizziness, paraesthesia)?
Tests to onset of P1/carefully beyond P1 ('Trust 1')/to Limit of movement (L)..
....
Initial tests/standardized tests, without overpressure/standardized tests with overpressure/'if necessary' ....
....

- Physical examination, reassessment and frst exploratory treatment:
  Inspection/observation...
  ....
  Functional demonstration (and differentiation)..
  Active tests (including overpressure) – may need 'if necessary' tests?...
  ....
  Isometric and muscle activation testing?...
  ....
  Neurological examination? (Conduction?)...
  ....
  Passive tests and reassessment: neurodynamic tests; passive components; other tests (e.g. instability testing)
  ....
- Plan when you intend to perform reassessment procedures

During physical examination procedures

During the application of physical examination procedures – particularly after the application of a functional demonstration test, including differentiation procedures, and after performance of active tests – a 'brief appraisal' is often necessary:

Shall I continue with the physical examination procedures as planned or do I need to change the course of the examination?...
....

After the frst session – prepare for the second treatment session

This is an essential reflection and planning phase.

- Reflect upon/summarize all the relevant information of the subjective, physical examination, exploratory treatment and reassessments
- Hypotheses – all hypotheses need to be made explicit now, including reconsideration of those hypotheses that have been made explicit after the subjective examination
- Pathobiological processes, including neurophysiological pain mechanisms..
  ....
- Sources of the movement dysfunction and pain, including possible structures involved............................
  ....
- Precautions and contraindications...
  ....
- Level of disability (expressed in terms of impairment, activity limitations and participation restriction)..............
  ....
- Contributing factors (posture, muscle balance, working patterns, ftness and health levels, etc.)......................
  ....
- Individual illness experience (beliefs, attitude, emotions, behaviour, social influences, values, habits, coping style, etc.), including specifc needs of the patient...
  ....
- Management: short-term and long-term objectives, interventions (and alternative choices to reach the objectives)...
  ....
- Prognosis..
  ....

Box 1.4—cont'd

- Do I recognize a clinical pattern?...
  - Are pathobiological processes at the background of the movement disorder (e.g unstable disc problem, lumbar stenosis)?..
    ....
    ....
  - Is it a one component or multicomponent movement disorder (e.g. pain in area of shoulder with more components involved such as neck, thorax, glenohumeral joint, motor control and neurodynamic system)?..
    ....
  - Is a multidimensional approach to treatment necessary, including consideration of cognitive, emotional and behavioural elements?...
    ....
    ....

Course of the second session

- Which subjective examination (C/O)*** do you want to reassess? (Know the indicators of improvement!)...........
  ....
- How do you want to complete the C/O? *(Main problem; body chart; 24-hour behaviour; Hx, special questions.)*... ... ...
  ....
- Which P/E*** do you want to reassess?...
  ....
- Which tests do I need to carry out to complete the P/E?

(Think of things like elements of observation, active testing, neurological examination, muscular testing, which you would have liked to have examined in the first session, but for some reason you did not do so.)... ... ...
... ...

- Other movement components: which component do you want to explore further? Screening tests – state which tests AND when you will perform them as reassessment procedures...
  ... ...
- Which treatment interventions, including which*** for reassessment?..
  ... ...
- Which components and elements would you like to investigate and/or treat in the third session?....................
  ... ...
- What will you do if:
  1. The patient is better?..
  2. The patient's condition is unchanged?...
  3. The patient may be worse?

  Consider C/O *and* P/E fndings and possible coping strategies.

Planning and preparation of the third session

Similar to the planning of the second session – a summary of main information from the frst and second sessions is needed (fndings, response to treatment):

- Reconsider all hypothesis categories: have they changed? (May relate back to sheet used after frst session.)
- Plan of concrete course of the third session – needs to include more treatment options and, if applicable, self-management strategies.

Planning and preparation of the fourth and consecutive sessions

Similarly to planning of the second and third sessions – consider *retrospective assessment* at regular intervals (every fourth session).

Box 1.4—cont'd

After three sessions – defning comprehensive treatment objectives and setting priorities: planning for the end-point

In this phase it is often necessary to consider the following questions, in order to plan treatment comprehensively, with short-term and long-term objectives as well as meaningful interventions:

1. relating to the individual illness experience
   - Which impairments have I found; which activities are limited; which activities and elements from participation may be used as outcome measures?..
   ....
   - Illness behaviour: adaptive/maladaptive?..
   ....
   - How much distress does the patient seem to have?...
   ....
   - Are there any pathobiological processes which I need to respect?
2. Relating to an optimum state of health with regard to movement functions – which can be considered as *'planning for the end-point'* – ask yourself, how close/far does the patient seem to be to an optimum state of health with regard to movement?
   - Normalizing impairments as far as possible...
   ....
   - Guiding the patient towards the experience of confdence in use of the body again..................................
   ....
   - Prophylactic measures...
   ....
   - Self-management strategies, implementation of coping strategies to learn to control symptoms.................
   ....
   - Optimizing level of activity and participation, ftness levels...
   ....
   - Towards the end of the treatment series – fnal analytical assessment...
   ....

Review of the whole therapeutic process, including statements of the patient regarding the individual learning process

- Reflection on the overall therapeutic process: which interventions were effective?.......................................
....
- Reflection on the learning process: what was especially important to the patient – what has been learned?.......
....
- The effectiveness of any prophylactic measures and self-management interventions....................................
....
- Prospective view: anticipation of possible diffculties and strategies to enhance long-term compliance with a regard to advice, self-management measures and exercises...
....
- Compliance enhancement strategies: which self-management interventions are especially benefcial? In which situations would the patient anticipate any diffculties in the future? Which activities or exercises would the patient resume in the case of recurrence of symptoms?..
....
- Suggestions for any medical or other measures that should be carried out..
....
- Prognosis on possible remaining functional defcits in impairment, activity and/or participation levels..............
....

The key features of the examination are:

- Communication during the subjective examination
- The subjective examination interview strategies
- Manual testing
- Reassessment during examination
- The order and structure of examination
- Reasoning strategies during examination
- Planning and performing physical examination.

Communication during the subjective examination

An attention to detail in communication and information about the patient's experience of their problems (C/O asterisks) should focus upon:

- What they feel and where (expressed on a body chart)
- How they are affected in their daily life
- How and when the problems started
- Whether the problems are new, ongoing, recurrent or related to other problems
- What health and medical risk factors may impact on therapeutic interventions.

The subjective examination-interview strategies

In the subjective examination the clinician needs to develop a range of interviewing strategies that suit the way that the patient can express themselves most effectively. In most cases a semistructured interview with open questions is most appropriate as this, collaboratively, gives the patient an opportunity to narrate their account of their problems and, in addition, gives the therapist an opportunity to gather therapeutically meaningful information.

In other cases it may be clear that structure to the interview is not appropriate. There are instances when the patient should be allowed to narrate their account unhindered by questions which may distract their train of thought and inhibit their ability to recount all the necessary information. The interview, therefore, should be unstructured and more of a discussion with a shared consensus on further actions.

There are times, however, when a very structured and directed interview is necessary. Although this is not patient-centred and collaborative it gives the therapist an opportunity to gather specific information where the patient may have learning or communication difficulties. This flexibility in interview and the further analysis and planning should, at all times, have a range of recognized clinical reasoning strategies embedded within them.

Manual testing

Manual examination, which is based on well-established tests with functional utility, will help to provide clinical measures and features (P/E asterisks) which will help to establish or confirm:

- Physical impairments
- Dysfunctions (activity limitations, participation restrictions) (WHO 2001)
- The source of the patient's symptoms
- Contributing factors
- Mechanisms of symptom production
- Possible treatment techniques or intervention strategies (Jones et al. 2006a, 2006b).

Reflection on information and tests will help in the planning and decision making related to the role of manipulative and movement therapies. Selection and progression of interventions can then be based on the desire to support the patient in managing or overcoming their movement impairments, limited daily tasks and restricted work or recreation.

Reassessment during examination

Further and repeated assessment and reassessment of the effects of interventions on the patient's reported problems and their functional status (C/O and P/E asterisks) will guide any need to progress or change treatment (Hengeveld & Banks 2005). In this way there is always a move towards a successful outcome, a partially successful outcome, or an outcome where it is clear that the patient and their condition requires management beyond the scope of manipulative and movement therapy treatments.

Take the patient (a young runner, 24 years old) with a tight groin when striding out. Thomas's test reveals tightness of the iliotibial band (ITB). On further investigation, activation of psoas did not alter the ITB length through reassessment but activation of gluteus medius led to a physiological lengthening of the ITB as evidenced by reassessment of Thomas's test. Interventions could then be directed accordingly to activation of a weak gluteus medius.

Consequent examination and reassessment led to recognition of improvement in running. The message here is that the discipline of assessment and reassessment drives and evidences interventions and appropriate outcomes.

The order and structure of examination

The format, order and structure of examining patients with NMS or any condition is well recognized (Boxes 1.5, 1.6 and 1.7) (Hengeveld & Banks 2005).

Box 1.5

Summary: subjective examination

The subjective examination may be considered *'an interrogation with empathy'*. It indicates the depth of questioning and enables the therapist to get an impression of patients' personal experiences of their disorders and the impact on their lives.

The subjective examination follows several objectives:

- Determination of the problem of the patient, from the patient's perspective
- Subjective parameters which serve reassessment procedures (subjective asterisks)
- Determination of precautions and contraindications to physical examination and treatment procedures
- Generation of multiple hypotheses, to be tested during physical examination procedures and treatment interventions.

The subjective examination can be divided into five parts:

- 'Kind' of disorder – establishing the main problem and perceived disability
- Site of symptoms – body chart
- Behaviour of symptoms and level of disability
- History (current, previous)
- Special questions.

Systematic recording of the information obtained is a valuable learning experience as it helps to identify the essential elements for further examination and treatment. Committing the information and thoughts to paper is an invaluable aid in the development of conscious clinical reasoning processes. Writing information subsequently on the same parts of, for example, the body chart may enhance self-monitoring skills for subsequent sessions and to enable you to assess if important information is missing.

Using asterisks in the recording of information is essential. This serves two functions:

1. It identifies those points which can be used in the reassessment of the patient's progress
2. It serves as a teaching process, to latch onto informative and significant words.

This speeds up the process and makes it more precise. It is important that the asterisk be used at the instant of recording the information (*'asterisk as you go along'*), not on completion of the examination as a retrospective exercise. This aids the therapist to be immediately aware of relevant information to be followed up during later stages in the therapeutic process.

'Making features fit' is an important principle of the Maitland Concept:

- Questions need to be asked to assess if the features of the history fit with the behaviour and localization of the symptoms. If severe disabling symptoms have been caused by a trivial incident, extreme caution is needed: 'the features do *not* fit' and cannot be explained by the movement behaviour of the patient or any structural changes (e.g. osteoarthritic changes). In such cases the patient may need to be referred to a medical practitioner for further investigation
- Furthermore, the Concept also assesses whether the behaviour of the symptoms fits with a recognizable syndrome or pathology. This includes the diagnosis of patterns of biomedical pathology or movement disorders
- This information will be linked with examination findings and reactions to therapeutic interventions which may aid the novice in the development of clinical patterns, thus contributing to the experiential knowledge base.

With some patients, the experienced physiotherapist may engage in forms of *narrative reasoning* in order to get a deeper understanding of the patient's beliefs, thoughts, feelings and earlier experiences with the disorder and the various health care practitioners. If the physiotherapist decides to follow a more narrative approach to the examination procedures rather than a procedural approach, it is essential to keep an overview of the rest of the information that needs to be gained from the subjective examination, as the patient frequently may engage in a description of the previous history and all the treatment interventions which have been undertaken so far. However, for many patients it may be a healing experience if they are allowed first to give their own account of their experience without being interrupted by questions which suit physiotherapy diagnosis.

Kleinmann 1988, Greenhalgh & Hurwitz 1998, Thomson 1998

Box 1.6

Planning sheet as preparation of the physical examination

A) Reflection of the subjective examination

(Verifcation that the subjective examination is complete in order to be able to start the physical examination and to perform a reassessment of subjective parameters – asterisks – in subsequent sessions.)

1. Summary of the main information of the subjective examination:

   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

2. Agreed treatment objectives based on the fndings of the subjective examination:

   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

3. Which subjective parameters (asterisks) will be used in subsequent sessions as part of the reassessment procedures? Describe the parameters in suffcient detail:

   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

4. Has the subjective examination been suffciently comprehensive to be able to make confdent statements and to develop hypotheses with regard to precautions and contraindications to physical examination procedures? (Check information of 'Q1', body chart, behaviour of symptoms, Hx, SQ):

   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

B) Hypotheses

Dominant neurophysiological symptom mechanisms

List the subjective information which supports the hypotheses of the various neurophysiological symptom mechanisms:

- Input mechanisms – nociceptive symptoms: ……………………………………………………
  ……………………………………………………………………………………………………
- Input mechanisms – peripheral neurogenic mechanisms: ……………………………………
  ……………………………………………………………………………………………………
- Processing – central nervous system mechanisms and/or cognitive/affective/sociocultural influences: ……………
  ……………………………………………………………………………………………………
- Output mechanisms – motor and autonomic responses: ……………………………………
  ……………………………………………………………………………………………………

Sources of symptoms/impairments

List *all the possible* sources of any part of the patient's symptoms that *must* be examined:

- Joints underlying the symptomatic area(s): ……………………………………………………
  ……………………………………………………………………………………………………
- Joints referring into the symptomatic area(s): …………………………………………………
  ……………………………………………………………………………………………………
- Neurodynamic elements related to symptoms and dysfunction: ………………………………
  ……………………………………………………………………………………………………
- Muscles underlying the symptomatic area(s): …………………………………………………
  ……………………………………………………………………………………………………
- Soft tissue structures underlying the symptomatic area(s): ……………………………………
  ……………………………………………………………………………………………………
- Others: ……………………………………………………………………………………………
  ……………………………………………………………………………………………………

Box 1.6—cont'd

Contributing factors

Which associated factors may be contributing/causing/maintaining the problem and disability?

- Neuromusculoskeletal: ....
....
  1. Reasons why the joint/muscle or other structure has become symptomatic/reasons why the disorder may recur (e.g. posture, muscle imbalance, muscle coordination, obesity, stiffness, hypermobility, instability, deformity in neighbouring joints, etc.): ....
  2. The effect of the disorder on joint stability:
- Medical factors: ....
....
- Cognitive factors: ....
....
- Affective factors: ....
....
- Behavioural factors: ....
....

When do you expect to incorporate these factors in physical examination procedures (immediately/in later sessions?). Specify: ....

Precautions and contraindications to examination procedures and treatment interventions

- Are the symptoms severe/irritable? Yes/No
  a. Specify your answer with examples from the subjective examination:
  ....
  b. Is it possible that ongoing sensitivity takes place due to central nervous system sensitization or avoidance behaviour? Specify your answer: ....
- Does the nature of the problem indicate caution? Yes/No
  a. Tissue pathology: ....
  ....
  b. Other pathological processes (e.g. osteoporosis): ....
  ....
  c. Stages of tissue healing: ....
  ....
  d. Stage of the disorder (Hx) (progressive/regressive/static): ....
  ....
  e. Easy to provoke exacerbation or acute episode (stability of disorder): ....
  ....
  f. Confdence to move/extreme guarding of the patient: ....
  ....

What are the implications of this answer with regard to the extent of the physical examination?: ....
....

- Management – objectives/if treating local movement impairment – P or R
  a. Which short-term or long-term goals of treatment are pursued?: ....
  ....
  b. If passive mobilization is a treatment option, do you expect to be treating pain, resistance but respecting pain, resistance or resistance to provoke 'bite'?: ....
  ....
  c. Are there any precautions or contraindications which need to be respected ('nothing at the price of'...)?: ......
  ....
  d. What advice should be included and/or what measures would you use to prevent/lessen recurrences and provide the patient with a sense of control over the symptoms?: ....
  ....

Box 1.6—cont'd

C) Procedures of examination

Anticipation of the results of examination procedures

Do you think you will need to be gentle or moderately frm with your examination procedures?: ....
....

Do you expect a 'comparable sign' to be easy/hard to fnd? (if hard to fnd, 'functional demonstration tests' and 'if necessary tests' may be planned in advance, hence saving time). Explain why: ....
....

What movements do you anticipate to be 'comparable'?: ....
....

Might there be any positions or movements that need specifc consideration during physical examination? (e.g. lying in prone positions): ....
....

Extent of examination procedures

Any positions you may need to avoid in the examination? (e.g. prone lying): ....
....

Which symptoms would you like to reproduce?: ....
....

Are there any symptoms which you would not want to produce? (e.g. dizziness, paraesthesia): ....
....

To what extent may you provoke symptoms? (list this for each relevant symptom area). Until the onset of P1/ carefully beyond P1 – maybe exploring 'Trust1'/move to the limit of the test movements:
....

Number of tests you will be performing: ....
....

Small number of initial tests (active movements short of limit)/standard tests without overpressure (active limit of movement)/standard tests with overpressure (active limit plus overpressure)/'if necessary' (or 'when applicable') tests

- Which components do you examine and which tests (including reassessment procedures) will you perform in the *first session*? ....
....
- Which components do you expect to examine in the *second session*? (And with which tests?): ....
....
....
- Which components or contributing factors do you expect to examine in later sessions? (And with which tests?):
....
- Sequence of examination procedures of the frst session: ....
....
    - Observation: ....
....
    - Functional demonstration test and differentiation: ....
....
    - Active movement tests (specify which): ....
....
    - Isometric tests (with which purpose?): ....
....
    - Specify which tests: ....
....

Box 1.6—cont'd

- Are any special tests indicated?: ....
  a. neurological examination (conductivity): ....
  b. others (e.g. instability testing): ....
- Neurodynamic testing: ....
- Palpation and passive movement testing: ....
  a. accessory movements (specify joint position; which acc. mvts): ....
  b. physiological movements: ....
  c. others: ....

When do you plan to perform reassessments during the P/E procedures?
(Indicate this with a double line behind the above-mentioned test procedures.)

The aim of the subjective part of the examination is to establish parameters of the disorder from the patient perspective, from medical records and from medical screening reports. How the disorder presents will generate a range of hypotheses (Jones et al. 2006a) which will influence further clinical examination and choice of therapeutic interventions.

Planning of the physical examination then helps the physiotherapist to focus on priorities.

The main aim of physical examination is to identify or confirm physical impairments related to the patient's symptoms. Often subjective examination merges with physical examination which in turn merges with treatment and reassessment.

The interrelationship between examination, planning, treatment and reassessment can be seen in the following example.

A patient with anterior knee pain says that he is having great difficulty climbing stairs because of his pain. This is an ideal opportunity for the therapist to ask the patient to 'show me'. Immediately, relevant physical examination has been identified.

The therapist then has the opportunity to analyse the activity of stepping up to the point of reproducing pain. Alignment or positional faults can be identified and adaptive faults can be seen. Misfiring of the quadriceps can be observed. Restriction in joints such as the ankle can be observed. Changes can be made to these faults or adaptations to assess whether changes in pain or range responses occur. Loading of different structures can confirm the source of the symptoms. Interventions such as medial glide of the patella resulting in decrease of pain and increase force in step-up can then be employed as treatment in functional positions.

Reassessment of the step-up will then evaluate whether such timely interventions have had an immediate effect on the functional deficit. Reassessment on subsequent visits will help to evaluate whether the treatment in the functional position and correction of alignment faults has led to sustainable gains.

This integrated approach will then support further investigation of the impact of the stiff ankle as a contributing factor or further afield to pelvic stability and lumbar mobility/stability, or as analysis of the functional movement determines.

Boxes 1.5–1.9 give an overview of how the subjective examination may be structured, how to plan the physical examination and the key details of what the physical examination may entail. Under specific conditions it will be necessary also to investigate for presence of red and yellow flags.

Box 1.7

General overview of physical examination procedures

Observation

- General observation, local observation
- Watch for patient's willingness to move the structures

PP (present pain)

- Correction of protective deformities

Functional demonstration – functional tests, including differentiation

Brief appraisal

Active movements

- Gait analysis, other active tests in weight-bearing (sitting, standing)
- Active physiological movements:
  - overpressure
  - 'if necessary' testing/'when applicable' testing
  - test movements faster, repeated, sustained, changing from one end to the other
  - combined movements
  - compression, distraction

Isometric tests

- Function – strength, coordination
- Symptom reproduction

Active tests of other components in the plan

- Joints possibly referring into the area
- Joints above and below – movement quality as a contributing factor to movement in the main component?

Brief appraisal

Special tests (e.g. neurological examination, instability testing, vascular testing)

Neurodynamic testing (may be performed as part of passive testing and component analysis)

Passive movements (as component analysis, including regular reassessment)

- Movement diagram
- Accessory movements (define position in physiological range)
- Physiological movements (e.g. F/Ad hip, shoulder quadrant)
- Muscle length tests

Palpation

- Temperature, swelling, wasting, sensation, position of structures, tenderness of structures
- Soft tissue examination (e.g. trigger points, muscle insertions)
- Nerve palpation

(Palpation of temperature/swelling may be done during observation and regularly during P/E; palpation of tissue tenderness/positions may be performed before passive testing.)

Check case records and radiographs

Highlight main findings with asterisks

Plan reassessments (when, which information/ tests)

Warning, instructions and recommendations

Box 1.8

Red flags

- Age of onset <20 or >55 years
- Violent trauma
- Constant progressive, non-mechanical pain (no relief with bed rest)
- Thoracic pain
- Past medical history of malignant tumour
- Prolonged use of corticosteroids
- Drug abuse, immunosuppression, HIV
- Systematically unwell
- Unexplained weight loss
- Widespread neurology (including cauda equina syndrome)
- Structural deformity
- Fever

Moffet & McLean 2006

Box 1.9

Summary of yellow flags

- A belief that back pain is harmful or potentially severely disabling
- Fear-avoidance behaviour (avoiding a movement or activity due to misplaced anticipation of pain) and reduced activity levels
- Tendency to low mood and withdrawal from social interaction
- Expectation of passive treatment(s) rather than a belief that active participation will help.

Moffet & McLean 2006

What should be emphasized, therefore, about the examination process is that it should be appropriate, relevant, comprehensive, logical and methodical. The patient should not be expected to fit the therapist's examination preferences. On the contrary, the examination should adapt to the needs of the individual patient.

Reasoning strategies during examination

Edwards et al. (2004) in a qualitative design study established a range of clinical reasoning strategies utilized by physiotherapists throughout an episode of care. These strategies also support flexibility and provide a clinical reasoning model on which therapists can explore and shape their clinical care pathway.

Box 1.10 outlines clinical reasoning strategies used by physiotherapists in clinical practice (Edwards et al. 2004).

Box 1.10

Reasoning strategies

Diagnostic reasoning

Presenting clinical features leading to the formation of a diagnosis related to hypothesis categories: impairment, pathobiology, pain mechanisms and contributing factors.

Narrative reasoning

Assessment and reasoning related to the patient's beliefs, culture and illness experience.

Reasoning about procedure

Reasoning underpinning decisions regarding examination and treatment procedures based on clinical evidence and supporting theoretical and research knowledge.

Interactive reasoning

Reasoning underpinning the strategic measures taken to optimize the therapeutic relationship.

Collaborative reasoning

A consensual approach to decisions related to goals, examination and management.

Reasoning about teaching

Reasoning underpinning teaching strategies selected and implemented.

Predictive reasoning

Reasoning related to prognosis.

Ethical reasoning

Reasoning related to ethical issues that emerge in practice.

Professional standards of practice and duty of care are embedded in decision making about the individual's health care needs.

Planning and performing the physical examination

Planning of the physical examination should be collaborative and ethical. This means that, with expert advice and information the patient is empowered to take ownership of their therapeutic care and share decisions with their physiotherapist. There should be collaboration, therefore, around what needs to be examined and how. How examination will be interpreted and what options for intervention, treatment and management will emerge.

Through planning, physical examination should be logical, appropriate and above all safe and risk reduced.

Physical examination should be designed around the patient's needs, such as:

- Movements or activities: which reproduce their symptoms or identify movement impairments; which take into consideration movement tolerance or acceptance (severity, irritability, nature); and which can be reassessed reliably. It is important that these movements or activities are functionally relevant to the individual and relate to *their* everyday activities.
- Differentiation strategies which identify structures at fault or mechanisms of symptom production (pain mechanisms).
- Brief appraisal of structures which could be contributing or are considered not to be at fault.
- Confirmation of impairment with specific manual tests.
- Risk assessment of vulnerable structures where treatment may be harmful.
- Manipulative or movement therapy treatment techniques which effect, within session, change in quality or quantity in movement or which

address contributing factors which mediate symptoms.

- Treatment technique where design can be directly traced back to and link with functional limitations or participation restrictions.
- Treatment techniques which are designed around what, for the patient, would be a successful outcome of treatment.

In effect, examination should be appropriate to the patient's individual needs and tolerances (patient-centred), should be safe (planned collaboratively and with consent) and should ensure effectiveness of treatment within scope of practice.

As with the subjective examination the physiotherapist should have the capacity to be flexible in physical examination to ensure that every aspect of it is relevant to the patient's condition and presentation. This needs some thinking about sometimes, but more often than not the patient will tell you what to do!

Interventions

It is important to clarify that there are no and never have been 'Maitland techniques'. Techniques of manual therapy, mobilization and manipulation should not be attached to any one concept of practice. The most important feature of any treatment using manipulative physiotherapy is that it achieves its known desired effects for the individual patient. It is important, therefore, to have:

- An overview of mobilization and manipulation and their effects
- An understanding of how techniques are selected, progressed and related to self-management strategies.

An overview of mobilization and manipulation and their effects

The technique should be adapted to the patient's needs rather than the patient's problems being made to fit a particular approach.

As a general theme, manipulative physiotherapy fits into the domain of movement therapies. The effects of manual therapy are at all levels of the movement continuum (see Fig 1.14) (Cott et al. 1995). The real effects will go beyond the tissues and have mechanical, physiological and behavioural effects all along the movement continuum.

Patient problems in relation to movement impairment or deficit will usually present as painful movement, movement which is protected, movement which is restricted, movement which is excessive or movement which is sensitive.

Fear, anxiety and loss of trust in movement should always be considered.

Manipulative physiotherapy techniques, therefore, should be designed around dealing with these patient problems using mobilization or manipulation techniques which reduce movement-related pain and excessive protection (e.g. grade I and II accessory or physiological movements) and which reduce restrictions in movement (e.g. grade III and IV physiological and accessory stretching). The techniques should also be designed around dealing with movement sensitivity (e.g. neurodynamic sliders and tensioners) and, at the same time, addressing cognitive or other psychosocial mediators of the patient experience.

At all times individual therapeutic interventions should be placed in the context of an outcome of healthy productive living. Therefore, linking treatment techniques to functionally demonstrated activity limitations and even performing the technique in the functionally limited movement will open up an extensive range of treatment possibilities.

An example of this is the reduction in pain and increased movement capacity when a lateral glide of a patient's tibia is applied during active knee flexion and extension after arthroscopic debridement of meniscus fragments (Fig. 1.5).

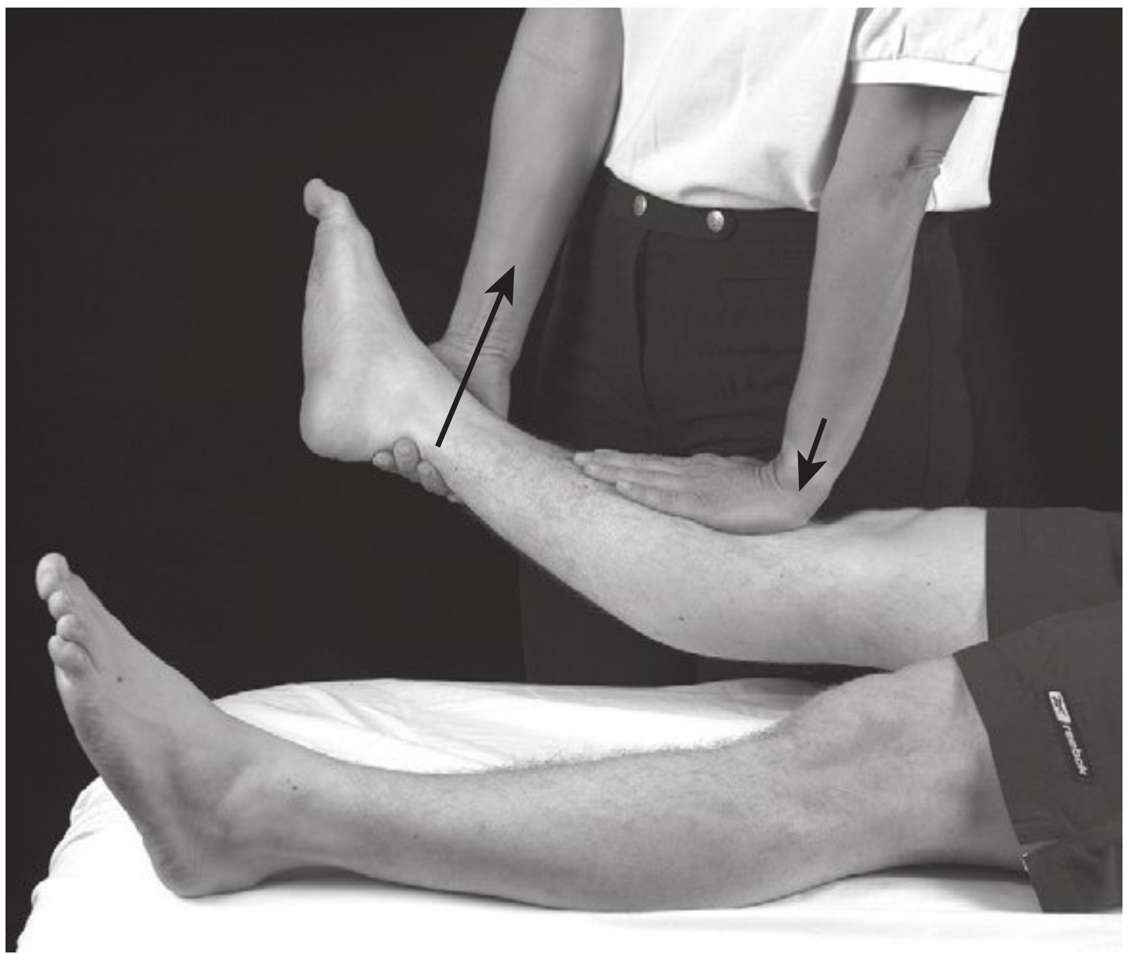


Figure 1.5 • Lateral tibiofemoral movements.

Figure 1.6 • Superior radioulnar joint: posteroanterior movement in supination.

Another example is the patient with lateral epicondylalgia who has pain around the lateral epicondyle of the elbow when gripping. The pain-free grip strength is improved when a posteroanterior glide is applied to the head of the radius (Fig. 1.6).

A further example is the patient with symptoms of nerve entrapment in the upper extremity associated with posterior shoulder tightness and restricted upper limb neurodynamic test-median nerve bias. The nerve entrapment symptoms and upper limb neurodynamic range improves when an anteroposterior glide is applied to the humeral head (Fig 1.7).

Figure 1.7 • Anteroposterior movement: in abduction.

The key to well-reasoned selection of manipulative and movement therapy interventions are to:

- Know the movement which reproduces the patient symptoms.
- Know what those symptoms are (pain, stiffness, spasm, giving way, weakness, etc.).
- Know what effects manipulative and movement therapy techniques have been shown to have on pain, stiffness, spasm, weakness and other symptoms.
- Know all possible techniques or interventions associated with the movement impairment (accessory and physiological movement, functional corners, neurodynamic sliders and tensioners, motor control activation and recruitment).
- Know how to deal with issues which affect the patient's experience and responses to movement (behavioural issues – avoidance, cognitive issues – fear of movement).
- Decide on the technique or intervention most likely to produce the desired effect (pain relief, reduce stiffness, reduce protective spasm, reduce nerve mechanosensitivity, improve motor control, activation and recruitment, reduce avoidance and fear of movement, improve functional capacity and performance of activities).
- Calibrate the technique parameters to suit the presenting severity and irritability of the symptoms and the stage in the pathological natural history of the disorder (starting position, localization and application of manual technique).
- Perform the technique or intervention and reassess its immediate effects.
- Plan further use of the intervention and associated techniques including progression and integration of treatment to different presenting impairments. (For example, cervical lateral glide with the median nerve in progressive positions of lengthening; stretching of the shoulder joint capsule to facilitate rotator cuff muscle re-education; mobilization of a stiff ankle to enhance alignment correction and reduce anterior knee pain).
- Work towards a shared successful outcome whereby changes are made to interventions and management strategies dependent upon responses to treatment.

An understanding of how techniques are selected, progressed and related to self-management strategies

It is clear, therefore, that the selection and progression of manipulative and movement-related therapies no longer adheres to well-established formulas. Maitland's *order of efficacy* (Maitland 1992) or *clinical groupings* (Hengeveld & Banks 2005) (Fig. 1.8) serve to give very loose selection criteria. Well-designed research methods have given the manipulative therapist a wider and more critical overview of selection of interventions and how we need to think of combinations of therapies which have been shown to have the best effects (Maricar et al. 2009). Moore and Jull (2010), in an editorial, suggest that multimodal packages of treatment are now being utilized in most situations. These packages should include a passive/active intervention which supports functionally relevant exercise, education and advice.

The key strategies for the selection of manipulative therapy interventions now lie in clinical reasoning underpinned by a broad and deep knowledge of manipulative and movement therapy theory and a broad and deep range of sensitive and specific handling skills. The key drivers for selection are:

- Collaboration with the patient so that interventions are well explained and meaningful to the patient.
- Well-established and shared outcomes of interventions which are known to be safe and effective.
- Support from research evidence.
- A deep understanding of the responses of NMS tissues and the patient to injury, surgery, disease or disorder.

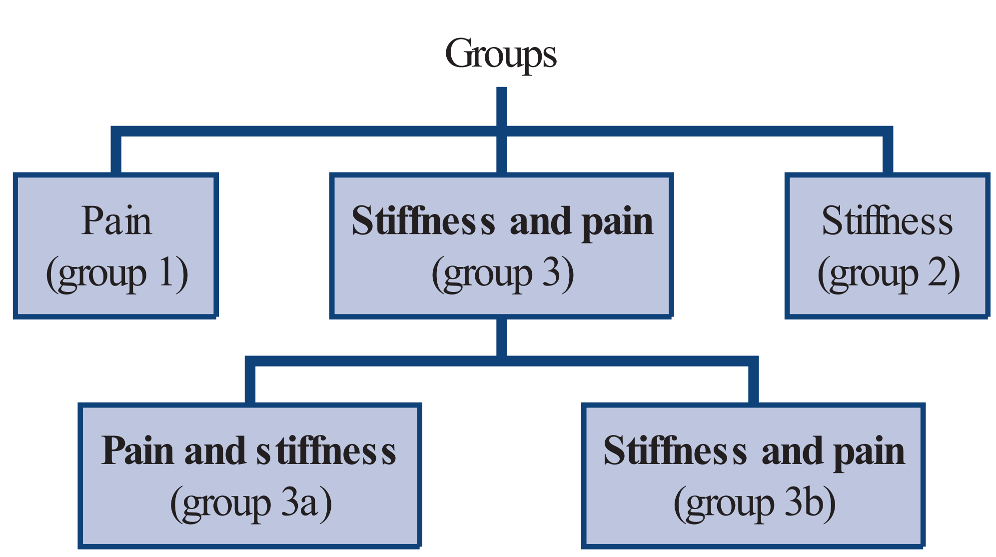


Figure 1.8 • Subdivision of patient groupings.

- Thoughtful relationships between the treatment and functional deficit.
- An attention to detail in the skilled application of techniques underpinned by knowledge of structure and function and an understanding of pain (symptom) mechanisms.
- An awareness of cognitive and behavioural issues which may impact on responses to interventions or contribute to mediating their effectiveness.

Table 1.3 shows examples of selection, progression and functional integration of manipulative and movement therapy interventions based on clinical reasoning hypothesis categories (Jones et al. 2006a). In this case the selection, progression and functional integration relate to a patient who has suffered an ankle sprain (two months ago) and is primarily experiencing ankle pain and stiffness.

Assessment

Assessment refers to:

- Analytical assessment at a first consultation (examination and treatment planning).
- Pretreatment assessment (the effects of the previous treatment session).
- Assessment during every treatment session (the efficacy of a technique at a particular stage in treatment).
- Progressive assessment (comparing the effects of treatment over three or four sessions).
- Retrospective assessment (looking back and re-evaluating treatment when progress has stopped or slowed).
- Final analytical assessment (the final outcome of treatment) (Maitland 1987).

Assessment and outcome measures

The evaluation of what would be a successful outcome of treatment, including mobilization and movement therapies, begins as soon as the patient identifies what, as far as they are concerned, is the main problem.

Any outcome should be measurable whether qualitatively or quantitatively.

Outcomes should be based on sound clinical reasoning and individual to the patient's needs.

Table 1.3 Examples of selection and progression of treatment

Hypothesis category and supporting evidence	Reasoning and selection
The patient's own perceptions and experiences: the patient believes there is something out of place in his ankle. He believes that his ankle joint is being worn away because of this. As a result of these beliefs he has developed a limp and does not put weight on his ankle because it hurts him to do so. **Source/impairment:** the patient complains of a deep ache across the front of the ankle, anterior knee pain and tiredness of the whole limb associated with aching back muscles.	Examination reveals that the ankle is painful and stiff to move and more so when the talocrural joint surfaces are compressed together and moved … SELECTION: it is very important at the outset of treatment to educate and inform the patient about his pain perceptions and beliefs. Understanding pain mechanisms will help the patient to change his beliefs about pain and harm. Use of an X-ray to dispel his fears would also be useful. Mobilization techniques such as graded exposure to movement can then be employed more effectively. Start with accessory grade III mobilization techniques of the talus with the talus distraction to treat the joint pain and stiffness. Progress onto the same techniques without distraction, then with compression and then in the functional load-bearing position as pain and stiffness are reduced and function improves. (Collins et al. 2004) Symptom areas suggest a stiff ankle joint (talocrural or inferior tibiofibular) leading to alignment faults in the knee (patellofemoral or tibiofemoral) and impacting on underlying postural faults within the lumbar or thoracic spine (Prior 1999). SELECTION: the ankle needs mobilizing, alignment faults need addressing, spinal adaptation needs investigation.
Dysfunction (activity, participation): symptoms manifest after a period (two hours) of prolonged walking, the ankle always feels stiff after an ankle sprain two years ago, the knee and back symptoms came on gradually over the last six months leading to progressive discomfort with walking. Not so good at bowling at cricket now because symptoms affect performance. **Pain mechanisms:** as the ankle gradually gets tighter and locally painful with walking, local nociceptive mechanisms in the ankle and knee would be suspected due to overload of the sensitized talocrural and tibiofemoral or patellofemoral tissues. The backache is likely to be originating from the muscles themselves with adaptive activity and the whole leg tiredness could be associated with a disproportionate autonomic nervous system response to irritation of postganglionic sympathetic chains in the postural adapted thoracic spine. Always keep in mind vascular or neurogenic claudication for the leg symptoms, as well as aches and pains as part of ongoing medical conditions such as diabetes or metabolic deficiencies.	Ankle stiffness is a key issue and could also be the cause of the source of anterior knee pain. One possibility to explain symptoms is sympathetic mediated tired feeling of the whole lower limbs associated with stiffness in the thoracic spine (Cleland & McRae 2002). SELECTION: a mobilization or mobilization with movement technique which addresses ankle stiffness and nociceptive mechanisms (e.g. a grade III or IV anteroposterior mobilization of the talus with active dorsiflexion in standing). The patient can still play cricket, therefore the severity and irritability of symptoms is not too high and a lot of walking is needed for the symptoms to become noticeable (Fryer et al. 2002). The local pain from an overloaded knee should settle with treatment of the ankle and correction of adaptive changes at the knee and spine. Sympathetic mediated symptoms can be affected by manipulative techniques to the thoracic spine if these symptoms are due to mechanical irritation of the postganglion sympathetic chains (Cleland et al. 2002).
Contributing factors: there would be an important need to address correction of alignment faults at the the knee and postural adaptations in the thoracic spine. These may manifest as motor control and recruitment issues around the hip, pelvis and trunk or mobility problems within the thoracic spine.	SELECTION: motor control and movement corrections with exercise and mobilization of the thoracic spine. It is important to use reassessment of each of these potential interventions to establish their contribution to the patient's symptoms and signs.

Table 1.3 Examples of selection and progression of treatment—cont'd

Hypothesis category and supporting evidence	Reasoning and selection
Pathobiology: as the ankle has been sprained, fibrous repair within the ankle collateral ligaments will have taken place. There may be possible signs of articular cartilage attrition at the knee. Postural adaptation inducing degenerative changes within the thoracic facet joints may be one explanation for the sympathetically mediated limb symptoms.	SELECTION: through range (grade III) and end of range (grade IV) ankle and thoracic mobilization techniques. Possible need to use through range mobilization of the knee to effect pain relief related to joint surface irritation. Through range accessory mobilization of the thoracic intervertebral joints and ribs if pain and stiffness of the thoracic spine is associated with limb symptoms.
Psychosocial mediators: mediators of recovery could take the form of worry about reduced function because of pain and stress related to concern over what is wrong. Ongoing worry about reliance on medication and impact on functional capabilities and fear of need for surgery may also be a factor. The psychological impact of the ankle sprain should also be linked to the patient's perceptions and pain beliefs as detailed above.	SELECTION: integrate manipulative and movement therapy techniques with an attention to informing, reassuring and supporting psychological and social concerns.
Treatment: there is clear evidence of a need for movement therapies and behavioural approaches.	SELECTION: whilst in standing with dorsiflexion of the ankle, mobilize the talus from anterior to posterior. Effect correction of alignment and motor control at the knee and trunk/pelvis. In long sitting slump mobilize the stiff ribs associated with the sympathetic type symptoms in the limb. Integrate functional gains into daily activities (walking) and recreation (cricket).
Prognosis: a successful outcome is based on collaborative goals to ensure the patient has the capacity to perform activities without pain and discomfort.	SELECTION: gradual reconditioning of tissues to as full a capacity as is possible. For impairments: full range of ankle and thoracic mobility, corrected alignments and adaptations of the knee and spine. For activities: recondition both physically and mentally to enable unhindered performance of activities such as walking and fast bowling. For healthy living: enable a return to functional status to enhance healthy living and feeling of wellbeing.

Outcome measures should be evidenced throughout the examination and assessment process and form the means by which interventions are evaluated in a meaningful and informative way.

Darzi (2008) advocates that outcomes of interventions should be patient-centred (informed choices), safe (free from risk) and effective (achieve their desired effects.

Evaluation or analytical assessment of treatment has always been the *keystone* of the Maitland Concept. Continual assessment forms the basis of decision making, justification for treatment and progression to discharge.

Individual outcome measures or asterisks (the most important clinical features for reassessment) can be utilized from anywhere within the clinical process.

C/O parameters are:

- The area and nature of the patient's symptoms as documented on a body chart.
- The amount of deficit in everyday activities or occupational or recreational participation.
- Evaluation of severity or irritability.
- The number of recurrences over a given period of time.

- Volume of medication needed to effect pain relief.

P/E parameters are:

- Observable impairments.
- Ability to carry out functional activities relevant to symptom reproduction.
- Active movements (range/pain/response and quality of movement).
- Passive movements (movement diagrams).
- Isometric testing, recruitment and muscle strength or length.
- Nerve conduction and neurodynamic capacity.
- Impact on psychosocial factors.

These individual outcome measures can be linked to specific and utility outcome instruments (usually questionnaires) which have been validated, for example, SF-36 (Brazier et al. 1992), to enhance and support selection of treatment, progression and decisions to stop treatment.

Within the Maitland Concept, analytical assessment means looking at the bigger picture, reflecting on practice and carrying out what is, in effect, an internal moderation of action taken.

Assessment means evaluation. Every action, treatment, exercise or management strategy should be evaluated to ensure its patient-centred desired effect, its safety and its measured impact on the patient and their health and well-being.

Analytical assessment

- Analytical assessment is the keystone of this concept of manipulative physiotherapy.
- Analytical assessment (evaluation) includes observation, judgement and reflection.
- It encompasses all procedures which are undertaken to monitor the therapeutic process between the patient and the physiotherapist. It serves to assess the indication for and effectiveness of therapeutic intervention in all treatment sessions.
- Assessment and treatment procedures are directly linked to each other, as many examination techniques can be used as treatment strategies as well (Fig. 1.9).
- Various forms of assessment are being employed during the therapeutic process.

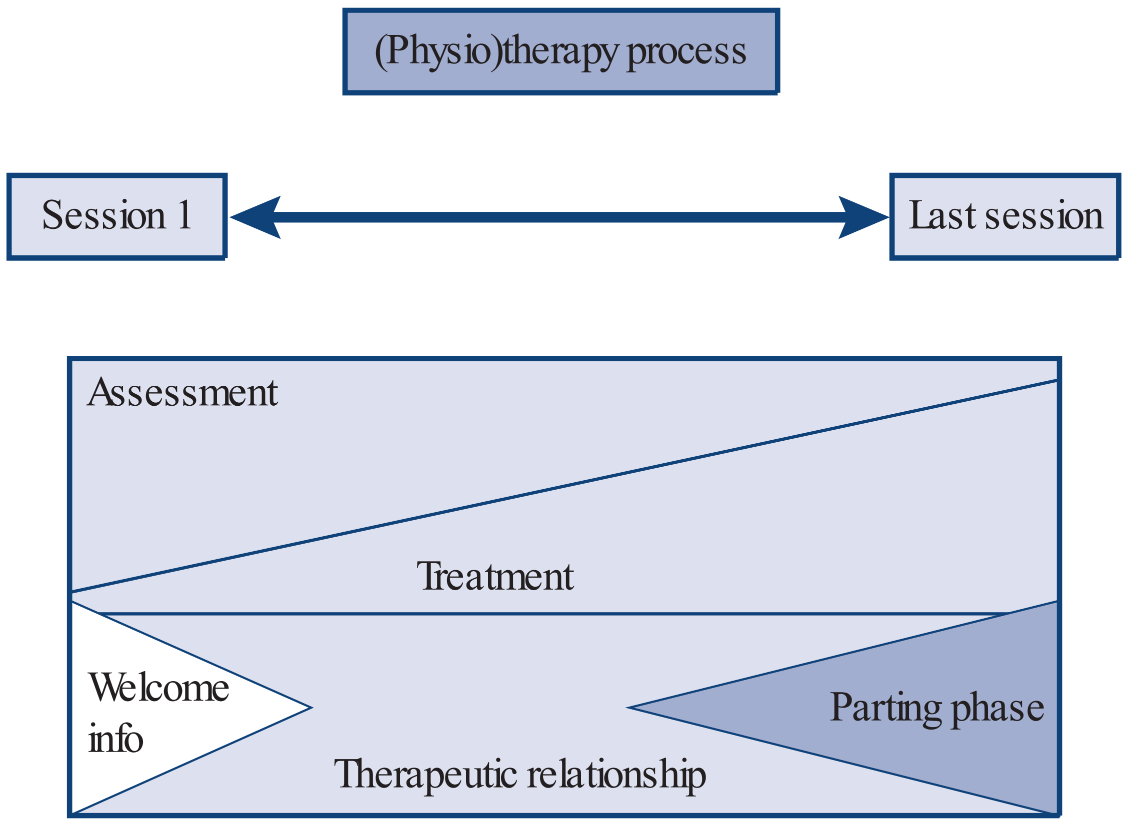


Figure 1.9 • Assessment serves to monitor the overall therapeutic process between the physiotherapist and the patient.

- Assessment procedures are a core skill in the planning and execution of physiotherapeutic interventions.
- The therapist decides to treat patients only after a thorough assessment and to monitor the effects of the treatments during every session.
- Analytical assessment encompasses the overall physiotherapeutic process, in which various forms of assessment are being employed, with the use of examination and treatment skills. Figure 1.10 depicts the relative importance of analytical assessment.

In the process of analytical assessment, the physiotherapist should consider the following questions and aims:

- Is the problem of this patient suitable for manipulative physiotherapy? This relates to questions of:
  - indications
  - precautions

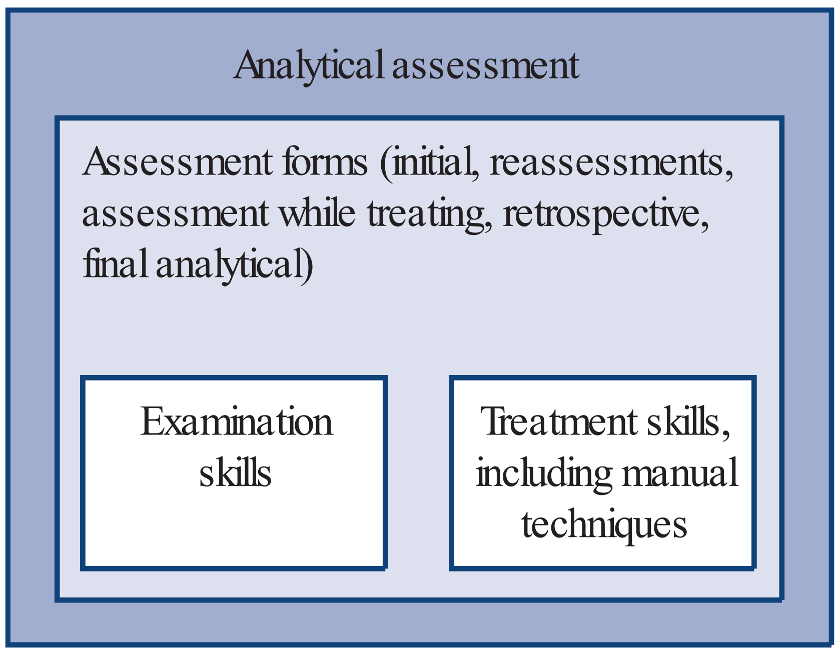


Figure 1.10 • Analytical assessment.

  - contraindications
  - screening for biomedical disease, including consideration of red flags
  - previous treatments the patient received for the same problem.
- If the problem of the patient does *not* seem suitable to treatment, the question arises to whom the patient should be referred?

The therapist, therefore, needs to develop a network of various clinicians to whom the patient could be referred.

- If the patient's problem is suitable for further treatment, consider how treatment should be approached and how should the therapeutic process be monitored? This relates to questions of:
  - physiotherapy diagnosis
  - definition of short-term and long-term goals of treatment (expressed in terms of the International Classification of Functions, Disability and Health – ICF) (WHO 2001)
  - selection of treatment methods and techniques
  - selection of parameters to monitor effectiveness of the selected treatment interventions
  - how to progress carefully and adapt the selected treatment, if positive results are being achieved
  - decisions when to integrate other treatment forms and techniques
  - decisions when to interrupt or stop the treatment
- Consider active integration of the patient in the therapeutic process – development of a therapeutic relationship with aspects of:
  - motivation
  - trust and confidence
  - information at regular moments of the therapeutic process
  - education and learning theories – adapting information strategies to the cognitive level of the patient
  - monitoring the information to ensure it deepens the understanding of the patient or seems to confuse them
  - cognitive–behavioural therapy: how can a person be motivated to change behaviour? This includes recognizing phases of change related to motivation which an individual may go through before new (movement) behaviour becomes an automatic part of daily life functions.

Forms of assessment

In order to be able to monitor the overall therapeutic process from the first to the last encounter, various forms of assessment are described in this concept of manipulative or musculoskeletal physiotherapy:

- Initial assessment
- Reassessment procedures
- Assessment while performing a treatment-techniques
- Retrospective and prospective assessment
- Final analytical assessment.

One suggestion is to employ the various forms in so-called 'critical phases' of the therapeutic process as they aid in reflection and clinical decision making (Fig. 1.11).

First assessment

The first session(s) serve to gather information with regards to causes, contributing factors, precautions, contraindications, treatment planning and the development of a therapeutic relationship (Fig. 1.12).

The main objectives of initial assessment procedures, consisting of interview and test procedures, can be summarized as follows:

- Definition of the patient's problem from the specific perspective of a physiotherapist: physiotherapy diagnosis, mostly expressed in terms of movement dysfunctions with the aid of the terms of the International Classification of Functioning, Disability and Health – ICF (WHO 2001) (i.e. structure and function – impairments; activities – limitations and resources; participation – restrictions and resources).
- Hypotheses generation with regards to:
  - sources of dysfunction
  - movement components and structures
  - contributing factors to the cause and/or maintenance of the disorder
  - pathobiological processes (tissue processes with regards to pathology, stages of healing; neurophysiological pain mechanisms: nociceptive, peripheral neurogenic, CNS modulation, ANS as output mechanisms)

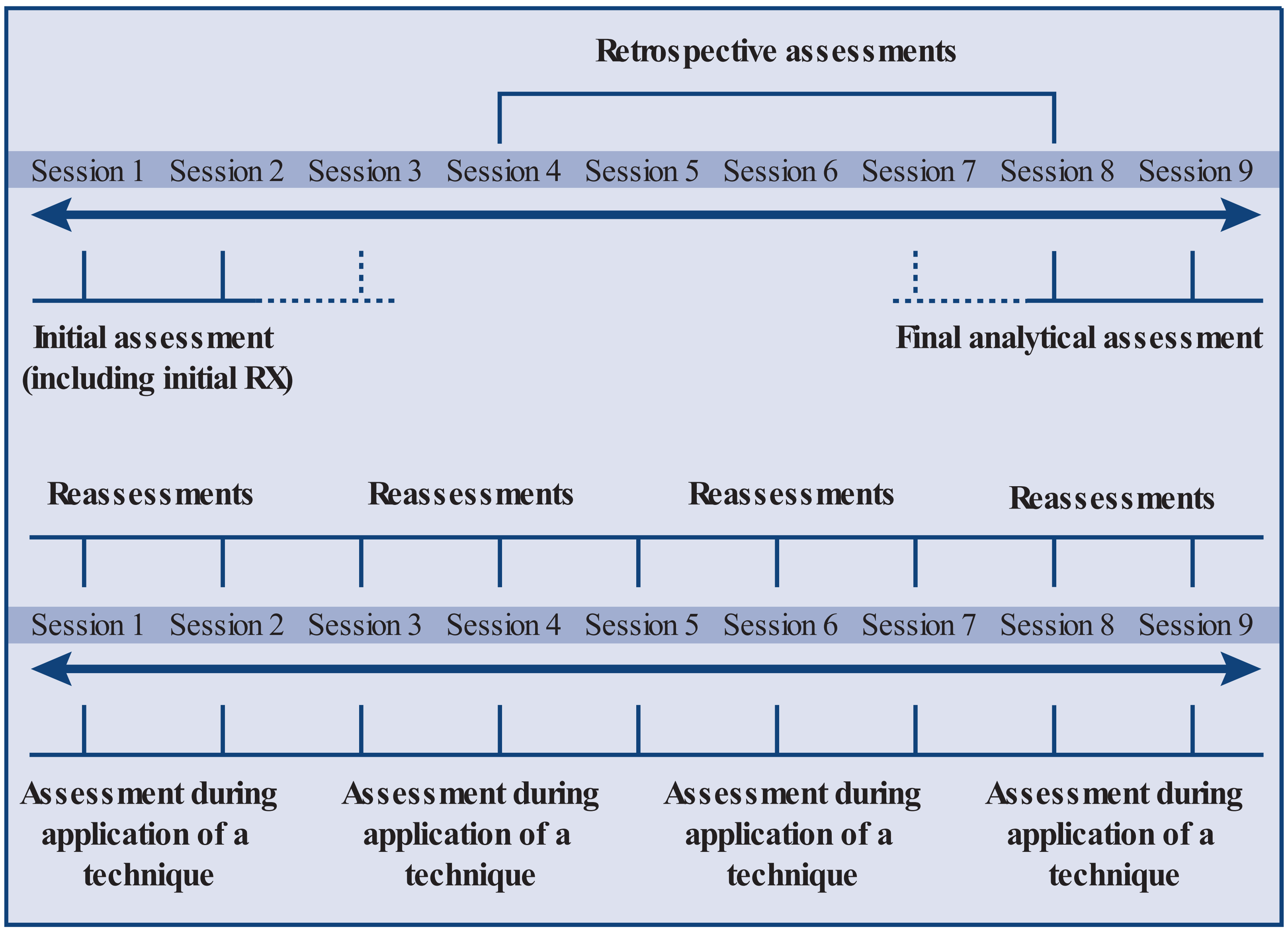


Figure 1.11 • Forms of assessment – employed in various stages of the therapy process.

- ○ contraindications and precautions to examination and treatment procedures
- ○ individual illness experience (regarding expectations, thoughts, feelings, level of understanding and attitude of the patient relating to the problem, influence on/of social environment, particular needs of the patient)
- ○ management: treatment objectives, selection of treatment procedures, progression of treatment
- ○ prognosis (short term and long term prognosis).

- Defining subjective and functional parameters (asterisks) to monitor the progress and success of treatment.
- Definition of treatment objectives and selection of initial treatment methods.

The frst session

The course of a first session usually will follow various stages (Box 1.11):

1. Introduction phase.
2. Subjective examination – interview of the patient.
3. Planning of the physical examination (Box 1.12).
4. Physical examination (Box 1.13).
5. Initial (probationary) treatment.
6. Planning of the next session (Box 1.14).

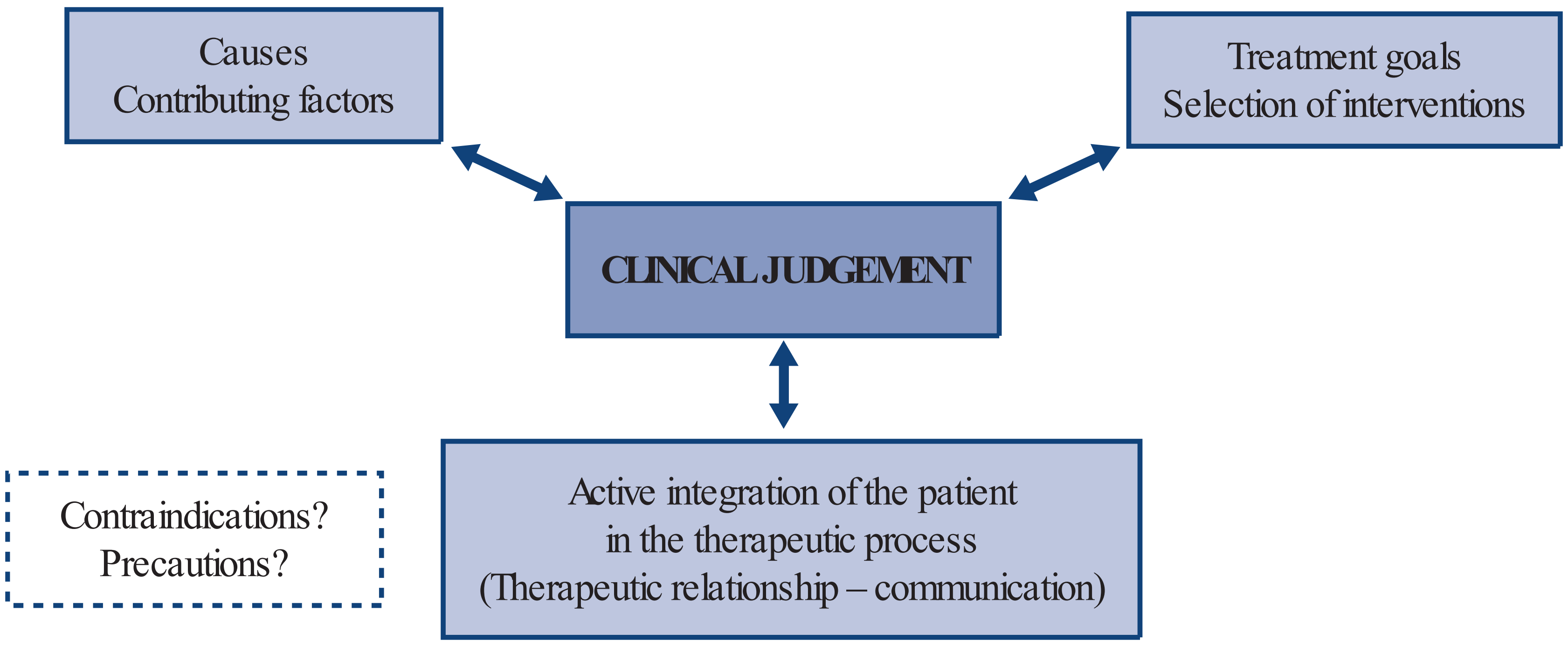


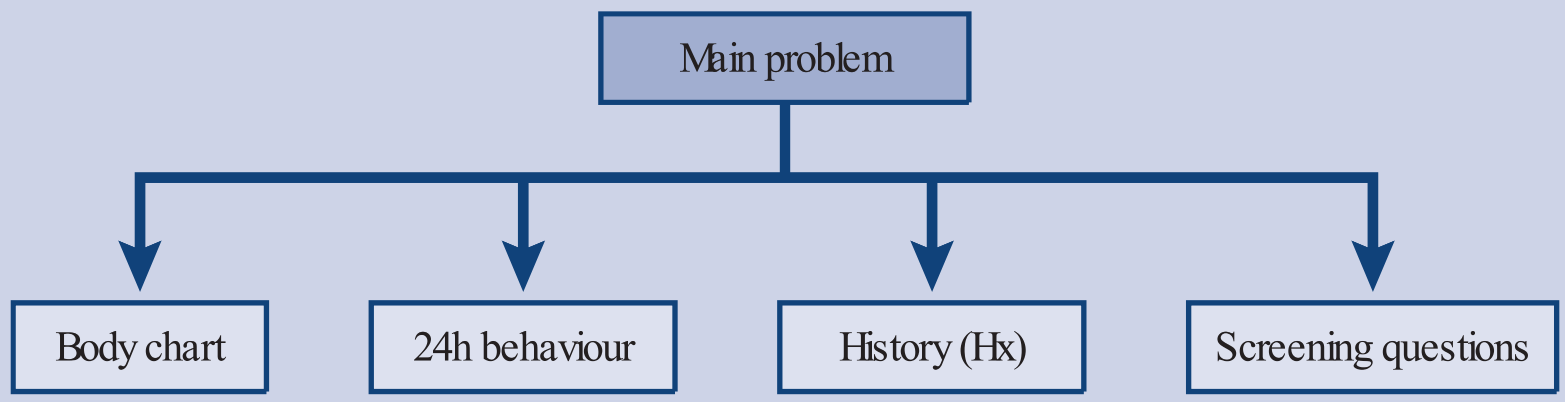
Figure 1.12 • Various objectives of assessment in the initial phase of physiotherapy.

Box 1.11

First examination and treatment

- Subjective examination (C/O – 'complains of')*
- Name, date of birth, profession, hobbies, medical diagnosis, goals of patient
- Main problem, including short statement on level of disability in daily life
- Body chart
- Behaviour of symptoms (over 24 hours/seven days)
- History (Hx), present and past history
- Medical screening questions

The sequence of questioning may be varied, according to the specific problem of the patient.



It may be difficult for a patient to understand that each member in a multidisciplinary team follows a unique frame of reference, which is in a sense exclusive to their profession (Kleinmann 1988). Therefore it is essential to inform the patient about the specific role of physiotherapist in the diagnosis and treatment of *movement dysfunctions*, being complementary to medical diagnosis and with a focus on restoring healthy living. This information needs to be given in an early phase of the encounter, before embarking on the examination and treatment process.

Furthermore, explanations need to be given about the setting and the steps which will be followed in the first session (interview, physical examination and movement testing, first probationary treatment, reassessment). It may be necessary to explain that this examination is highly important to individualize the treatment to the specific problem and needs of the patient.

Additionally, it is necessary to find out if the patients have been expecting physiotherapy as a treatment option for their problem at all

Box 1.12

Planning a physical examination

This essential phase before performing a physical examination includes three stages:

- Reflection on the previous phase of the subjective examination: have I searched for all information with regards to possible contraindications and precautions to examination- and treatment procedures?
- Consideration of some hypotheses ('Making implicit hypotheses explicit')

Sources of symptoms
Contributing factors
Pathobiological processes
Tissue pathology
Phases of tissue healing
Dominant neurophysiological pain mechanisms (nociceptive, peripheral neurogenic, CNS modulation, Autonomic NS output mechanisms)
Contraindications to physical examination procedures
Precautions to physical examination procedures – determined by factors of **severity, irritability and nature** of the disorder.

- Extent of examination procedures:
  - Which symptoms do I want to reproduce?
  - Which symptoms do I want to avoid reproducing?
  - Extent of testing: until first onset of pain (P_1)/to the limit of the movement (to L, respecting pain)
  - Initial tests/standard testing/standard testing with overpressure/'if necessary' testing
- Sequence of the physical examination, including an estimation of first exploratory treatments as well as planning of reassessment procedures.

Box 1.13

Physical examination (P/E), including reassessment

Physical examination procedures encompass various movement tests, specifc screening tests for biomedical disease, probationary treatment procedures and reassessment as below:

- Observation
  - General observation of posture, bodily alignment
  - Local observation of position, wasting, swellingWillingness to move the structure
  - Present pain? (PP)
  - Correction of observable asymmetries
- Functional demonstration – functional tests, including differentiation procedures if possible
- Brief appraisal (considering plan of examination – continue or change plan?)
- Active tests (observing quality, quantity and symptom reaction)
  - Gait analysis
  - Active physiological movements (of main movement component; may include movements of other components in the plan: joint referring in the area; joints above and below area of symptoms)
- 'If necessary' testing to active tests including:
  - Overpressure
  - Test movements performed faster, repeated, sustained, performed under load.
  - Combined movements
  - Compression, distraction, tapping tests
- Brief appraisal (considering plan of examination – continue or change plan?)
- Special tests (neurological conduction – radicular or peripheral nerve distribution; instability testing, vascular testing, other test procedures as aspect of screening for biomedical disease)
- Neurodynamic testing (may be performed as part of passive testing and component analysis)
- Passive testing (as component analysis, including regular reassessment)
  - Movement diagram (see page 58)
  - Accessory movements (defne position in physiological range: in … do …)
  - Physiological movements (e.g. F/Add hip, Shoulder quadrant; PPIVMs)
  - Muscle length tests
- Palpation
  - Temperature, swelling, wasting, sensation, position of structures, tenderness of structures
  - Soft tissue examination (e.g. ligaments, muscle, tendon)
  - Nerve palpation

(Palpation of temperature/swelling may be done during observation and regularly during P/E; palpation of tissue tenderness/positions may be performed before passive testing.)

- Check case reports and radiographs
- *Highlight main findings with asterisks* (to allow for quick referral in later sessions)
- Plan reassessments (when, which information, which tests (includes subjective statement and P/E tests)
- First probationary treatment, including reassessment
- Warning, instructions and recommendations. (Patient is encouraged not only to observe but also to compare.) To be included in patient records.

Box 1.14

Planning of the following session(s)

Subsequent sessions must be planned thoroughly to make sure that examination procedures are properly completed and also to adapt and refne the initial treatment procedures.

Planning steps for subsequent sessions should encompass:

- Subjective reassessment: seeking spontaneous information and comparison of activities and symptoms
- Additional subjective examination questions not completed at the frst consultation
- Reassessment of the physical examination parameter, which reproduced the patient's symptoms in the previous session as well as those parameters which have been considered relevant 'comparable signs'
- Additional examination procedures, such as, for example, neurological conduction testing, instability testing, not completed at the frst consultation
- Screening of other movement components involved (active testing, passive testing) followed by reassessment procedures
- Reasoning about treatment – what kind of treatment will be performed if the patient is better/the same or worse as a result of the previous session(s)?
- How are the treatment techniques based on the examination fndings and available research evidence?
- What kind of self-management strategies will be incorporated into the treatment – how will this taught to the patient? How will it be reassessed?

(particularly in those cases where a patient has been referred by another medical practitioner). Also, it is useful to ascertain whether the patient understands that physiotherapy encompasses various methods of movement therapy (not only gymnastics), such as touching as used in, for example, passive mobilizations, manipulations, soft tissue techniques and other modalities.

In this introductory phase, by means of careful listening and observing, the therapist may become aware of some anxieties of the patient with regards to therapy, setting and therapist, which may be addressed as well (Main & Spanswick 2000).

Physical examination

- Discuss with the patient essential steps, for example, reassessment procedures.
- Gain consent for touching, particularly if the patient is not able to see the physiotherapist.
- Explain to the patient that the active tests which reproduce the symptoms will be used to compare treatment results at a later stage. Ask the patient to try to remember how the movement felt and which symptoms occurred.
- When performing accessory movements on the spine, explain to the patient that especially those movements which provoke the pain may be used in treatment strategies but performed short of the onset of pain or with a controlled amount of pain.
- If there are favourable results in reassessment procedures, summarize the results for the patient.
- Be mindful of what is being said to the patient as it may be differently perceived by the patient if a therapist says 'I cannot fnd anything' in contrast to 'I think your reflexes, muscles strength are perfectly in order'.

Reassessment before and after treatment

The effects of the various examination and treatment interventions are continuously monitored by reassessment procedures and the treatment is adapted to the actual situation of the patient as required.

Reassessment procedures should take place during each treatment session:

- During the initial physical examination phase in the first encounter, after the examination of various active and passive movement tests, before continuing to examine another possible movement component involved.
- At the beginning of each subsequent treatment session, pretreatment assessment to reflect on the reactions to the last treatment and the time leading up to the current therapy session.
- Immediately after the application of the various treatment interventions – proving the value of the intervention and monitoring if treatment objectives step by step are being achieved. These interventions may include passive mobilization techniques, active movements, and application of physical agents, information and educational strategies.
- At the end of the treatment session.

Purpose of reassessment procedures:

- Allows the physiotherapist to compare treatment results and prove the value of selected interventions.
- Provides differential diagnosis: not only examination findings, but also reactions to treatment interventions make a contribution to differential diagnosis of the sources and contributing factors of movement dysfunctions ('differentiation by treatment').
- Enables the physiotherapist to reflect on the decisions made during the diagnostic and therapeutic processes. Through reassessment procedures, hypotheses with regard to sources, contributing factors and management may be confirmed, modified or rejected. The therapist learns to recognize patterns of clinical presentations, which will aid in future decision making. Reassessment procedures support the development of the individual, experiential knowledge base of the physiotherapist, and thus play a central role in the development of clinical expertise.
- Enables the patients in their learning processes. From a cognitive–behavioural perspective, reassessment procedures play a central role in the development of the perception that indeed beneficial changes occur, even if the pain still seems to be lasting. If patients are being guided towards the *experience* of the various changes in the test movement (e.g. quantity, quality of the movement, along with symptom responses), they may learn to perceive changes which they initially did not expect to occur.
- Reassessment procedures are one of the crucial aspects of the therapeutic process.

Indicators of change

It is essential to bear in mind how symptoms and signs may change in order to guide the patient comprehensively in reassessment procedures and to monitor even minor beneficial changes (Box 1.15).

However, it is essential that the starting point is clear: if it is not sufficiently clear from the first assessment which daily life functions are limited due to pain or other reasons, comparison to identify change in later sessions is compromized. This may often leave the patient in doubt as to whether the therapy has really served its purpose. Furthermore, the definition of clear treatment objectives may be impeded and neither patient nor physiotherapist is capable of observing in sufficient detail if something is changing beneficially in the patient's situation.

Box 1.15

Indicators of change

Subjective examination

- Pain: sensory aspects such as intensity of pain (may be expressed in VAS), quality of symptom, duration, localization, frequency
- Emotions/mood
- Normalization of level of activity and participation
- Confidence in use of body during daily life situations
- Motivation/self-efficacy
- Decrease in use of medication
- Increased understanding
- Deliberate employment of coping strategies if discomfort increases again

Physical examination

- Inspection parameter (posture, form, skin, aids)
- Active testing: range of movement, quality of movement, symptom-reaction
- Passive testing (as neurodynamic testing, PAIVMs, PPIVMs, muscle length): change in behaviour of pain, sense of resistance and motor responses
- Muscle testing: changes in strength, quality of contraction and symptom response
- Palpation findings: quality and symptom response
- Neurological conduction testing changes in quantity and quality of the responses

Treatment intensity

- Higher intensity of active movements, passive mobilizations (grade, duration, inclination, combinations), exercises, soft tissue techniques without provoking discomfort

Behavioural parameter

- As, for example, facial expression, non-verbal language, eye contact, use of key words and key gestures, habitual integration of extremity with daily life functions

Balanced reassessment of subjective and physical parameters

Note: a balanced approach to reassessment of subjective and physical parameters is necessary. Some physiotherapists focus solely on the observation of physical examination findings and may only employ tests with an acceptable intertester and intratester reliability. However, it is argued that a certain degree of scepticism should be retained if tests with a high reliability coefficient are directly claimed to be clinically useful and vice versa: that tests with a relatively low coefficient would not be useful clinically (Keating and Mayas 1998, Bruton et al. 2000). Often the combination of tests of both subjective and movement parameters may provide the clinician with valid reassessment parameters (Chesworth et al. 1998).

Leaving out a subjective parameter carries the inherent danger that the therapeutic process becomes a rather mechanical process in which not much space is left for the individual perceptions of the patient with regard to the disorder. Furthermore, the observation of the more subtle behavioural parameter (e.g. less guarding of the affected arm), changes in facial expression and use of words may be indicative that changes in the individual illness experience are taking place.

The 'art' of reassessment

- With reassessment procedures it is essential that the physiotherapist develops a clear image as to which interventions have an effect on the patient's condition. Some interventions may influence some active parameters, while other interventions influence other tests and activities.
- Consequently, it is necessary to follow multiple parameters in reassessment procedures.
- Profound reassessment: the indicators of changes have to be monitored meticulously rather than being satisfied with a more superficial question at the beginning of a session as for example 'how have you been?' without further follow-up of the information.

- A balanced approach to reassessment and treatment procedures: if some patients have a condition with a high level of irritability, or have difficulties getting up and down a plinth, it may be useful to reassess only the subjective experience regularly and to perform some reassessment test while the patient is still lying on the treatment plinth.
- Cognitive objectives: in case of educational treatment strategies, monitor if the information has been understood and acted upon. This engagement should manifest as changes in daily living activities and exercise compliance. The clinician should also re-evaluate the patient's beliefs and whether these have also changed. For example, does the patient still believe that any pain is harmful.
- In some cases, where pain seems to have become a dominant feature in the individual illness experience without any changes over time, it may be useful to find metaphors for the experience of the patient (e.g. a wave on the ocean, which may be subsiding). In other cases it may be helpful to integrate more functional movements as, for example, 'tennis service' or a working activity – in which the patient learns to observe various parameters other than pain alone as a sensation.
- It is essential that the physiotherapist remains in control of the treatment collaboratively with the patient. Given practice and experience, treatment, including profound reassessment procedures, is not a lengthy procedure.

Assessment while performing a treatment procedure

Assessment *during* the application of treatment procedures need to be distinguished from reassessment procedures.

Assessment during the application of treatment

Note: while performing a passive movement, exercises, educational session or other therapeutic procedures with a patient, the physiotherapist has to pursue the following questions:

- Are the objectives of the treatment procedure being achieved?
- Is the treatment free from undesirable side effects?

Particularly during the application of passive mobilizations, changes in the behaviour of pain and sense of tissue resistance should be monitored. If pain or the feel of resistance changes, immediate adaptation of the techniques will then be possible. As long as these changes are favourable, the technique may be continued. Also, when the changes cease to take place after a period of treatment, it is often useful to perform a reassessment-procedure of the main parameters of physical examinations to evaluate the direct effect of the technique applied.

Therefore, assessment *while* applying a treatment technique is a decisive factor in determining the duration of the technique being performed.

On the other hand, the physiotherapist needs to consider *possible undesired side effects*.

In some cases, while monitoring the desired results of a therapeutic intervention, simultaneously the physiotherapist may need to observe the following aspects by noting any adverse or undesirable responses to treatment such as:

- Inflammatory signs (alertness to swelling, redness, temperature).
- Increase of pain (particularly in cases of acute, irritable nociceptive and peripheral neurogenic pain states).
- Neural conductivity (monitoring reflexes, muscle function, sensation).
- Impaired healing processes in soft tissues or bones (in relation to the phases of physiological healing processes).
- Autonomic reactions, for example, redness of skin, sweating, coldness (e.g. during palpation of the spine).
- General tension with increased muscle guarding and breathing patterns (particularly in those patients, whose contributing factor to their disorder may be lack of relaxation or autonomic imbalances).
- Self-efficacy beliefs/externalization of locus of control/development of passive coping strategies (in cases where the patient seems to attribute the effects of treatment only to the hands of the therapist, without applying the suggested self-management strategies).
- Fear of movement (e.g. increase in fear-avoidance behaviour).
- Confusion (e.g. in educational sessions, where much information is given without reassessment and consideration of the cognitive level, previous knowledge and beliefs of the patient).

Retrospective assessment

One of the most essential, but often neglected, forms of reassessment is retrospective assessment in combination with skilled communication (Maitland 1986).

Retrospective assessment should take place at regular intervals in the overall process, in which the physiotherapist reflects on all the decisions and hypotheses made so far and patients are encouraged to compare changes in their condition over a longer time period rather than session-to-session changes. See Box 1.16 for reassessment questions.

> **Box 1.16**
>
> **Retrospective assessment**
>
> Questions need to be asked to establish the following:
>
> - Assessment of the overall well-being of the patient in comparison with the frst sessions
> - Which subjective and physical parameters (asterisks) have improved so far? Which ones have remained unchanged?
> - The percentage improvement of C/O and P/E asterisks. Which aspects of the asterisks have and have not changed?
> - Which treatments have helped the most?
> - Are agreed treatment goals being achieved?
> - What has the patient learned so far? What was especially important to the patient in the learning process?
> - Monitoring the effects of the various treatment interventions (patient's information as well as checking of treatment records)
> - What does the patient feel is needed to change the remaining symptoms and signs?
> - **Prospective assessment:** (re)determination of the treatment objectives for the next period of therapy: does the therapy need to be adapted to newly defned goals? (*'Which aspects should we work together on now?'*) It may be useful to 'think from the end': which treatment objectives should be followed in order to optimize the 'individual sense of well-being' with regard to activities in daily life?
> - Determination if other therapeutic or medical measures may be necessary
> - Does the therapist need to undertake more compliance enhancement strategies in order to support the patient in the behavioural change with regard to suggestion, exercises and recommendation?
> - (Re)determination of the parameters to monitor the agreed goals of treatment. (It may become a more functional movement parameter, such as, for example, tennis service, bending activities as performed at work)

When improvement has stopped

Retrospective assessment is also useful if therapy seems to be stagnating or does not seem to bring the desired results. The following reflections need to be considered:

- Have I compared the subjective and physical parameters (asterisks) regularly enough and in sufficient detail?
- Did I ensure that the patient would become aware of positive changes in these parameters as well?
- Did I follow up the correct physical 'asterisks', which reflect the patient's main problem and the goal of the therapeutic intervention?
- Have I performed a review of the therapeutic process collaboratively with the patient?
- Has the right source of symptoms been treated?
- Have potential contributing factors been addressed adequately (physical, psychological, environmental)?
- Have the self-management procedures been pursued enough? Did these procedures provide the patient with sufficient control over the pain and well-being on *all* daily life situations?
- Are any medical or other interventions necessary?

Final analytical assessment

Final analytical assessment encompasses a reflection of the overall process which has taken place between the physiotherapist and the patient (Box 1.17). This includes information from the initial subjective and physical examination, behaviour of the disorder throughout treatment, responses to various treatment interventions, details derived from retrospective assessments, the state of affairs at the end of planned treatment, taking into account the changes in subjective and physical parameters (asterisks).

Prognosis

Making a prognosis may be one of the most challenging skills for a clinician. In the examination and treatment of a patient the clinician frequently needs to estimate how treatment results may be achieved, how long it may take and which concrete results can be achieved.

Box 1.17

Final analytical assessment

Final analytical assessment includes the following aspects:

- Review of the whole therapeutic process, including statements of the patient on the individual learning process
  - Reflection on the overall therapeutic process: which interventions brought which results?
  - Reflection on the learning process: what was especially important to the patient – what has been learned?
  - The effectiveness of any prophylactic measures and self-management interventions.
- Prospective view: anticipation of possible diffculties and strategies to enhance long-term compliance with a regard to advice, self-management measures and exercises:
  - Compliance enhancement strategies: which self-management interventions are especially benefcial? In which situations would the patient anticipate any diffculties in the future? Which activities/exercises would the patient resume in the case of recurrence of symptoms?
  - Suggestions for any medical or other measures that should be carried out.
  - Prognosis on possible remaining functional defcits in impairment, activity and/or participation levels.

International Classification of Functioning, Disability and Health – WHO 2001.

Box 1.18

The various phases of prognosis

- At the beginning of a treatment series:
  - What can be achieved on a short-term basis: which results can be expected within the frst three to four sessions?
  - What can be achieved on a long-term basis during the overall process of physiotherapy?
  - What may not be achieved?
- During the treatment series, especially during retrospective assessment in each of the three to four sessions, it is essential to reflect on all the hypotheses formed and rejected so far in the therapeutic process; the reflection on the prognosis especially may aid the clinician to learn profoundly from each encounter with a patient and to develop and deepen clinical patterns in memory
- At the end during fnal analytical assessment – making a prognosis for the time after the therapy will be completed considering:
  - The likely restraints on lifestyle.
  - The likelihood of recurrences of episodes of the disorder, and the possible early warning signs the patient must heed to minimize the severity of the recurrence; and the step the patient then needs to take.
  - The need for specifc ongoing exercises, intermittent maintenance treatment or follow-up assessment.

Patients rightfully will seek answers to the following questions, which include queries about prognosis:

- What is wrong with me?
- What can be done about it?
- How long is it going to take?

Furthermore, from a physiotherapy-specific perspective, but also from the viewpoint of insurance companies and referring physicians, endeavouring to answer these questions is essential.

When a manipulative physiotherapist makes a prognosis, theoretical knowledge (e.g. tissue healing) and clinical experience (experiential knowledge base) is matched with the clinical presentation of the patient's problem. Therefore, it contains an element of clinical-pattern recognition, similar to the process of recognizing possible contraindications to treatment.

The art and skill of prognosis may appear to be linked to the years of clinical experience and may grow over the course of clinical practice. Nevertheless, novices in the field can also learn to make prognoses if they explicitly take certain questions into consideration, deliberately make hypotheses about the prognosis throughout the whole therapeutic process and regularly reflect upon them. Furthermore, once they have treated some patients with a similar clinical presentation (e.g. postoperative care of the anterior cruciate ligament of the knee) they will soon be able to forecast what kind of treatment the patient will need, which reactions to expect and how to progress the treatment. This element of a developed clinical pattern will be enhanced if regular reassessment and reflection upon the therapy is performed. The various phases of prognosis are outlined in Box 1.18.

In making a prognosis it is essential to bear in mind:

> [Prognosis] is an art, or skill, not a science. It concerns probabilities, not certainties and it refers to individual, not the general … Fortunately, although individuals differ in their response to insult, their ailments follow recognised patterns and it is possible to form generalised predictions of the natural history of disorders.
>
> (Jeffreys 1991, cited by Maitland et al. 2005)

Specific hypotheses categories should also be considered to enhance the prognosis:

- Disorders that are easy or difficult to help (e.g. complex regional pain syndromes).
- Nature of the person, including attitudes, beliefs, feelings, values, expectations, (movement) behaviour and so on.
- Nature of the disorder (intraperiarticular disorders; mechanical osteoarthritis/ inflammatory osteoarthritis, acute injury/chronic degenerative, nociception alone/nociception with peripheral neurogenic or central sensitization).
- The body's capacity to inform and adapt. (The way the patient 'feels' about their disorder often correlates well with other aspects of prognosis. For example: 'I've had knee pain for 20 years so I know I'll never totally get rid of it'.)
- Contributing factors and other barriers to recovery (structural anomalies, systemic disease, general health problems such as diabetes, ergonomic/socioeconomic environments such a keyboard workers, heavy manual work, repetitive unilateral activities at work, little control over work circumstances).
- Expertise of the physiotherapist, especially in the field of communication and handling.

The bio-psychosocial model of the ICF (International Classification of Functioning, Disability and Health – WHO 2001) may serve as an aid in considering aspects of a prognosis (Fig. 1.13). If only function impairments are present, as for example restricted mobility of the shoulder and muscle imbalance with a patient in good health, without large activity limitations, participation restriction and no negative contextual factors, the prognosis will be, of course, much more favourable than when disturbances of all elements would be present. The physiotherapist has to evaluate if discrepancies between the elements of the model are present.

In making a prognosis many factors need to be taken in consideration in relation to either short- or long-term goals, such as:

- General health.
- General fitness level.
- Stage of tissue healing and damage.
- Mechanical versus inflammatory presentation of the disorder.
- Irritability of the disorder.
- Relationship between impairments, activity limitations and participation restrictions.
- Onset of the disorder, duration of the history, stability of the disorder and progression/course of the disorder (are attacks more frequent or disabling?).
- Previous existing disorders and dysfunctions (e.g. a patient has fallen on the shoulder, but may have had degenerative changes in the neck with some pain for a few years).

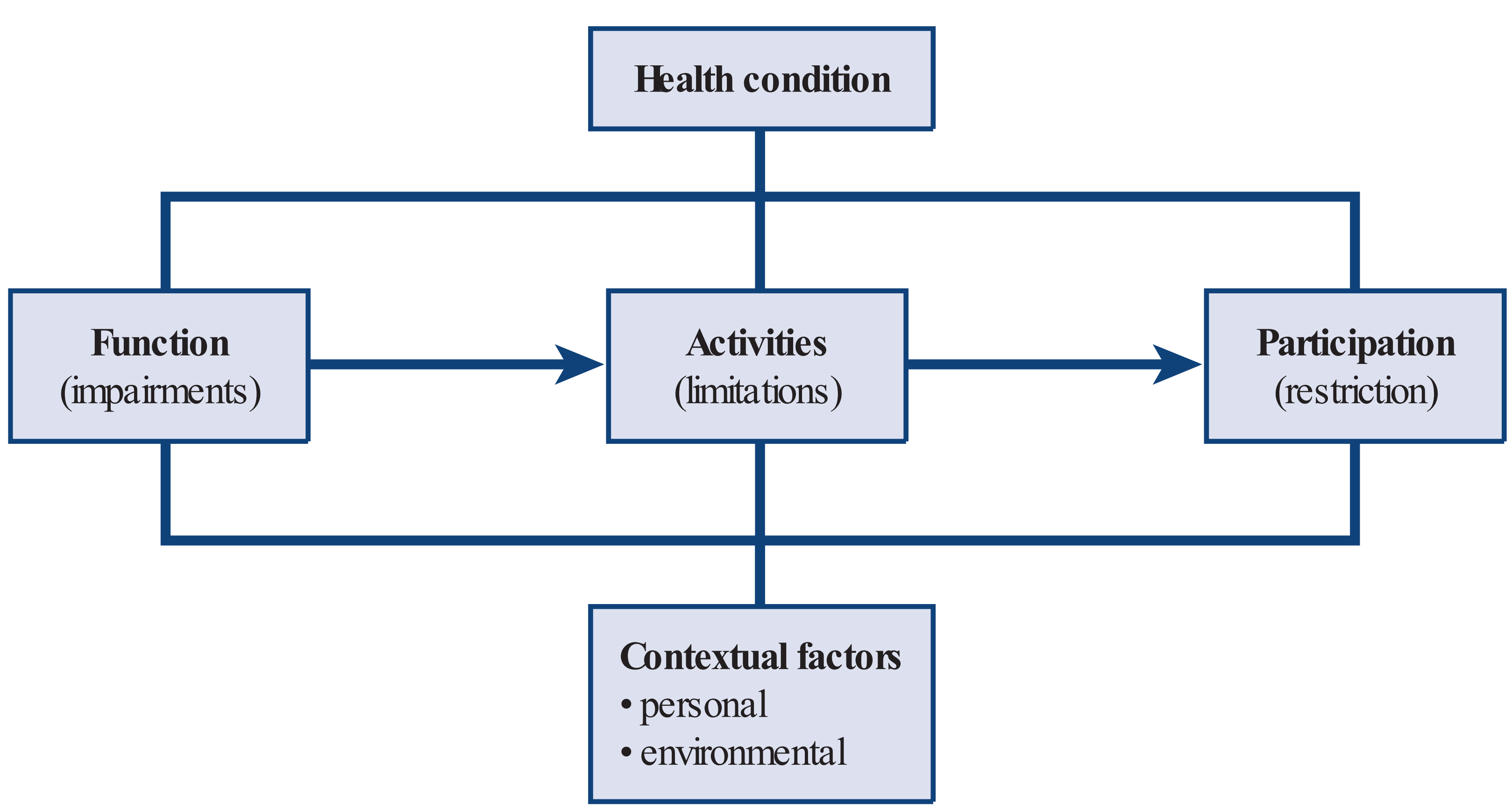


Figure 1.13 • The bio-psychosocial model of the ICF (International Classification of Functioning, Disability and Health). Adapted from WHO 2001.

- Uni- or multicomponential movement disorder (e.g. only local movement dysfunction in the elbow, or the disorder has more components contributing to it: shoulder, cervical and thoracic spine, neurodynamic dysfunction).
- Contributing factors – 'cause of the source' (e.g. posture, muscle weakness or tightness, discrepancies in mobility of joint complexes such as spine or wrist, etc.).
- Cognitive, affective, sociocultural aspects, learning processes (patient's beliefs, earlier experiences, expectation, personality, lifestyle, learning behaviour, movement behaviour).
- Multidimensional approach to treatment (consideration if the cognitive, affective, behavioural dimension needs to be addressed in treatment).

Over the course of some years of clinical experience, physiotherapists learn to recognize which kinds of clinical presentation react more or less favourably to treatment. These are outlined in Table 1.4.

Table 1.4 Types of disorders

Disorders which may be more easy to help	Disorders which may be more difficult to help
Recognizable/typical syndrome or pathology. Strong relationship of patient's symptoms and movement	Weak relationship between the symptoms and movements in the patient's mind. Atypical, unclear patterns, syndromes or pathology
Predominantly primary hyperalgesia and tissue-based pain mechanisms (nociception; peripheral neurogenic)	Predominantly secondary hyperalgesia from central nervous system sensitization rather than stimulus-response-related tissue responses
Model of patient: helpful thoughts and behaviours ('I can still do some things'; 'I have found ways to get relief')	Maladaptive thoughts and behaviour: ('I don't think I ever get better'; 'I dare not move because it always hurts me') and other yellow flags
Familiar symptoms which the patient recognizes as tissue-based ('it feels like a bruise')	Unfamiliar symptoms which the patient has dif f culty describing in sensory terms
No or minimal barriers to recovery of predictors of chronicity ('yellow flags')	Multifactorial/multicomponent/complex regional pain syndromes
Severity, irritability and nature of the patient's symptoms correspond to the history of the disorder/to injury or strain to the structures of the movement system	Severity, irritability and nature do not f t with the history or stage in the natural history of the disorder
The patient has had a previously favourable sampling experience with manipulative physiotherapy	Previous unfavourable sampling experiences or knowledge of manipulative therapy ('my mate had manipulation of his shoulder and he said it was much worse afterwards')
There are easily identif able signs of impairment and activity limitations which have a strong relationship with movement	Evidence of movement impairments but with little correspondence to the degree of activity limitation
Patients are touch-tolerant (gain relief by touch, rubbing or massage)	Patients are touch-intolerant ('I don't like anyone touching my knee')
An internal locus of control ('I just need to know how I can help myself'); locus of control with regard to health and well-being is consistent	An externalized locus of control ('you are the physiotherapist, you sort me out') or inconsistency in locus of control with regards to health and well-being
The patient has realistic expectations for recovery which correspond with the natural history of the disorder	Unrealistic expectations for recovery ('I wish I would wake up and all the pain would be gone')
The patient will resume appropriate activity and exercise at relevant stages of recovery	Ongoing pain states with little changes in symptoms over a long period of time

At the third or fourth treatment session and the final analytical assessment, the manipulative physiotherapist should be able to answer the following questions about a patient's disorder in the quest for a prognosis:

- What is the biomedical diagnosis and what pathobiological mechanisms are involved? (Tissue mechanisms – pathology, healing processes; neurophysiological pain mechanisms.)
- What is(are) the source(s) of the patient's symptoms?
- What are the contributing factors to the source of the symptoms? ('Cause of the source'.)
- To what extent are movements impaired and activities or participation restricted by the symptoms?
- To what extent is severity or irritability limiting movement and activity?
- Which predictions can be made about the natural history of the disorder based on its onset, stage of pathological development and pathological stability/lability? (e.g. healing phases of a lumbar disc.)
- Which predisposing factors are influencing the course of the disorder? (Pre-existing pathology, comorbidity, weak link, the nature and extent of injury, age-related processes, general health state, physique, occupation, hobbies, lifestyle, genetic predisposition, etc.)
- Which factors are contributing to a favourable or unfavourable prognosis?
- Is the disorder one that will be easy or difficult to help (based on examination and response to treatment)?
- What do we understand about the patient's nature and response to injury and illness? (Adaptive/maladaptive behaviour; beliefs, thoughts, feelings, attitude, former experiences, values etc.).

In summary, prognosis is a forecast of the future history of a patient's disorder based on the probability of physical, psychological and functional recovery of the patient and the disorder. Therefore consideration should be given to:

1. The natural history of a particular disorder. (Be cautious as some studies claim that e.g. tennis elbow and frozen shoulder can recuperate over a period of two years; however, what is the amount of remaining functional impairment?)
2. The response to manipulative physiotherapy – has the progress been acceptable?
3. What is acceptable to the patient – has the main problem been solved?
4. Is there need for prophylaxis – is a self-management programme needed to complement or maintain recovery? Is the patient capable of implementing elements of this programme at adequate moments? Is 'top-up 'treatment required periodically?
5. Prognosis should at all times be realistic.

It is essential to maintain at all times a self-critical attitude towards prognosis and regularly pose the same questions as in retrospective assessment if therapy seems to be stagnating:

- Have I compared the subjective and physical parameters (asterisks) regularly enough and in sufficient detail?
- Did I ensure that the patient would become aware of positive changes in these parameters as well?
- Did I follow up the correct physical asterisks, which reflect the patient's main problem and the goal of the therapeutic intervention?
- Have I performed a review of the therapeutic process with retrospective assessment procedures, collaboratively with the patient?
- Has the right source of the symptoms been treated?
- Have the self-management procedures been pursued profoundly enough? Did these procedures provide the patient with sufficient control over the pain and well-being on *all* daily life situations? Did I teach them well enough?
- Are any medical or other interventions necessary?

Even if physiotherapists embark on a therapeutic process with a less favourable prognosis, they should bear in mind that a prognosis deals with probabilities and hypotheses and should still maintain a positive attitude towards treatment. The following quote relating to neurological rehabilitation may serve as a demonstration of this principle:

> A positive approach right from the start can contribute greatly to the success of treatment. I find it helpful when I first start treating a patient to picture him walking out of the hospital unaided one day, well-dressed and waving goodbye with a smile, even if

things look bleak during the early days following his admission. Should a patient not survive the initial trauma or sadly never regain consciousness, nothing will have been lost by the active intervention, but so much gained. All too often I am told that things went so wrong because everyone thought that the patient would not survive for long. Statistical studies concerning prognosis can also lead to negative attitudes, but statistics are not about individuals, and there have been many surprising exceptions. It has been wisely pointed out that the clinician's attitude may influence the recovery to the extent that cessation of recovery after 6 months, a widely held belief, may possibly in fact be the result of a self-fulfilling prophecy.

(Davies 1994)

Competencies framework and autonomous practice

Physiotherapy is a competencies-based profession. To ensure best practice is being enhanced by knowledge skills and attributes, physiotherapy competencies need to be framed in relation to:

- Standard of Orthopaedic Manipulative Physiotherapy (OMT) as determined by the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT)
- Physiotherapists as autonomous practitioners.

OMT and IFOMPT

The definition of OMT (Orthopaedic Manipulative Therapy) as voted by the IFOMPT (International Federation of Orthopaedic Manipulative Physiotherapists) general meeting in Cape Town, South Africa in March 2004 is:

> Orthopaedic Manual Therapy is a specialised area of physiotherapy/Physical Therapy for the management of Neuromusculoskeletal (NMS) conditions, based on clinical reasoning, using highly specific treatment approaches including manual techniques and therapeutic exercises.
>
> Orthopaedic Manual Therapy also encompasses and is driven by the available scientific and clinical evidence and the bio-psychosocial framework of each individual patient.
>
> (Beeton et al. 2008)

The IFOMPT Educational Standards Committee headed by Dr Alison Rushton (Beeton et al. 2008) made available an educational standards document for member organizations. The purpose of the document is to support each national representative group with their curriculum development and delivery.

The standards document gives a detailed insight into dimensions and competencies required by manipulative physiotherapists to practice at an agreed international standard. The IFOMPT Educational Standards Committee identifies 10 dimensions each with three qualifying competencies (knowledge, skills and attributes). Each dimension is relevant to the definitions of and the paradigm within which OMT is practiced (Box 1.19).

Each dimension is qualified in terms of the three competencies which demonstrate the major

Box 1.19

IFOMPT dimensions

IFOMPT Dimensions

Dimension 1: Demonstration of critical and evaluative evidence-based practice

Dimension 2: Demonstration of critical use of a comprehensive knowledge base of the biomedical sciences in the speciality of OMT

Dimension 3: Demonstration of critical use of a comprehensive knowledge base of the clinical sciences in the speciality of OMT

Dimension 4: Demonstration of critical use of a comprehensive knowledge base of the behavioural sciences in the speciality of OMT

Dimension 5: Demonstration of critical use of a comprehensive knowledge base of OMT

Dimension 6: Demonstration of a critical and advanced level of clinical reasoning skills enabling effective assessment and management of patients with NMS disorders

Dimension 7: Demonstration of an advanced level of communication skills enabling effective assessment and management of patients with NMS disorders

Dimension 8: Demonstration of an advanced level of practical skills with sensitivity and specifcity of handling, enabling effective assessment and management of patients with NMS disorders

Dimension 9: Demonstration of a critical understanding and application of the process of research

Dimension 10: Demonstration of clinical expertise and continued professional commitment to the development of OMT practice

Beeton et al. 2008

functions for performance in clinical practice in each one. Competencies are defined as:

Knowledge: the theoretical and professional understanding, use of evidence, principles, procedures.

Skills: the cognitive, psychomotor and social skills needed to carry out predetermined actions.

Attributes: the personal qualities, characteristics and behaviour, in relation to the environment. (Beeton et al. 2008).

The Educational Standards Committee also presents a clinical practice framework which assures and enables the control of quality delivery of health care within the neuromusculoskeletal speciality and movement therapy health care domains.

The standards document also emphasizes the importance of effective clinical reasoning in underpinning high quality clinical practice. Banks and Hengeveld (2010) present a clinical practice framework for practice from which a competencies-based profession has evolved and enable manipulative physiotherapists to *think, plan, execute to prove.*

Box 1.20 represents a feedback method which has been developed within the authors' clinical practice domain. The aim of the feedback sheet is to match clinical practice to IFOMPT standards of dimensions and competencies. Twenty clinical competencies or measures of performance have been identified with supporting criteria. This form of feedback has been valuable in identifying areas of good practice and areas where individuals can focus on their learning needs through continuing professional development (CPD).

Autonomous practice

Autonomous practice is defined by the American Physical Therapy Association (2009) as being 'characterized by independent, self-determined

Box 1.20

Assessment of standards of clinical practice

Assessment of clinical practice matched to IFOMPT dimensions 1–8.

There should be evidence, in practice, of the criteria below.

Subjective examination

- **Demonstrate a patient-centred approach to clinical practice (dimension 6)**

  The patient is consistently given choices

  The patient is consistently included in decision making

  Informed consent is clearly sought throughout

  The therapist recognizes the body's capacity to inform and drive decision making

  The clinical reasoning process is patient-driven and decisions made are clearly based on evidence from the patient

  There is a focus on 'you' as the patient
- **Demonstrate a collaborative approach to interviewing (dimensions 6 and 7)**
  - Use of open, unambiguous questions
  - Questions focus on the patient experience of their complaint
  - The therapist listens to the patient (i.e. no interrupting, not bombarding them with questions)
  - Directed questions are the exception rather than the rule
  - The patient is given an opportunity to tell their story
- **Demonstrate an attention to detail in information gathering (dimensions 6 and 7)**
  - Detailed analysis of patient's main problems, body chart (symptom areas and nature), behaviour of symptoms (including analysis of movement tolerance and acceptance), present and past history of symptoms, relevant medical and health questions and risk factors
- **Demonstrate thoughtful and effective communication strategies (dimension 7)**
  - Attention to non-verbal issues such as patient/therapist positions during interview, barriers to communication
  - Attention to developing an effective therapeutic relationship (patient at ease, included)
  - Questions asked with clarity and one at a time
  - Clear meaning to the question
  - Attention to seeking reliable answers
  - Questions unbiased
  - Therapist recognizes the importance of key words and phrases
  - Need for immediate response questions and feedback loops identifed ('so are you saying that ...?')

Box 1.20—cont'd

- **Demonstrate advanced skills in clinical reasoning (hypothetico-deductive, pattern recognition) (dimension 6)**
  - Multiple hypotheses considered and analyzed (deductive reasoning)
  - Clear use of knowledge to support analysis of clinical evidence
  - Ability to recognize clear patterns of clinical presentation (inductive reasoning)
  - Clear explanation to the patient of fndings from interview, examination and treatment, what they mean and what should be expected (diagnostic, narrative, procedural and prognostic reasoning)
- **Demonstrate an expert awareness of differential medical diagnosis and risk/beneft analysis (dimension 2)**
  - Identify patient's current medical and health status
  - Understanding of medication
  - Understanding results of medical screening
  - Awareness of differential diagnosis (mimicking symptoms)
  - Awareness off red flag/yellow flag issues
- **Demonstrate expertise in linking the patient experience to physical examination assessment (dimension 6)**
  - Attention to planning physical examination (including agreement and consent on state of undress)
  - Knowing what tests to carry out and to what degree (to P1 or L)
  - Identify potential and relevant contributing factors
  - Any special testing needed
  - Possible interventions

Physical Examination

- **Demonstrate expertise in observation (dimension 8)**
  - Time allocated to general and specifc observation
  - Recognition of relevant faults
  - Recognizing what is ideal and what isn't
  - Effects of correcting faults on symptoms
- **Demonstrate expertise in analysis of functionally demonstrated movements (dimension 8)**
  - Linking functional demonstration directly to complaints
  - Identify clear parameters of movement impairment (limitations and restrictions)
  - Detailed analysis of the functional movement
- **Demonstrate expertise in structural differentiation (dimension 8)**
  - Direct link to analysis of functional demonstration
  - Detail of knowledge of structure and function applied to differentiation
  - Skill in loading and unloading individual movement system structures (arthrogenic, myogenic, neurogenic)
  - Reproducibility and reliability of response and handling
- **Demonstrate a broad and deep range of multidimensional clinical handling skills applied appropriately (dimension 8)**
  - Detail and range of clinical measures adopted (active movement, overpressure, palpation, combined movements, motor control strategies, neurodynamic testing, muscle length strength, joint motion (accessory/physiological, functional corners) specifc diagnostic tests, special tests
- **Demonstrate an ability to clearly link examination fndings to interventions (dimension 6)**
  - Understanding of how to merge examination with interventions
  - Relate interventions to subjective and objective data
- **Demonstrate an ability to use research evidence and knowledge to support clinical decision making (dimension 1)**
  - Relate clinical presentation, clinical measures and interventions to relevant evidence in the literature or knowledge of structure, function and pathobiology
  - Depth and breadth of research portfolio

Treatment

- **Demonstrate accuracy and sensitivity in the application of a broad and deep range of clinical intervention skills (dimension 8)**

  Attention to detail of:
  - Joint mobilization techniques
  - Neurodynamic techniques
  - Motor control strategies
  - Cognitive behavioural/education strategies
  - Exercise design and application
  - Electrotherapy and kindred modalities
  - Self-management
  - Rehabilitation
  - Movement capacity and performance

Box 1.20—cont'd

Reassessment, documentation and analysis

- **Demonstrate an ability to link interventions to appropriate multidimensional outcome measures (dimension 6)**
- Establish clear patient-centred outcomes

  Outcomes related to:
  - Impairment
  - Activity limitation
  - Participation restriction
  - Understanding the context of environmental and personal mediators
- **Demonstrate an expert ability to use reassessment as an effective clinical reasoning tool (dimension 6)**

  Details of reassessment:
  - During treatment
  - After each intervention
  - Before each treatment session
- **Demonstrate an ability to document assessment, examination and treatment in line with HPC and CSP standards**

  Documentation meets professional and medico-legal standards. Documentation is:
  - Accurate
  - Comprehensive
  - Logical
  - Methodical
  - Meaningful
- **Demonstrate an ability to reflect upon clinical skills and theoretical knowledge and the appropriate use of supporting evidence from research and the biomedical, clinical, behavioural sciences (dimensions 2, 3, 4 and 5)**
  - Attribute of reflective practice
  - Identify skills and knowledge used
  - Identify and propose action for skills and knowledge gaps
- **Demonstrate an ability to analyze clinical skills and theoretical knowledge and the appropriate use of supporting evidence from research and the biomedical, clinical, behavioural sciences (dimensions 2, 3, 4 and 5)**
  - Attribute of analytical practice
  - Ability to analyze practice and knowledge in relation to the individual patient
  - Ability to analyze clinical evidence in relation to knowledge and research and vice versa
- **Demonstrate an ability to critically appraise clinical skills and theoretical knowledge and the appropriate use of supporting evidence from research and the biomedical, clinical, behavioural sciences (dimensions 2, 3, 4 and 5)**
  - Attribute of critical appraisal of knowledge and practice
  - Identify reliable and unreliable evidence

Based on IFOMPT Educational standards, part A, Competencies in OMT 1 – (Beeton et al. 2008).

professional judgement and action. Physical therapists have the capacity, ability and responsibility to exercise professional judgement within their scope of practice and to professionally act on that judgement'.

Paris (2008) describes autonomous practice as: (practitioners who are) 'able to work independently of others appropriate to their education'.

The Chartered Society of Physiotherapy (2008) defines scope of practice as:

> any activity undertaken by an individual physiotherapist that may be situated within the four pillars of physiotherapy practice where the individual is educated, trained and competent to perform that activity … And (be) supported by a body of evidence.

McMeeken (2007), in a review of physiotherapy education in Australia, acknowledges that physiotherapists in Australia were the first to practice autonomously and have been doing so since 1976.

In the United Kingdom the then Department of Health and Social Services (DHSS) issued a code of practice in September 1977. HC (77)33 recognized the rights of allied health professionals, including physiotherapists, to make their own decisions about interventions, progression and discharge of patients referred to their service. The circular also recognized the right of therapists to decline to perform therapies that are harmful to individual patients.

The American Physical Therapy Association (2009) outlines the privileges that autonomous practice can bring. These include:

- Development of the patient's direct and unrestricted access to physical therapy services
- The capacity to referral of patients to other medical and health professionals where a patient's health care needs are beyond physical therapy scope of practice
- The capacity to recommend referral for diagnostic test requirements beyond the scope of practice.

Autonomy, therefore, demands practice within professional scope and within a culture of interprofessional collaboration. Autonomous practice is clearly enhanced by the clinical practice framework which is underpinned by the five pillars of clinical practice, the dimensions and competencies matched to IFOMPT educational standards and the recognition of the scope or practice or even extended scope of practice (see Chapter 4).

The bio-psychosocial model of health care

The International Classifcation of Functioning, Disability and Health (WHO 2001)

A paradigm shift has taken place in the allied health professions. There has been a significant move away from the traditional biomedical model of health care to one that also incorporates other constituents of health such as psychological, social, personal and environmental factors (the biopsychosocial model).

Evidence-based or, preferably, evidence-informed practice, forms the basis of clinical guidelines and care pathways for a range of health-related conditions (Childs et al. 2008).

Stucki and Grimby (2007) have identified a need to organize rehabilitation and related research into distinct scientific fields. They also recognize that the human functioning sciences should aim to 'understand human functioning and to identify targets for comprehensive interventions with the goal of contributing to the minimization of the experience of disability in the population'.

Lord Darzi, in his Next Stage Review of the NHS in the UK focused on the idea that 'We can only be sure to improve what we can actually measure' (Darzi 2008).

Bithel (2009) in a preliminary discussion paper on the learning and development strand of the Chartered Society of Physiotherapy focus group on 'Charting the future' asks whether there is a need to move the curriculum towards a social model of disability. By using the ICF as an international standard for measuring health and disability Bithel (2009) argues that ICF could become a tool for improving communication between rehabilitation professions as well as with patients and doctors.

The World Health Organization's International Classification of Functioning, Disability and Health (WHO 2001) has been developed to describe, classify and measure function in health care practice and research. Rundell, Davenport and Wagner (2009) suggest that WHO/ICF appears to provide an effective framework for therapists to prioritize intervention selection by better understanding the patient's experience.

ICF has been linked to: clinical assessment tools (Xiong & Hartley 2008); Specific conditions such as Back pain (Rundell et al. 2009); neck pain (Childs et al. 2008); and goals of interventions (Mittrach et al. 2008).

Sykes (2011) recognizes the importance of the ICF as a framework which physiotherapists can use when trying to unravel the multifaceted and multidirectional nature of human function. Sykes refers to its importance in recognizing not only functional defect but also the role that other personal factors and the environment play in determining what mediates an individual's response to health care issues.

The movement continuum theory of physiotherapy

Banks and Hengeveld (2010) have linked ICF to the bio-psychosocial paradigm of physiotherapy practice through the movement continuum approach presented by Cott et al. (1995).

Interrelated levels of molecules, cells, tissues, organ systems, body parts, person in the environment and person in the society influence the movements of a person. It is recognized that external, social and cultural factors, as well as internal, physiological and psychological factors will influence the movement functions at each level of the movement continuum. Each level has a *current movement capacity* and a *movement potential*, which ideally should be the same. In this movement continuum

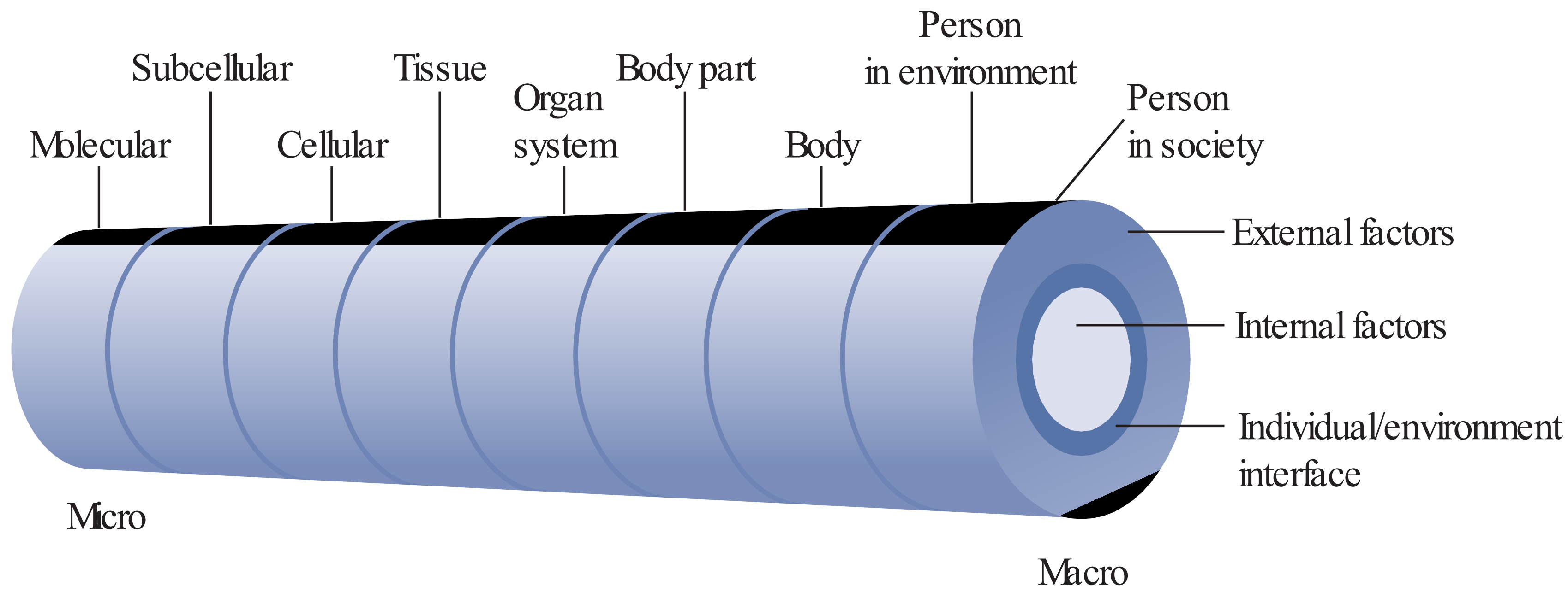


Figure 1.14 • Movement continuum theory: suggested model of body of knowledge of physiotherapy. The levels are interdependent, functions of one level influence movement capacity of other levels. This model should incorporate all concepts of physiotherapy practice. Reproduced by kind permission from Cott et al. (1995).

all different concepts and methods of physiotherapy should find their place (Fig. 1.14).

Passive mobilization, manipulation and other interventions of manual therapy find their place at the level of movement of 'body parts'. This demonstrates that passive movement may play a central role in 'kick-starting' active movement and independent functioning of an individual in many movement disorders. However, if recovery of full functioning is being achieved, this needs to be determined by regular reassessment, which is another core element of the Maitland Concept of manipulative physiotherapy. Other movement and associated therapies may need to be included in the treatment programme if functional restoration seems to be lagging behind.

The movement continuum theory and the International Classification of Functioning, Disability and Health (ICF)

The movement continuum theory (Cott et al. 1995) may become the theoretical model which underpins clinical practice and guides research. However, in daily practice such a model may not be suitable for making a physiotherapy diagnosis, as the micro-levels describe aspects of movement which cannot be directly *observed* within the routine clinical examination.

Therefore, diagnosis in physiotherapy may be expressed in terms of movement dysfunctions using the levels of disability as described in the International Classification of Functioning, Disability and Health (ICF) (WHO 2001) (Box 1.21, Fig. 1.13).

The analysis of movement-impairment has been the original domain of manual therapists, in which passive movement and manipulation frequently play a central role. Figure 1.15 delineates a model in which manual therapists may be able to

Box 1.21

ICF domains

- Functions are the physiological or psychological functions of body systems
  - Body structures are anatomical parts of the body such as organs, limbs and their components
  - Impairments are problems in function or structure such as significant deviation or loss
- Activity is the execution of a task or action by an individual
  - Activity limitations are difficulties an individual may have in executing activities
- Participation is involvement in a life situation
  - Participation restrictions are problems an individual may experience in involvement in life situations
  - Environmental and personal factors make up the physical, social and attitudinal environment in which people live and conduct their lives
- Health condition: any pathobiological process influencing the levels of functioning

WHO, 2001

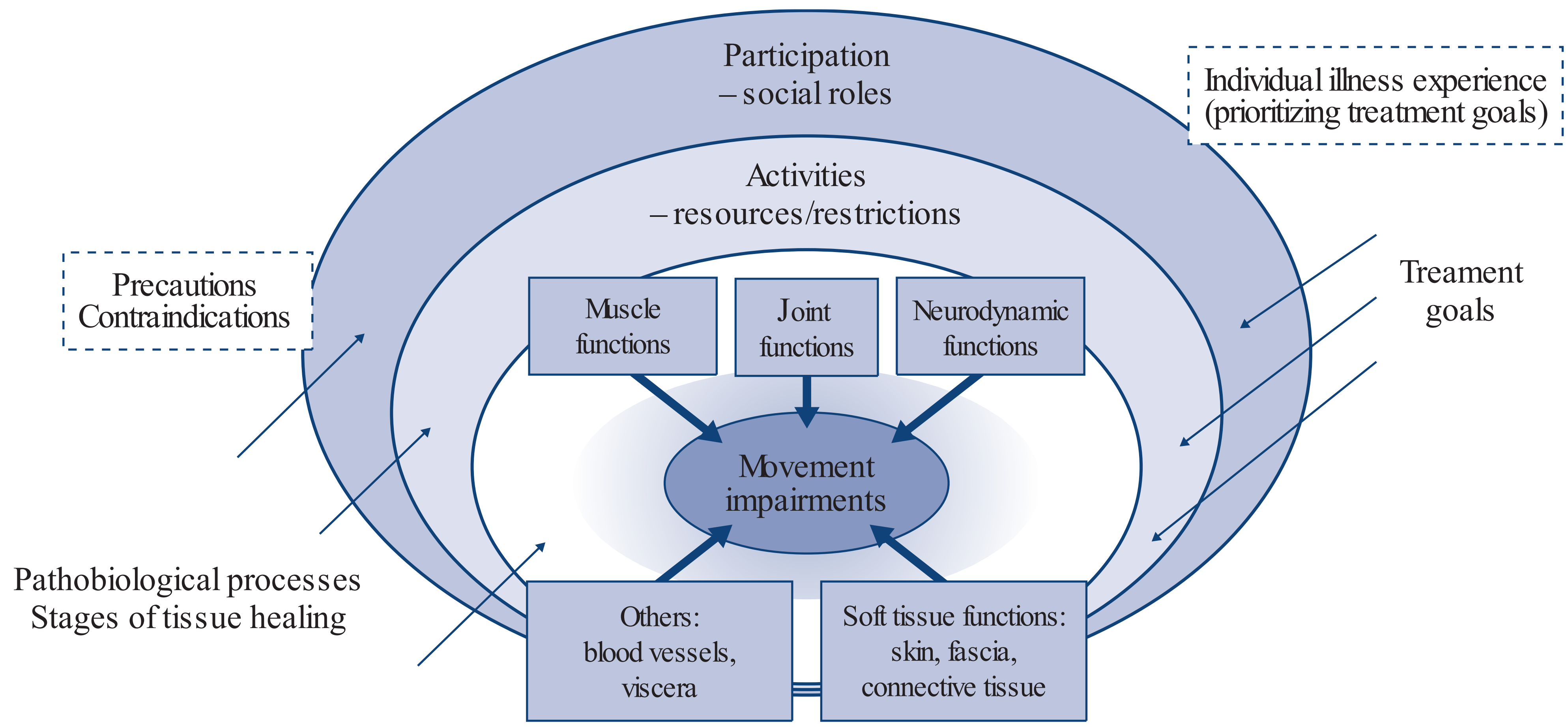


Figure 1.15 • Model of ICF in which manual/NMS physiotherapists integrate the specific taxonomy of the analysis of movement impairments. Adapted from Hengeveld 1999 with permission.

integrate their specific body-of-knowledge and practice into the model of the ICF (Hengeveld 1998, 1999).

This model presented here may further serve to support comprehensive treatment objectives at all levels of disability, in which the individual illness experience (Kleinmann 1988) will be the priority in goal-setting.

With the ICF model, the specific strengths of allied health professions can be maximized. For example, community physiotherapists and occupational therapists have developed skills in rehabilitation at the level of activities and participation. Manipulative physiotherapists utilize their manual and rehabilitation skills within all of the ICF domains and levels of the movement continuum including: physical impairment (e.g. muscle weakness); activity limitations (e.g. walking); and participation restriction (e.g. playing tennis). Within these domains the impact of environmental and personal contextual factors (e.g. beliefs and attitudes and employment circumstances) on how health is mediated are always considered (Fig. 1.15).

From a medical to a bio-psychosocial paradigm

In the past physiotherapy practice and research has been influenced by the biomedical paradigm. Historically, the founders of the physiotherapy profession in the nineteenth and twentieth century accepted medical hegemony and adopted biomedical perspectives in their work to support their professional recognition and permission to practice (Parry 1997, Barclay 1994, Welti 1997).

Over the past decades, however, the biomedical model has been challenged, both in the fields of medicine and physiotherapy. Engel (1977) challenged the biomedical model, by arguing that it placed too much emphasis on pathology without consideration of the psychosocial impact of illness and disease.

From a bio-psychosocial perspective it is suggested that various factors may contribute to the development and maintenance of disease, pain and disability:

- Biological processes
- Emotional aspects
- Cognitive aspects
- Social factors
- Cultural factors
- Behavioural factors.

The role of the biomedical model in manipulative physiotherapy

In spite of the shift in paradigm towards bio-psychosocial models, biomedical thinking (Box 1.22) still has an important role to play in

Box 1.22

The role of the biomedical model

The biomedical model has value in:

- Establishing a medical or orthopaedic diagnosis as an initial point of reference for manipulative physiotherapy
- Medical screening to determine contraindications and precautions to examination and treatment procedures
- Prognosis making – estimating the natural history of healing and recuperation

the clinical reasoning processes of manipulative physiotherapists, for example, in the need to establish precautions, contraindications and the limitations of scope of practice.

The role of the bio-psychosocial model is outlined in Box 1.23.

International classifications of disease (ICD) and functioning, disability and health (ICF) and the brick wall concept

It is also possible to place the ICF in the context of the clinical practice framework of the Maitland Concept through the symbolic permeable brick wall model of compartments of theory and clinical practice as detailed in Table 1.5. Once again, the symbolic permeable brick wall model ensures that the physiotherapist can keep facts and evidence about disease and functioning separate from one another. An understanding of disease processes is a requirement of the brick wall. This understanding, however, should be independent of and not be the driver of, the physiotherapist's ability to make decisions on how to restore a patient's functional capacity and physical performance. The domain of physical health

Box 1.23

The role of the bio-psychosocial model

Bio-psychosocial paradigms are now central to manipulative physiotherapy clinical reasoning, particularly in determining management approaches, such as those that relate to:

- The individual illness experience (Kleinmann 1988) and the individual's frame of reference and the ways in which they have learnt to deal with illness
- Communication skills between patient and therapist. Attentive listening and observation often give an insight into the world of thoughts, feelings, attitude, values, earlier experiences, behaviour of the patient with regard to the disorder
- The psychological and socioeconomic variables in the human experience and how they are more likely to contribute to ongoing pain and disability rather than be a cause of them (Kendall et al. 1997)

The essential components of the bio-psychosocial paradigm are:

- A client-centred attitude, with empathy, unconditional regard, genuineness (Rogers 1980)
- Ability to employ various communication skills
- Collaborative goal setting, joint defnition of parameter to monitor treatment results and selection of treatment interventions with the patient
- Choosing treatment interventions which are meaningful to the patient
- Explanation, information and educational strategies to enhance understanding, motivation and confdence to use the body again
- Awareness of behavioural changes: as manipulative physiotherapists frequently follow objectives to change (movement) behaviour, it is important to realize that behaviour will not change overnight. Insights from cognitive behavioural therapy are helpful in the guidance of a patient in this process of change
- A *salutogenetic* perspective as complementary to a pathogenetic perspective. While a pathogenetic perspective mainly focuses on causative factors and the prevention of disease and other disorders, a salutogenetic perspective concentrates on questions as to why people stay healthy in spite of the presence of certain stressors and which factors help to guide people to fnd a better sense of health. As stated by Antonovsky (1979) 'salutogenetic factors are not necessarily the other side of the coin of pathogenesis'. Other factors, as summarized in the term 'Sense of Coherence' (with the elements of comprehensibility, meaningfulness, manageability), play a role in the question of why people maintain a sense of health and well-being in spite of the presence of stressors.

The role of manipulative physiotherapists is to guide patients towards a sense of health with regard to movement functions. Hence, within professional practice a salutogenetic orientation is already present.

Table 1.5 ICF in context of the symbolic permeable brick wall

Neuromusculoskeletal conditions	Movement-related disorders
ICD-10 (International Classification of Disease) • Biomedical diagnosis • Pathobiology (disease) • **Causes** • Trauma • Degeneration • Disease	ICF (International Classification of Functioning, Disability and Health) • Bio-psychosocial • Functional (performance and capacity) • **Impact** • Impairment (body structure and function) • Activity limitations • Participation restrictions • Contextual factors (personal and environmental)

is, in essence, what defines the physiotherapy scope of practice.

The bio-psychosocial paradigm and healthy living

Moore and Jull (2010), in an editorial, encourage physiotherapists to embrace the challenges to manipulative and movement therapies, which have been driving the changing complexities of health economics and the changing needs of the populations of most countries.

The changes in provision of health care have enabled physiotherapists to focus on quality, innovation, productivity and prevention in the design of their services. Physiotherapy is becoming an important feature of the public health domain whereby the patient is empowered to take ownership of their health in partnership with their health care professionals. High quality clinical skills remain central to these demands.

Outcomes are now the focus of quality within health care (Department of Health 2010). This means that by being able to link patient-reported problems to functional deficit and then by designing health care around interventions which lead to successful functional outcomes, physiotherapists' skills in assessment and clinical reasoning are pivotal. The clinical practice framework presented in this chapter provides an ideal model to meet these changing needs and demands.

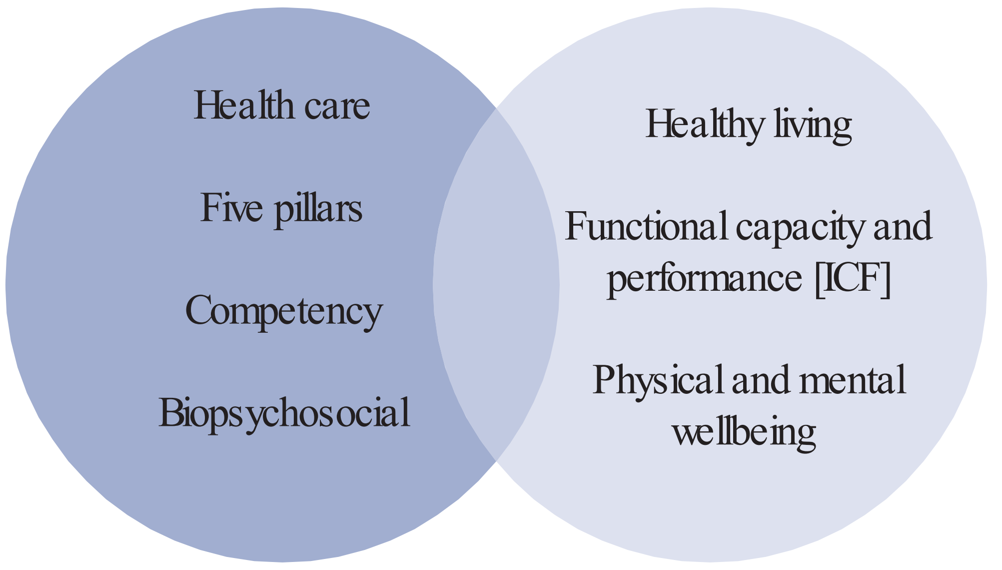


Figure 1.16 • The health care/healthy living interface.

Physiotherapists and other health care professions have a strategic role at the health care, healthy living interface.

Fig. 1.16 demonstrates how skills and knowledge in the neuromusculoskeletal and movement disorder domain can provide effective health care and support the individual in a return to healthy living, the health advantages of which are all too clearly evident.

Ultimately physical and mental health and wellbeing are constituents of and help to promote life expectancy (adding years to life) and above all healthy life expectancy (adding life to years) (Middleton 2008).

Research and the Maitland Concept

Well-designed research is now an established partner of clinical practice and underpins the daily working activity of manipulative physiotherapists (Jones et al. 2006b).

Reliable evidence relevant to manipulative physiotherapy practice is enhancing professional accountability to service users, the public at large, medical and health care peers and the scientific community as a whole.

The Maitland Concept and its features have not been immune from research. In many research papers, designed to measure the reliability and effectiveness of manipulative physiotherapy interventions, the techniques described in such detail by Maitland (1986, 1991) are used as methodological reference standards (Maricar et al. 2009, Fujii et al. 2010, Courtney et al. 2010).

Features of the Maitland Concept which have been subject to varying degrees of academic and experimental scrutiny include:

- Passive movement
- Irritability

- Grades of mobilization and manipulation
- Dosage parameters of mobilization and manipulation
- Movement diagrams
- Assessment/reassessment and appraised.

Passive movement

Maitland (1987) was always a great advocate of the use of passive movement as a therapeutic intervention. Maitland always understood the context of the use of passive mobilization or manipulation within the whole therapeutic process. The demand was that the technique achieved its desired effect and that effect was measurable through detailed subjective C/O and physical P/E markers. If the technique did not achieve its clinical effect then Geoff Maitland was open to different, new and innovative ways of helping the patient. For example, the authors of this chapter once saw him treat a woman with a painful arthritic knee who was not responding to accessory mobilization. He asked the women to lie on a mat on the floor, he used his sternum to apply a compressive force through the knee whilst mobilizing it into extension and adduction.

Maitland believed that 'assessment examination and treatment by passive movements', if carried out with empathy, detail and skilled application would support the patient in being able to move with less pain or with greater mobility. He also believed that passive movement had a different therapeutic effect to active interventions alone.

Zusman (2010) in a perspective on passive movement used analysis of existing research to support a hypothesis that manual application of passive mobilization techniques can 'facilitate optimal repair and tissue integrity when applied to healing soft tissue'. Zusman discusses the present knowledge about the intrinsic sensitivity of connective tissue cells to mechanical stimuli such as stretch, pressure and glide. The implication for passive movement as a therapeutic intervention is also noted.

Connective tissue is known to need regular mechanical stimuli to enhance and maintain tissue health. Evidence is clear (Van Wingerden 1995) that stress deprivation leads to unhealthy and therefore potentially painful tissue.

Zusman (2010) concludes that there is emerging knowledge about how passive movement is likely to be beneficial to optimal healing of recently traumatized tissue. Specific tissue perturbations could facilitate and optimize repair by providing a specific external 'anchor point' needed to enhance the structural and biochemical events associated with healing and growth.

Although related to exercise prescription, Khan and Scott (2009), in a review article, detail how the body converts mechanical loading into cellular responses and structural changes by 'Mechanotransduction'. Shear and compression loading of tissues is thought to cause physical perturbations of the cells that make up the tissue. Evidence from studies on tendon, muscle, cartilage and bone suggest that, 'mechanical stimulus on the outside of the cell promotes intracellular processes leading to matrix remodelling'. The message here is that 'Mechanotherapy', including mobilization and manipulation as well as exercise, has a role to play in promoting tissue healing.

This analysis may well be the 'something different' that Maitland always considered set passive mobilization aside from other forms and uses of therapeutic movement (Box 1.24).

Irritability

Box 1.25 defines the term irritability (Maitland et al. 2005) along with the original definitions of its companions – severity and nature.

Box 1.24

Defining passive movement

Any movement (of a joint or vertebral segment) which is produced by any means other than the particular muscles related to the particular joints or vertebral segment's movement is a passive movement. It includes mobilization and manipulation.

Mobilization

This is a 'passive movement' but its rhythm and grade are such that the patient can prevent it being performed.

Manipulation

Loosely defned as any kind of 'passive movement' used in examination and treatment. A small amplitude rapid movement (not necessarily performed at the limit of a range of movement) which the patient cannot prevent from taking place.

Maitland et al. 2005

Box 1.25

Severity, irritability and nature defined (SIN)

Severity

A symptom is defned as being severe if the activity that causes the pain needs to be interrupted and stopped because of the intensity of the pain. In many cases this is an indication that caution is needed with examination and treatment procedures.

Irritability

Irritability refers to the amount of stimulus (activity, posture, etc.) required to provoke symptoms, the severity of those symptoms and the time they take to settle once the stimulus has been discontinued. Like most things, it exists as a continuum. A very irritable presentation means that a little activity causes a lot of pain that takes a relatively long time to settle. In many cases this is an indication that caution is required during examination and treatment procedures.

Nature of the disorder and the person

Aspects of a problem that require consideration in examination and treatment procedures may include the pathobiological processes underlying the disorder, contributing factors such as osteoporosis, stage of healing, stage and stability of the disorder and certain personal features such as fear of moving.

Smart and Doody (2007) using a qualitative semistructured design research method, interviewed experienced physiotherapists. The purpose of the study was to investigate their clinical reasoning strategies in relation to pain presentations. Through the interviews of seven participants evidence emerged that clinical decisions are based on an evaluation of severity and irritability from the information on pain reports. In particular, assessment of irritability was used to help decide on the extent of any physical examination. And, with severity, there was evidence of the concept of severity and irritability influencing decisions on planning the extensiveness of subsequent treatment. The purpose of such reasoning about severity and irritability seems to be grounded in the clinician's desire to avoid exacerbation of symptoms as a result of examination and treatment. Smart and Doody (2007) conclude that their study supports the use of severity and irritability as a clinical reasoning tool even though there is little evidence of such concepts being explored elsewhere in the literature other than in textbooks.

Barakatt et al. (2009) specifically explored the concept of irritability in patients with low back pain. In a cross-sectional design study, a sample of 183 patients with low back pain (LBP) were recruited from three physical therapy clinics and first asked to complete a series of disability and beliefs questionnaires and a pain-rating scale. Participants were then examined and treated according to practice standards. Therapists were then asked to record their irritability judgement of the subject's low back pain. The study findings indicate that LBP characteristics as identified through disability questionnaire, the presence of peripheralized symptoms and movement analysis (forward bending) are all associated with therapists' judgements of irritability as proposed by Maitland (1986).

Grades of mobilization and manipulation

Whilst idiosyncratic (Zusman 2010) grades of mobilization are accepted in many manipulative physiotherapy quarters as a working model for the refinement and documentation of mobilization techniques (Maitland et al. 2005) (Box 1.26).

There are many instances in the experimental design research and clinical practice guidelines where techniques described by Maitland are used as the methodological standard for trials which evaluate the effects of mobilization on a range of peripheral conditions (Maricar et al. 2009, Fujii et al. 2010, Courtney et al. 2010). Grades of mobilization are also described in research which aims to determine the effects of mobilization on pain and dysfunction (Moss et al. 2007).

Chester and Watson (2000) recognize that physiotherapists typically use rhythmical oscillatory passive movements to treat symptoms of pain and stiffness. Chester and Watson also consider grading as a benchmark against which treatment and progression can be planned.

Jull (2002) acknowledges that the manipulative therapy approach developed by Maitland has underpinned the practice of Australian Physiotherapists for over 50 years and, an audit of treatment protocols for patients with cervicogenic headache from within a multicentre randomized trial, demonstrates that, where manipulative therapy was being applied in practice, both high velocity manipulation and low velocity mobilization treatment techniques were used.

Box 1.26

Grades of mobilization defined

Position in range and amplitude (grade)

- **Grade I:** a small amplitude movement performed at or near to the beginning of the available range
- **Grade II:** a large amplitude movement performed within the *resistance-free* part of the available range (in this case resistance which is frm and starts to limit the movement)
- **Grade III:** a large amplitude movement performed into frm resistance or up to the limit of the available range
- **Grade IV:** a small amplitude movement performed into frm resistance or up to the limit of the available range
- **Grade V:** a small amplitude high velocity thrust movement localized to a single joint or vertebral segment usually but not always near the end of the available range (always within the physiological limits of the joint's movement)
- **Grade V manipulation techniques,** as defned above, should be used mainly for progression of treatment when mobilization techniques to treat stiffness of vertebral segments are no longer effective. grade V techniques require care and experience in selection and application. The detail of the principles and practical application of grade V techniques are beyond the scope of this text and should only be applied clinically after adequate training and practice in accordance with Professional Codes of Practice.

Bazin & Robinson 2002

Rollins and Robinson (1980) in a pragmatic, non-control study evaluated student-physiotherapists' understanding of the grading system (I-IV developed by Maitland). After training and instruction on how to perform grades, students were asked to identify grades performed by an experienced instructor on a videotape. Grades were also performed on students by the instructor. The technique used was the anteroposterior glenohumeral mobilization technique described by Maitland (1991). In this study, out of 720 grades of mobilization randomly allocated there was a 94.5% visual accuracy and 91.7% kinaesthetic accuracy in identifying the correct grade. Although the methodological quality of this study does not hold up to scrutiny, it still provides a snapshot of the potential for the use of grades in skills acquisition and therefore greater competency in therapeutic application.

An example of the use of grades in research related to potential effectiveness of mobilization therapeutically is provided by Fujii et al. (2010). In a cadaver study Fujii et al. explored the effect of mechanically generated distal tibiofibular joint mobilization on ankle dorsiflexion range of movement. The force applied to the tibiofibular joint equated to a grade III mobilization as described by Maitland (1991) leading to a significant increase in cadaver range of ankle dorsiflexion. Although the study is not directly related to patient treatment it demonstrates how the grades of mobilization are being used as methodological standards in research.

In a clinical trial with a control group Courtney et al. (2010) used a grade III posteroanterior knee mobilization technique as described by Maitland (1991) to evaluate the effects this may have on flexor withdrawal response in patients with knee osteoarthritis. This low-powered study demonstrated a significantly reduced nociceptive reflex response (electrocutaneous stimulation) after joint mobilization. Whilst the inferences from this study are limited or non-existent there is still value in recognizing that a strong debate is going on within the physiotherapy world about the clinical, neurophysiological and functional value of graded passive mobilization techniques in conjunction with other interventions.

In a single-case design, Maricar et al. (2009) investigated the effects of exercise and exercise with mobilization on shoulder mobility, function and pain. The mobilization method consisted of the application of grade IV anteroposterior mobilization in flexion and longitudinal caudad mobilization in abduction on a population of patients with adhesive capsulitis. The study found that there was improvement in pain, function and range of movement with both exercise and exercise with mobilization. Range of movement improved more so with exercise and the addition of mobilization.

Nelson and Hall (2011) used lumbar accessory movements to identify segmental hypomobility in a case report of a young tennis player with bilateral dorsal foot pain. Grade III− and grade III unilateral posteroanterior mobilization techniques were used in combinations with lower extremity neurodynamic treatment techniques to effect successful neurodynamic management of this particular young patient. The successful management of this patient is attributable to an attention to detail in clinical reasoning and the application of reliable manual skills and treatment techniques.

Dosage parameters of mobilization and manipulation

A grey area of evidence when selecting and applying oscillatory passive mobilization techniques is in relation to dosage parameters. Hengeveld & Banks (2005) suggest that techniques which are designed to have an immediate modulating effect on severe or irritable movement related pain should be:

- Graded I or II
- Of a slow smooth rhythm
- Of short duration, performed for up to two minutes
- Repeated only once or twice in a session.

Whereas techniques which are designed to have an effect on movement related stiffness and pain should be:

- Graded III or IV
- Of a quicker, sharper staccato rhythm
- Performed for several minutes
- Repeated several times within a session.

Grade V manipulation techniques of peripheral joints are not the main focus of this text and are described in more detail in other texts (Kesson & Atkins 1998). The parameters of a grade V, however, are that they should be of small amplitude and high velocity and only performed up to three times over a number of sessions to achieve their desired effects.

Zusman (2010) suggests that it may be time for the physiotherapy profession to revisit arbitrarily arrived at parameters of passive mobilization such as frequency, delivery and time span of use in order to maximize the emerging knowledge of how specific tissue and cellular mechanical perturbations could facilitate optimum tissue repair.

Table 1.6 details the studies and trials that have used passive mobilization techniques and which have had an immediate effect on pain, movement and function. The treatment parameters are outlined and the reasons behind the selection of these parameters are given. Analyzing the evidence presented in experimental design studies may serve as evidence to inform decisions about technique selection and progression.

Movement diagrams

Movement diagrams were developed within the Maitland Concept 'solely as a teaching and communication aid' (Maitland 1991). The idea was for the movement diagram to serve as a 'dynamic map', whereby clinicians can analyze passive movement, (e.g. hip flexion/adduction), in terms of available range and the relationship between clinical features such as pain, resistance (stiffness) and spasm with movement. With this analytical understanding the clinician can then make a link to the reasoned application of appropriate grades of mobilization.

Figures 1.17 and 1.18 remind the reader how a movement diagram can be constructed.

Evidence in the literature demonstrates that attempts are being made to validate movement diagrams as tools for pain and motion indicators (MacDermid et al. 1999), as a measure of treatment effectiveness (Conroy & Schneider 2005), and as a tool to try to enhance intertherapist reliability in performing grades of movement through a greater understanding of R1 perception (Cook 2003).

MacDermid et al. (1999) in a blind clinical trial demonstrated the use of a movement diagram to assess passive lateral rotation of 34 patients with a variety of shoulder conditions. The study found a correlation between movement diagrams and range of movement assessed with goniometry. There was also a correlation between pain scores and movement diagram recorded pain onset and intensity as well as impairment measures from the movement diagram and patient-rated shoulder disability. There is good reason, therefore, to consider movement diagrams as providing relevant information about movement impairment and pain in patients with shoulder conditions.

In a case presentation on T4 syndrome, Conroy and Schneider (2005) explored the use of a movement diagram to establish the segmental impairment (pain and stiffness) attributable to symptoms associated with T4 syndrome. In this case, the value of the movement diagram was to ensure the correct segment was treated and the grade of posteroanterior mobilization on the thoracic spinous process was appropriate to the pain and stiffness impairments identified by the diagram. Conroy also explored the relationship between the changes in the parameters of the movement diagram with the change in symptoms.

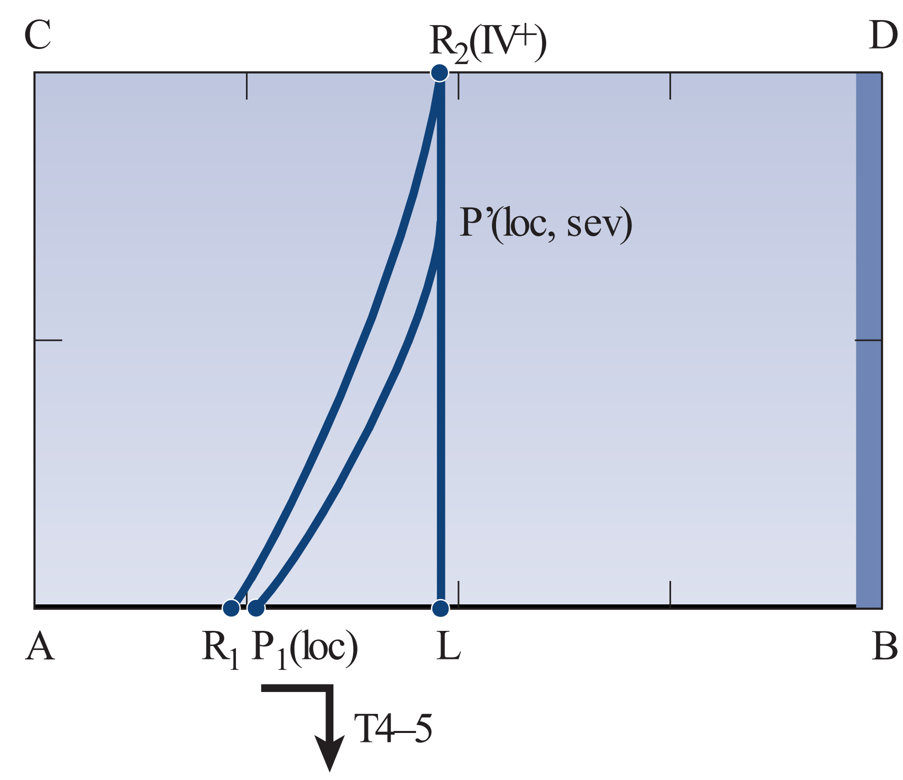
Table 1.6 Parameters of mobilization and manipulation treatment techniques

Citation	Technique	Grade, speed, rhythm, duration	Selection reasoning
Courtney et al. (2010)	Posterior to anterior accessory mobilization techniques on the tibia with the knee in 20 degrees of flexion	Grade III Pain-free range 45 oscillations per minute Six minutes duration Reassessment within 15 seconds	Use of a rhythmical oscillation for joint pain. Assessment of flexor withdrawal reflex as a measure of nociceptive excitability in the presence of osteoarthritis of the knee
Fuji et al. (2010)	Simulated cadaveric postero-superior mobilization of the lateral malleolus	Grade III 30 N force calculated to produce 2 mm of movement of the fibula Cyclical loading from 15–30 N 15 N per second speed 1000 cycles	Use of a grade III large amplitude movement to improve the range of dorsiflexion of the ankle of cadaver specimens
Wang & Meadows (2010)	C5/6 Lateral glide mobilization on the right side	Grade III One to two times per second Five minutes duration	Use of mobilization technique to reduce inhibitory stimuli from the spine causing inhibition of lateral rotation strength of the shoulder
Maricar et al. (2009)	Anteroposterior mobilization of the glenohumeral joint in 90 degrees of shoulder flexion Longitudinal caudad mobilization of the glenohumeral joint in 90 degrees of shoulder abduction (both techniques performed with grade I distraction)	Grade IV Two to three oscillations per second Approximately 30 seconds Repeated if reassessment improvement was noted	Use of end-of-range and small amplitude mobilization techniques to increase shoulder range of motion in patients with adhesive capsulitis
Jull (2002)	High (manipulation) and low (mobilization) velocity techniques to the cervical spine	Eight to 12 treatments over a six-week intervention period	Commonly used treatment techniques for patients with cervicogenic headaches
Herzog (2000)	High velocity, low amplitude cervical spinal manipulative thrust	Typical duration of 100–200 ms Typical force of 100–150 N	Used to produce a number of effects including a temporary increase in the degree of displacement available within a joint

Cook (2003) used the concept of movement diagram construction to explore whether its use as a preperceptual teaching tool helped therapists inter-rater reliability in performing grades of mobilization. There was no evidence that this was the case in this study. However, the author of the study does recognize the intrinsic motor variables of each individual therapist and the difficulties this poses for the universal perception of grades of mobilization.

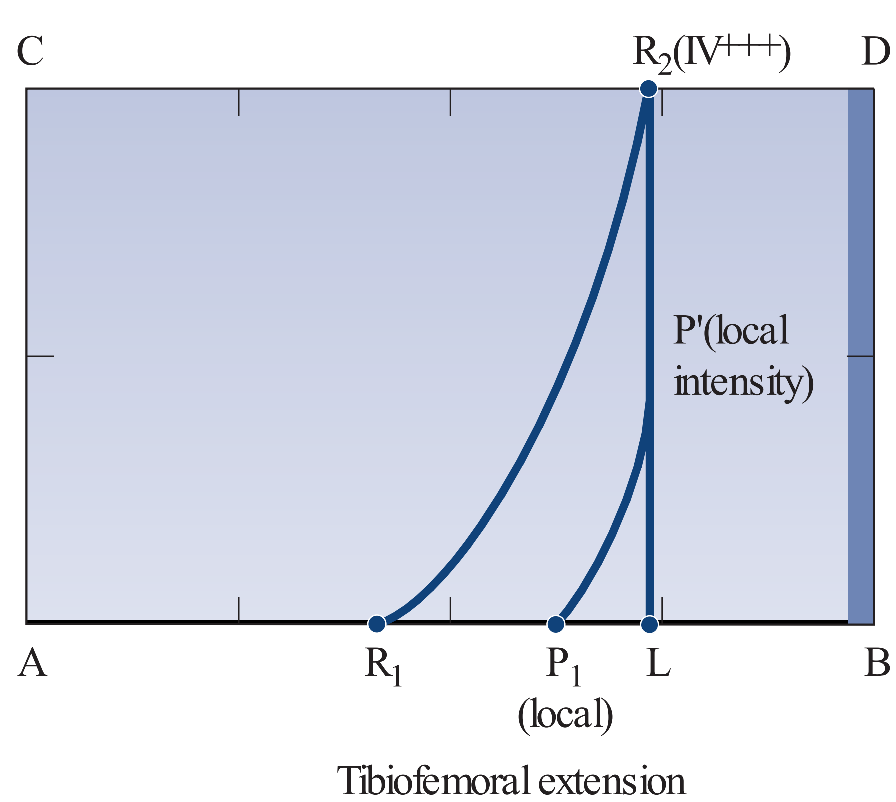
Reassessment

Assessment and reassessment is the keystone that holds decision making together within the Maitland Concept. Attention to detail in assessing changes in a patient's signs and symptoms with treatment is the requirement of the Concept and is integral to the discipline of recording the effects of treatment to evaluate:



AB = A passive movement direction (physiological, accessory, combination)
A = Any starting position
B = End of average normal range (B is naturally variable and is depicted as a thickened line)
AC = The quantity, quality, nature and intensity of the factors being plotted
CD = The maximum quantity, quality, nature and intensity of the factors being plotted
R_1 = The start of perceptible resistance to movement
R_2 = The maximum quantity of resistance allowable
A–R_1 = Friction free feel
R_1–R_2 = The end feel (hard, soft, etc.)
L = Pathological limit of range
H = Average normal end of hypermobile range

Figure 1.17 • Dimensions and features of movement diagrams. Reproduced with permission from Banks & Hengeveld 2010.



- Define parameters
- Choose direction for testing
- Find P_1 (approx/exact)
- Qualify P_1
- Find limit (L)
- Qualify L (R_2)
- Find R_1
- Find and qualify P'
- Connect P_1 to P'
- Connect R_1 to R_2
- Define clinical group and role of mobilization

Figure 1.18 • Constructing a movement diagram. Reproduced with permission from Banks & Hengeveld 2010.

- The effects of treatment during the previous session
- Planning of the next session
- Effects of treatment whilst it is being performed
- Immediate effects of treatment
- Effects in between treatment sessions.

Figure 1.19 demonstrates the documentation of recording of a treatment.

Tuttle (2005) recognizes that physiotherapists use within-session changes in patients' symptoms and signs to help guide and refine treatment and management plans. Tuttle explores the seemingly face validity of Maitland's assessment and reassessment of range of movement, for example, as an indicator of manipulative physiotherapy treatment. The clinical trial explores whether within-session changes in cervical range of movement in patients with neck pain

Examples

Passive movement	
Rx G/H Supine In: 150° F (before P_1) Do: ↓ →→ ↷ lat. IV - IV Smooth rythm, rel, quick Totally ca. 6' 'comfortable': after 4' R1 to L, especially with ▪ – after ca 6' no furhter changes in P or R	**C/O:** 'same' **P/E:** F 160° Ⓛ IV++ ☺ (feels much freer. I can move higher) HBB: range ISQ, P ISQ **Plan:** repeat same Rx: if HBB remains ISQ, do acc, mvt in EOR HBB

Other forms of treatment:	
Exercises	
In sitting: do F/Ad hip ri and le. 5x, ca 10, til slight pulling buttock 'comfortable'	**C/O:** 'lighter than before to stand' **P/E:** LxF: 2cm ✓ ac1 EOR ☺ Hip F: 130° Ⓘ IV+ ☺ **Plan:** do ex. at home/work: at least 3x/day AND when P buttocks starts 1–2 series: 5x/30 each leg
Ultrasound	
Sitting knee extended Rx: US 3 MHz large head; 1:2 int. 1.0 W/cm², 3'; on tender spot, medially knee No pain	**C/O:** 'not tender now' **P/E:** Squat: full ranage ✓ ☺ E/AB: ✓, Ⓘ IV+ ☺ *(frequently it is useful to compare the results and to mark which elements may have improved folowing the intervention)*

Figure 1.19 • Example of recording treatment. Reproduced with permission from Banks & Hengeveld 2010.

predict between-session changes in the same. The study of 29 subjects found that within-session changes in range are predictors of between-session changes and therefore a positive outcome. This study, therefore, demonstrates that explicit evaluation of changes in range of movement during treatment is important in the process of planning progression of treatment towards a successful outcome.

In a further longitudinal observational study of patients with neck pain, Tuttle et al. (2006) demonstrated that changes in impairments of movement during the first two treatment sessions using manipulative physiotherapy can help to predict outcomes in impairment (range of movement) but not in activity limitations (disability index and functional scales). The inferences from this study support Maitland's view that gains during treatment should be translated into functional gains with an emphasis in assessment, not only of range of movement (P/E asterisks), but also on the 24-hour behaviour of symptoms between sessions. In this way an analysis and evaluation of both impairments and activity limitations can be identified and dealt with not only with manipulative therapy but with other more active functional exercise strategies. Maitland would always ensure that treatment had functional carry-over with a well-designed and appropriate home programme.

Cook et al. (2012) followed up these studies by investigating the long-held clinical observation that when patients' pain and movement improve with exploratory manual therapy treatment (mobilization and/or manipulation) during initial assessment and at subsequent follow-up visits, this provides good evidence that the patient has and will respond well to manual therapy intervention. Cook et al. (2012), therefore, carried out a secondary database analysis of a randomized clinical trial. This study of patients treated with manipulation and mobilization for low back pain tried to establish whether within-session changes (improvement in either pain and mobility during a single visit) and between-session changes (carry-over improvement at subsequent visits) were experimentally associated with self-reported functional improvement, pain reduction and enhanced recovery. If this association was present, a further objective was to determine the extent of change needed to establish this association between within-session or between-session changes and functional recovery.

If patients exhibited within-session changes in the reproduction of their symptoms with a unilateral posteroanterior movement or a central posteroanterior movement, they progressed to the treatment phase. All patients (N=102) were then treated by experienced physiotherapists with manual therapy, home exercises and other modalities as they would be in clinical practice. Self-reported findings (numerical pain rating scale, Oswestry disability questionnaire, rate of recovery and within-session or between-session scores for pain) were then collected (on initial assessment) after two visits and on discharge.

The results of 100 patients who progressed to discharge suggest that if patients report a significant within-session or between-session reduction in findings, this is useful in determining who will most benefit functionally. There is no significance, however, in within-session or between-session changes and high self-reporting of rate of recovery.

The authors acknowledge that inferences cannot be drawn from this study as there was no control group and the lack of impairment-based outcome measures, such as range of movement, limits the true clinical application of the study results.

They concluded, however, that evaluating within-session and between-session changes in self-reported findings, complements clinical decision making in that it provides evidence of who is likely to respond to manual therapy treatment.

The oxymoron that is the Maitland Concept

The clinical practice framework presented in this chapter contains all the features of the Maitland Concept as presented by Geoff Maitland (1987). The framework is designed as a structure that is transferable into clinical practice.

Whilst it does not give all the answers it helps manipulative and movement therapists to operate effectively in the domain of NMS and movement-related disorders (WHO 2001). The framework for clinical practice developed by GD Maitland, up to the point of his retirement, is an oxymoron in many ways. Geoff Maitland, himself, was fiercely passionate about manipulative physiotherapy yet gentle and caring in his relationship with all his patients. The Concept reflects this in being stubbornly adaptable in its principles. It demands a scientific artistry to its skills. It allows logical laterality in thinking. It is complex in its detail yet simple in its desired effects.

These are the strengths of the Maitland Concept and if it is used in a way that provides a firm and immovable structure and yet is able to embrace change and progress then it will serve its purpose and be sustainable and accepted for another 50 years or more.

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The Maitland Concept: Evidence-based practice and the movement sciences

2

Elly Hengeveld

CHAPTER CONTENTS

Key words

Movement continuum theory, ICF, evidence-based practice, client centeredness, paradigms of movement-analysis and treatment

Introduction

In the past few decades the science of physiotherapy has established itself in the field of the movement sciences. It has become accepted that physiotherapists follow a specific movement-rehabilitation paradigm within a bio-psychosocial framework (CSP 1990, CPA 1992, KNGF 1998, APTA 2001).

The roots for this perspective are inherent to the profession, however, it was Hislop's groundbreaking lecture, which laid the foundation for movement as the core of the declarative knowledge of the profession (Hislop 1975). She proposed a cybernetic model with a hierarchy of functions for the research, analysis and treatment of human motion. Cott et al. (1995) have elaborated on Hislop's model with the movement continuum theory of physiotherapy (Fig. 2.1). Interrelated levels of molecules, cells, tissues, organ systems, body parts and physical and social environment all have an influence on a person's movement functions. It is recognized that external, social and cultural factors, as well as internal, physiological and psychological factors influence the movement functions at each level of the movement continuum. Each level has a current movement capacity and a movement potential, which ideally should be the same. In this movement continuum all the different concepts and methods of physiotherapy should find their place.

The World Confederation of Physical Therapy (WCPT) also recommends following a movement paradigm and adheres to Cott et al.'s movement continuum theory by pointing out that:

> [Physiotherapy] is concerned with identifying and maximizing movement potential within the spheres of promotion, prevention, treatment and rehabilitation. This is achieved through interaction between physical therapist, patients or clients and caregivers, in a process of assessing movement potential and in working towards agreed objectives using knowledge and skills unique to physiotherapy … It places full and functional movement at the heart of what it means to be healthy.
>
> WCPT 1999, p 7

Physiotherapy diagnosis and ICF

In the developmental process of this specific physiotherapeutic movement paradigm, numerous authors around the globe postulated the necessity of this viewpoint as well as the need for clinicians to

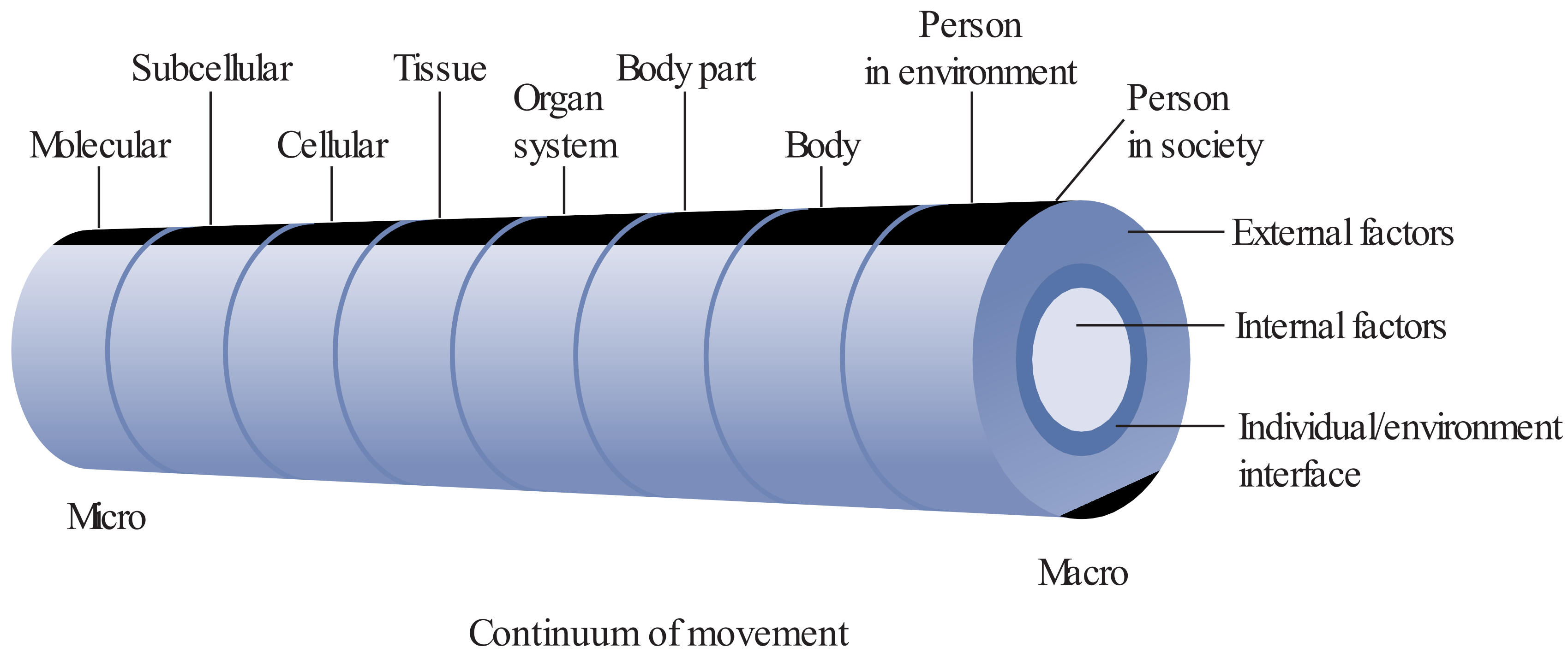

Figure 2.1 • Movement continuum theory: suggested model of body of knowledge of physiotherapy. The levels are interdependent: functions of one level influence movement capacity of other levels. This model should incorporate all concepts of physiotherapy practice. Reproduced with permission from Cott et al. 1995.

make a movement diagnosis as a basis for treatment (Rose 1988, 1989; Sahrmann 1988, 1993, Guccione 1991, Grant 1995, Delitto & Snyder-Mackler 1995, Hüter-Becker 1997, de Vries & Wimmers 1997). Also Maitland, in his early development of the concept, postulated that his work was related to the treatment of 'movement directions', which need to be analyzed on their quality, range of motion, motor reactions and pain. The core of the concept was dedicated to the rehabilitation of movement functions, overall well-being and meaningful actions (Maitland 1986).

The World Confederation of Physical Therapy takes a clear stance with regard to physiotherapy diagnosis and movement functions:

> Diagnosis arises from the examination and evaluation and represents the outcome of a process of clinical reasoning. This may be expressed in terms of movement dysfunction or may encompass categories of impairments, functional limitations, abilities/disabilities or syndromes.
>
> WCPT 1999, p 7

International Classification of Functioning, Disability and Health (ICF)

While the movement continuum theory (Cott et al. 1995) eventually may become the theoretical model which underpins clinical practice and guides research efforts, in daily practice it may not be suitable for making a physiotherapy diagnosis, as the micro levels describe aspects of movement, which cannot be directly observed with the regular clinical examination tools of the physiotherapist.

Therefore, diagnosis in physiotherapy may be expressed in terms of movement dysfunctions using the levels of disability as described in the International Classification of Functioning, Disability and Health (ICF) (WHO 2001):

- Functions are the physiological or psychological functions of body systems.
- Body structures are anatomical parts of the body such as organs, limbs and their components.
- Impairments are problems in function or structure such as significant deviation or loss.
- Activity is the execution of a task or action by an individual.
- Participation is involvement in a life situation.
- Activity limitations are difficulties an individual may have in executing activities.
- Participation restrictions are problems an individual may experience in involvement in life situations.
- Environmental and personal factors make up the physical, social and attitudinal environment in which people live and conduct their lives.

One suggestion is to incorporate the ICF in the basic taxonomy of physiotherapy and manual therapy practice (Hengeveld 1998, 1999) to allow follow-up of treatment goals beyond impairment levels, as debated by Dekker et al. (1993) and Van Baar et al. (1998ab).

The analysis of impairments of movement functions has been the specific domain of manual therapists for a long time. Figure 2.2 delineates a model in which manual therapists can integrate their

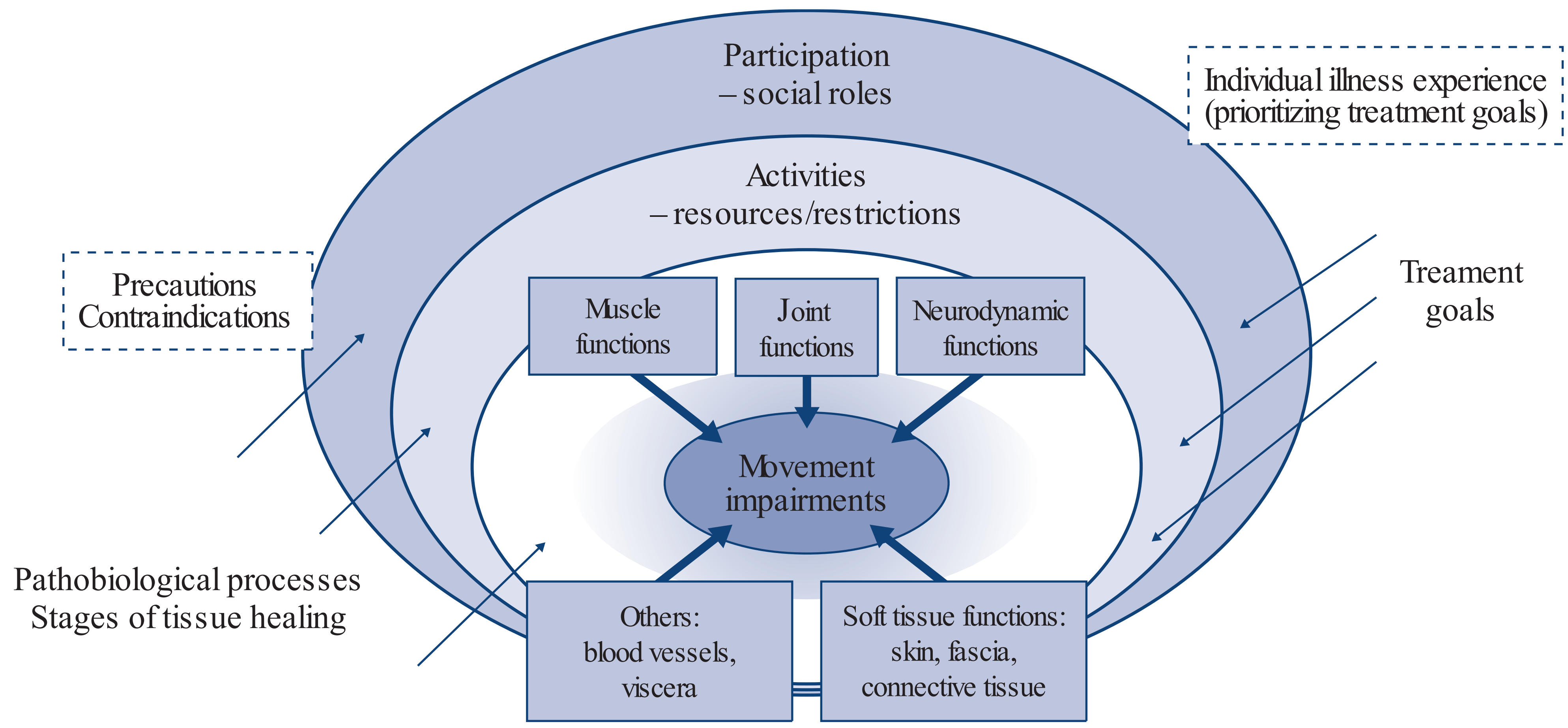

Figure 2.2 • Model of ICF with the integration of a manual therapy-specific taxonomy of impairment analysis.
Adapted from Hengeveld 1998, 1999 with permission.

specific taxonomy of analysis of the components of movement impairment into a model of the ICF. This model may further serve in the definition of comprehensive treatment goals at all levels of disablement, in which the individual illness experience (Kleinmann 1988) may determine the priorities of goal setting at each level of disablement. In rehabilitation, the specific strengths of the different professions may be better utilized: for example, generalist physiotherapists and occupational therapists have developed many skills in rehabilitation at the levels of activities and participation, whereas manual therapists are able to give their special contribution to a team through the analysis and treatment of movement impairments and pain.

Evidence-based practice

The physiotherapy profession has come a long way since Hislop's historical, groundbreaking lecture in 1975. Many countries have established scientific communities and a regular exchange of information at conferences, in peer-reviewed journals and by electronic means is taking place. As is the case with many other professions in the medical field, physiotherapy has moved into the era of *evidence-based practice*. Practice guidelines are being developed and recommendations for care are given based on reviews and meta-analyses of clinical trials.

Evidence-based practice has been defined as follows (Sackett et al. 1998):

> *The conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research.*

It is emphasized that evidence-based medicine is not 'cook book' medicine and the clinician needs a mastery of patient interviewing and physical examination skills (Sackett et al. 1998, p 2, 3, IX).

Dilemmas and challenges of evidence-based practice

Compliance with evidence-based practice is highly recommended; however, at times it may put clinicians in a dilemma when making decisions based on the best available external clinical evidence. Part of the dilemma is caused by the fact that factors other than selecting treatment procedures play an important role in providing optimal care; furthermore, clinicians might encounter problems, which might not have been put under scientific scrutiny in such a way as to be accepted as 'best evidence' within the value system of a given scientific and political community.

Sackett et al. (1998) and Straus et al. (2005) described different levels of evidence, which are, however, in contrast to levels of evidence as described by van Tulder et al. (1999, in Bekkering et al. 2003) (Table 2.1).

Table 2.1 Levels of evidence of different research groups

Level of evidence		Level of evidence		Level of evidence	
I	Systematic review	1A 1B 1C	Systematic review/RCTs RCTs with narrow confidence interval All or none case series	1 strong	Consistent results from several RCTs of high quality
II	RCT – randomized clinical trial	2A 2B 2C	Systematic review cohort studies Cohort study/low quality RCT Outcomes research	2 moderate	Consistent results from one RCT of high quality
III	Quasi-experimental studies	3A 3B	Systematic review/case-controlled studies Case-controlled study	3 limited/ contradictory	One RCT or inconsistent results in several RCTs
IV	Pre-experimental Studies	4	Case series, poor cohort case controlled	4 no evidence	No RCTs
V	Expert opinion	5	Expert opinion		
VI	'Hearsay'				
Sackett et al. 1998		Sackett et al. 2008		Van Tulder et al. (1999) in Bekkering et al. 2003	

It appears that both listings have been developed from different viewpoints. While van Tulder et al.'s list might help scientists with meta-analyses and forms the basis for the development of practice guidelines, Sackett et al.'s list has probably been developed from a clinician's point of view. In particular, van Tulder et al.'s levels of evidence list might cause clinicians problems in various daily clinical situations because physiotherapists often need to make decisions on treatment for problems for which no randomized control trials (RCTs) have been published. For example, the treatment of common problems such as osteoarthritis of the carpometacarpal joint with passive mobilizations and muscular control does not appear to have caught the interest of clinical researchers yet. A CINAHL and Medline Database search up to December 2011 reveals that there are no studies investigating this topic, although numerous studies have dealt with the physiotherapeutic treatment of osteoarthritis of other joints, such as the knee complex or hip (e.g. Hoekstra 2004, Ottawa Panel 2005, Dieppe & Lohmander 2005, Moss et al. 2007, Altmann et al. 2010). Similar examples can be given for the treatment of neurodynamics and movement disorders. A body of knowledge, underpinned by systematic inquiry, is growing, however, to date, only few systematic reviews have been published (Ellis & Hing 2008). Therefore, a list of levels of evidence, which integrates only RCTs may leave physiotherapist-clinicians with a sense of discomfort, particularly because they have been integrated into practice guidelines (Bekkering et al. 2003) and therefore may have implications on policies being derived from them.

The emphasis on experimental, quantitative research, RCTs and meta-analyses as the highest level of evidence may be useful from a somewhat purist scientific point of view. However, sometimes information from qualitative research or clinical case studies might be more informative for clinical decision making than a RCT or meta-analysis.

Clinician physiotherapists may face various other dilemmas with regard to evidence-based practice as, for example:

- In the rehabilitation of painful movement disorders, the way that treatment is applied, the communication between the physiotherapist and the patient and aspects such as motivation, beliefs, learning experiences, collaboration, education, setting, individual concerns and so on may influence the results of the treatments applied (Linton 1998). In decision-making processes with regard to treatment subtle *non-biomedical* cues as intonation of voice, body language, facial expression and selection of words may have a decisive influence on the way treatment is being applied (Stein 1991).

This raised the question: if the effects of a sound therapeutic relationship as a basis for clinical practice have already been researched in such detail that RCTs and meta-analyses would be available to underpin current clinical practice? (Linton 1998).

- Regardless of available studies, it is more likely that evidence-based practice guidelines may at times give an indication as to which decisions *not* to take, such as, for example, avoiding bed rest and overreliance on X-rays, but they may give little indication as to which topics specifically should be addressed, which may be of concern to the individual patient and which may influence the final outcome of the patient's problem (Van Tulder et al. 2006, Vleeming et al. 2008). In an analysis of evidence-based practice and client-centred care, Bensing (2000) raises the question as to how much client-centeredness is represented within evidence-based practice and how far evidence-based client-centred practice has been established to date. She argues that evidence-based practice, in spite of its definition, has become more disease-oriented rather than client-oriented. In a client-centred approach clinicians should base their decisions on the best available evidence and an individual's needs and preferences. She postulates that with the development of guidelines, protocols and standards derived from evidence-based medicine, 'the discussion about norms and values seems to shift from the clinician's consultation room to the conference room of the professional association' (p. 19), in which there may be no space left for individual decision-making processes by the clinician collaboratively with the client. In this way, individualization of treatment may become restricted and the responsibility for clinical decisions shifts from a personal clinician-patient decision to a professional group decision (Bensing, 2000). In a study with audiotaped interviews and questionnaires with one-month follow up Turner et al. (1998) concluded that providers typically addressed medical issues, but did not assess or inconsistently assessed functional limitations related to pain and did not discuss how to resume normal activities, although this was a highly rated goal for most patients. Physicians often did not adequately reassure patients that serious conditions were ruled out, nor did they consistently address explicit worries by the patient. Foster et al. (2008) support the need to assess patients' cognitions about their back problem, as they concluded from their study, using various questionnaires that patients expecting their back problem to last a long time, perceiving serious consequences or holding weak beliefs in the controllability of their pain, were more likely to have poor outcomes six months after initial consultation. On the other hand, Moore et al. (2000) point out that illness perceptions, such as pain-related worries and fear–avoidance beliefs, may be more effectively treated when self-care about pain and functional limitations are addressed at an initial consultation and written information material, such as books or videos, is provided.
- The inclusion and exclusion criteria for many studies form another aspect of the dilemma. Physiotherapists may not always recognize their *own* patients as they are presented in clinical studies: inclusion criteria may be based on pathobiological diagnoses rather than on movement disorders (Maluf et al. 2000) or outcome measures used in the studies may not reflect the relevant clinical outcome measures of pain and movement function of the physiotherapist (Jones & Higgs 2000). Nevertheless in recent years several classifications appear to give a more suitable reflection of the clinical reality of physiotherapists, such as, for example: McKenzie's (1981) classification of pain distribution and a patient's reactions to repeated movements; Sahrmann's and O'Sullivan's classification of movement and motor control (O'Sullivan 2005), and also the adaptation of O'Sullivan's work on movement disorders of the foot and ankle (Kangas et al. 2011). However, it appears that no internationally established, validated classification system is available yet for physiotherapy-specific research (Billis et al. 2007).
- Another dimension of the dilemma may lie in the fact, that many of the problems encountered in daily physiotherapy practice are multicomponential and multidimensional movement disorders, whereas many studies deal with problems which are unistructural in nature, in which it is assumed that the

problems have a single cause and need a single treatment approach.

- Studies with regard to outcome measurements may not be of the same relevance as outcome measurements in daily clinical practice (Jones & Higgs, 2000). Furthermore, it appears that in every newly built scientific community similar discussions seem to take place, on for example, the questions of validity, reliability, sensitivity and specificity of clinical assessment procedures. Some scientists seem inclined to recommend discarding tests with low reliability coefficients, for example, palpation procedures and intervertebral mobility tests, without offering useful alternatives to assess the parameter concerned (Comeaux et al. 2001, Bullock-Saxton et al. 2002). However, a more differentiated analysis of reliability studies and their results show that values may increase if the data are being clustered (DePoy & Gitlin 1998), or when reference standards different from inter-therapist comparisons are being employed (Jull & Bogduk 1988, Phillipps and Twomey, 1996). Although it may be useful to discard examination and treatment methods, which are proven to be ineffective, no relevant procedures should be rejected without offering meaningful alternatives.
- Whether there is an increasing gap between research-based knowledge and its application in clinical practice is debatable. Some authors claim that clinical practice by definition lags behind science (Van den Ende 2004). However, Schön (1983) argues that the *experiential knowledge* base of clinicians needs to be respected, as clinicians often need to interpret incomplete and ambiguous information in order to make decisions with regard to practice. In particular, experiential knowledge with insights or unusual observations from numerous clinical situations may lead to meaningful research questions, which over time could be generalized in overall practice (e.g. the application of neurodynamics examination and treatment or passive mobilization treatment under compression of joint surfaces). In such cases clinical practice may be ahead of science. In fact, it is noted by Parry that many physiotherapists who contributed to current clinical practice employed forms of qualitative research without explicitly referring to it:

> Current practice owes its diversity and vitality to qualitative observation. … Bobath, Knott, Maitland and others who have contributed in no small amount to the knowledge and practice of physiotherapy went through a process, which is characteristic of ethnography, to develop their concepts and techniques. … observed patients and own handling systematically, constantly analyzing the effects … keeping a written record, making comparisons with other records, and using insights from experience to modify techniques. … In this way physiotherapy can run ahead of science for decades before research in the biomedical sciences begins to provide objective supporting evidence. In the interim many innovations will be rejected as well as disseminated according to practitioners' judgement of their effectiveness.
>
> (Parry 1991, p 437)

In order to allow for future innovative practice, and not just to scrutinize existing practice, physiotherapy practice needs clinicians with a balanced approach to the application of research findings and an open mind to clinical presentations which seem at odds with the current actual theoretical models and clinical frameworks. A critical testing of research findings is needed in daily encounters with patients. This requires precise observational abilities, critical self-reflective skills, lateral thinking, profound assessment and consequent reassessment procedures, and a refined and systematic documentation system, which can describe both regular and uncommon clinical observations in sufficient detail. Hence the core elements of this concept of NMS-physiotherapy are as relevant as decades ago, when Maitland first described them.

Evidence-based practice and clinical reasoning

As a consequence of these dilemmas physiotherapists are frequently left to their own devices when making the best decisions with and for their patients in daily practice. They often need a balanced and pragmatic approach towards clinical practice and results from evidence-based practice. Not only will physiotherapists need a *mastery of patient interviewing and physical examination skills* (Sackett et al. 1998), but they will also need a *proficiency in the application of various treatments, including communication abilities and clinical reasoning skills*.

Clinical reasoning may be summarized as 'wise action' (Jones 1995), in which physiotherapists endeavour to integrate three areas into their decision-making processes:

1. The best of science
2. The best of current therapies with sound assessment procedures and varied treatment strategies
3. The best of the patient–therapist relationship, with a client-centred approach with empathy, unconditional regard and genuineness (Rogers 1980), communication, educational strategies and an awareness of the possibilities of a cognitive–behavioural approach to the overall therapeutic process.

Nevertheless, evidence-based practice is an essential skill for enhancing clinical practice; however, it can only be applied successfully with an increased awareness of clinical reasoning processes (Jones & Higgs 2000) and consequent assessment procedures. Here evidence-based practice correlates with one of the main pillars of this concept of physiotherapy: the primacy of clinical evidence (Wells 1996).

The application of consequent reassessment procedures allows for reflection on the decisions made with regard to treatment, be they arriving from the experiential knowledge base or from a propositional knowledge base as evidence-based research findings. Only the clinical results will indicate if the suggestions of the 'best evidence' are indeed applicable to the individual patient. In this way, daily clinical practice may be considered level IV or at times level III of Sackett et al.'s Levels of Evidence, as every treatment session may be considered as a clinical case study, provided these are guided by conscious clinical reasoning processes and consequent reassessment-procedures. It appears that the unique approach to clinical practice with the principles as worked out by Maitland more than four decades ago still seems applicable at the beginning of the twenty-first century. It may be appropriate to conclude this paragraph with the following quote from Professor Lance Twomey, Vice Chancellor, Professor of Physiotherapy, Curtin University of Technology, Perth, Australia:

> Maitland's emphasis on very careful and comprehensive examination leading to the precise application of treatment by movement and followed in turn by the assessment of the effects of that movement on the patient, forms the basis for the modern clinical approach. This is probably as close to the scientific method as is possible within the clinical practice of physical therapy and serves as a model for other areas of the profession.
>
> Twomey in Foreword to Refshauge & Gass (1995)

Movement sciences and paradigms to movement

Paradigms to movement

Maitland's 'brick wall' model of clinical reasoning serves as a framework for decision-making processes (see Chapter 1). It serves therapists to take different viewpoints in the analysis of a person's (movement) disorder and pain. The brick wall model of clinical reasoning delineates that a conscious distinction needs to be made in the application of biomedical, pathobiological knowledge and physiotherapy-specific insights. It serves physiotherapists to dissociate from biomedical diagnoses, without discarding them, and to formulate a physiotherapeutic, movement-oriented diagnosis as a basis for decision-making processes with regard to specific physiotherapeutic treatment. The brick wall model of clinical reasoning laid the foundation for physiotherapists to become aware that they should apply different paradigms in the problem-solving processes with a patient.

In addition to biomedical and physiotherapeutic paradigms, other models and perspectives may be integrated in the brick wall model of clinical reasoning. It is postulated that physiotherapists or manual therapists use various paradigms (models) in their clinical reasoning processes, which, dependent upon the clinical relevance of a given situation, may be employed more or less dominantly (Banks & Hengeveld 2010). Several of these models appear to be more or less profoundly scientifically examined and hence contribute more or less to the accepted body of knowledge of the scientific communities concerned. However, it seems possible that some studies resulting from less dominant paradigms in a scientific community may find less acceptance and may not be regarded as relevant knowledge contributing to the levels of evidence. Figure 2.3 illustrates different paradigms in clinical reasoning processes.

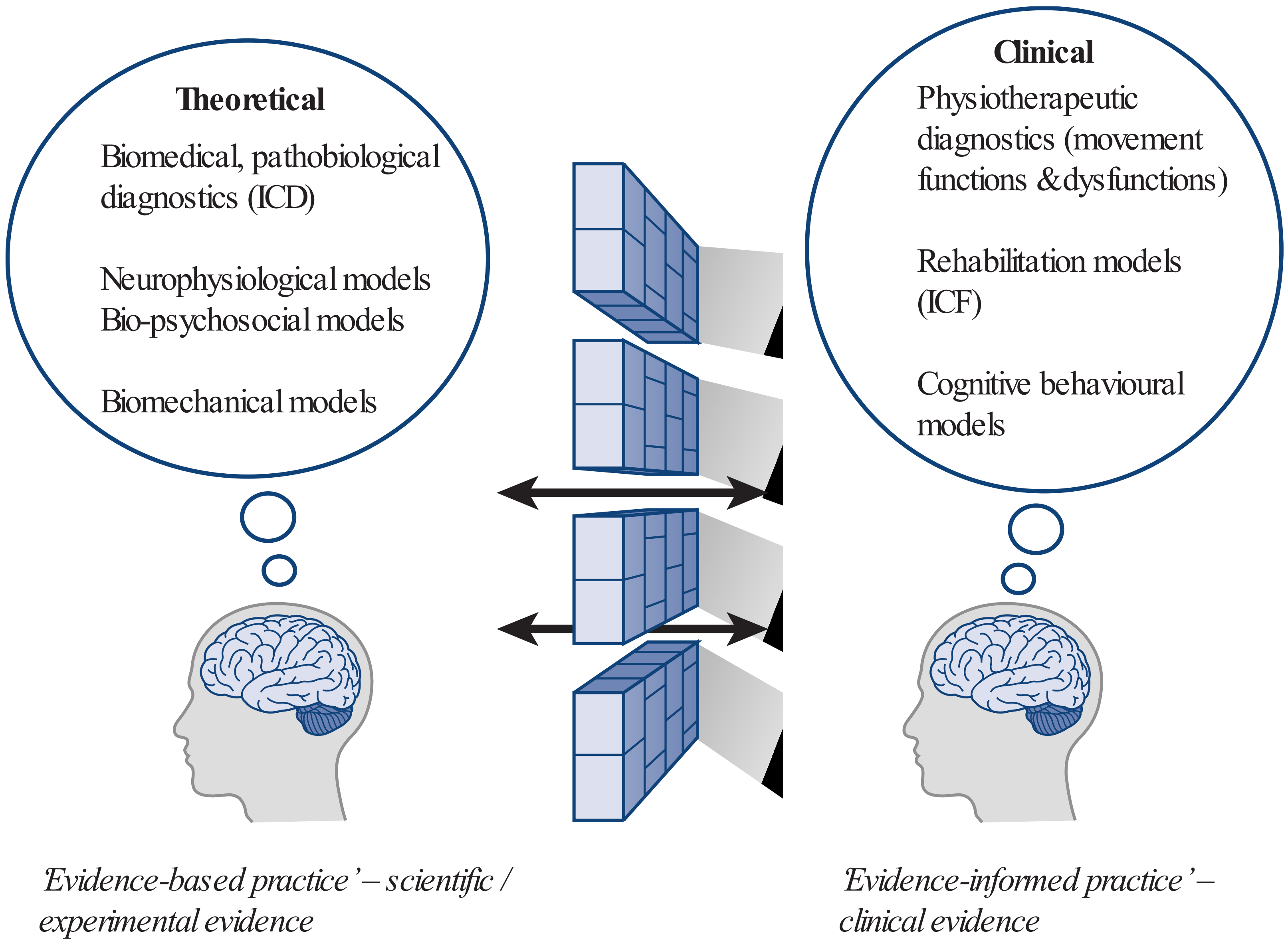

Figure 2.3 • Physiotherapists employ different paradigms in their clinical reasoning processes.

Physiotherapy diagnosis

As stated before in this chapter the basis of physiotherapy diagnosis stems from the subjective and physical examination and exploratory treatments (Banks & Hengeveld 2010). Passive mobilizations play a central role in physiotherapy diagnosis in many movement disorders – not only for screening with the aim of reproducing the patient's symptoms emanating from different joints, neural structures or soft tissue areas, but also during exploratory treatment and reassessment. The latter demonstrates an important principle of this concept of manipulative physiotherapy: *differentiation not only by assessment procedures, but also by treatment*.

Therefor in physiotherapy diagnosis the various forms of assessment, as they have been described by Maitland play an essential role. Not only initial assessments, but also the assessment during and the reassessments after the application of a therapeutic intervention, as well as, at times, retrospective assessments, need to be applied to confirm the hypotheses, which have been elaborated during the therapeutic process, to come a final physiotherapy diagnosis.

The terms of the International Classification of Functioning, Disability and Health (ICF – WHO 2001) may serve as a basis in the description of the physiotherapeutic diagnosis (see Fig. 2.4). A comprehensive description of a patient's condition needs to integrate observations regarding functional and possible structural impairments, activity and participation resources and/or limitations, the influence of biomedical conditions on the levels of functioning and possible social – psychological contributing factors to the levels of functioning (Fig. 2.4).

From biomedical models to bio-psychosocial models

In the past physiotherapy practice and research has been influenced strongly by the biomedical paradigm. Historically, the founders of the physiotherapy profession in the nineteenth and twentieth centuries accepted medical hegemony and adopted biomedical, often positivist-oriented, perspectives in their work to support their professional recognition and permission to practice (Barclay 1994, Parry 1997, Welti 1997, Terlouw 2007). However, over the past decades the biomedical model has been challenged, both in the fields of medicine as in physiotherapy. Engel (1977) challenged the biomedical model by arguing that it placed too much emphasis

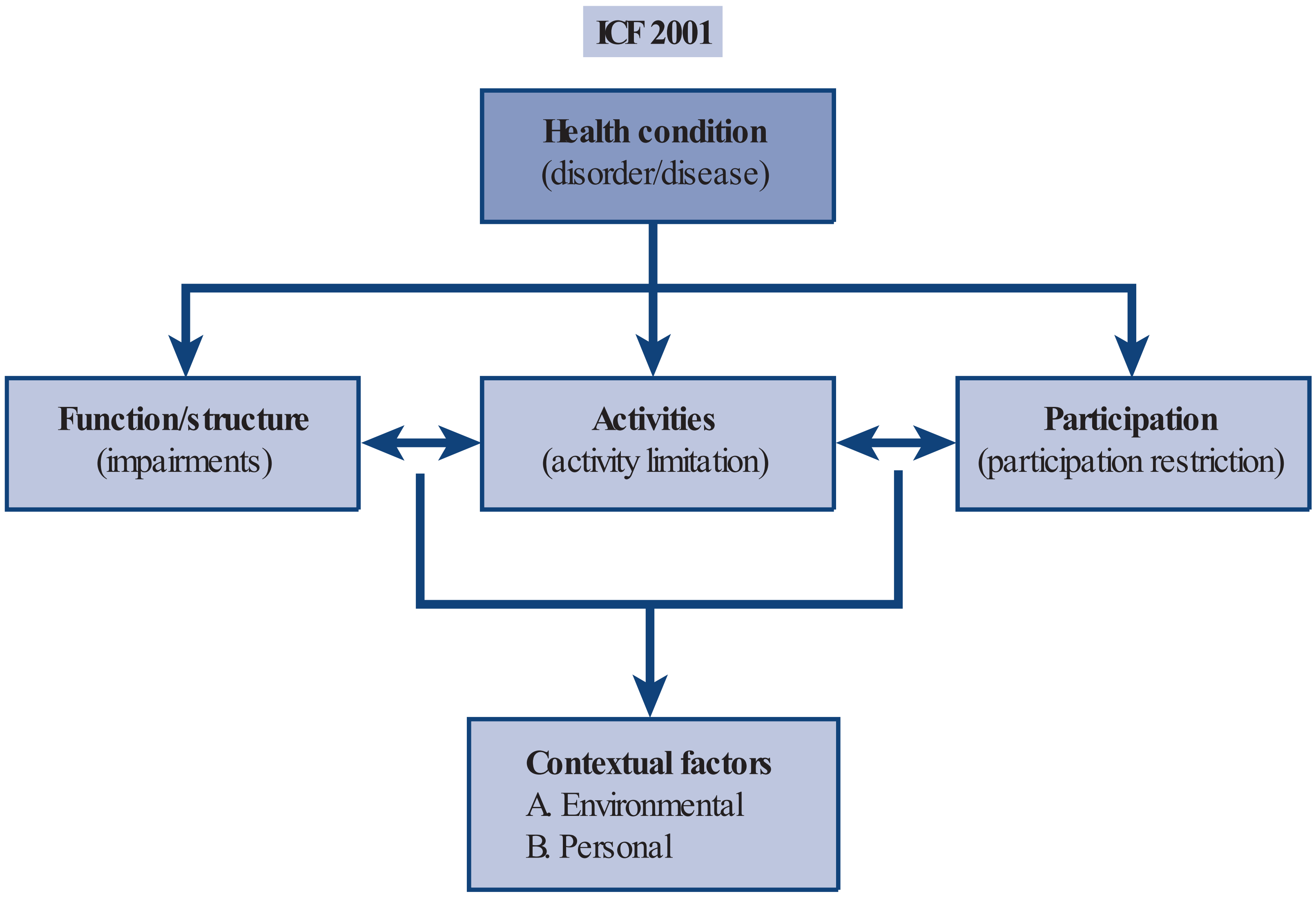

Figure 2.4 • Physiotherapeutic diagnosis needs to encompass all dimensions of the ICF (after WHO 2001). Reproduced with permission from Banks & Hengeveld 2010.

on pathology without consideration of the psychosocial impact of illness and disease. He argued that biomedical models places too much emphasis on explaining illness and disease by deviations in biological processes. The sole application of the biomedical model creates, according to Engel, a dichotomy with organic elements of a disease on the one hand and, on the other, the psychosocial elements of human malfunction, which are often associated with causal principles such as psychopathology or psychosocial problems.

From a bio-psychosocial perspective it is suggested that various factors may contribute to the development and maintenance of disease, pain and disability:

- Biological processes
- Emotional aspects
- Cognitive aspects
- Social factors
- Cultural factors
- Behavioural factors.

The role of the biomedical model

In spite of the shift in paradigm towards bio-psychosocial models and to a more specific physiotherapy diagnosis, biomedical thinking still has an important role to play in the clinical reasoning processes of manipulative physiotherapists. This model is of particular value in:

- Establishing precautions, contraindications and the limitations of scope of practice.
- Establishing a medical or orthopaedic diagnosis as an initial point of reference for manipulative physiotherapy.
- Medical screening to determine contraindications and precautions to examination and treatment procedures
- Prognosis making – estimating the natural healing of healing and recuperation.
- Recognizing specific clinical patterns as a contributing factor to a patient's movement disorder, including their consequences for physiotherapeutic examination and treatment as, for example, movement disorders with a basis in a combination of lumbar stenosis and an activated osteoarthritis of the hip or a stable lumbar disc disorder and so on.

In the current era of shifting towards the integration of psychosocial issues in medical and physiotherapeutic diagnostics and possibly overemphasizing these, it is essential not to neglect pathoanatomical lesions as a possible source of pain, discomfort and disabilities (Hancock et al. 2011, Jull & Moore 2012).

As a biomedical diagnosis may give a hint as to physiotherapeutic diagnostics, a physiotherapy diagnosis may give indications to biomedical diagnostics. In fact, both perspectives on the diagnosis of a person's problem may be in many cases complementary. However, in order to define comprehensive treatment goals and measures collaboratively with a patient, the specific physiotherapeutic examination and assessment procedures, as outlined in this concept of manipulative physiotherapy, should not be skipped over.

The role of the bio-psychosocial model

Bio-psychosocial viewpoints are now central to clinical reasoning in manipulative physiotherapy, particularly in determining management approaches, and relate as such to:

- The individual illness experience (Kleinmann 1988) and the individual's frame of reference – for the ways in which the individual has learnt to deal with illness and/or disability.
- Communication skills between patient and therapist. Attentive listening and observation often given an insight into the world of thoughts, feelings, attitudes, values, earlier experiences and behaviour of the patients with regard to their disorder.
- The psychological and socioeconomic variables in the human experience and how they are more likely to contribute to ongoing pain and disability rather than being a cause of them (Kendall et al. 1997).

The essential components of the bio-psychosocial paradigm are:

- A client-centred attitude, with empathy, unconditional regard, genuineness (Rogers, 1980).
- Ability to employ various communication skills.
- Collaborative goal-setting, joint definition of parameter to monitor treatment results and selection of treatment interventions with, rather than for, the patient.
- Choosing treatment interventions which are meaningful to the patient.
- Explanation, information and educational strategies to enhance patients' understanding, motivation and confidence to use their body again.
- Awareness of behavioural changes: as manipulative physiotherapists frequently follow objectives to change (movement-)behaviour, it is important to realize that behaviour will not change overnight. Insights from cognitive–behavioural therapy and an awareness of the various roles a clinician may play to motivate a person, are helpful in the guidance of a patient in this process of change.

Phenomenological perspective

Within a bio-psychosocial paradigm a phenomenological perspective may play a central role. Within this perspective the viewpoints of Kleinmann (1988) with regard to the individual illness experience and of Antonovsky (1979) with his studies on a salutogenic outlook on health, illness and treatment deserve special attention.

The construct of *individual illness experience* relates to the personal experience of bodily processes and the impact of social and cultural influences on this experience. The following aspects are emphasized (Kleinmann 1988):

- The illness experience is always culturally shaped and is dependent on what a society regards as appropriate behaviour, on the personal biography of the person, and on psychological processes, meanings and relationships, so that the social world is always linked with the inner experience of feeling ill.
- In this experience powers may exist that can either amplify or reduce suffering and disability including the behaviours of others, such as relatives or clinicians. This notion is supported by Pilowsky (1997), who argues that clinicians need to be aware of the influence of their behaviour on the behaviour of the patients they are treating. Furthermore, there is indication that the clinical reasoning of physiotherapists may be different, dependent on the culture in which they are active (Cruz et al. 2012), and may accentuate certain behaviours in themselves and their clients.
- Every professional is trained to translate the illness experience of an individual into theoretical terms of disease and into a profession-specific taxonomy and nomenclature. Therefore it is essential that patients understand that every clinician may have different viewpoints on their individual illness experience, which may serve as a basis for treatment.

- Interpretation of the narratives of this individual experience should be a core task in medical practice. Neglect of the individual account of the personal experience may lead to alienation of the patient from the caregiver.

The perspective of the individual illness experience may be complemented with the *salutogenic viewpoints*, as delineated by Antonovsky (1979). Based on a critical appraisal of research outcomes, which have a tendency to focus on pathogenic factors, the introduction of a *salutogenic perspective* – which follows up questions as to why certain people stay healthy in spite of many stressors – has been suggested.

Whilst a pathogenic perspective mainly focuses on causative factors and the prevention of diseases and other disorders, a salutogenic perspective concentrates on questions as to why people stay healthy in spite of the presence of health-risk stressors, and which factors help to guide individuals to find a better sense of health and well-being. As stated by Antonovsky (1987), 'salutogenic factors are not necessarily the other side of the coin of pathogenic factors'. Based on a study with Second World War concentration camp survivors, Antonovsky noted that a relatively high percentage of participants indicated to be of good physical and emotional health in spite of the many stressors they had had to endure during the years of the war. He concluded that a '*sense-of-coherence*' supports a better resilience to life stressors. This construct supports the development and maintenance of a sense of health, a sense of purpose and well-being. He postulated that health is not a fixed state, but that people move continuously on a continuum between two extremes of 'dis-ease and ease'. In the examination of patients those factors need to be evaluated, which leads to a backward and forward movement on this health–disease continuum. It may be noted that the salutogenic viewpoints are increasingly recognized in health promotion programmes and they are implicitly present in the professional description of physiotherapy practice (Hengeveld 2006).

In particular, the sense of coherence merits attention in this process. It contains three core elements:

- *Comprehensibility*: can the person comprehend the situation in which he finds himself? In the case of physiotherapy practice it is essential to know which perceptions patients have about the cause, diagnosis and treatment options for their problem. Essentially, if the patient understands the basic paradigms of physiotherapy practice, movement functions can support healing processes and may lead to a better sense of well-being.
- *Meaningfulness*: can the person find a sense of meaning in the situation in which he finds himself? Physiotherapists need to take time to explore this construct with their patients and to employ different strategies to enhance the sense of meaningfulness. These may encompass educational strategies about pain mechanisms and the use of (active/passive) movement and relaxation as treatment possibilities as well as regular reassessment procedures in self-management strategies to support the development of a sense of success.
- *Manageability:* does the person appear to have resources to meet the stressors of the situation? Physiotherapists need to develop meaningful self-management strategies, which have to be reassessed regularly in order to contribute to a sense of success and to the meaningfulness of the treatment chosen and manageability of the problem.

To summarize, a salutogenic perspective emphasizes various aspects:

- Reflection on the basic viewpoints on health and disease – which factors may be decisive as to why certain people remain healthy and others get ill in the presence of certain stressors?
- A sense of coherence – this appears to be an important factor for successful coping with stressors and maintaining a sense of health.
- Health and disease – these should be defined on two extreme ends of a dynamic continuum.
- Following both pathogenic and salutogenic paradigms, in which the caregiver seeks those factors which may lead to a move backwards towards an experience of illness. Furthermore, the caregiver also seeks factors which promote a forward movement towards an experience of health or well-being (Antonovsky 1987, Schüffel et al. 1998).

With special attention to wording the true value of the salutogenic perspective can be recognized in clinical practice, for example, during examination, reassessment and treatment procedures. This may guide the patient towards a greater sense of health and well-being. Some examples are given in Table 2.2.

Table 2.2 In a salutogenetic perspective paying special attention to wording is essential

Situation	Pathogenetic orientation	Salutogenetic orientation
Subjective examination: establishing the severity and irritability of a disorder	If it hurts whilst cleaning windows, do you have to stop because of the pain?	Would you be able to continue with cleaning the windows, in spite of the pain you're feeling?
Subjective examination	Why is it worse in the morning?	Why would you think the afternoon is better than the morning? What would you be able to do to make the morning the same as the afternoon?
Subjective examination: 24-hour behaviour	What are you not able to do anymore because of the pain?	Which activities are still possible in spite of the pain? Which hobbies and activities would you really like to do?
P/E: active tests of e.g. Lx, F, E, Sideflexion, Rot.	Could you please bend over? Now turn? etc.	I would like to do the following four movements. (short demo) Which one would you prefer?
P/E: neurological conduction testing	I do not find anything here!	As far as I am concerned, your reflexes, muscles and sensation are perfectly in order.
Examination of accessory movements (many movements are sensitive and the patient demonstrates extreme guarding)	Where does it hurt?	If I move you in this area, where would you feel it to be more comfortable and relaxing?

E = extension, F = fexion, Lx = lumbar spine, Rot. = rotation, P/E = physical examination
(Banks & Hengeveld 2010)

Both perspectives – Kleinmann's view on the individual illness experience and Antonovsky's model of the disease–health continuum – allow for the development of a specific phenomenological perspective on physiotherapy practice (Hengeveld 2003).

On the one hand, physiotherapists need to investigate the more pathogenic factors, which lead to a backward movement on the disease–health continuum, such as, for example, the presence of possible pathobiological processes, the levels of disability, the suffering and distress of a person with regard to the problem and the illness behaviour, which in itself is the result of physiological, cognitive, emotional and sociocultural elements of the experience. On the other hand, in treatment planning it may be useful to 'think from the end' and consider the possible ideal state of movement functions if all treatment objectives could be achieved. In defining treatment goals collaboratively with a patient, physiotherapists may consider which aspects are missing in the 'ideal state' and are particularly meaningful for the patient. (Fig. 2.5). These include:

- Which movement impairments should be improved if an ideal state could be achieved?
- Which activities have to improve? Do any activities regarding participation need to be followed up?
- Is the general level of activity in daily life optimal, too low, or relatively high? If too low, how does one motivate the patient to increase levels of fitness and apply a fitness programme? If relatively high, is there any relaxation strategy that the patient may employ in daily life? Is there any disuse of structures by habituated movement patterns in daily life which need to be addressed?
- Does the patient seem to trust the movement of his or her body in daily life? (If not, how can the manipulative physiotherapist guide the patient to the experience?)
- Does the patient move with an overly increased bodily awareness (and guarding) or does the body seem to be 'forgotten' during meaningful activities?

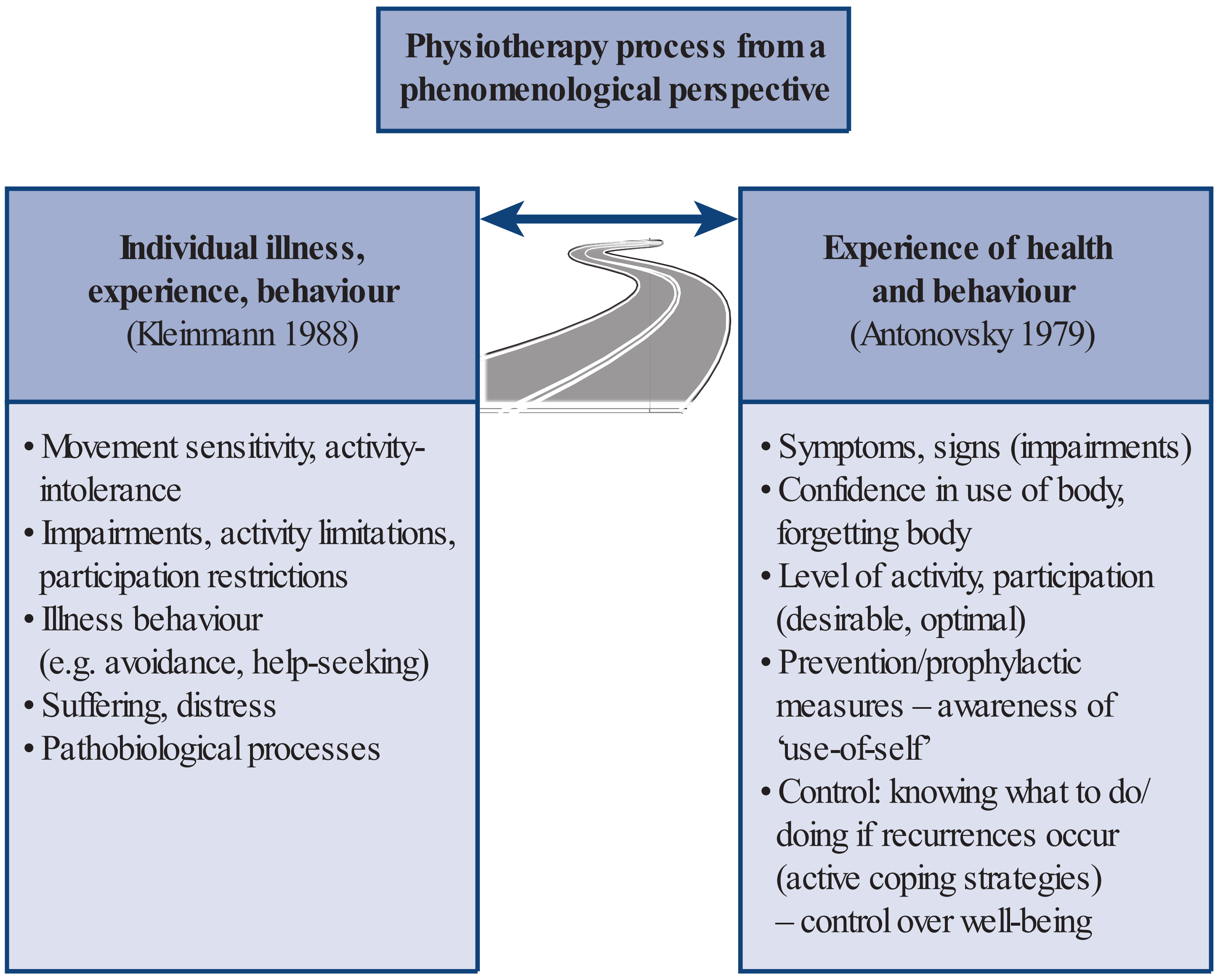

Figure 2.5 • Within a phenomenological perspective manipulative physiotherapists guide patients on a disease–health continuum, towards a sense of health and well-being with regard to movement functions. This approach guides physiotherapists in a comprehensive planning of treatment objectives.

- Is the patient aware of any preventive measures and the way he or she uses the body in daily life situations?
- Does the patient seem to have an adequate sense of control of the pain or well-being? If not, what measures should be undertaken?

Currently only few scientific studies have been undertaken to examine the role of these phenomenological viewpoints of the individual illness experience and the role of salutogenesis on physiotherapeutic clinical reasoning and treatment outcomes.

Neurophysiological models

The introduction and acceptance of the 'gate control' theory in 1965 (Melzack & Wall 1984) appears to have catalyzed a shift in the research, assessment and treatment of pain, in which the dominant biomedical dualistic paradigm is gradually being replaced by a more holistic bio-psychosocial paradigm. In the biomedical paradigm, pain was considered as a symptom directly related to the extent of bodily damage. Consequently, treatment was based on the normalization or removal of the underlying pathology. In the absence of bodily damage the mind was assumed to be at fault and psychopathology was inferred (Vlaeyen & Crombez 1999).

The gate control theory proposed the hypothesis that central nervous system processing was involved in the integration of both sensory-discriminative and affective-motivational aspects of pain. From a neurophysiological perspective the gate control theory implied that pain was not only the result of nociceptive information ascending from peripheral structures, but also that pain could be modulated by descending pathways in the central nervous system. With this theory it has been recognized that pain could be a result of processing in neuronal networks rather than a consequence of tissue damage alone. The implication of this theory was that cognitive, emotional, behavioural, social and cultural dimensions were identified as essential contributing factors to the pain experience of a person.

Therefore, neurophysiological paradigms serve various purposes:

- They serve to develop a broader understanding of the pain experience of the patient.
- They aid in the educational and information processes of patients, to enhance better comprehension of pain and the role of movement and other therapeutic forms in the treatment of pain.
- They may also provide therapists with explanatory models for (manipulative) physiotherapeutic processes and methods within a bio-psychosocial perspective, ranging from interviewing, physical examination procedures, therapeutic interventions, to communication and educational strategies.

- They give basic information on human learning processes and motor learning, in particular.

Neurophysiological pain mechanisms

It is argued that pain should be ascribed to diverse mechanisms of the nociceptive system in neuronal networks rather than to a single neurophysiological pain mechanism (Cervero & Laird 1991) and to elements of neuroplasticity or learning processes (Loeser & Melzack 1999). It is suggested that the assessment of pain should distinguish between these underlying neurophysiological pain mechanisms (Cervero & Laird 1991). Table 2.3 demonstrates the clinical identification and neurophysiological supporting evidence for the main pain mechanisms commonly encountered in neuromusculoskeletal practice. The interventions of a physiotherapist have to be adapted with the incorporation of, for example, self-management and/or educational strategies.

It appears that these neurophysiological pain mechanisms have become a relevant hypothesis category on which clinical decisions are being based in physiotherapy practice. A qualitative study at the end of the 1990s concluded that the conceptualization of pain mechanisms and related concepts still seemed to be an implicit process within manipulative physiotherapy practice (Hengeveld 2000). However, in 2007 in a qualitative study with experienced physiotherapists observing videotaped treatment sessions and interviews, Smart and Doody (2007) concluded that the selected participants integrated the above mentioned pain mechanisms and related concepts in their clinical reasoning processes. In a three-phase Delphi study Smart et al. (2010) established consensus among 103 clinical experts about the clinical criteria by

Table 2.3 Clinical identification of the main neurophysiological pain mechanisms

Neurophysiological pain mechanism	Neurophysiological background	Clinical presentation	Remarks
Nociceptive mechanisms	Activation of A_δ- and C-fibres by mechanical, chemical or thermal stimuli, activating the primary afferent neuron. Following 'all-or none' responses, secondary and tertiary afferent neurons are activated as a result, leading to pain perception (Fields 1988). Numerous areas in midbrain and cortex are involved (Neuromatrix) (Moseley 2003)	Stimulus-response related symptoms. Quality of symptoms may be stabbing, pulling, sharp, dull. Pain and disability in line of natural history of disorder, i.e. normally in the expected time of recuperation pain decreases and ability to move and function increases	In cases of tissue injury, antidromic activity of C-fibres may contribute to the inflammatory process ('neurogenic inflammation') and contribute to a state of hyperalgesia (Fields 1988). However, concurring with the stages of healing this process will be reversed. In fact, its main function appears to lie in the support of healing processes
Peripheral neurogenic mechanisms	May be provoked by changes in blood pressure gradients (Sunderland 1978), abnormal impulse generating sites due to changes in ion channels, trauma such as traction or rubbing (Butler 2000)	Stimulus–response related symptoms. Pain and disability in line of natural history of disorder. May be more severe. Quality burning, throbbing, cramping. May be particularly severe at rest. Symptoms and disability may follow course of the natural history of the disorder; however, due to the underlying mechanisms this may take more time than dominant nociceptive mechanisms	Treatment first may need to be addressed to the tissues surrounding the nerves (interfaces), before directing treatment to the nervous system by palpation, 'slider' or 'tensioner' techniques (Butler 2000, Shacklock 2005, Coppieters & Butler 2008)

Table 2.3 Clinical identification of the main neurophysiological pain mechanisms—cont'd

Neurophysiological pain mechanism	Neurophysiological background	Clinical presentation	Remarks
Central nervous system (CNS) modulation	Ongoing sensitized states in dorsal horn, thalamus, cortex. Pathophysiological processes as well as cognitive, emotional and/or behavioural factors may play an important role in ongoing sensitization (Woolf 1991, Jeanmonod et al. 1993, Gifford & Butler 1997)	No clear relationship between pain, disability, natural history of the disorder and movement behaviour. Clinical presentation does not necessarily follow a clear recognizable clinical pattern	Especially the modulatory influence of the central nervous system on transmission of nociceptive impulses has received increasing attention in physiotherapy literature, in which it is recommended to view the central nervous system as an integrated cyclical system rather than a simple cause-and-effect system distinguishing between afferent and efferent aspects of function (Wright 1999). A sensitized state is a normal phenomenon in injuries but over the course of healing normally the sensitization decreases. However, in some cases due to pathophysiological processes (e.g nerve trauma) or due to cognitive/ emotional/sociocultural/behavioural factors the CNS remains sensitized
Autonomic nervous system mechanisms	The autonomic nervous system is considered a mediator in the patient's experience of pain. The level of autonomic activity is determined by the level of threat of the pain experience and is expressed in 'fght or flight' stress responses (Selye 1976, Sapolsky 1994)	Pain may be perceived in a more generalized area, limbs may feel swollen, cold and with differences in sweating reactions	From a clinical perspective, whilst the threat imposed by the pain is still present, the autonomic activity will be maintained until the threat level, whether this is due to physical, psychological or socioeconomic factors, is dealt with

Banks & Hengeveld 2010

which mechanism-based classification patient presentations are made. A common denominator in hypotheses generation with regard to nociceptive mechanisms and central nervous system modulation appeared to lie in the relationship between the onset of symptoms and the subsequent reduction of pain and improvement of activity levels with the expected time of tissue regeneration and the perceived sense of control over pain and general well-being. In standardized assessments of patients, it has been described that the classification accuracy of nociceptive mechanisms and peripheral neurogenic mechanisms is high in patients with low back pain and leg disorders (Smart et al. 2012a, 2012b, 2012c).

End-organ dysfunction and altered nervous system processing – complex clinical reasoning processes

The complexity of clinical reasoning processes on multiple, parallel tracks is demonstrated by the neurophysiological pain mechanisms. On the one, hand a clinician needs to relate active nociceptive and peripheral neurogenic mechanisms to possible tissue pathology, which needs further medical action or serves as a specific precaution or contraindication to physiotherapeutic interventions. On the other hand, the way in which the altered nervous system processing is influencing the pain experience and disability of a person needs to be considered. In particular, at the present time when psychosocial issues receive more attention than before (Hancock et al. 2011) and where practice guidelines may become a restricting factor in free clinical reasoning processes (Bensing 2000), it is imperative to consider possible tissue pathology as 'endorgan dysfunction', which needs to be addressed appropriately.

Apkarian and Robinson (2010), therefore, propose focusing, on the one hand, on an 'end-organ dysfunction model' (EODM) in which a recognizable event led to the development of symptoms and the symptoms coincide with a recognizable presentation, which can be ascribed to certain tissue or pathobiological processes. In EODM no altered nervous system processes may be suspected, that is, the pain should decrease and the level of activity should improve over the time of tissue regeneration. Symptoms and signs demonstrate a recognizable, repeatable stimulus-response pattern. On the other hand, if symptoms and signs do not relate to the history or to stimulus-response repeatability, altered nervous system processing models (ANSPM) should be considered.

Dynamics of a pain experience

A pain experience and related disability often change over time. This can be due to interactions between the individual, his or her environment and medical professionals (Delvecchio Good, et al. 1994) or due to an increasing influence of cognitive, emotional and behavioural factors (Vlaeyen & Crombez 1999), which may include an increasing sense of distress or suffering, worries, anxiety, a sense of helplessness because of not being able to control the pain or even a sense of worthlessness and impaired self-esteem (Corbin 2003). Therefore it can be argued that the interpretation of neurophysiological pain mechanisms may be too linear and that it acknowledges the dynamics of a pain experience insufficiently. As the dynamics of pain start to change over time, the physiotherapist needs to be aware that whereas functional capacity may improve, the pain experience or the sense of helplessness may not improve correspondingly and therapeutic interventions should reflect this common phenomenon. The interventions of a physiotherapist have to be adapted with the incorporation of, for example, self-management and/or educational strategies.

Integrative, dynamic models of pain

From a neurobiological perspective, integrative models express the dynamics of a pain experience to which the approach to therapy needs to be adapted. Such models include:

- The mature organism model (Gifford 1998)
- The processing model (Shacklock 1999).

These models try to explain the pain experience from the perspective that input of noxious stimuli will be processed in the central nervous system, which consequently may influence output response of the body to the threat of the noxious stimuli.

From a biological point of view, the brain or central nervous system may be seen as a discrimination centre that continuously scans the environment, one's own body and relevant past experiences (Gifford 1998).

The central nervous system processing may be influenced by biological factors, cognitive, emotional aspects, social-cultural meanings and previous learning experiences. It is suggested that this processing of the central nervous system may be of major influence on efferent physiological systems, like muscle tone, autonomic responses, endocrinological and immunological systems, as well as on behavioural reactions like expression, movement or activities ('output mechanisms'). Furthermore, these 'output mechanisms' will influence the 'input' and the sensitivity to all kinds of stimuli – demonstrating the cyclical nature of 'input', 'central processing' and 'output' mechanisms (Gifford 1998, Shacklock 1999).

Definitions of pain with regard to inclusion criteria in research

As pain mechanisms appear to become increasingly relevant inclusion criteria to research projects, Bogduk (2009) discusses the necessity of making a clear distinction between nociceptive back pain, somatic referred pain, radicular pain and radiculopathy. If radicular pain is not distinguished from somatic referred pain, diagnostic errors may occur and patients may be allocated to faulty (sub)groups in scientific research. (Table 2.4). Bogduk postulates that nociceptive back pain and somatic referred pain occur more frequently than radicular pain and radicular pain may be investigated with MRI or X-ray procedures, while somatic referred pain often gives inconclusive results.

Table 2.4 Distinction between common types of pain (combinations are possible)

Description	Cause	Remarks	Type of pain
Nociceptive back pain	Noxious stimuli of lumbar structures		'Dull, aching pain in back'
Somatic referred pain	Noxious stimuli of lumbar structures – no stimulation of lumbar root structures. Explanation: convergence of nociceptive afferent impulse on the secondary afferent neuron	Distinguish this type of symptom from visceral referred pain and radicular pain	Normally this type of pain is perceived in those areas, which share segmental innervation. 'Dull, aching, gnawing', and at times 'expanding pressure'. Tends to be fixed in location, difficult to define boundaries of the area – pattern of presentation does not necessarily share dermatomal patterns
Radicular pain	Pain caused by ectopic salvos in dorsal root or spinal ganglion. Often, but not necessarily always, in conjunction with disc protrusions. Inflammation of the nerve is the critical pathophysiological mechanism	A nerve root does not react on compression, unless an inflammation is present. A spinal ganglion, on the other hand, is highly sensitive on compression and reacts with heterospecific impulse salvos within the whole nerve.	Lancinating pain quality, shocking, electric quality. (the term sciatica should be replaced by radicular pain)
Radiculopathy	Neurological condition with a nerve block	Radiculopathy is not defined by pain, but by motor and sensory changes	Numbness (dermatomal), weakness, reduced reflex activity

Cognitive–behavioural models

Physiotherapists play an important role in changing patients' behaviour, particularly in relation to movement and functional capacity. From a phenomenological perspective they guide individuals to a sense of well-being and health-promoting (movement-) behaviour. In this context it is recognized that behaviour and habits may not change overnight, after a single instruction session. Part of the work of physiotherapists involves change management, for which motivation, awareness, insight and careful planning by the patient and therapist are needed. It is necessary to recognize that patients may go through different phases of motivation in which they need guidance before new behavioural patterns are effectively incorporated into daily life. Therefore, it may be useful to incorporate insights from cognitive–behavioural models into clinical reasoning processes.

Cognitive–behavioural practice has a role to play in the application of mobilization and manipulation and more particularly in achieving the desired effect of maximizing functional capacity. This may encompass:

- Changes in movement behaviour in daily life – if pain or discomfort occurs, individuals learn to perform certain movements, relaxation techniques or simple exercises
- Changes in habitual patterns of movement in daily life, which may be a causative factor of pain
- Motivation to change behaviour with regard to training and maintaining fitness
- By means of information and educational strategies patients may develop a different perspective on their problem. For example, the meaning of pain as a threat may change; therefore the patient is empowered to develop different coping strategies.

As well as skilled communication, an awareness of key cognitive–behavioural strategies is important for more effective clinical practice. These include:

- Phases of change
- Role of a physiotherapist as an educator
- Compliance enhancement.

Phases of change

It has been suggested that individuals may go through various phases of motivation before they start to change behaviour. It is essential to recognize these phases and to adapt the education and instructions to them. Prochaska and DiClemente (1994) proposed the stages of change model:

1. Pre-contemplation: in this phase change of behaviour is not considered.
2. Contemplation: change of behaviour is considered; however, no concrete plan exists.
3. Preparation: plans are developed actively to change behaviour in the short term.
4. Action: phase in which the desired behaviour is performed.
5. Consolidation: the desired behaviour is maintained and reversion to previous behaviour is prevented.

The physiotherapist as an educator

Increasingly educational strategies to motivate patients to change are being used in physiotherapy treatments and research. The application of educational principles, such as the establishment of the cognitive level of the patient and the selection of educational methods and material, are important elements.

Compliance enhancement

Various strategies may need to be employed to enhance the patient's compliance with the physiotherapist's suggestions, recommendations and instructions. This may include motivational phases, short-term and long-term compliance.

The phases of change, education and compliance enhancement are discussed in more detail in Chapter 8 of Maitland's Vertebral Manipulation (Hengeveld & Banks 2014).

Research

Some studies appear to compare cognitive–behavioural therapeutic approaches with physiotherapeutic approaches (Pool et al. 2010); however, it can be challenging to comply with the protocols, as intrapersonal physical and cognitive factors and situational variations determine the prioritization of treatment procedures, including communication and advice (Green et al. 2008, Sandborgh et al. 2010). Overall it seems that the *integration* of cognitive–behavioural therapeutic approaches to physiotherapy practice is recommended and there is moderate evidence that they enhance treatment outcomes (Bunzli et al. 2011). It is postulated that cognitive–behavioural concepts, such as distraction and self-efficacy, are intrinsic to physiotherapy practice and need to be explicitly employed in the provision of physical self-help strategies in gaining control over pain (Zusman 2005). An integrated approach of physiotherapy and behavioural medicine implies that cognitions, emotions, physical and social environment are as important as physical prerequisites for movement behaviour (Sundelin 2010). An increasing number of publications regarding the implementation of behavioural principles in physiotherapy practice demonstrated beneficial effects on disability levels, fear-avoidance behaviour, increased pain control and perceived ability to manage future activities (Moore et al. 2000, Johansson & Lindberg 2001, Söderlund et al. 2001, Åsenlöf et al. 2005, Bunzli et al. 2011).

Biomechanical models

Biomechanical insights such as the 'convex–concave rule' for peripheral joints (Schohmacher 2009) or theories on coupling of spinal movement (White & Panjabi 1978) may also be models that can be utilized in clinical practice. In fact, in several schools of manual therapy they have been a pivotal part of decision-making processes with regard to treatment. Current insights, however, demonstrate that that the joint surfaces may move differently than the theoretical rule would imply (Stenvers 1994, Schohmacher 2009, Vicenzino & Twomey 1993). This should not be used an excuse to dismiss the application of theoretical, biomechanical models to the care of the individual patient, but these models need to be linked to clinical findings such as, for example, changes in pain and resistance perceived during passive motion. Selection of passive treatment techniques should primarily be based on clinical findings of changes in pain, resistance and motor responses during passive accessory and physiological movement. In conclusion, biomechanical theories can enhance decision making, provided the effects of every selected technique are regularly reassessed.

Conclusion

NMS physiotherapists' thought processes revolve around various paradigms with the aim of individualizing and optimizing treatment for individual patients. It seems that a moderate to acceptable scientific knowledge base derived from these paradigms is available to underpin clinical practice. However, it appears that several practice guidelines are still based within a biomedical model. In order to guarantee client-centred approaches to physiotherapeutic treatment in the future, in this era of evidence-based practice, it is suggested that the practitioner acknowledges various paradigms in clinical practice guidelines as elements of the 'best available evidence', in particular, the cognitive–behavioural integration into physiotherapy practice, salutogenic approaches as complementary to pathogenic approaches and the insights from neurophysiological pain mechanisms.

The principles of the Maitland Concept of neuromusculoskeletal physiotherapy as outlined some decades ago are still relevant in these times of evidence-based practice. Individualized assessment procedures, deliberate treatment planning collaboratively with the patient, conscious communication strategies with the development of a therapeutic, client-centred relationship and a constructive self-critical attitude towards their own clinical decision making processes are the basis for the clinical approach. If physiotherapists regularly reflect on their decisions in planning phases of treatment and during reassessment procedures and implement 'the best of science' into their work, then they will support their own development towards clinical expertise and may contribute to clinical science by the observation, treatment and reporting of uncommon clinical phenomena. Individualized treatment needs to be based on thorough clinical assessment procedures, in which the patient's movement status, movement potential and preferences are established. Therapeutic touch and the art of passive movement as a kick-start to active movement still have a considerable role to play in the rehabilitation of many painful movement disorders, as stated by Jull and Moore (2012):

> Hands on, hands off? There is ample evidence of changes in motor control in association with neck and back pain. Thus there is no argument that exercise and activity are important components of any rehabilitation program to address these deficits. There is also ample evidence that zygapophysial joints and discs are common sources of pain. Manipulative/manual therapy is directed towards the painful joint dysfunction and there is a considerable body of research into the mechanisms of effect and effectiveness of manipulative therapy. Manipulative/manual therapy has proven pain relieving effects. […] the evidence suggests that the use of manipulative/manual therapy should not be forgotten. Painful joint dysfunction is present in the vast majority of neck and low back pain patients …
>
> (Jull & Moore 2012, 199)

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Management of craniomandibular disorders

3

John Langendoen

CHAPTER CONTENTS

Introduction

The temporomandibular joint complex differs from other peripheral joints in the human body in several aspects. Both distal joint partners are part of one bone, the mandible, which makes both joints a Siamese twin joint, the only peripheral one of the neuromusculoskeletal system. This means that one joint cannot move or be moved without the other. Moreover, the jaw joints are parts of other systems as well: the stomatognathic system, part of the digestive tract, the breathing system, and the joint complex play a role in communication and expression. Anatomically, arthrokinematically, neurophysiologically, and therefore in many pathological states, the craniomandibular complex is directly related to the cervical spine.

In addition to the joint surfaces, joint contents and muscles, a third entity plays a relevant role in the position and movement of the jaw complex: teeth contact (occlusion and guidance), or the absence of (disclusion), during jaw movements and at rest. Occlusion as a leading entity can be included in Panjabi's three subsystem model of stability, as referred to in several chapters of this edition. Panjabi's model provides a useful model for understanding and managing the majority of temporomandibular dysfunctions (TMD) and orofacial pain (OFP). Occlusal aspects may play a role in postural control as well.

In modern society, teeth also play an increasing role in human aesthetics and psychosocial issues. Large, beautiful, teeth and an inviting smile are considered important, can increase self-esteem and can be career-supporting. Nowadays, orthodontics is a standard procedure for adolescents in many countries to guide and correct mandibular and teeth growth inconsistencies. The latter are common as the mandible needs to grow to a much greater extent than its adjacent skull bones, the maxilla and the temporal bone, after birth and a variety of factors may interfere with flawless development.

Beautiful teeth, however, have to follow the functional rules of occlusion and disclusion at rest and guidance at movement as well. In dentistry, occlusal factors are considered to play a relevant role in the

Key words

Temporomandibular joint, craniomandibular dysfunction, larynx, hyoid, trigeminal nerve, spinal nucleus of the trigeminal nerve, chewing muscles, masticatory muscles, masseter, temporalis, lateral pterygoid, medial pterygoid, infrahyoidal muscles, suprahyoidal muscles, occlusion, parafunctional habit, bruxism, emotional motor system, splint

etiology and management of many dysfunctions and pain. Therefore, the primary discipline involved in analysis and management is likely to be dentistry or orthodontics for most patients.

Furthermore, the chewing muscles play a natural role in stress coping. Excessive grinding and clenching of the teeth may lead to abrasia of the anterior teeth, the incisors and canines, as well as to muscle pain. Teeth grinding at night (bruxism) is the most common example of a variety of stress-induced parafunctional habits and bio-psychosocial and neurophysiological factors should be considered in treatment, alongside assessment and management.

Finally, women in their reproductive years suffer up to four times more from craniomandibular dysfunctions than men (LeResche et al. 1997, Cairns et al. 2003). There are several accepted explanations for this. There are differences in stress coping between men and women. Female hormonal factors, such as the effects of oestrogen, play a role in pain threshold and intensity before the menopause and women's chewing muscles have less endurance and less force than those of men. Specific factors that only affect women should be considered in the management of dysfunctions, for example, changing contraceptives or applying appropriate relaxation modalities. These can be decisive factors in the long-term success of treatment.

All of the above indicates that various disciplines can be involved in the management of a single patient. Specialization in these disciplines is required and it is recommended that one provider should be in charge of the coordination of the complex, logistically challenging, long-term multidisciplinary overall management plan.

The temporomandibular joint complex is not a regular part of the undergraduate physiotherapy curriculum in many countries. Exploration of basic (neuro)anatomical and arthrokinematical principles in this chapter aims to counter common misconceptions or simplifications in the management of TMD and OFP as well. Dental nomenclature and dental medical concepts need to be introduced to enable appropriate understanding of multifactorial, multidimensional dysfunctions, as well as to enable the manipulative physiotherapist to participate effectively in a multidisciplinary setting. Although the role of passive movements in the management of TMD or OFP may be limited, the manipulative physiotherapist can actively contribute in establishing the clinical diagnosis and the formulation and performance of an overall multidisciplinary management plan.

Finally, the many disciplines involved in TMD or OFP and the huge amount of available literature account for the ongoing controversies about different areas, ranging from etiology to management. The literature cited in this chapter is a strictly limited selection, but it will enable the reader to explore TMD or OFP in more depth.

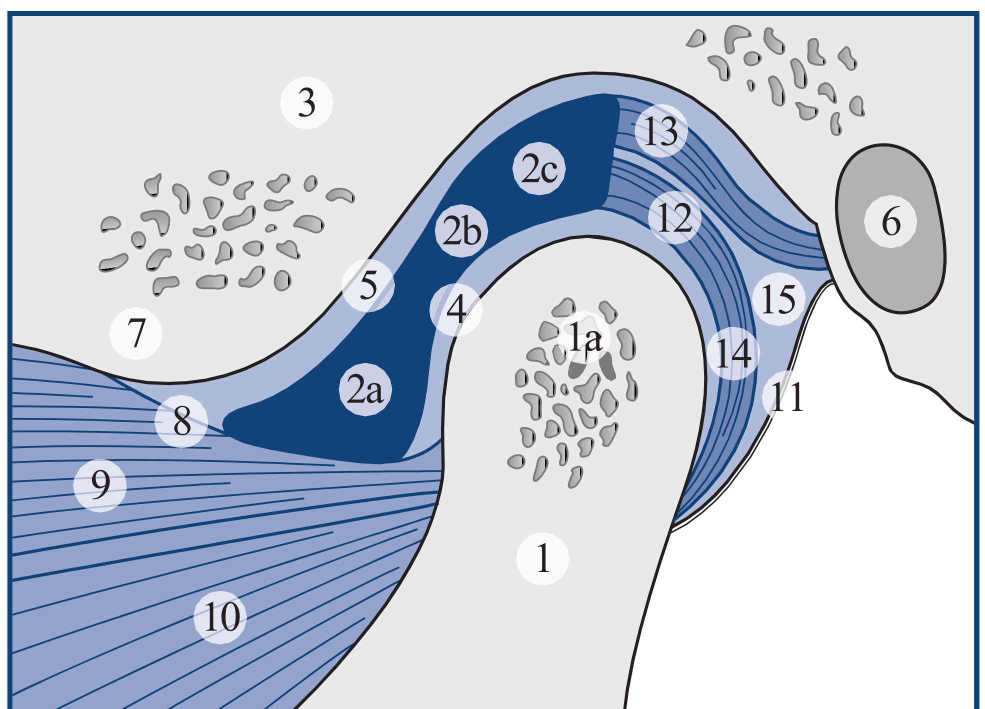
Theory – functional anatomy

For comprehensive theoretical information the reader should refer to anatomical, biomechanical, dental and orthodontic textbooks (e.g. Ide et al. 1991, Fitzgerald 1992, Kraus 1994, Okeson 1985, 1996, 1998). Selected areas are explored in this chapter to give some insight into the most common dysfunctional, pathological conditions.

- The fossa of the temporal bone articulates with the mandibular head, which is elliptical and mushroom-shaped. Its cartilage is fibrous, not hyaline, and undergoes remarkable changes in shape in the course of an arthropathy (Müller et al. 1992ab).
- The anterior capsule is attached approximately 4.4 mm (standard deviation 1.7 mm) anteriorly of the eminentia articularis (articular tubercle) (Johansson & Isberg 1991), allowing the mandibular head to move beyond the tubercle. The joint partners are not congruent and movement and position of the mandibular head is aided by the articular disc. The disc is a three-dimensional, biconcave, hat-shaped cartilage structure with thick anterior and posterior parts as well as a thin intermediate part, which divides the joint into two compartments with two different movement tasks.
- The posterior border of the disc is aligned on top of or even slightly anterior to the

mandibular head (11 or 12 o'clock position in radiological terms). The physiological position of the mandibular head in the temporal fossa in a closed mouth position with maximum intercuspation (full teeth contact) is defined by the concept of centric relation (CR): most anterior, most cranial and midway between medial and lateral, with the disc in its correct position (Schimmerl et al. 1993, Bumann & Lotzmann 2000). It is estimated that 85% of the entire population show a different condyle fossa position in habitual occlusion, called centric occlusion (CO). In dentistry it is a major task to maintain or to restore the centric relation. Note that the normal resting position of the mandible in a closed mouth situation is slightly discluded (upper postural position of the mandible, UPPM), indicating the proprioceptive abilities of the stomatognathic organ (Kraus 1994).

- A main function of the lateral pterygoid muscle is to control fossa-disc-condyle stability in rest and during movements. The muscle acts as a fine-tuning, balancing, local stabilizing muscle (Osborn 1995a, Langendoen 2004, Phanachet et al. 2003, 2004). There is experimental two-dimensional evidence that the DA moves passively over the condylus (De Vocht et al. 1996) and that activity of the lateral pterygoid muscle is not required.
- In dentistry, the retrodiscal intra-articular area is called bilaminar zone (BZ). It contains synovial fluid, the genu vasculosum, a vascular pad acting as an artero-venous shunt during mouth movements and which has significant inflammatory potential as well as two ligaments (Schimmerl et al. 1993).
- The upper ligament, the Lig. disco-temporale or stratum superius, can be folded and lengthened, enabling translation of the disc-condyle complex in the upper joint compartment. The ligament is anchored in the permeable petro-tympanic fissure, containing fibres of the chorda tympani and may be the explanation for a type of tinnitus in temporo-mandibular arthropathies.
- The lower ligament, the Lig. disco-condylare or stratum inferior, is non-elastic, remains the same length during movements, thus preventing translation in the lower joint compartment, which is designed for rotation only (Rees 1954, Dauber 1987, Bumann et al. 1991, Eckerdal 1991, Scapino 1991, Rodríguez-Vázquez et al. 1993, Wilkinson & Crowley 1994, Chiarini and Gajisin 2002, Linsen et al. 2006).
- Therapeutically, the above implies that anterior-posterior, posterior-anterior and longitudinal cranial accessory movements of the mandible are contraindicated treatment directions in by far the majority of articular TMD cases.
- The innervation of the TMJ and the masticatory muscles is supplied by auriculotemporal, masseteric and buccinator end branches of the mandibular branch (NV_3) of the trigeminal nerve (CN5). The trigeminal nerve complex plays a major role in sensory innervation of almost all craniofacial structures, is connected with several other cranial nerves (facial, vestibulocochlear, glossopharyngeal, vagus nerves) and its relevance is further outlined below (Fig. 3.1).



1	Condylus mandibulae
1a	Caput mandibulae
2a	Discus articularis, Pars anterior
2b	Discus articularis, Pars intermedius
2c	Discus articularis, Pars posterior
3	Fossa mandibulare ossis temporalis
4	Lower compartment
5	Upper compartment
6	Meatus acusticus externa
7	Eminentia/Tuberculum articularis ossis temporalis
8	Anterior capsule
9	M pterygoideus lateralis superior
10	M pterygoideus lateralis inferior
11	Posterior capsule
12	Bilaminar zone/retrodiscal area
13	Lig. disco-temporale/Stratum superius
14	Lig. disco-condylare/Stratum inferius
15	Genu vasculosum/vascular pad

Figure 3.1 • Anatomy of the temporomandibular joint.

Causes and contributing factors for craniomandibular dysfunction

- The five axial movements of the mandibula are called:
  - depression (mouth opening)
  - elevation (mouth closing)
  - protrusion or protraction (forward shifting of the chin)
  - retrusion or retraction (shifting the chin posteriorly)
  - laterotrusion or lateropulsion (lateral movements to the left and right).
- Due to the Siamese twin construction both joints move at the same time, symmetrically or asymmetrically.
- Depression, protrusion and laterotrusion are excursive movements as the disc-condyle complex can move beyond the anterior tubercle, whereas the returning movements of the disc-condyle complex into the fossa are named incursive. Although most patients complain of excursive movements, the cause of the dysfunction is often due to a-physiological incursive movement such as a preliminary occlusal contact of two molars.
- The functional chewing movement is a three-dimensional event with a favourite chewing side and a contralateral balance side.
- Arthrokinematically the joint shows at depression: initial rotation of the mandibular head in the lower compartment is gradually followed by anterior translation of the disc-condyle complex over the joint surface of the fossa in the upper compartment (Piehslinger et al. 1993, 1994, Ferrario et al. 2005, Mapelli et al. 2009). Limited upper compartment translation is a recognized major etiological factor in the onset and development of an arthropathy.
- Increased intra-articular pressure, for example, due to a physiological compression, makes the disc act like a suction cup, inducing a vacuum between its intermediate part and the fossa (Nitzan & Marmary 1997).
- Another simultaneous or subsequent factor is a compensatory physiological translation in the lower compartment, commonly occurring in cases of underdevelopment of the antero-posterior size of the mandibular head, which negatively extrapolates the fossa-caput discongruence (Müller et al. 1992ab). The latter is one more reason to avoid anterior-posterior or posteroanterior accessory movements, whereas longitudinal caudad distraction, manually, with a continuous distraction splint (for approximately six months) and subsequent dental restoration, seem the appropriate management for most arthropathies (Hugger et al. 2004, Linsen et al. 2006).
- The mandibular heads' fibrous cartilage enables gradual rebuilding from a rounded shape to an anterocaudad slope, induced by pathological translation in the lower compartment. This is considered a major component in arthropathies such as disc instabilities.
- As the anteroposterior diameter of the mandibular head cannot be influenced therapeutically, other components, as outlined in Panjabi's stability model (Panjabi 1992ab) are challenged to compensate.
- Panjabi'sstability model consists of three interacting subsystems: the passive, the control and the active (Fig. 3.2).
- The passive subsystem in relation to the temporomandibular complex contains the joint surfaces of the temporal fossa and mandibular head, the anterior and posterior capsule, the extra-, peri- and intra-articular ligaments, the articular disc and all teeth (occlusal component). Occlusal faults such as a lack of molar disclusion in the resting position of the mandible, preliminary molar contact at incursive movements, lack of incisive guidance at anterior as well as lack of canine guidance at lateral movements or a lack of posterior support due to loss of molars (Dulcic et al. 2003) are all considered relevant causal factors for dysfunction and can be dentally managed.
- Further deficits of the passive subsystem are recognized being relevant factors in TMD, for example:
  - a small anteroposterior diameter of the mandibular head (Müller et al. 1992ab)
  - a deep steep fossa, indicating an increased resistance for excursive movements and muscle activity in the lateral pterygoid muscle (Osborn 1995a)

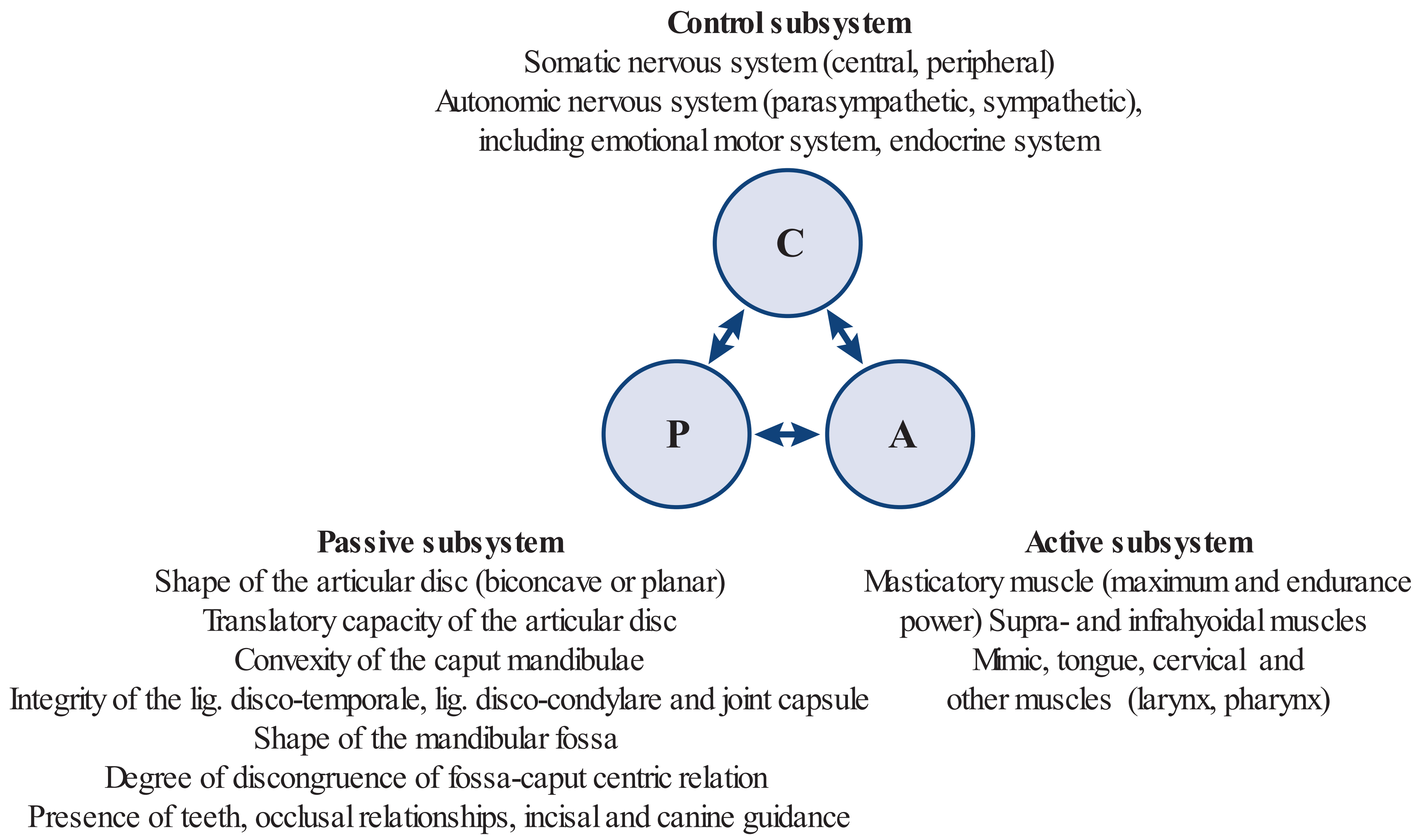


Figure 3.2 • The three subsystems of stability for the craniomandibular complex (Panjabi 1992ab).

- All this can be compensated within the limits of physiological tolerance by adequate functioning of the other subsystems and remains subclinical. If the limits of structural tolerance are exceeded, for example, by distress factors, the system will decompensate (Okeson 1985, 1996, 1998, Hansson et al. 1987).
- Distress factors can be categorized within the concept of the control subsystem. The control subsystem for the craniofacial complex contains many parts of the peripheral and central somatic nervous system (SNS) and autonomic nervous system (ANS), such as:
- Peripheral course of cranial (primarily trigeminal, facial, glossopharyngeal, vagus, accessory, hypoglossal) and cervical nerves from the cervical plexus and upper cervical posterior rami including autonomic gangliae as well as the sympathetic trunk (Pedulla et al. 2009).
- Central nervous system parts with motor nuclei in the brainstem (the truncus cerebri contains pons, mesencephalon, medulla oblongata) and upper cervical myelum, including the nucleus trigeminocervicalis (spinal sensory nuclei of the trigeminal nerve) (Price et al. 1976, Sessle et al. 1976, Bushnell et al. 1984, Kojima 1990, Widenfalk & Wiberg 1990, Fitzgerald 1992, Neuhuber 1998, Imbe et al. 1999, Iwata et al. 1999, Gibson & Zorkun 2008).
- The latter receives nociceptive and thermal trigeminal as well as facial, glossopharyngeal and vagal input and its caudad part expands at least to the C3 segment.
- Within the spinal trigeminal nucleus, information is represented in an onion skin fashion. The lowest levels of the nucleus, the pars caudalis in the upper cervical cord and lower medulla, represent peripheral areas of the face (scalp, ears and chin). Clinically, this is the most commonly affected area in TMD patients and so it is important to include the upper cervical spine in the assessment and management of TMD (Clark et al. 1987, Browne et al. 1998, Friedman & Weisberg 2000, Huelse M 1998, Reisshauer et al. 2006, Toti et al. 2010). Higher levels in the upper medulla, the pars intermedius, represent more central areas (nose, cheeks, lips). The highest levels in the pons, the pars cranialis, represent the mouth, teeth, and pharyngeal cavity (Figs 3.3 and 3.4).
- Trigeminal, facial and vagus motor nuclei are directly influenced by the limbic system, also known as the Emotional Motor System (EMS) (Holstege et al. 1996; Holstege 2001,

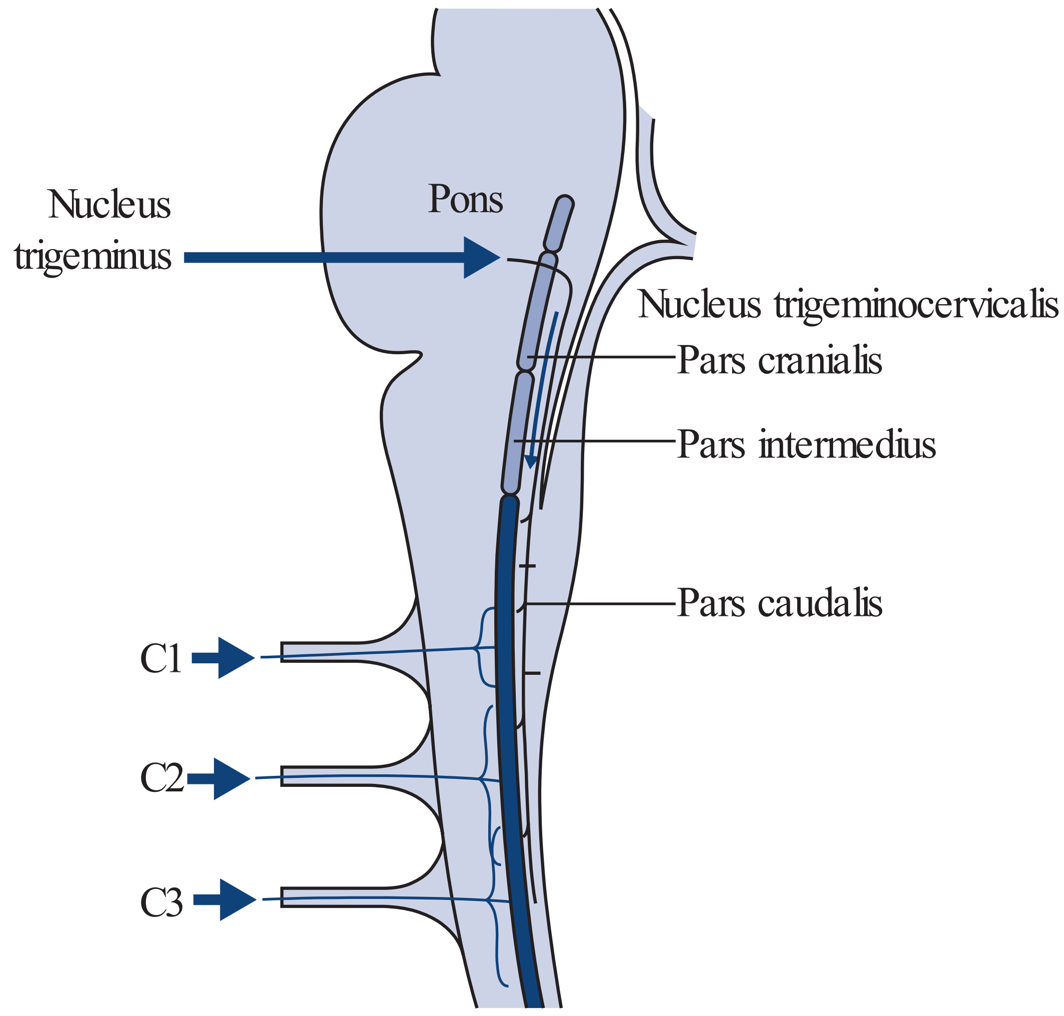


Figure 3.3 • Spinal sensory nuclei of the trigeminal nerve for thermal and nociceptive afferences: nucleus trigeminocervicalis, pars cranialis, intermedius and caudalis.

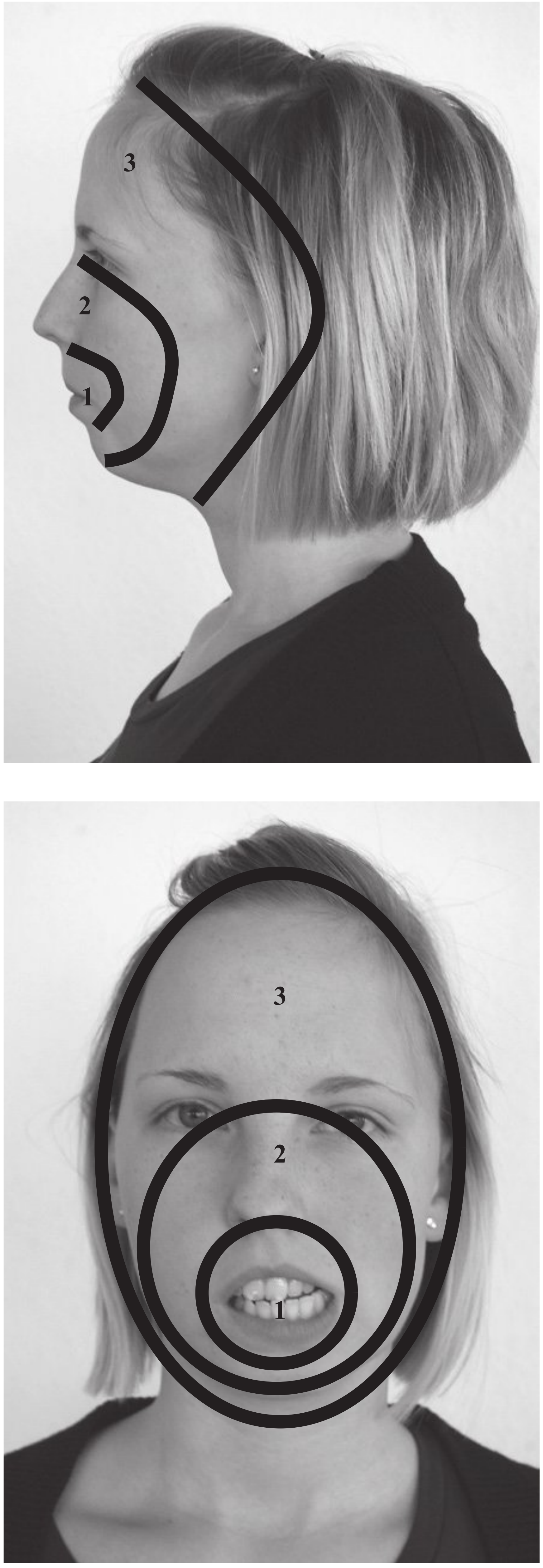


Figure 3.4 • Representation of facial areas in the nucleus trigeminocervicalis. 1. Pars cranialis: mouth, teeth, pharyngeal cavity. 2. Pars intermedius: nose, cheek. 3. Pars caudalis: scalp, ears, chin.

van der Horst et al. 1997, 2001, Gerrits et al. 1999, 2004, Mouton et al. 2005).

- Distress-induced limbic system activity, for example, resulting from the amygdala, nucleus retroambiguus or the periaqueductal grey) can activate several descending motor pathways causing:
    - mimicking expression
    - vocalization
    - licking, chewing and swallowing
    - and, with an additional hormonal component, lordosis behaviour or receptive posture in females. The latter implies changing tone and activity of abdominal, back, psoas major, adductors and hamstrings during the menstrual cycle.
- The EMS offers, in the absence of direct peripheral nervous connections, an explanation for the reflectory Meersseman phenomenon (Esposito & Meersseman 1988, Huelse & Losert-Bruggner 2002, Entrup 2009, Fischer et al. 2009) that malocclusion, limited mandibular depression and limited length of some pelvic muscles correlate.
- The EMS is clearly demonstrated by football and hockey coaches during matches. Chewing gum may increase alertness and reduce stress (Tahara et al. 2007, Hellhammer et al. 2009, Scholey et al. 2009, Smith 2010, Johnson et al. 2011) demonstrating that parafunctional habits, to a certain extent, are a useful congenital strategy to cope with stress (Slavicek & Sato 2004).

- Panjabi's model can be used to address a major question in dentistry 'How much occlusion do we need?' Whereas persons with positive interactions between the three subsystems can easily deal with a suboptimal occlusion, patients with further dysfunctions (of the passive subsystem: hypermobility, small mandibular condyle, of the control subsystem: excessive parafunctional habits of the active subsystem: weak muscles) need the best possible occlusal relationships (Okeson 1985, 1996, 1998, Hansson et al. 1987). The model also confirms the recognized necessity for interdisciplinary cooperation.
- Psychological factors, being part of the control subsystem, are generally considered relevant in TMD (Stam et al. 1984, Dworkin et al. 1990, Dworkin & LeResche 1992, Suvinen et al. 1997, Auerbach et al. 2001, Dworkin et al. 2002, Rantala et al. 2003, Ohrbach et al. 2010).
- Stress coping and management of stress-induced complaints are a common component of the overall management plan and may include splint, cognitive behavioural, pharmacological, body-mind and physical therapy. The role of the physiotherapist in this field may vary from applying local massage or electrotherapy to relax chewing muscles, individual body-mind therapy such as craniosacral therapy, bio- and myofeedback with breathing procedures, to group therapies with a social character such as yoga, qi gong, or meditation classes.
- Relaxing effects on the autonomic nervous system can be monitored with heart rate variability (HRV), a mode to assess the state of the parasympathetic nervous system (Brown & Gerbarg 2005, Cysarz & Buessing 2005, Jovanov 2005, Lee et al. 2005, Khattab et al. 2007, Raghuraj & Telles 2008, Li et al. 2009, Schmidt & Carlson 2009, Asher et al. 2010, Patra & Telles 2010, Tang et al. 2009, Matsubara et al. 2011, Nugent et al. 2011).
- Gender differences can play a role in all three subsystems and specific female characteristics need to be considered, for example:
  - passive subsystem: hypermobility, a small mandibular condyle (Müller et al. 1992ab)
  - active subsystem: less muscle endurance power (van Eijden et al. 1995, English & Widmer 2003)
  - control subsystem: different stress coping strategies, hormonal aspects that increase pain sensitivity (LeResche et al. 1997, Cairns et al. 2003) and muscle tension.

Subjective examination

A structured standardized questionnaire and examination such as Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD of the Department of Oral Medicine, Orofacial Pain Research Group, University of Washington, Seattle USA, Dworkin & LeResche 1992, List & Dworkin 1996, Dworkin et al. 2002) may be advocated for a number of reasons in multidisciplinary clinical or scientific settings.

However, the RDC/TMD questionnaire has recognized limitations in the diagnosis of some articular conditions (Look et al. 2010) and the Maitland model of a semi-structured dialogue is preferred as it enables the clinical physiotherapist to gain in-depth information, to develop various hypotheses simultaneously, and to recognize mixed conditions using sound clinical reasoning.

Kind of disorder

Four types of complaints can be considered as leading symptoms for TMD:

- Pain just in front of, at or in the ear on mandible (mouth) movements
- Sounds just in front of, at or in the ear on mandible (mouth) movements
- A blocked mouth opening or closing, all indicating an intra- or periarticular dysfunction
- Pain in the masseter and temporal region at mouth opening, chewing or in the early morning, indicating an extra-articular problem

A patient with a TMD most commonly has symptoms associated with mandibular movements, such as wider mouth opening, indicating that the source of the TMJ is structural (intra-/peri-articular or extra-articular).

Apart from pain, the main symptom of TMD can be a block, or a clicking sound.

In a case where mouth movements and chewing-muscle activities do not seem to relate to the facial or cranial complaints, a primary TMD is less likely and other possible causes, such as dysfunctions of

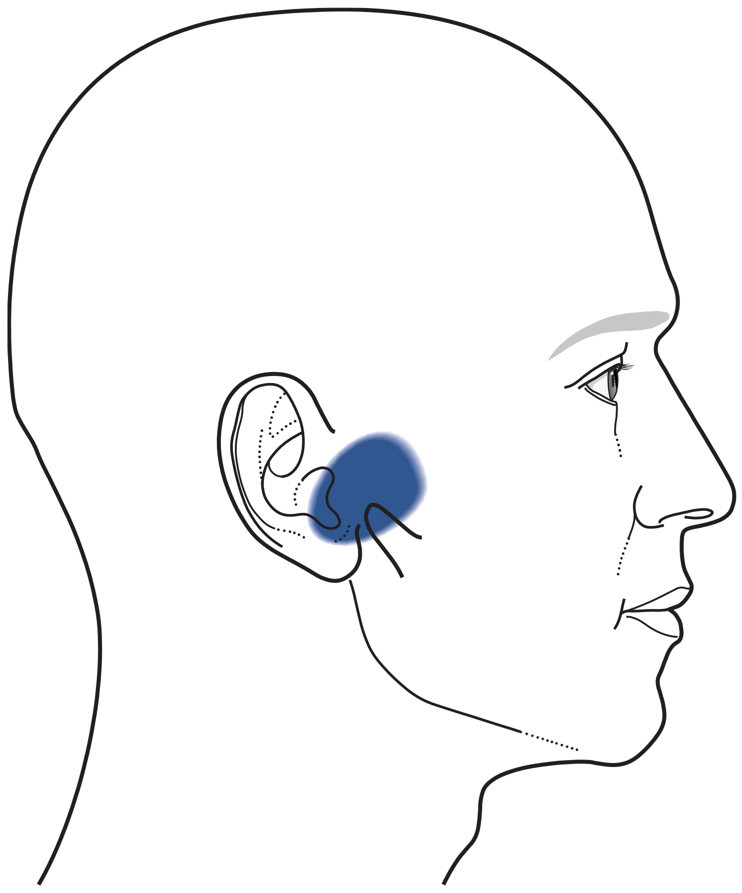


Figure 3.5 • Typical primary area of symptoms in intra- and periarticular temporomandibular joint disorders.

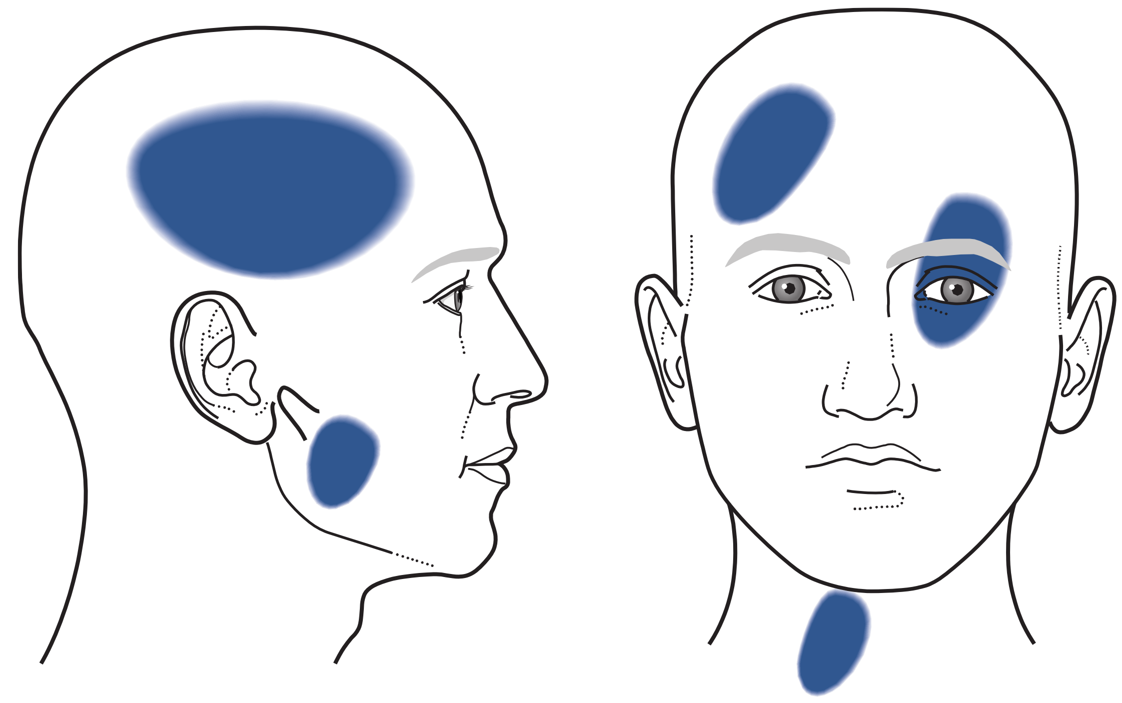


Figure 3.6 • Typical myogenic or other areas of pain and symptoms in extra-articular temporomandibular joint dysfunctions.

the upper cervical spine, have to be considered. Pins and needles, numbness of the head, face or tongue and all kinds of other symptoms outside the aforementioned areas (different types of headaches, dizziness, complaints about or difficulties with swallowing, tinnitus, blurred vision and other visual problems, smell, taste or hearing impairments, etc.) can lead to primary cervical spine, neurological, visceral, eye/ear-nose-throat hypotheses.

Areas of symptoms (body chart)

- Figure 3.5 shows the commonest pain areas described by patients with an intra- or periarticular TMJ disorder (Campbell et al. 1982).
- Figure 3.6 shows common pain sites in patients with extra-articular dysfunctions (Svensson et al. 2003).
- Symptoms can include local pain over chewing or hyoidal muscles, radiating pain from trigger points of chewing, hyoidal or cervical muscles, for example, radiating to the teeth, mandible pain after a fracture, etc.
- Pain in the jaw can be related to periodontal dysfunctions, tooth decay or infection (odontogenic pain), which may also cause referral of pain locally from the teeth along the jaw.
- Aching in the cheeks and jowls could be due to a disorder of the parotid glands. This will be accompanied by changes in function of the salivary glands such as overproduction or dryness of the mouth, even during eating.
- Ongoing neck pain that is not responding to adequate neuromusculoskeletal treatment may be due to parafunctional habits or occlusal faults and needs dental screening (Clark et al. 1987, 1993, Browne et al. 1998).
- TMD may be accompanied by tinnitus or may mimic otological disorders such as middle ear infections, which, however, are accompanied by alteration in auditory function and vestibular function (vertigo).
- The craniofacial area can host many different, bizarre, often called 'associated symptoms' that may have a viscero- or neuro-cranium background and may be related to upper cervical and cranial nerves, meninges, cranial bones and osseous connections, parasinuses, auricular or other structures or even neoplasms (Ciancaglini et al. 1994, International Headache Society 2003, Parker & Chole 1995, Steigerwald et al. 1996, Tuerp 1998, Wright et al. 2000, Lam et al. 2001, Peroz 2001, 2003, Tuz et al. 2003, Sobhy et al. 2004, Wright 2007, Biesinger et al. 2008, 2010, Boesel et al. 2008, Losert-Bruggner 2000).
- Such symptoms can be pins and needles affecting the head, face or tongue, spasm or trismus of the masticatory muscles, tinnitus, dizziness, vestibular disturbance, tearing, difficulties at swallowing, feeling of a lump in the throat, dystonia, dysfunctions of classic senses (olfaction, audition, vision, gustation,

tactition), nausea, as well as loss of concentration, memory loss, panic attacks and various types of headaches, such as tension type, migraine with or without aura and neuralgic pains (IHS 2003). All these symptoms require specific neurological screening of the central nervous system, the upper cervical and cranial nerves, as well as radiological and/or ear, nose and throat (ENT) screening.

- True trigeminal neuralgia is characterized by severe episodes (attacks) of, often unexpected, burning neuralgic pain, for example, due to arterial compression of the trigeminal nerve (CN5) when leaving the pons or after a herpes zoster virus infection, and is a primary indication for pharmacological or surgical management.
- The mandibular condyle is a relatively common site of (often) benign tumours. Obvious accompanying signs will be a swollen mass and other signs of impending or actual inflammation. Pain will be relatively constant and unchanging with rest.
- Symptoms such as pain along the zygomatic arch or the frontal bone accompanied by pressure changes and respiratory dysfunction may well be of sinus origin.
- Synovial joints also occur between the thyroid cartilage and the sides of the cricoid cartilage, the laminae of the cricoid cartilage and the base of the arytenoid cartilage and occasionally between the lesser and greater cornua in the hyoid bone (Banks & Hengeveld 2005). It is not common for these joints to be painful but as they possess synovial joint material and are supported by ligaments, they occasionally give rise to local symptoms.

Behaviour of symptoms (over a 24-hour period)

- Typical provoking and/or limited activities in TMD are wider mouth opening when eating, biting, chewing, yawning, singing, kissing, swallowing and prolonged playing of instruments such as the violin, flute or other wind (brass) instruments (Yap et al. 2001).
- Parafunctional habits, for example, teeth grinding or clenching (bruxism), inducing muscle pain normally bothers most sufferers in the early morning after sleep or at times of increased distress, whereas occlusal faults may cause muscle pain at (sub)maximal use of the chewing muscle, for example, in biting (Svensson et al. 2008). It is estimated that up to 80% of all TMD patients may suffer this type of myogenic pain (Graber 1989, Bendtsen et al. 1996), which are would primarily be managed by dentists or orthodontist (Ommerborn et al. 2011).
- Biting on the tongue may be a stress-induced coordination problem.
- Psychosocial factors should be ruled out by screening (yellow flags).
- While muscle pain is common, muscle lesions are rare.
- Chewing and supra- or infrahyoidal muscles may include trigger points with typical patterns of radiation, for example, teeth pain from a medial pterygoid trigger point at biting (Svensson et al. 2003ab, Bertilsson & Strom 1995).
- Tension-type headaches and muscular neck pain may be accompanied by temporal, masseter or pterygoidal muscle pain.
- Only one in eight patients may show a true, isolated arthropathy, with or without clicking; however, they need more often and longer physiotherapeutic treatments than patients with myogenous problems.
- The remaining 8% of all TMD patients seem to have oro-craniofacial symptoms from other sources such as the cervical spine or the cranial nerves (Graber 1989).
- Therapists in practices might not see many patients with severe or irritable pain, who are unable to move the mandible and cannot use the mouth at all.
- The source of intra-articular pain is likely to be in the bilaminar zone, as the retrodiscal area has a large inflammatory capacity. These patients are likely to be managed by the dentist with anti-inflammatory drugs, local cooling and a splint.
- Clicking sounds are most often a sign of instability of the disc–condyle complex on excursive and or incursive movements.
- The disc may be anteriorly, anteromedially or anterolaterally displaced in static occlusion or is displaced during excursive movements. The

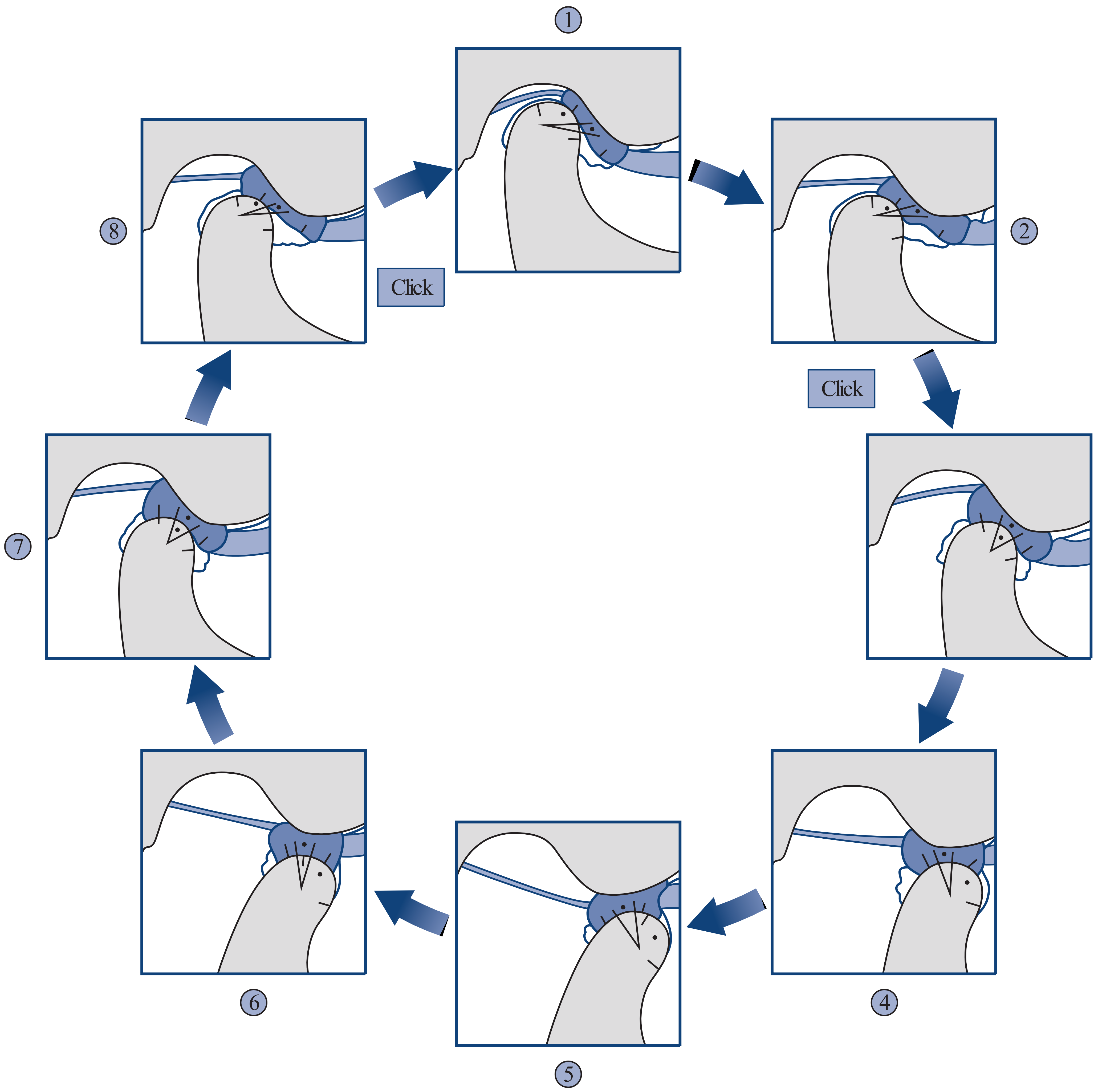


Figure 3.7 • Temporomandibular joint internal derangement, reciprocal click. (From Kraus 1985. Reproduced with kind permission.)

most classic one, accompanied with a louder click on opening is due to repositioning of the disc on the condyle, whereas the anterior displacement click, terminally at elevation, may not be heard or felt. The clicking on opening may appear initially, intermediate or terminal during opening, representing a further development of the pathology, eventually leading to a non-repositioning situation with the anterior displaced disc limiting full mouth opening (Figs 3.7 and 3.8).

- Eminentia clicking is due to poor control at terminal depression or initial elevation and may develop into a block if, when yawning, the patient is unable to close the mouth again.
- A repositioning might need to be performed under general anaesthetic.
- A lateral ligament clicking or snapping through range of mandibular motion can be palpated superficially with a finger tip on the lateral pole of the condyle.
- This is normally not painful and may be due to a lateral malposition of the condyle, causing an increased tension in the lateral capsule and ligament.
- Crepitations are normally signs of degenerative processes, roughing of temporal fossa or

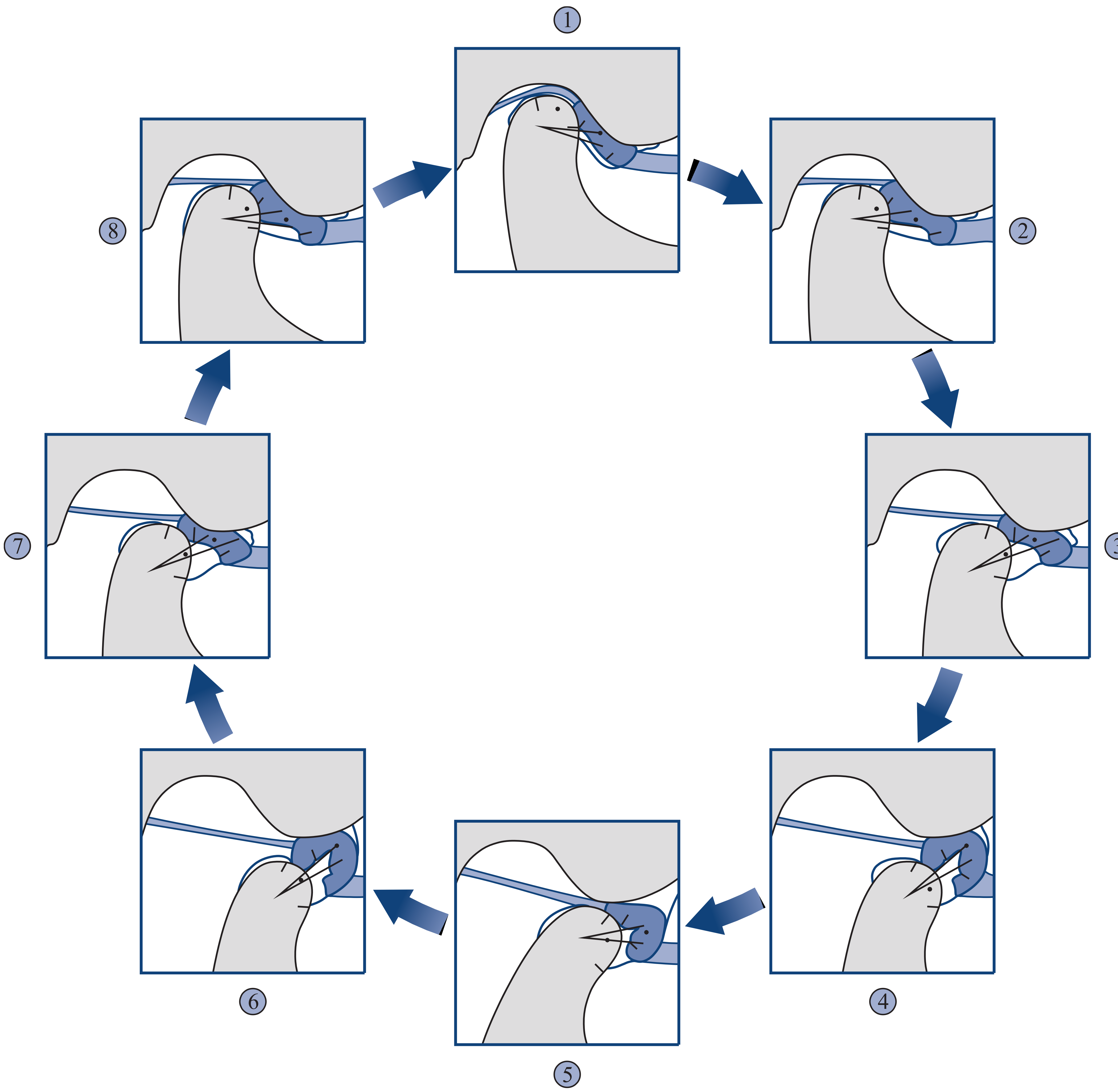


Figure 3.8 • Temporomandibular joint internal derangement-closed lock. (From Kraus 1985. Reproduced with kind permission.)

articular disc surfaces, maybe accompanied by morning stiffness of the jaw, however are seldom painful.

- Occasional, almost silent, popping sounds may be caused by sustained compression-induced fibrous adhesions between the fossa and disc.
- A fracture of thin osseous border with the meatus acusticus externa may cause an over-/underpressure-induced movement of the remaining capsule at every mandibular movement and so a loud audible snapping noise (Muhl et al. 1987, Westesson & Eriksson 1985, Osborn 1995b, Capurso 1997, Widmalm et al. 1996, 2003ab, Prinz 1998abc, Bumann & Lotzmann 2000, Leader et al. 2003).
- These 'in range-of-motion' clicking conditions are contraindications for intra-articular directed manual therapy techniques, whereas longitudinal caudad directed techniques to mobilize the capsular structures may be beneficial to deload the intra-articular structures as well.
- End-range intra-articular conditions, such as fibrosis after trauma or surgery, are far less common in daily practice; however, they might profit from transverse medially directed

Table 3.1 Examples of TMD categorized according the localization of symptoms in relation to the temporomandibular joint and the degree of the dysfunction

Source of the symptom and degree of dysfunction	Intra-articular	Periarticular	Extra-articular
Pain problem (severe, irritable) Mandibular movements (almost) not possible	Acute retrodiscal inflammation in the bilaminar zone, e.g. upper ligament (stratum superius or Lig. disco-temporale)	Acute capsulitis	Tooth pain or tooth extraction pain, mandibular fracture, throat inflammation, trigeminal or facial neuralgia, otitis, chewingmuscle injury, etc.
Through range-of-motion (pain) problem	Disc–condyle instability with/without clicking on excursive/incursive movements	Subacute capsulitis or lateral ligament clicking	Spasm (trismus) of chewing muscles, trigeminal or facial neuropathy
End-range (pain) problem	Anterior displaced disc, blocked condylar incursion anteriorly of eminentia articularis (articular tubercle), post-traumatic intra-articular fibrosis	Chronic capsulitis, limited capsular flexibility, degenerative joint disease	Tightness of the chewing muscles, (upper) cervical spine disorders (including first rib)

accessory movements at the limit of the problematic excursive movement(s).

- Active training of the rotatory movement component in the lower joint compartment, however, is generally indicated to support the effect of passive movements (see Fig. 3.55).
- An extra-articular, muscular dysfunction commonly represents an end-range problem, even to such an extent that it prevents an end-range joint examination, which needs immediate management, if possible (Table 3.1).
- The laryngeal or hyoid joints and muscles may cause local symptoms such as a feeling of a lump in the throat or a sore throat on swallowing, talking or coughing, which requires medical as well as cervical and psychosocial screening (Pancherz et al. 1986, Winnberg 1987, Winnberg et al. 1988).
- Acute pain problems are likely to be managed by dental medical disciplines.

History of symptoms (present and past)

The onset may have been a trauma, an event or the problem may have occurred completely spontaneously.

Trauma

- Traumatic onsets may have injured, or even fractured, the mandible, the condyle, the bilaminar zone of the TMJ or other skull and neck structures as in motor vehicle accidents, falls with direct impact on the mandible when skiing, biking, being hit at boxing and martial arts or by a hockey stick, being kicked by a horse, or being hit by an elbow, a head or a shoe at soccer (Weinberg & Lapointe 1987, McKay & Christensen 1998, O'Shaughnessy 1994, Garcia & Arrington 1996, Abd-Ul-Salam et al. 2002).
- Even a tooth extraction might become a trauma for the TMJ, with a subsequent inflammation of the bilaminar zone or capsulitis.
- A severe retrodiscal inflammation may cause an anterior disc displacement.
- Arthroscopy may have been performed to remove a displaced disc. This procedure is not performed routinely, as the disc may resolve in the anterior capsule without causing many problems.
- Surgery, in contrast, may be necessary after trauma (fracture) or in the case of neoplasms.
- Previous surgery or arthroscopy of the TMJ may demand extensive rehabilitation for

mandibular movements and resting position as well as for the cervical spine.

Events

- The onset of the problem might reveal a specific use category.
- Some examples are biting a hard nut, a big apple, a king-size burger, intensive training with (new) musical instruments (jaw muscles, larynx or hyoid region pain), or a period with prolonged and increased distress prior to examinations.
- Further common causes are long dental treatment, characterized by maximum mouth opening, an occlusal problem, for example, after dental treatment (new filling), orthodontic management with braces, or other excessive, aberrant use of the mandible.
- Even learning a new language might cause transient functional complaints.
- Professional singing may lead to complaints at maximum mouth opening, for example, an inability to close the mouth (closing block) when the head of the mandible cannot overcome the tubercle at the beginning of the incursive movement in hypermobile women.
- Recognition of the appropriate use category will lead to adequate management and a change in practice.
- Recognized distress factors may be the cause of myogenic complaints or even the onset, rather than the cause, of intra-articular complaints.
- Bruxism-induced muscle pain may account for 30% of all complaints (Graber 1989). The pain is originally felt at the temporal and/or masseter area; however, it may spread to the anterior and posterior neck area in later stages.
- Local symptomatic treatment is normally insufficient and long-term success is related to recognition and managing the causal stress factors.

Spontaneous onset

- The main reason for spontaneous pain in the jaw region is odontogenic and dental treatment will normally be successful. Hidden tooth infections, possible causing diffuse general complaints, challenge clinicians and scientists, and may only be discovered after a long period of suffering.
- Answers to further targetted questions may reveal a hidden cause of the problem.
- Analysis of previous trauma, events, psychoemotional and socioeconomic factors as well as further investigations may reveal a range of predisposing factors:
  - an old condylar fracture or juvenile rheumatoid arthritis might have led to a degenerative joint disease
  - a range of congenital abnormalities, maldevelopments of mesodermal structures such as a cleft palate, a suboptimal or absent dental or orthodontic management during the growth years to asymmetrical joints
  - a too small anteroposterior diameter of the condyle to disc-condyle instability
  - a loss of molars to increased joint compression, mainly in elderly people.
- Occlusal faults may explain spontaneous symptoms of myogenic origin that are estimated to account for 50% of all complaints (Graber 1989).
- Dysfunctions of the anterior upper cervical spine offer another regular explanation for facial pain.
- Postural faults, such as an exaggerated thoracic kyphosis with flexion of the lower cervical spine, lead to a compensation in the upper cervical spine into extension (poking chin), a posterior change of the upper postural resting position of the mandible and habitual occlusion (bite) (Fink et al. 2003, Klemm 2009, Mansilla-Ferragut et al. 2009, Matheus et al. 2009, Munhoz & Marques 2009, Saito et al. 2009, Schupp et al. 2009, Toti et al. 2010).
- A posterior shift of the mandibular condyle challenges the physiological centric relation and may induce intra-articular compensation and hyperactivity of the chewing muscles.
- In the absence of any predisposing factor, diseases such as benign neoplasms, gland and lymphatic disorders should be taken into consideration, as well as mandibular and tooth growth anomalies in children (Egermark et al. 2003, Tecco et al. 2010, Thilander et al. 2002).

Gradual onset

- Establishing the patient's history will help towards the diagnosis and the assessment of the stability of the disorder.
- The fibrous type of cartilage of the mandibular head allows a long slow development of degeneration without complaints. After the onset of arthrogenic problems, however, imaging procedures will show a progressed stage of the pathology and recovery might take a long time or fail.
- Many patients with a long history report different types of management that have not been completely successful.
- Ongoing complaints affecting the facial area may have a large impact on daily life and psychoemotional state.
- Persisting impairments and related sensitization of the central nervous system with secondary hyperalgesia and allodynia may lead to the condition becoming chronic, with spreading or bizarre pain patterns and descriptions, accompanied by other psychosomatic symptoms that may overshadow the somatic and still relevant dysfunctions.

Contributing factors

- A psychosomatic origin (parafunctional habits causing myogenic pain) as well as psychoemotional consequences of ongoing complaints justify psychosomatic management approaches such as pain management strategies (coping, pacing, graded exposure), cognitive–behavioural therapy, bio- or myofeedback or mind-body therapies, for example, craniosacral therapy, as part of the overall management.
- Cranium techniques can be applied in different ways depending on the present state of the patient and the actual aim of the therapy (Ridley 2006).
- With structure-directed treatment, cranium techniques may be applied end range, whereas emotional states might profit from very gentle, slow rhythm handling, inducing balancing effects on the autonomous nervous system, measurable with heart-rate variability (HRV) and the emotional motor system, for example, measurable with EMG of the chewing muscles (see the section on Management).

Medical screening questions

- The patient's answers to routine questions about their general health, other medical problems, use of medication and unexplained weight loss may suggest non-neuromusculo-skeletal disorders, serious pathology or relevant comorbid factors that require further examination a change in management or caution.
- Women might suffer more frequent and stronger pain due to oestrogen and may need to be referred to a gynaecologist. Specific medication or a change of the type of contraceptive pill might be indicated.
- Imaging procedures are considered important ancillary tools for precise diagnosis. An (ortho) pantomogram is an X-ray procedure performed by the dentist or orthodontist, mainly for dental diagnostics, however, it also shows both TMJ and the atlas-axis relation.
- In the case of suspected intra-articular temporomandibular disorder, functional magnetic resonance imaging (MRI) in a closed mouth and open mouth position is a mandatory examination. Further mandibular positions might be examined, for example, while the patient is wearing the splint.
- Functional MRI reveals the physiological or pathological position of the disc, an instability of the articular disc, the precise direction of displacement, repositioning of the disc, or lack of, the degree of compensatory or degenerative changes of the head of the mandible, additional inflammatory signs, and also muscular or other anomalies (Schmid et al. 1992, Pressman et al. 1992, Schimmerl et al. 1993, de Laat et al. 1993, Langendoen-Sertel & Volle 1997, Mueller-Leisse et al. 1997, Yang et al. 2002, Guler et al. 2003, Rocha Crusoé-Rebello et al. 2003, Kitai et al. 2004, Pedulla et al. 2009).
- Re-examination after a six-month continuous distraction splint therapy usually shows a stable distraction, indicating the newly formed connective tissue in the distraction-induced joint space.
- Special attention should be given to splints that patients may or should wear on the upper or lower dental arch (Bumann & Lotzmann 2000, Tuerp et al. 2004, Al-Ani et al. 2005).

- The main types of splints are:
  1. *Relaxation type of splint* ('Michigan') or other devices with the same aim, such as an anterior bite stop or a nociceptive trigeminal inhibition tension suppression system (NTI-tss) (Stohler & Ash 1986, Canay et al. 1998, Becker et al. 1999, Baad-Hansen et al. 2007, Macedo et al. 2007, Kares 2008). The splint is worn during sleep with the aim of reducing grinding, thus protecting teeth against abrasia by optimizing occlusion as well as frontal and canine teeth guidance. Patients report that jaw muscle pain, as well as (tension type) headaches and neck pain are positively influenced. In extreme cases (bruxomania), this type of splint may be worn during the day as well.
  2. *Repositioning splint*. Only indicated in acute disc displacements with an intact morphology of the disc and the retrodiscal ligaments. To be worn to induce a stable repositioning of the disc and in combination with anti-inflammatory drugs.
  3. *Distraction (or decompression) splint*. Indicated in intra-articular disorders, however mainly used in disc displacements with pain, to continuously distract the head of the mandible (six months, 24 hours a day), enabling the formation of hard connective tissue in the joint space that serves as a substitute disc (Hugger et al. 2004).
  4. *Centric relation splint*. This aims to optimize the centric relation, reducing bilaminar and periarticular loading (Tuerp et al. 2004). This type can be used in articular conditions when a distraction splint is rejected by a patient.
- Splints normally have a built-in frontal and canine teeth guidance to optimize the quality of the mandibular movement and prevent adverse tissue loading (Fitins & Sheikholeslam 1993).
- Special questions and specific examination procedures for upper cervical risk factors are described in Chapter 4 of *Maitland's Vertebral Manipulation* (Blake & Beames 2013).
- If the patient has not been referred by a dentist, a consultation is recommended for occlusal screening and, if necessary, management (Egermark et al. 2003, Suvinen & Kemppainen 2007, Tecco et al. 2010).

Physical examination

After having summarized the initial hypotheses, the physical examination is planned accordingly. The following section describes a general flowchart that is appropriate for the majority of outpatients with a dominant peripheral nociceptive type of problem, who do not demonstrate an acute, severe or irritable problem, or a chronic pain problem with dominant central nervous system processing mechanisms.

For examination of cervical and thoracic structures, see Maitland et al. 2005 and Chapter 4 of this volume for examination of shoulder girdle structures. Examination of the upper cervical spine should always be included in an initial craniomandibular examination (Box 3.1).

Present pain?

Note area and intensity.

Observation

In standing

General inspection of thoracic, cervical spine and shoulder girdle.

In sitting

- Colour changes
- Scars
- Atrophy
- Swelling/hypertrophy, for example, convexity of masseter area (Fig. 3.9)
- Facial asymmetries.

En face

- Any obvious skull or mandibular developmental abnormalities, for example, open mouth/lips and/or discluded/occluded resting position of the mandible (also, ask the patient about the resting position of the tongue).
- Note nasal or mouth breathing.
- Horizontal alignment of the eyes, zygomatic arches, auricular tragus or ear lobe and mouth.
- Symmetry in vertical dimension of the lateral canthus of the eye – corner of the mouth.

Box 3.1

The physical examination of the craniomandibular region

Observation

- In standing: general postural obervation
- In sitting and or supine lying: viscerocranium, extraoral
- Later in supine lying: intraoral inspection for occlusal relationships, periodontological changes, preceding intraoral palpation and accessory movements

Functional demonstration

- *Their* demonstration of *their* functional movements affected by their disorder
- Clinical differentiation of their demonstrated functional movements

Brief appraisal

Active mandibular movements and initial palpation in sitting

Active movements

- Move to pain or move to limit, if appropriate with overpressure in supine lying
- Depression, elevation, protraction, retraction, lateral movement left and right
- Note pain, quantity and quality, including occlusal contacts, incisal and canine guidance

Isometric tests

Stomatognathic muscles in supine lying

Neurological examination

Upper cervical and cranial nerves or other precautions if indicated

Other structures in plan

- Actively and passive physiologically
- Cervical spine (commonly at Rx1)
- Pelvis/hip (muscles) in combination with occlusion (Rx1 or 2)
- Thoracic spine, shoulder girdle (Rx2 or 3)

Neurodynamic testing

For spinal canal, upper cervical and cranial nerves in sitting or supine lying

Palpation

Extraorally: TMJ, stomatognathic muscles, nerve palpation sites

Accessory movements

- In supine lying in an appropriate starting position of the mandible and including reassessment
- TMJ, extraorally: transverse medially

Preceded by:

- Observation (periodontological and occlusal)
- Palpation (masseter and pterygoid muscles)

Intra-orally:

- Longitudinal caudally ↔
- Posteroanterior ↓
- Anteroposterior ↑
- Transverse medially ←
- Transverse laterally →
- Longitudinal cranially
- Longitudinal dorso-ceph

Palpation and accessory movements of the cervical spine

- Cervical spine (Rx1 or 2)
- Hyoid, cricothyroid joint, viscero- and neurocranium in supine (Rx2 or 3)

Order of tests may vary

Check case records, etc.

Highlight main fndings with asterisks

Instructions to patient

- Overbite or loss of vertical dimensions can be assessed by comparing the distances between the lateral canthus of the eye and the corner of the mouth.
- With the anterior nasal spine and the point of the chin (Trott 1986, Kraus 1994). These two distances are normally equal but overbite is present if the second measurement is more than one centimetre less than the first.
- Anterior neck with hyoid bone and larynx cartilages (including the cricothyroid joint).

In profile (Fig. 3.10)

- Concave (prognathic)
- Convex (retrognathic, for example, overbite) or
- Straight (orthognatic) facial alignment
- Assess in relation to cervical posture (poked chin?)

Figure 3.9 • Convexity of cheek: A indicating masseter hypertrophy due to parafunctional habit (bruxism) or B occlusal fault. (Reproduced with the permission of the Interdisciplinary Forum for Cranio-Facial Syndromes (IFCFS).)

Figure 3.10 • Facial convexity due to retrognathy: A relaxed with open mouth (habitual) and B with forced corrected closed mouth. (Reproduced with the permission of the IFCFS.)

Functional demonstration

- If pain around the TMJ is reproduced during eating with upper cervical extension and mandibular depression (Fig. 3.11):
  - stabilize the head at the onset of pain and increase or decrease the mandibular depression
  - stabilize the mandible at the onset of pain and decrease and increase upper cervical extension.
- If pain is felt at waking up prone with the head rotated (Fig. 3.12), does the contraction of the chewing muscles produce pain in the temporal or masseteric area? Is palpation of muscular sites painful?
- TMJ, ear, atlas area:
  - stabilize the head at the 'bite' of pain and increase or decrease the lateral deviation of the mandible in the appropriate direction
  - stabilize the mandible in depression/lateral position and increase or decrease the cervical spine
  - apply temporomandibular and upper cervical accessory movements (for example,unilateral posteroanterior) in the rotated position for further confirmation.
- If throat pain is reproduced during extension of the head, stabilize the head at the point of onset of the symptoms and ask the patient to swallow or move the position of the tongue to differentiate between the laryngeal and hyoid joints and the anterior cervical intervertebral structures.
- Check for the correct position of the tongue at the hard palate when swallowing.

Brief appraisal

In sitting

- Observe the habitual occlusion.
- Opening the mouth as widely as possible while monitoring cervical movement.
- Clenching the teeth tightly.

Figure 3.11 • Differentiating between the upper cervical spine (extension) and TMJ (depression) of pain in an eating position.

Figure 3.12 • Differentiating between upper cervical spine (rotation) and TMJ (depression, lateral movement) in prone lying with rotated head.

- Move the mandible maximally to the left and right (Fig. 3.13).
- Palpation of the chewing muscles.

Active movements

- In supine lying, with bilateral condylar palpation and sight of the incisal and canine teeth.
- The therapist sits beyond the patient's head facing the patient's feet.
- The patient has to open his lips actively at all times during testing.
- Assess pain, quantity and quality such as clicking sounds, incisal and canine guidance, deflective occlusal contact, note and differentiate deviations or deflections.
- Apply overpressure if appropriate, with stabilization of the cervical spine.
- Note the effects of head on neck, neck on neck and neck on trunk position on ranges of TMJ movement, pain response and clicking (Lee et al. 1995, de Wijer et al. 1996abc, Palazzi et al. 1996, Higbie et al. 1999, Ioi et al. 2008).
- The examination movements may be applicable as treatment techniques in selected cases.

Mouth opening (depression) (Figs. 3.14 and 3.15)

- Pain: where and when (in mm)? Related to clicking? No pain: apply overpressure by applying a 'money-counting' kind of movement with the thumb and index finger. The tip of the

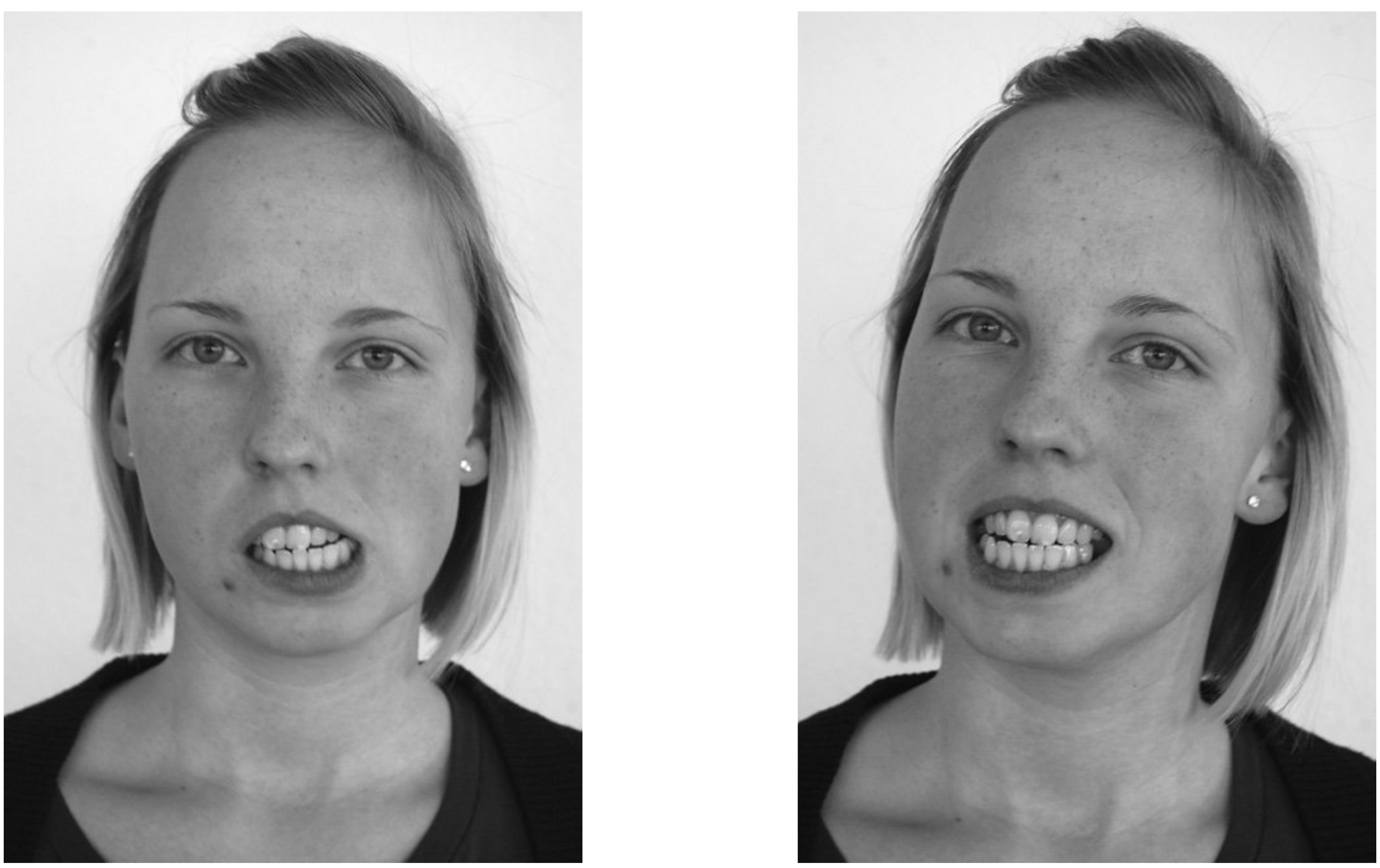


Figure 3.13 • Brief appraisal of lateral movement to the left and right in sitting. Lateral movement to the right shows a malocclusion-related compensatory cervical tilt. (Reproduced with the permission of the IFCFS.)

thumb should push the upper incisal teeth upwards and the tip of the index finger should push the lower incisal teeth caudally. The other hand is placed behind the occiput and cervical spine with the anterior side of the shoulder on the frontal bone to stabilize the head and the neck.

- Range: measure in mm including vertical overbite (normally 4 mm), normally 40–55 mm or the width of three fingers (index, middle and ring finger) at the proximal interphalangeal joints (PIP).
- Is there limitation in range with pain in a chewing muscular area? Treat immediately with local massage, hold-relax techniques, electro-massage or taping to relax the tensed muscle (Figs 3.16 and 3.17).
- Course: symmetrical condylar movement? Deflexion or deviation, with clicking? Initial, intermediate, terminal clicking?

Figure 3.14 • Active mouth opening with bilateral condylar palpation and observation of the mandibular course of the movement.

Figure 3.15 • Overpressure for mouth opening with thumb and index fingers at the front teeth.

Figure 3.16 • Hold-relax technique, biting, with transverse application of spatulas to relax masticatory muscles and gain range of motion.

Figure 3.17 • Intraoral massage technique with thumb (intraorally) and index or middle finger (extraorally) to treat localized masseter tightness.

- Clinical differentiation of clicking in cases of a suspected anterior disc displacement (ADD) with an unstable excursive repositioning, which shows a deviation with clicking initial or intermediate excursively, with or without pain.
- Clinical differentiation: depression with a sustained longitudinal cephalad pressure (dynamic compression), which is likely to create more resistance for repositioning and causes a later or louder clicking (more pain?) (Fig. 3.18).
- If this confirms an ADD, then perform the differentiation – apply medial pressure (dynamic medial translation) during depression, which is likely to ease repositioning and make the clicking is less loud or absent (Fig. 3.19).
- Differentiation. Positioning cotton rolls between the posterior molars prevents terminal incursive movement and disc displacement. Absence of clicking on subsequent depression movements confirms the hypothesis (Fig. 3.20).

Figure 3.18 • Mouth opening with sustained bilateral longitudinal cephalad pressure at the angle of the mandible (dynamic compression) for clinical differentiation of a clicking phenomenon.

Figure 3.19 • Mouth opening with sustained transverse medial pressure at the mandible for the right TMJ (dynamic translation) for clinical differentiation of a clicking phenomenon.

Figure 3.20 • Preventing terminal mouth closing with bilateral cotton rolls between the molars.

Mouth closing (elevation) (Fig. 3.21)

- First, an upward movement of the mandible is performed up to the initial contact.
- Is there full simultaneous occlusion or a premature, deflective occlusal contact?
- Maximum clenching (simulating ‘‘overpressure’ as well) towards maximum intercuspation might be accompanied by a palpable and visible mandibular shift or clicking with occlusal faults.
- Palpable, respectively with a stethoscope, audible clicking, confirms the suspicion of terminal incursive anterior disc displacement.

Protraction

- Pain: assess the site of pain and the range in mm.
- In absence of pain, apply overpressure by pushing both angles of the mandible forward with the middle and ring fingers of both hands, while keeping the thumbs at the zygomatic bone to stabilize the head (Fig. 3.22).
- In case this causes a lot of pressure pain, pull the mandible forwards with the thumb at the oral side of the mandibular incisives, while stabilizing the head as in depression (Fig. 3.23).
- Range: approximately 8 mm, including 3–4 mm horizontal overbite.
- Course: look for incisal guidance with disclusion in praemolar and molar area (Fig. 3.24).
- In severe open bites or worn-down incisives this forward teeth guidance is absent and needs to be restored. Look for deflective occlusal contacts.
- A deviation with clicking or deflexion might show a similar pattern to depression.

Retraction

- A small movement (1–4 mm) should be visible and palpable.
- No movement indicates a pathological posterior position of the condyle in the fossa.
- In absence of pain, overpressure, which compresses the bilaminar zone, is performed with the web space grip around the chin, while stabilizing the neck and the head as in depression (Fig. 3.25).
- Lateral movement (lateropulsion or laterotrusion) left and right.
- Ipsilateral movement pattern: a linear condylar movement (Bennett shift).
- Contralateral movement pattern: an angular condylar movement (Bennett angle).
- Assess the site of pain and measure the range of occurrence.

Figure 3.21 • Mouth closing with maximum clenching and bilateral condylar palpation.

Figure 3.22 • Application of overpressure for protraction at the angle of the mandible with middle and ring fingers on both sides and fixation with the thumb at the zygomatic bone.

Figure 3.23 • Application of overpressure for protraction by pulling the mandibular incisives forward with one thumb and fixation of head and neck with the other hand.

Figure 3.24 • Physiological incisal guidance at protraction showing premolar and molar disclusion. (Reproduced with the permission of the IFCFS.)

Figure 3.25 • Application of overpressure for retraction by pushing the mandible backwards with the web space of the hand and fixation of head and neck with the other hand.

- In absence of pain, overpressure is applied with the ulnar border of the hand, which is metacarpo-phalangeally flexed 90°, on the corpus and ramus of the mandible.
- The other hand holds the head and neck in place, with the thumb on the zygomatic bone (Fig. 3.26).
- Course: look for physiological canine guidance, or compensatory incisal guidance, assess the site of lacking (prae)molar disclusion respectively (Figs 3.27 and 3.28).
- Range: normally approximately one quarter of depression (Figs 3.29 and 3.30).

Figure 3.26 • Application of overpressure for lateral movement to the left with a flexed ulnar border of the hand at the right mandible and head and neck fixation with the other hand.

Figure 3.27 • Physiological canine guidance at lateral movement to the right and complete ipsi- and contralateral disclusion. (Reproduced with the permission of the IFCFS.)

Figure 3.28 • Absent canine guidance on lateral movement to the right due to deflective occlusal contact between left molars. (Reproduced with the permission of the IFCFS.)

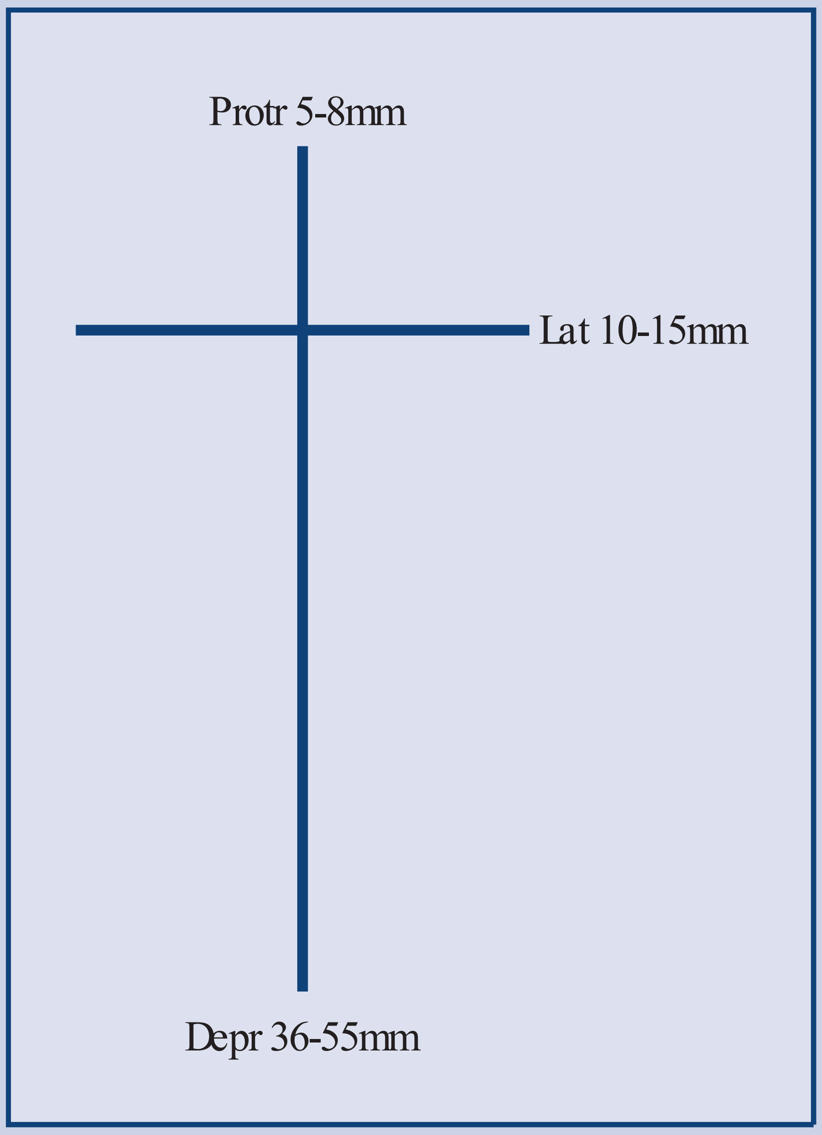


Figure 3.29 • Visual range of motion scale with normal ranges of movement. (Reproduced from Curl 1992).

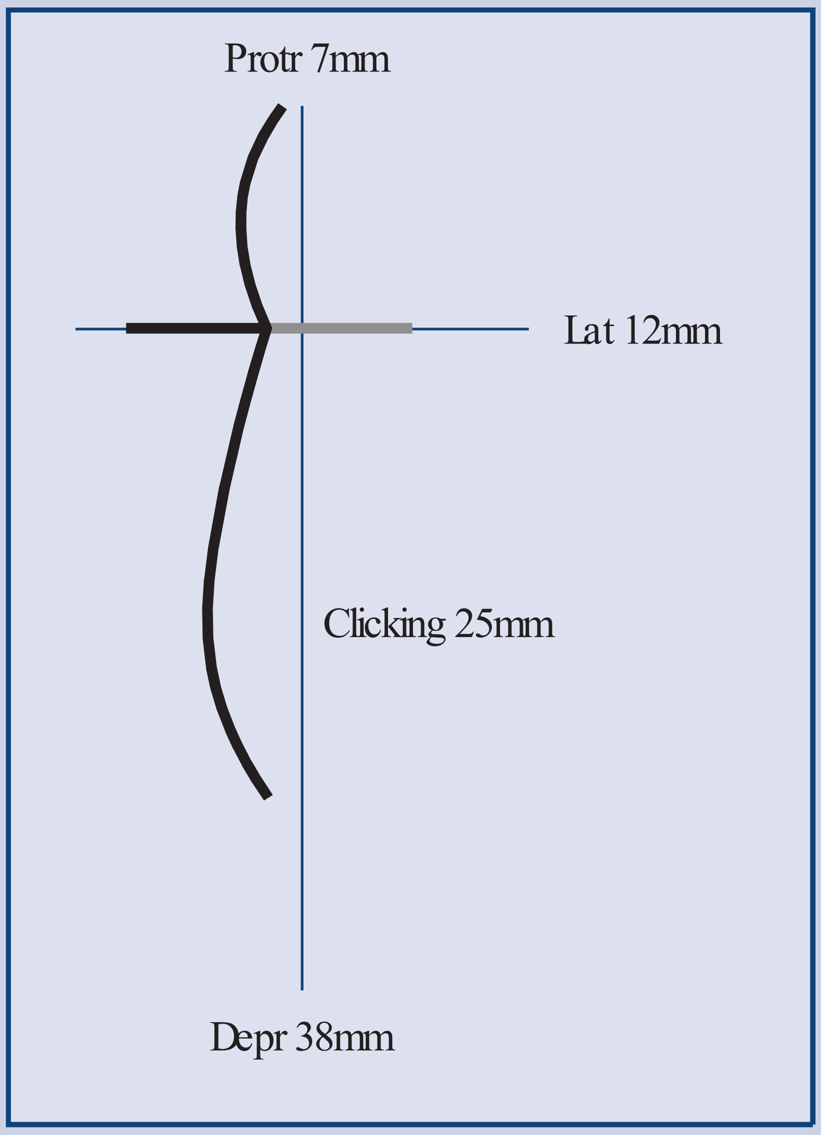


Figure 3.30 • Graphic representation of active mandibular movements in a patient with an anterior disc displacement and an unstable excursive repositioning. (Reproduced with the permission of the IFCFS.)

Figure 3.31 • Asymmetrical starting position of upper and lower midline for lateral movements. (Reproduced with the permission of the IFCFS.)

- Consider a midline asymmetry of the lower and upper teeth at measuring (Fig. 3.31).

Isometric tests

In supine lying

- Aim: to reproduce muscular pain.
- No pain indicates that there is no muscular lesion.
- However, muscle soreness or tightness due to bruxism or other parafunctional activities may not react with pain on contraction.
- Therefore, muscular palpation of sore muscles is considered relevant for diagnosis.
- Resistance is applied in a loose-pack position of approximately 2 cm mouth opening with a 'V' grip for depression and elevation, while the other hand and shoulder are stabilizing the cervical spine and frontal head respectively (Fig. 3.32).
- Further tests are indicated only in cases of pain provocation.

Figure 3.32 • Isometric testing with a web space 'V'-grip around the chin and a stabilized head and neck.

- In cheek pain, differentiation between the masseter and medial pterygoid muscle is performed by giving resistance against ipsi- and contralateral movement.
- Ipsilateral resistance challenges the masseter more and contralateral resistance is more challenging for the medial pterygoid.
- In preauricular pain, differentiation between the lateral pterygoid muscle and joint pain may be performed with resistance against protruding contralateral lateral movement or with the PNF technique 'rhythmic stabilization' during a chewing-act position, which could provoke a typical cramp reaction of the muscle.

Active tests of the cervical spine

To prevent loading of the TMJ, different grips are advocated when applying overpressure.

- *Upper cervical fexion and upper cervical quadrant:* Place the web space of the hand on the maxilla instead of around the chin.
- *Extension:* Place the web space of the hand at the occiput instead of around the chin.

Precautions

Neurological examination

- Indicated for the peripheral (cervical plexus, cranial nerves) and central nervous systems in the case of present neurological symptoms, such as motor deficits or sensory loss, numbness, pins and needles (head, face, tongue) and should include examination of the classic senses by a neurologist.
- Further precautions may include testing of upper cervical stability and cervical arteries (Blake & Beames 2013).

Neurodynamic tests

Cervical slump and occipital nerve major test (Maitland et al. 2005)

- The trigeminal and facial nerves may be involved in facial pain and need to be assessed on pain and range of motion.
- An initial neurodynamic differentiation can be incorporated in the functional demonstration. The painful position is stabilized while the effect of additional slump-test components from cephalad to caudad is monitored.
- For example, a male person demonstrates mandibular pain while shaving the right caudad side of the chin in the morning, standing flexed in the bathroom in front of the mirror facing himself with his cervical spine in upper cervical extension, rotation and side flexion to the left, the mandible in lateral position to the left and slightly depressed. This position can be established in sitting on the plinth.
- Mandibular as well as upper cervical movement change the pain. Keep the mandible and neck fixed and add thoracic flexion, then lumbar flexion and finally, if possible, a both-sided straight-leg raise to assess changes in the mandibular pain response and to clinically confirm a mandibular nerve involvement.

Mandibular nerve, right side

- Standardized tests for cranial nerves have been described (von Piekartz 2006).
- The patient lies supine with the head over the edge of the plinth supported by the therapist's abdomen or with his head on the plinth, with 1.5 cm depression and the tongue relaxed.
- The therapist stands beyond the patient's head facing the patient's feet, grasps the occiput with both hands, with thumbs at the side of the skull, pointing anteriorly.

- The upper cervical spine is then flexed, laterally flexed to the left and rotated to the left.
- The therapist shifts his right hand forward and applies a lateral mandibular movement to the left.

Facial nerve, right side

- The patient lies supine with his head at the edge of the plinth.
- The therapist sits behind the head and let his forearms rest on the plinth.
- Upper cervical flexion, contralateral side flexion and ipsilateral rotation are performed with an ipsilateral grip at the frontal bone and mandible, while the contralateral hand is at the contralateral occiput.
- Different parts of the facial nerve can be loaded additionally, for example:
  - a neurocranium manipulation of the temporal bone for the most superior branches
  - depression and contralateral movement of the mandible for the buccal nerve
  - laterocaudad movement of the hyoid bone for inferior branches as well as
  - additional facial muscle contractions.
- In this way the mechanosensitivity of the right mandibular branch of the trigeminal nerve and the facial nerve can be assessed and compared with the left side, which can be further confirmed by palpation of superficial branches of trigeminal and facial nerves.
- Observation, palpation and accessory movements can be performed extra- as well as intraorally. For intraoral examination and treatment by a physiotherapist, the patient has to give informed consent in many countries. The therapist may enter the oral cavity with one thumb, one index finger, one little finger, or an index and a middle finger, and needs to wear a medical glove. As patients might have an allergic reaction to latex, vinyl gloves are recommended. In this way, intraoral observation, palpation and accessory movements can be performed more easily at the same time.
- The patient's gag reflex may be stimulated. The therapist must allow the patient to overcome this before proceeding.
- If intraoral procedures take a longe time, for example, when applying viscero-cranium treatment techniques, it is appropriate to remove the fingers now and then to let the patient relax, swallow or drink some water.

Extraoral palpation

Palpation of the TMJ

- The joint line is located directly anterior to the external auditory meatus and can be palpated from within the ear or laterally just in front of the ear.
- The posterior joint tissue is likely to be most tender and swollen and thickened.
- Assess the symmetry of both lateral condylar poles in relation to the temporale bone.
- Palpation of the superficial branches of the trigeminal and facial nerves aims to confirm neurogenic components of the dysfunction.
- Increased sensitivity may have a peripheral cause (compression site); however, with long-standing dysfunctions it is more common that tender neural sites are reflecting central sensitization, see Table 3.2.

Extra- and intraoral palpation of stomatognathic muscles

- The masticatory, infra- and suprahyoidal muscles can be palpated for tenderness and trigger points in cases where myofascial symptoms are present (Travell & Simons 1983).
- The masseter can be palpated intraorally (using a gloved little finger, index finger or thumb) at its origin along the zygomatic arch and extraorally from inferior to the zygomatic arch moving inferiorly and posteriorly to the angle of the jaw. Have the patient clench their teeth to locate this strap-like muscle extraorally.
- The temporal branch can be palpated intraorally (using a gloved little finger) as it inserts into the coronoid process of the mandible and extraorally by asking the patient to clench their teeth and palpating the fan-like muscle at its temporal location.

Table 3.2 Neural tissue palpation sites

Nerve	Site
Supraorbital branch of the ophthalmic nerve	In the eye brow
Temporalis of the craniolateral facial nerve of musculus orbicularis oculi	Laterally of the eye brow
Nasociliary branch of the ophthalmic nerve	Laterally at the nose
Infraorbital nerve of of the maxillary nerve	Below the middle of the eye on the maxilla
Zygomatic branch of the facial nerve	Over the zygomatic arch
Posterior auricular nerve of the facial nerve	Over the petrous portion of the temporal bone, 5–18 mm behind the external auditory meatus
Auriculotemporal branch of the mandibular nerve	Between the external auditory meatus and the mandibular head, usually during mouth opening
Buccal branch of the mandibular nerve	Below the zygomatic bone, over the buccinator
Mandibular branch of the facial nerve	Ventrally of the parotid gland on the superficial masseter, usually during light contraction
Lingual branch of the mandibular nerve	Anteriorly and internally of the mandibular angle, just anterior of the medial pterygoid muscle
Mental nerve of the mandibular nerve	Laterally on the chin

- The lateral pterygoid can be palpated extraorally, by firmly pressing medially, just anteriorly of the mandibular head and possibly intraorally by entering the maxillary buccal vestibule then moving superiorly, posteriorly and medially towards the insertion on the condyle of the mandible.
- The practical application of intraoral palpation of the lateral pterygoid and its validity and reliability are disputed.
- Medial pterygoid can be palpated extraorally at the medial side of the angle of the mandible.
- Of the suprahyoidal muscles, the digastric muscle might show trigger points in its anterior belly, extraorally palpated at the caudad surface of the floor of the mouth, as well as in the posterior belly behind the ramus of the mandible. Intraoral palpation of the floor of the mouth may reveal a tender or trigger point of the mylohyoid muscle.
- The infrahyoidal omohyoideus muscle with a sling dividing the superior and inferior bellies may be damaged by anterior neck surgery, possibly leading to insufficiencies in swallowing and speech. Occasionally the lower belly shows local tenderness and tightness, which might interfere with the superior brachial plexus so causing neurogenic arm pain.
- Any reproduction of pain on muscular palpation indicates an immediate symptomatic treatment option with passive techniques (massage, trigger point, electromassage, elastic taping) or active rehabilitation aimed at muscular relaxation and rebalancing.
- Further examination is required to establish the cause of the myogenic finding.

Intraoral observation and palpation

- *Resting position of the mandible*: part the patient's lips to reveal the incisors.
  - the teeth should be slightly separated and the incisors should be aligned. If the mandible is deviated, correct this and assess the effects this has on the patient's symptoms.
- *Malocclusion*: look for open bite, cross bites, retro- or prognathic malposition, missing teeth (Fig. 3.33).
  - ask the patient to bite, noting any pain, then part the lips and note whether there are any signs of malocclusion such as contact of the teeth on one side more than the other or overbite due to lack of posterior support. This will force the mandible into retraction, compressing the pain-sensitive retrodiscal tissue.
- *Inspection of the teeth*: ask the patient to open the mouth and look for excessive wear

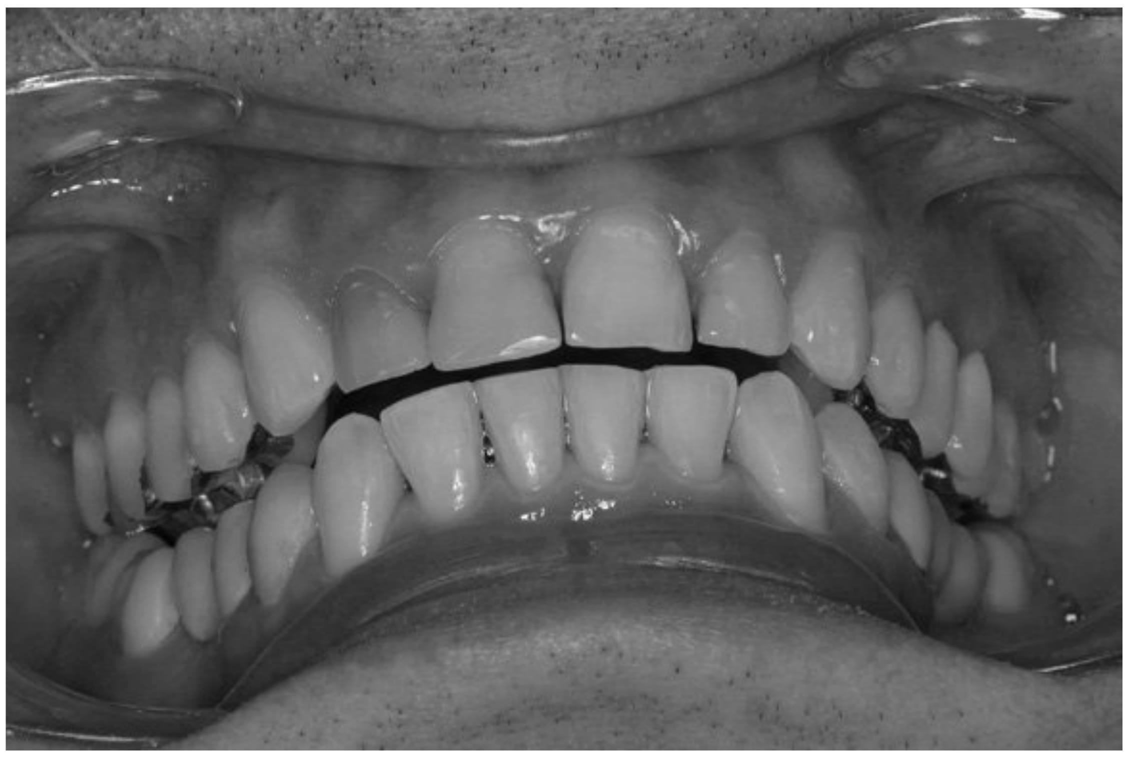


Figure 3.33 • Open bite in central relation. (Reproduced with the permission of the IFCFS.).

patterns on the teeth, which may be related to bruxism
- palpate and press the teeth in buccal, lingual, oral, palatinal directions to assess pain
- look for periodontologic signs such as gingival recession, clefts or swellings (garland), which could by a sign of periodontal disease or parafunctional activity such as bruxism
- the latter might cause swelling at the oral side of the cheek as well, when patients suck the cheek between the teeth.

- *The resting position of the tongue* should be relaxed at the floor of the mouth. At swallowing (closed lips) the tip of the tongue should rest against the anterior part of the upper palate just posterior to the upper incisors. Ask the patient to swallow and then ask where the tongue was pressing during swallowing.
- *Inspection of the tongue*: due to parafunctional habits, abnormal swallowing patterns or speech abnormalities, the tongue may push against the upper (or lower) teeth or between them and indentations of the teeth on the tongue will be the result.

Accessory movements

The basic examination consists of seven accessory movements, which may need to be assessed in neutral or functional positions of the TMJ and the cervical spine (Fig. 3.34). These tests are considered specifically for peri- and intra-articular structures and allow further structural interpretation of the dysfunction (Langendoen et al. 1997, Bumann & Lotzmann 2000). All movements can be performed intraorally, whereas adequate extraoral end-of-range assessment is limited to the transverse movements.

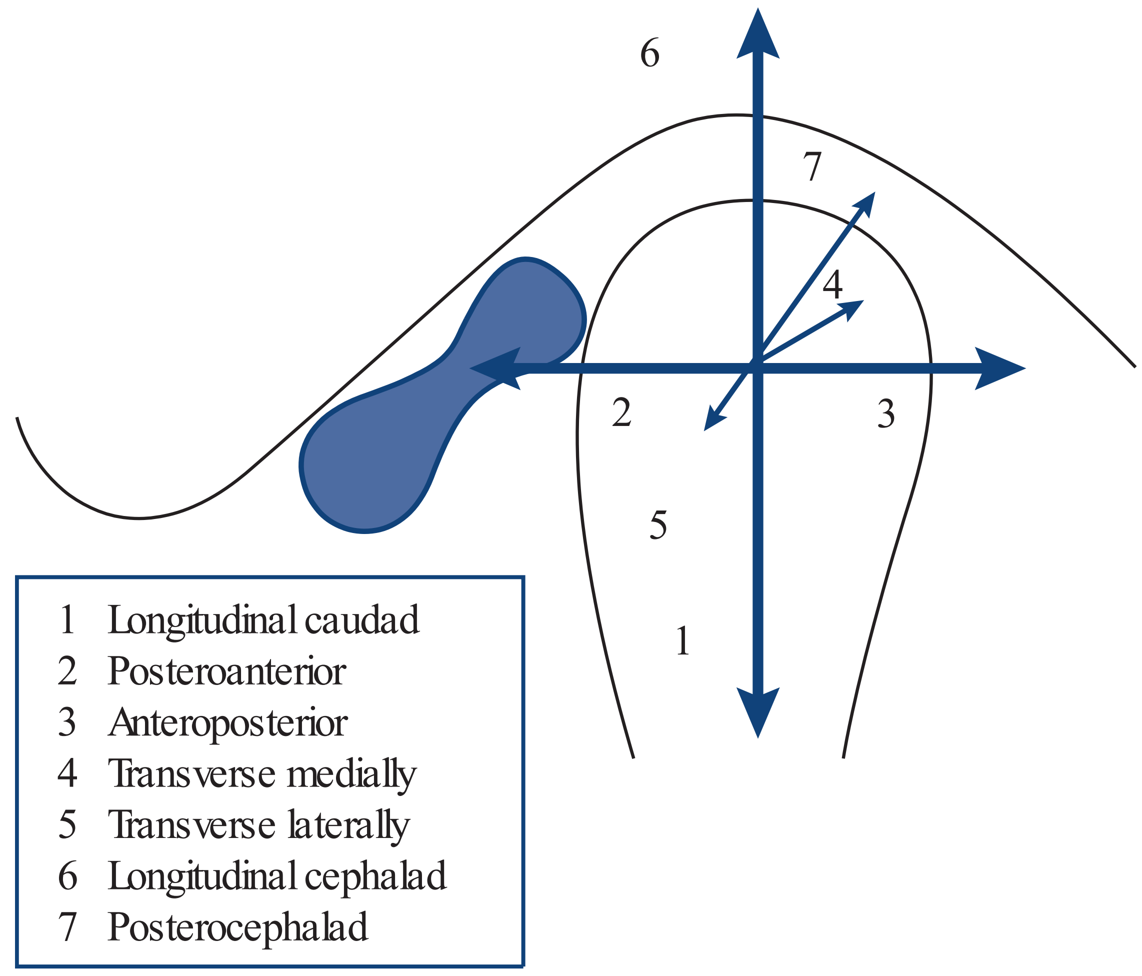


Figure 3.34 • Graphic representation of standard accessory movements of the mandible in a TMJ with an anterior displaced disc. (Reproduced with the permission of the IFCFS.)

The seven movements are, in the order of intraoral application:

- longitudinal caudally ↔
- posteroanterior ↕
- anteroposterior ↕
- transverse medially ←
- transverse laterally →
- longitudinal cranially
- longitudinal dorso-ceph.

Most accessory movements can be used as treatment techniques. Indication, contraindication and type of performance have to be considered carefully according the clinical condition, the structural diagnosis and the overall management aims and plans.

Extraorally applied accessory movements

Transverse movement medially (Fig. 3.35)

- *Direction*: Movement of the condyle of the mandible in a transverse medial direction in relation to the mandibular fossa.

Figure 3.35 • Extraoral application of a transverse medial accessory movement with fixation of head and neck and palpation of the contralateral joint.

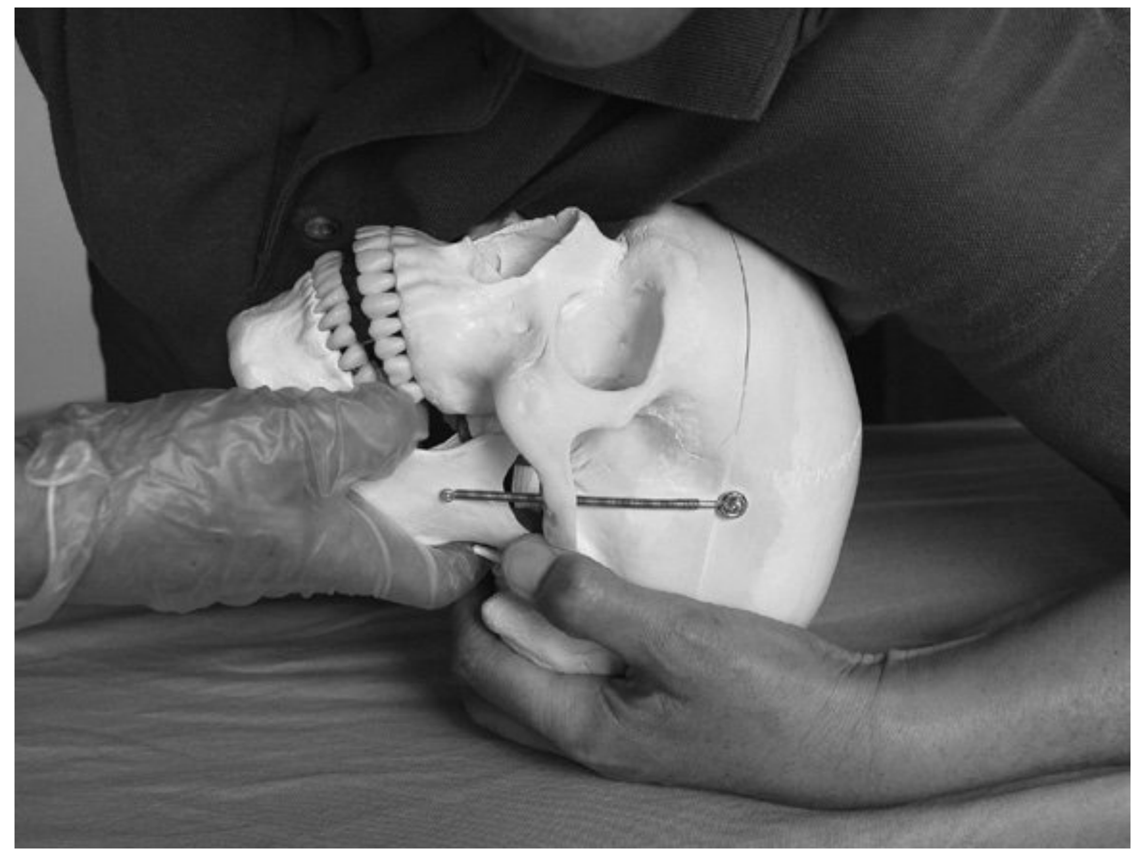


Figure 3.36 • Transverse position of the tip of the right thumb at the last contralateral, left, molar, while palpating the left TMJ and fixating the head with the ipsilateral hand and anterior shoulder.

- *Symbol*: ←•–
- *Patient starting position*: Side lying with the head supported on a pillow. Occasionally in supine lying with the head on a pillow and turned to the left, if that is considered relevant.
- *Therapist starting position*: Standing behind the patient's head facing across the patient's body.

Localization of forces (position of therapist's hands)

- The pads of both thumbs are placed over the head of the mandible pointing towards each other.
- The backs of the thumbs may be positioned close together.
- The fingers of both hands spread comfortably around the thumbs to provide stability.
- The arms must be directed in line with the transverse movement of the mandible.
- Alternatively, to reduce pressure discomfort, apply the movement with the ipsilateral thenar, while the other hand fixes the head and neck and palpates the contralateral joint with the index finger.

Application of forces by therapist (method)

- Small amplitude (grade I) oscillatory mobilizations are produced by the therapist's arms acting through stable thumbs.
- Very little pressure is required to produce quite a lot of movement.
- Care must be taken to make sure the movement is as comfortable as possible.

Interpretation of fndings

- Ipsilateral pain and movement limitation indicates an intra-articular obstruction such as a displaced disc or fibrosis after trauma.
- Contralateral pain indicates a capsular dysfunction, either an acute capsulitis or a painful stiff capsular tightness.

Uses

- The main indication is an end-range intra-articular condition, for example, due to fibrosis after trauma or surgery.
- The effect on the contralateral joint is a transverse lateral movement, which might be an indicated treatment direction in painful or stiff periarticular conditions. Avoidance of ipsilateral local pressure pain is a major advantage of contralateral application.

Intraorally applied accessory movements (Figs 3.36 and 3.37)

Longitudinal movement caudad

- *Direction*: Movement of the head of the mandible in a longitudinal direction caudad in relation to the mandibular fossa.
- *Symbol*: ←•→

Figure 3.37 • Intraoral application of accessory movements in a functional position of the mandible with fixation of head and neck.

Figure 3.38 • A bilateral longitudinal caudad movement can be applied as a treatment technique in various rhythms, grades and positions of the mandible.

- *Patient starting position*: Supine, lying over towards the therapist.
- *Therapist starting position*: Standing by the patient's side, level with the shoulder.

Localization of forces (position of therapist's hands)

- The left thumb is placed intraorally and transversely at the occlusal surface of the most posterior molar. The left index and middle finger are around the angle of the mandible.
- The right hand and arm stabilize the patient's head with one finger of the right hand in a position to be able to palpate for movement of the right TMJ.

Application of forces by therapist (method)

- While the therapist's right hand stabilizes the patient's head, the therapist exerts pressure against the right lower molar so as to distract the TMJ.
- This is best produced as an oscillatory movement at the limit of the range.

Interpretation of fndings

- Decrease of pain indicates an intra-articular source of pain, as well as an option for treatment.
- Early pain reproduction without resistance indicates an acute capsulitis; with stiffness it indicates a more longstanding capsular limitation.

Uses

- Mobilization in a caudad direction is the most commonly used articular treatment technique.
- The caudad movement is most useful as a technique to stretch into when there is limitation of mouth opening due to tightness of the joint's capsular structures.
- Grade II mobilizations without pain may be beneficial to support management of an (sub) acute capsulitis or bilaminar zone inflammation.
- Caudad mobilization of a capsular tightness, with or without inclinations, can be beneficial in the case of a coexisting intra-articular disc derangement.
- The technique decompresses the joint surfaces enabling improvement of anterior translation of the disc in the upper joint compartment.
- Note: posterior-anterior movement of the mandible stimulates translation in the lower compartment, possibly increasing the intra-articular dysfunction and might not positively influence the discal translation.
- A more forceful variation of the technique for mobilizing a stiff capsule is performed by supporting the treatment hand at the wrist with the other hand into caudad direction, while controlling the patient's head position with the anterior side of the shoulder.
- A lighter, more subtle variation of the technique, mainly for relaxation, is a bilateral application with the index and middle finger in various positions of the mandible (Fig. 3.38).

Posteroanterior and anteroposterior movement

- *Direction*: Movement of the head of the mandible in a posteroanterior and anteroposterior direction in relation to the mandibular fossa.
- *Symbols*: ↓, ↑
- *Patient starting position*: Supine, lying over towards the therapist.
- *Therapist starting position*: Standing by the patient's side, level with the shoulder.

Localization of forces (position of therapist's hands)

- The left thumb is placed intraorally and transversely at the occlusal surface of the most posterior molar. The left index and middle finger are around the angle of the mandible.
- The right hand and arm stabilize the patient's head with one finger of the right hand in a position to be able to palpate for movement of the right TMJ.

Application of forces by therapist (method)

- The movement in these directions is produced by the therapist's arms acting through thumb, index and middle finger.
- The area of contact at the mandibular angle can be uncomfortable with stronger pressure.

Alternative in case intraoral application is not possible

- *For posteroanterior*: standing by the patient's right shoulder facing across the patient's body.
- *For anteroposterior*: standing by the patient's left shoulder facing across the patient's body.

Localization of forces (position of therapist's hands)

For posteroanterior

- The pads of both thumbs, pointing towards each other are placed against the posterior surface of the head of the mandible, behind the ear lobe, with the backs of the thumbs close together.
- The fingers rest comfortably over the forehead and mandible.
- Both forearms are directed in line with the posteroanterior movement of the joint.

For anteroposterior

- The pads of both thumbs, pointing towards each other are placed against the anterior surface of the condyle of the mandible as close to the head as is possible without losing contact with the anterior surface of the condyle, with the backs of the thumbs close together.
- The fingers spread comfortably around the patient's forehead, mandible and neck.
- Both forearms are directed in line with the anteroposterior movement of the joint.

Application of forces by therapist (method)

- The mobilization in these directions is produced by the therapist's arms acting through both thumbs.
- As these areas of contact are normally sensitive to touch it is necessary to position the thumbs carefully and produce the movement with the arms and not the thumb flexors.

Variations in the application of forces

- The posteroanterior movement can also be produced by making contact with the head of the mandible from within the external auditory meatus.
- The anteroposterior movement can be produced by making contact with the ramus of the mandible rather than the condyle.

Interpretation of fndings

- Posteroanterior movement stretches the posterior and compresses the anterior capsule and may be painfully limited in a peri-articular condition.
- In the case of an anterior-displaced disc the movement might feel blocked and pain may arise from stretching the already compressed intra-articular ligaments.
- Crepitus on movement, often not related to pain, indicates degenerative joint disease.
- Anteroposterior movement loads the posterior capsule, compresses the bilaminar zone and will be painful if there is intra-articular inflammation.

- A very limited movement indicates a pathological posterior position of the head of the mandible in the fossa.

Uses

- Posteroanteriorly directed movements are only indicated in treatment if increased stiffness is definitely related to pain(for example, due to fibrosis after trauma) and the disc-condyle complex is very stable.
- Anteroposterior movement is not indicated as a treatment direction in any intra- or periarticular condition as it may interfere with disc-condyle stability and the centric relation by promoting non-physiological translation in the lower compartment.

Transverse movement medially and laterally

- *Direction*: Movement of the condyle of the mandible in a transverse medial and lateral direction in relation to the mandibular fossa.
- *Symbols*: ←•—, —•→
- *Patient starting position*: Supine, lying over towards the therapist.
- *Therapist starting position*: Standing by the patient's side, level with the shoulder.

Localization of forces (position of therapist's hands)

- The left thumb is placed intraorally and transverse (medially or laterally) at the occlusal surface of the most posterior molar. The left index and middle finger are around the angle of the mandible.
- The right hand and arm stabilize the patient's head with one finger of the right hand in a position to be able to palpate for movement of the right TMJ.
- For the transverse lateral movement, shift the tip of the thumb to the lingual side of the last molar.

Application of forces by therapist (method)

- Transverse medially to the mandible by the extraorally positioned index and middle finger and transverse laterally by the thumb at the lingual side of the last molar.
- The intraoral application enables end-range testing.

Interpretation of fndings and uses

- Pain and movement limitation on transverse medial movement indicates an intra-articular obstruction such as a displaced disc or fibrosis after trauma. In stiffmess without disc derangement this technique (grade III/IV) can be applied for treatment.
- Pain and movement limitation on transverse lateral movement indicates a capsular dysfunction, either an acute capsulitis or a painful stiff capsular tightness. These conditions can be managed with a painless resistance-free (grade II) application and a end-range technique with some pain (grade III−/IV−, or III/IV) respectively.

Longitudinal movement cephalad and posterocephalad

- *Direction*: Movement of the head of the mandible in a longitudinal direction both cephalad and posterocephalad in relation to the mandibular fossa.
- *Symbol*: ←•→
- *Patient starting position*: Supine, lying over towards the therapist.
- *Therapist starting position*: Standing by the patient's side, level with the shoulder.

Localization of forces (position of therapist's hands)

- The left thumb is placed intraorally and transversely at the occlusal surface of the most posterior molar. The left index and middle finger are around the angle of the mandible.
- The right hand and arm stabilize the patient's head with one finger of the right hand in a position to be able to palpate for movement of the right TMJ.

Application of forces by therapist (method)

- The technique is one of pushing cephalad respectively posterocephalad in different functional starting positions of the mandible (medially, neutrally, laterally, anteriorly positioned) to load the mandibular fossa at various points.

Interpretation of fndings

- With the disc in place, the cephalad movement can never be painful.

- Any pain indicates an intra-articular disorder. Posterocephalad pressure specifically loads parts of the bilaminar zone and the discotemporal ligament, which can be painfully inflamed, even in absence of a disc displacement.

Uses

- The cephalad and posterocephalad movements are never treatment directions.

Conclusion

After examination of the TMJ with accessory movements and a subsequent reassessment of the relevant findings, a clinical conclusion about the intra- and periarticular status should be made. An initial treatment for an intra- or periarticular condition may follow and examination of further structures, for example:

- accessory and passive physiological movements of the upper cervical spine
- the cervico-thoracic junction and upper ribs
- functional muscle tests of relevant neck-shoulder girdle muscles, are to be performed during the next sessions.

The conclusions might need to be reported to the practitioners of the other disciplines involved and the therapist might contribute to the formulation of the overall management plan. It might be appropriate to assess the function of an existing splint, to perform instrumental measurements, for example,

- jaw motion analyzer
- electromyography of the masticatory muscles
- heart rate variability recording and/or
- imaging procedures such as functional magnetic resonance imaging in the case of an arthropathy

Other structures in plan

Further examination may complete the first session or may follow in the next session.

Hyoid and larynx (Fig. 3.39)

- Resting position of the hyoid bone, which can be located anteriorly just below the mandible at the level of C3.

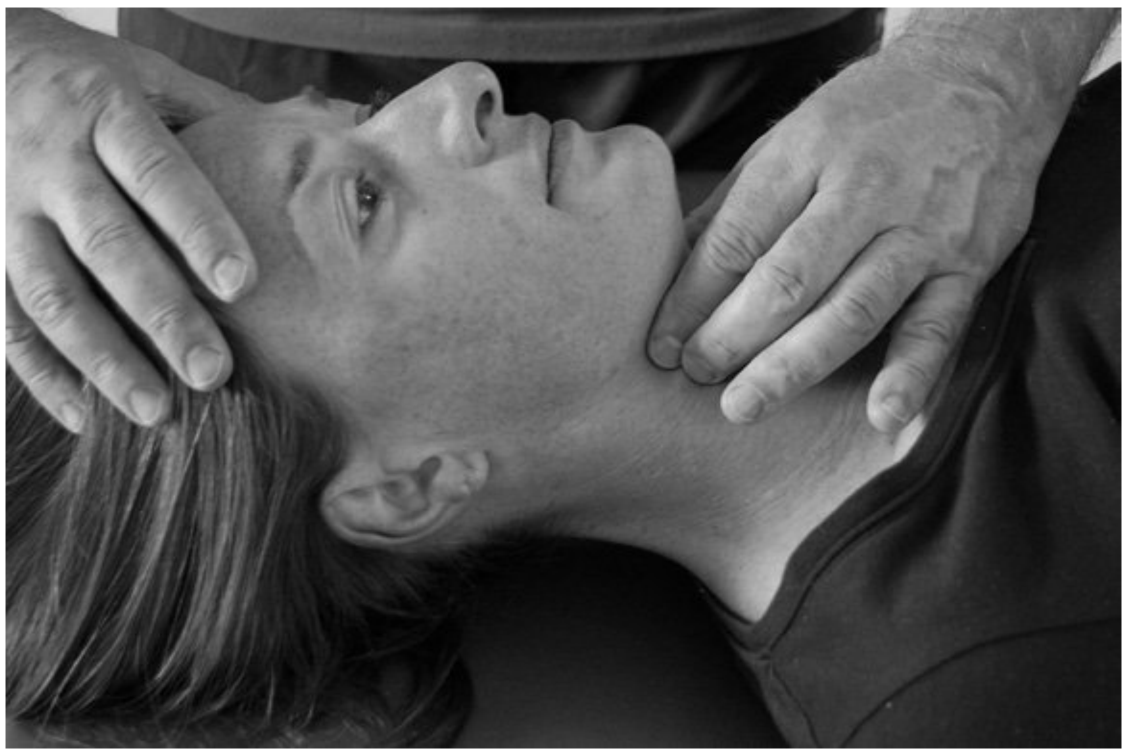


Figure 3.39 • Examination and treatment of the hyoid bone.

- Screening with simultaneous palpation of hyoid and laryngeal structures with coughing, swallowing and talking.

Transverse and rotary movement of the laryngeal and hyoid joints

- *Direction*: Transverse or rotary movement of the cricothyroid joint in relation to the hyoid bone or the hyoid bone in relation to the mandible and cricothyroid cartilage.
- *Symbols*: ⟷, ↻
- *Patient starting position*: Supine, lying without a pillow so that neither the head nor neck is flexed. An extended examination might require repetition of the routine tests in different positions of the upper cervical spine and mandible.
- *Therapist starting position*: Standing by the patient's side, facing across the patient.

Localization of forces (position of therapist's hands)

Movement of the thyroid cartilage

- The thumb and index finger of the left hand loosely grasp the upper margin of the thyroid cartilage.
- The thumb and index finger of the right hand loosely grasp the lower margin of thyroid cartilage.
- The fingers spread forwards over the adjacent neck, chest and face.
- The little fingers make the firmest contact.

Movement of the hyoid bone

- The index finger and thumb of the left hand hold the hyoid bone.
- The right hand stabilizes the thyroid cartilage or the head.

Application of forces by therapist (method)

- Movement of the thyroid cartilage away from the therapist is produced by pressure through the thumbs.
- The little fingers form a pivot about which the thumb movement takes place.
- To make the pressure as comfortable as possible the movement should be produced by glenohumeral joint adduction and slight elbow extension rather than by the thumb flexors.
- Movement of the thyroid cartilage towards the therapist is produced by the opposite movement of the therapist's arms acting through the index fingers.
- A rotary movement can also be performed.
- The hyoid bone can be moved from side to side as well as rotated around a sagittal axis, with the index finger and the thumb in different positions of the upper cervical spine and mandible to assess its mobility and any pain response to movement.
- Particularly note small asymmetries in mobility accompanied by subtle discomfort.

Uses

- When transverse or rotary movements of the laryngeal and hyoid joints are painful, gentle and slow painless movements are performed.
- Sustained gentle hyoid techniques are used for local or deep relaxation within a standardized protocol.
- Hyoid reassessment may confirm the effectiveness of soft tissue management for tight supra- and infrahyoidal muscles.

Occlusal–cervical–pelvic relationships

The theory of and evidence for the Emotional Motor System may provide an explanation for the Meersseman Test (Esposito & Meersseman 1988, Holstege et al. 1996, van der Horst et al. 1997, 2001, Gerrits et al. 1999, 2004, Holstege 2001, Huelse & Losert-Bruggner 2002, Mouton et al. 2005, Entrup 2009, Fischer et al. 2009).

An algorithm for clinical application of the Meersseman test procedure could be:

1. Measure in standing with closed lips and discluded teeth:
   - **a.** the finger to floor distance and/or
   - **b.** lumbar unfolding at lumbar flexion (relate to pelvic tilt) and/or
   - **c.** heel to heel distance at bilateral hip abduction and/or 2 below.
2. Measure in supine lying the range of motion of:
   - **a.** straight leg raise and/or
   - **b.** hip abduction and/or
   - **c.** hip extension for iliopsoas length (Thomas test).
3. Then reassess the most relevant test(s) (1a–c, 2a–c):
   - **a.** during full intercuspation
   - **b.** at biting with cotton rolls between the molars, uni- or bilaterally (as in Fig. 3.20), depending occlusal assessment
   - **c.** after upper cervical mobilization
   - **d.** after taping to relax chewing muscles (see Fig. 3.52).

Another, reversed, algorhythm could be:

1. Assess maximum mouth opening in supine lying.
2. Reassess after:
   - **a.** active lengthening of tensed muscles (hamstrings and or adductors) and/or
   - **b.** taping for relaxation of the hamstrings or adductors or psoas or
   - **c.** upper cervical mobilization.

Integration of the test procedure in Rx1 or Rx2 is indicated in extra-articular conditions such as occlusal faults or parafunctional habit-induced hyperactivity of the chewing muscles with or without complaints in the lower low back–pelvic hip area.

Cranium

- Skull bones are able to move in young years and may still be able to adapt to stress and loading – able to 'breathe' – after adolescence.

- Sutures contain nerve receptors and can be considered a possible source of symptoms.
- Skull development and alteration of transmission of forces between the skull bones may well result in painful conditions (headaches) and a whole array of bizarre symptoms such as loss of concentration, dizziness, altered behaviour, weeping, bed-wetting, loss of senses, etc., not only in the young.
- Apart from inter-cranial forces, cranial bones are an interesting and challenging medium between the forces of the extracranial muscles and the intracranial meninges.
- This implies that related muscles and neuromeningeal structures, if not treated, still have to be assessed and reassessed when dealing with skull techniques.
- Techniques which assess the response of the fibrous suture lines of the skull to pressure changes have been described in traditional craniosacral therapy (Liem 2000).
- Cranium techniques have been integrated into the Maitland Concept of assessment and management of neuromusculoskeletal dysfunctions (von Piekartz & Bryden 2000).

A number of commonly used techniques aiming to decrease TMD/OFP symptoms of extra-articular origin such as muscular pain, headaches due to parafunctional habits (e.g. bruxism), as well as other symptoms, which might indicate (benign) dysfunctions of cranial nerves possibly due to cranium dysfunctions (suturae, foramina) are described, however, a full description of all techniques is beyond the scope of this book.

Hypothethical rationales for the techniques are:

- Rebalancing of the autonomous nervous system, deep relaxation to stimulate the parasympathetic part, particularly the nucleus ambiguus (measurable with heart rate variability) (Marthol et al. 2006).
- Rebalancing the extracranial structures (muscles, muscle attachments) with the intracranial meninges and their cranial attachments.

Generally, there are three ways, attitudes or visions for using cranium and craniosacral techniques (Ridley 2006), which can be related the Maitland grading system (Banks & Hengeveld 2005):

1. High intervention (corresponding with grade IV− to IV+). Either direct techniques, using forces to move the bones or indirect when a perceived motion is followed to the end and kept. Both methods are structure–function models. A change in structure will change function (direct, immediate, transient?), whereas function changes lead to structure rebalancing (indirect, slower, more permanent?).
2. Light intervention (corresponding with grade II): A perceived motion is followed, however, not kept till relaxation or normalization occurs.
3. 'No' intervention: manual contact is just following breathing movements till changes in rhythm or movements and relaxation occurs (grade I).
   - *Patient starting position*: for the described techniques the patient should comfortably lying supine on a treatment plinth with or without a pillow.
   - *Therapist starting position*: apart from for the maxilla and mandibula techniques, sitting behind the head of the patient.

Occiput-C1 longitudinal cephalad (Fig. 3.40)

- This technique is a typical example of a direct, high-intervention technique, aiming to restore function at the junction, which includes relaxation of the suboccipital muscles and even the dura mater.

Localization of forces (position of therapist's hands)

- Both hands are left and right posteriorly at the caudad occiput.
- The forearms are relaxed on the plinth.
- Fingers II to V move in as gently and slowly as possible towards Occ-C1.

Application of forces by therapist (method)

- Apply a sustained IV−−, IV− longitudinal cephalad at the occiput for one or two minutes.
- Follow this with a longitudinal caudad movement applied by the index and middle finger, while the ring finger and little finger keep the longitudinal cephalad pressure on.

Figure 3.40 • Longitudinal cephalad technique for relaxation of occiput-C1.

Figure 3.41 • Temporal bone. Bilateral medial technique.

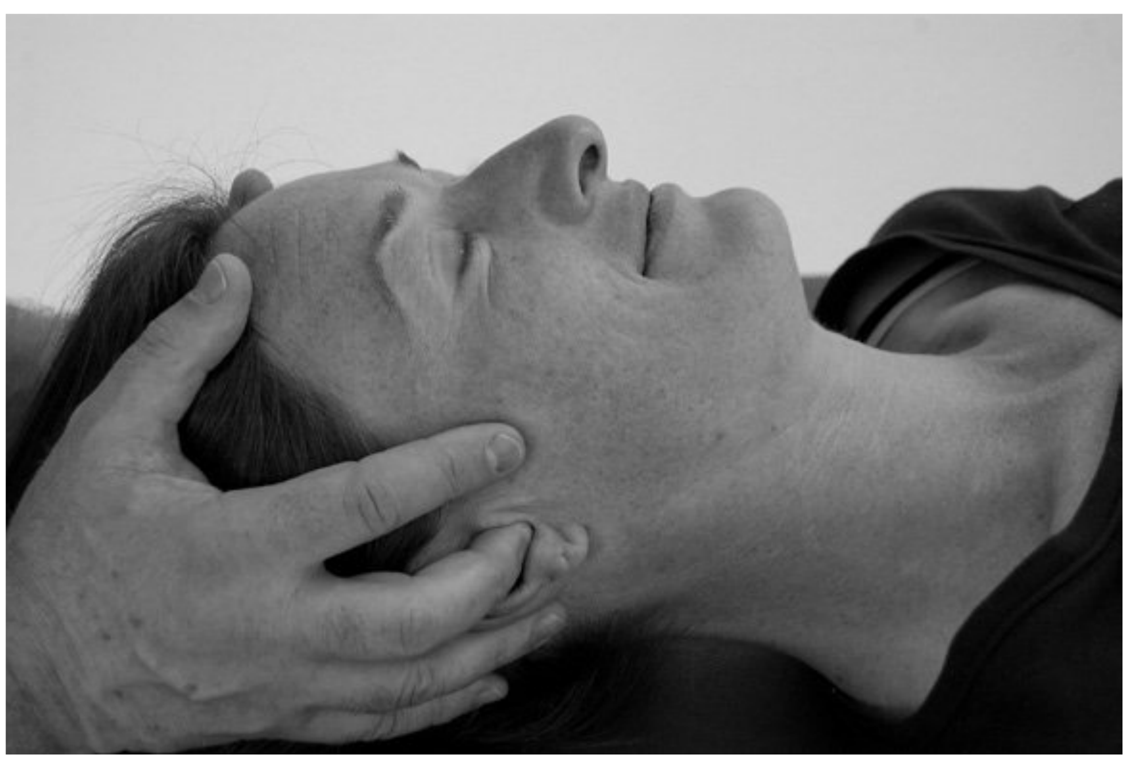


Figure 3.42 • Temporal bone. Bilateral circumferential technique.

- Finally, gentle rocking in flexion–extension direction induced by the wrists of the therapist adds a mobilizing component.

Temporal bone

Bilateral medial – lateral (Fig. 3.41)

Localization of forces (position of therapist's hands)

- Both hands are left and right posteriorly at the occipital condyles and mastoid process.
- The forearms are relaxed on the plinth.

Application of forces by therapist (method)

- Both thenars apply a sustained alternating medial (lateral) pressure (IV––)

Bilateral circumferential (Fig. 3.42)

Localization of forces (position of therapist's hands)

- The index finger tip at the zygomatic bone, the middle finger tip in the external auditory meatus, the ring finger tip at the mastoid process.

Application of forces by therapist (method)

- Apply a combined movement, flexion–extension and internal rotation – external rotation around an oblique axis around the petrous portion of the temporal bone.
- The traditional order of the technique is:
  1. bilaterally symmetrically
  2. feel for easier side, move that side as described first
  3. the same with the more difficult side
  4. both sides opposed.

Bilateral caudolateral (Fig. 3.43)

Localization of forces (position of therapist's hands)

- Thumbs are positioned at the lower border of the external auditory meatus.

Application of forces by therapist (method)

- Thumb pulls bilaterally simultaneously in a laterocaudad direction (towards the acromion) (temporal decompression).

Figure 3.43 • Sustained caudolateral movement by pulling at the lower border of the external auditory meatus in the direction of the acromioclavicular (A/C) joint (decompression of temporal bone).

Figure 3.44 • Sustained longitudinal cephalad movement (TMJ compression) with middle and ring finger under the body of the mandible for local and deep relaxation.

Figure 3.45 • Sustained longitudinal caudad movement (TMJ decompression) with index, middle and ring finger at the mandible for local and deep relaxation.

TMJ: bilateral longitudinal (compression – decompression)

Bilateral longitudinal cephalad (phase 1,compression) (Fig. 3.44)

Localization of forces (position of therapist's hands)

- Tips of the middle and ring fingers are at the caudad side of the body of the mandibula and the mandibular angle, while the rest of the hand is lying relaxed on the face and the thumb on the frontal bone.

Application of forces by therapist (method)

- Apply a sustained IV— longitudinal cranially at and just anteriorly of the angle of the mandible.

Traditional rationale

- Movement of the temporal bone over the parietal bone and tensioning of the cerebral falx.

Bilateral longitudinal caudad (phase 2, decompression) (Fig. 3.45)

Localization of forces (position of therapist's hands)

- Tips of the index, middle and ring fingers are on the body of the mandibula and the mandibular ramus, while the little finger is relaxed without face contact and the thumb is lying relaxed on the frontal bone.

Application of forces by therapist (method)

- Apply a sustained longitudinal caudal movement (IV—) first, then gradually change to a 30° anterior angle during the expiration phase of the breathing cycle.
- Feel for relaxation.

Rationale

- Release of the temporal fascia.

Mandibula

Bilateral longitudinal caudad (distraction) (Fig. 3.38)

- *Therapist starting position*: Standing next to one shoulder of the patient.

Localization of forces (position of therapist's hands)

- The tips of the index and middle fingers of one hand are intraorally lying on the most posterior left and right mandibular molars.

Application of forces by therapist (method)

- Apply a sustained longitudinal caudal movement (IV—) first, then gradually change to a 30° anterior angle during the expiration phase of the breathing cycle.
- Feel for relaxation.

Rationale

- Release of the temporal fascia.

Maxilla (Fig. 3.46)

Lateral, anterocephalad

- *Therapist starting position*: Standing next to one shoulder of the patient.

Localization of forces (position of therapist's hands)

- The tips of the index and middle fingers of one hand are intraorally on the occlusal surface of the posterior maxillary molars left and right, while keeping the other hand at the head (sphenoid bone).

Application of forces by therapist (method)

- First, feel for medial–lateral movement of the hard palate (maxilla), then firstly apply a sustained bilateral lateral movement (IV—) and, after having monitored some relaxation, follow this with an anterocephalad movement (IV—).

Sphenoid bone (Fig. 3.47)

Anteroposterior (compression) and posteroanterior (decompression)

Localization of forces (position of therapist's hands)

- Both forearms are relaxed lying on the plinth, both hands are controlling the mastoid process and occipital bone. The tips of the thumbs are positioned at the sphenoid bone just cephalad of the zygomatic arch on both sides.

Application of forces by therapist (method)

- *Anteroposterior (compression)*: Apply with the thumbs a bilateral sustained posterior

Figure 3.46 • Sustained bilateral lateral or anterocranial movement of the maxilla, applied at the upper molars.

Figure 3.47 • Bilateral anteroposterior (compression) and posteroanterior (decompression) movement of the sphenoid bone with both thumbs while fixating the head and the neck with both hands.

movement (IV—), while both hands stabilize the occiput.

- *Posteroanterior (decompression)*: the same anteriorly.

Management

- Due to the complexity of the craniomandibular region, disorders, which manifest as craniomandibular pain or dysfunction, are often multicomponential and multidimensional.
- Physical therapy applications are likely to be part of a multidisciplinary, overall short- and long-term management plan of movement-related disorders of the temporomandibular complex.
- One provider serves as the leader of the multidisciplinary team, most commonly the dentist.
- The patient has to agree with the management plan, which has to pace all relevant context factors.
- If long-term management is needed, optimal compliance of the patient is essential.
- Initial management aims to decrease the complaints (short-term aim) (Table 3.3) as well as to create an equilibrium before starting definite management such as teeth restoration (long-term).
- Anti-inflammatory drugs, or even a change in hormonal medication, may be indicated.
- Adequate dental management with splints (Figs 3.48 and 3.49) and teeth restoration is essential for long-term recovery in the majority of cases with occlusal components.
- Physical therapy modalities may be an important support in these cases.
- Other cases might profit greatly from a large variety of physical, non-dental treatment options with a mechanical or a neurophysiological bias.
- As outlined, passive movements of painful or stiff TMJ might be indicated in selected cases within the scope of the overall management.
- Accessory movements in functional positions, rather than passive physiological movements, seem to be more appropriate.
- Active movements, performed in combination with a sustained accessory movement, for example, active depression with sustained transverse pressure medially, may be beneficial treatment options.

Figure 3.48 • A splint showing physiological incisal guidance.

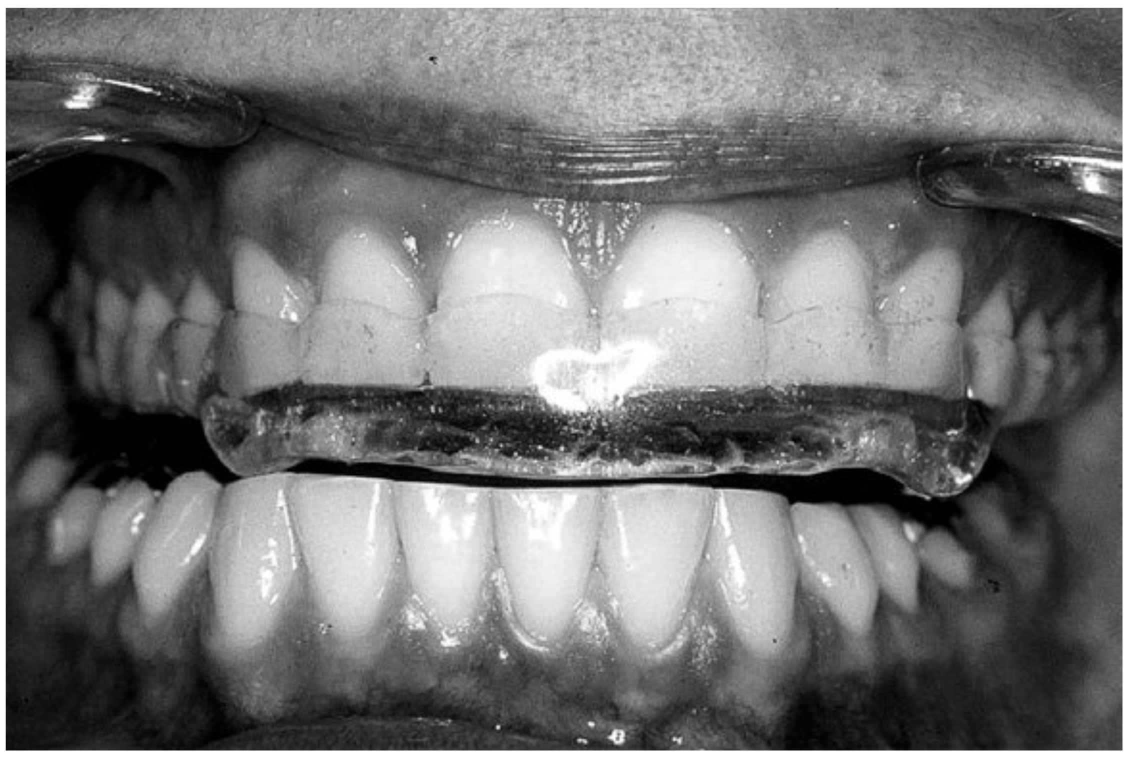


Figure 3.49 • A splint showing physiological canine guidance.

Definitive occlusal restoration/therapy after successful/stable symptomatic therapy

Beyond passive movements, the physical therapist may play a larger role in the overall management, such as:

- Active rehabilitation aiming to restore normal quality of mandibular movement
- Myofunctional training for lip closing, tongue control and swallowing pattern, postural control, including optimizing cervical mobility and dynamic control

Table 3.3 3 × 3 table for primary, symptomatic management of TMD/OFP

Adapted from the Interdisciplinary Forum for Cranio-Facial Syndromes (IFCFS), with permission. Localization	Intra-articular (e.g. bilaminar zone)	Periarticular (e.g. capsulitis)	Extra-articular (e.g. teeth, muscles, cervical spine)
Pain problem	NSAIDs! Ice Distraction splint? Repositioning splint? (only in highly acute cases with intact retrodiscal ligaments)	NSAIDs! Ice Centric splint?	Teeth pain: dentist Chewing muscles (e.g. masseter trismus –dentist)
Range-of-motion problem	NSAIDs? Ice? Distraction splint! 24/7/>6 PT: rotation training MT: contraindicated	NSAIDs Ice Centric splint with teeth guidance (build-up in stages)! 24/7? PT: rotation training without pain MT: pain-free longitudinal caudad (+/− angulations) Elastic taping from the zygomatic bone to the mandibular angle	Chewing and hyoidal muscles: ice, (electro) massage, trigger points (TrP), elastic taping, proprioceptive neuromuscular facilitation (PNF), biofeedback – stress ball (HRV), muscle-relaxing drugs, relaxation splint with incisal and canine guidance Botulinum neurotoxin Orofacial/mimic: myofunctional therapy (lip closing, swallowing) Neurorehab (FOTT (Facial-Oral Tract Therapy – Kay Coombes) Cervical: PAIVMs according degree of dysfunction (EOR) (more causally)
End of range	Distraction splint? PT: rotation training Elastic taping from the zygomatic bone to the mandibular angle? MT: transverse medially	Centric splint with incisal and canine guidance! (24/7/?) PT: Rotation training without pain MT: longitudinal caudally (+/− angulations)	Craniosacral: mechanical/ neurophysiological (more causal therapy) Neural: 'Sliders' of impaired neural tissue following treatment of cervical spine, cranium, medication/neurosurgery

EOR = end of range, HRV = heart-rate variability, MT = manual therapy, NSAIDs = non-steroid anti-inflammatory drugs, PAIVMs = Passive accessory intervertebral movements, PT = physiotherapy

- Extra-articular soft tissue management for myogenic components incl. trigger-point treatment, electrotherapy (relaxing massage) or elastic taping (Figs 3.50, 3.51, 3.52, 3.53 and 3.54). (Sturdivant & Friction 1991, Suvinen et al. 1997, Treacy 1999, Sander et al. 1999, Nicolakis et al. 2000, 2001a, 2001b, 2002, Wolf et al. 2000, Carlson et al. 2001, Oh et al. 2002, Wahlund et al. 2003, Michelotti et al. 2004, McNeely et al. 2006, Medlicott & Harris 2006, Gunsch 2007, Fischer et al. 2009, La Touche et al. 2009, Mansilla-Ferragut et al. 2009).

Stress coping and management of stress-induced complaints are a common component of the overall

Figure 3.50 • Treatment of a medial pterygoid trigger point during static mouth opening against slight resistance.

Figure 3.51 • Electromassage for bilateral relaxation of the masseter muscles. (Reproduced with the permission of the IFCFS.)

Figure 3.52 • Bilateral elastic tape application in myogenic craniomandibular dysfunction to support management for relaxation. The base of the tape is at the zygomatic arch just anterior of the TMJ, the ending is caudad side of the mandible in the midline (tape width is 2.5 cm). The starting position of the mandible is depression short of or at R1. The tape is applied without stretch. (Reproduced with the permission of Kinematic Taping®.)

Figure 3.53 • Bilateral elastic tape application in arthrogenic craniomandibular dysfunction to support rotatory movement training of the condyle. The base of the tape is at the caudad side of the zygomatic bone, the ending is caudad side of the angle of the mandible (tape width is 2.5 cm). The starting position is central relation. The tape is applied without stretch. (Reproduced with the permission of Kinematic Taping®.)

Figure 3.54 • One-sided elastic tape applications in neurogenic craniomandibular dysfunction to support management of mandibular or facial nerve pain. The base of the tapes is at the mastoid process and the zygomatic arch just anterior of the TMJ, the ending is caudad respectively anterior side of the mandible across the midline (tape width is 2.5 cm). The starting position of the mandible is depression, contralateral lateral movement short of P1. The tape is applied without stretch. (Reproduced with the permission of Kinematic Taping®.)

management plan and may include splint, cognitive–behavioural, pharmacological, body-mind and physical therapies.

The role of the physiotherapist in this field may vary from applying local massage or electrotherapy to relax chewing muscles, individual body-mind therapy such as craniosacral therapy, bio- and myofeedback with breathing procedures, to group therapies with a social character such as yoga, qi gong, or meditation classes. Relaxing effects on the autonomic nervous system can be monitored with heart rate variability (HRV) – a way of assessing the state of the parasympathetic nervous system (Shiba et al. 2002, Brown and Gerbarg 2005, Cysarz & Buessing 2005, Jovanov 2005, Lee et al. 2005, Khattab et al. 2007, Raghuraj & Telles 2008, Li et al. 2009, Schmidt & Carlson 2009, Asher et al. 2010, Patra & Telles 2010, Tang et al. 2009, Hallman et al. 2011, Matsubara et al. 2011, Nugent et al. 2011).

- Long-term active management requires discipline from both the provider and the patient and therefore a routine exercise practice should be promoted intensively.
- Rocabado (1985) advocated the use of a daily routine programme in order to maximize patient compliance for craniomandibular rehabilitation.
- The 6 × 6 programme includes six instructions, six times each, six times per day. The regime included:
  1. learn a new postural position
  2. counter the ‘soft tissue memory’ of the old position
  3. restore original muscle length
  4. restore normal joint mobility
  5. restore normal body balance
  6. return to the exercise programme when symptoms reappear.

- A patient-centred (also addressing compliance factors), assessment-related, individual routine self-management may include:
  1. memory aids. Use fixed times and places, for example, put memory notes (red dots, smileys) for training on the bathroom mirror, near the lavatory, on the steering wheel, on the monitor of the computer, etc
  2. favourite numbers: instead of six times per day the patient may prefer other numbers (five, seven, ten)
  3. train the correct resting position of the mandible: closed lips (mouth closed) and teeth apart, tongue resting at the floor of the mouth
  4. train nose breathing with a diaphragmatic breathing pattern. Deep, long breathing cycles initiate relaxation and rebalancing of the autonomic nervous system. Relaxation and/or dynamic training of the pelvic floor may be necessary
  5. train correct swallowing with the anterior one-third of the tongue against the anterior part of the top palate just behind the upper front teeth
  6. train correct tongue movements at speaking. Adverse swallowing patterns, inability to keep the mouth closed, adverse tongue movement patterns may demand specific myofunctional therapy
  7. train rotation of the lower TMJ compartment, and avoid anterior translation without rotation of the mandible. With the tip of the tongue placed and maintained at the hard palate and the body ideally aligned, ask the patient to hinge open the mouth. The patient can feel the lateral pole of the condyle for control and should give a low resistance with one thumb to the opening movement. If the tongue stays on the top palate this will reinforce control of ideal rotation of the head of the mandible in relation to the disc and mandibular fossa and reduce the tendency for early translation of the head of the mandible and the disc in the fossa (Fig. 3.55)
  8. train cervical posture and control with mandibular function. First, lengthen the cervical spine with the occiput sliding upwards at the door and a minimal chin tuck, meanwhile maintaining a diaphragmatic breathing pattern. Then, subsequent performance of correct mandible movements, speaking, singing, biting or chewing can be performed. Avoid risky, uncontrolled activities
  9. train spinal mobility. This commonly includes, self-mobilization for upper cervical flexion and lower cervical, upper (mid, lower) thoracic extension
  10. train general posture including shoulder girdle retraction and posterior pelvic tilt. In contemporary practice this relates to the restoration or awareness of functional control of the scapula and spine during arm, head or jaw movements. Be aware of concomitant thoracic outlet or lumbar spine dysfunctions and complaints that need additional management, such as mobilization of the first rib or rebalancing the relevant pelvic/hip muscles
  11. self-management of chewing-muscle tension with self-massage, trigger-point massage,

Figure 3.55 • General exercise for craniomandibular rehabilitation. Opening and closing lips without clenching the teeth and keeping the tip of the tongue at the hard palate to limit opening to the rotatory phase of condylar movement. Subtle resistance with a thumb under the chin aims to relax the masticatory muscles and to restore muscle balance between the masticatory and hyoidal muscles. Variations include manual compression or movement components with the other hand simultaneously applied at the mandible and or functional positions or movements of the cervical spine.

electrotherapy, self-taping or wearing the splint during the day time (Figs 3.49–3.54). Development of habit-reversal strategies, for example, a chewing gum parafunctional habit should be reduced to a non-sugar after-meal-only chewing gum routine and in between meals the habit should be replaced by an exercise or relaxation technique. Self-mobilization of the joint capsule is not possible due to the activity of the chewing muscles

12. modern technology enables the patient to use electronic devices, for example, computer software and bio-/myofeedback machines with electrodes or (anti)stress balls with coloured light for relaxation and balancing the autonomous nervous system
13. in contrast, traditional activities such as yoga, meditation, qi gong, pilates or oriental dance classes in a pleasant social environment may be just as relevant for regaining a neurophysiological (autonomic) and structural balance
14. conscious living with awareness of distress, adequate stress coping (for example, solving the problem), with discipline and rituals, regular training as well as relaxation, are general, relevant components in overall long-term health management

Case study 3.1

The role of mobilization in the management of movement-related temporomandibular joint disorders

Mrs H, a 42-year-old community psychiatric nurse has developed a painful click in her jaw when she opens her mouth. This she believes has developed in line with occlusion problems as a result of dental work and gum disease. She also has a very stressful job which does not help.

Kind of disorder

Mrs H indicated that her main problems are:

- An inability to fully open her mouth without experiencing a very painful click in her jaw
- A sharp pain in the jaw when biting hard
- Associated pins and needles in her face on occasions
- Tension-type headaches when she is stressed.

Areas of symptoms (body chart)

Mrs H's areas of symptoms are represented on the body chart in Figure 3.56.

Activity limitations/24-hour behaviour of symptoms

- Mrs H only experienced the painful click on trying to open her mouth fully as in yawning or trying to shout.
- She experienced the sharp pain in her jaw when biting hard down on the molars, usually on the opposite side to the pain.
- The pins and needles in the face would only be present for a few minutes as an after-effect of the jaw pain.
- The tension headaches are only present once or twice per week at the end of the day and the following morning after a stressful day at work.
- None of her symptoms limited her activities, but she was not able to open her mouth as fully or widely she could before.

History (present and past)

- Mrs H had been having a lot of dental work to stabilize her loose upper front incisors which had become loose due to progressive gum disease.
- She felt she had altered her bite so as not to dislodge her front teeth and, therefore, all her eating now involves use of the molars.
- Stress at work in the last six months was thought to have contributed to the onset of the tension headaches and she thought the pins and needles had developed with her jaw problem.
- This was the worrying factor which had led her to see her GP, who referred her on to physiotherapy for exercises to help her jaw pain.
- The click had developed spontaneously and had only recently become painful. On further reflection, she recognized the onset of the pins and needles at the same time as the click became painful.
- Currently she is under the care of an orthodontist.

Medical screening questions

- Routine special questions about general health, effects of medication and relevant screening were unremarkable.

Case study 3.1—cont'd

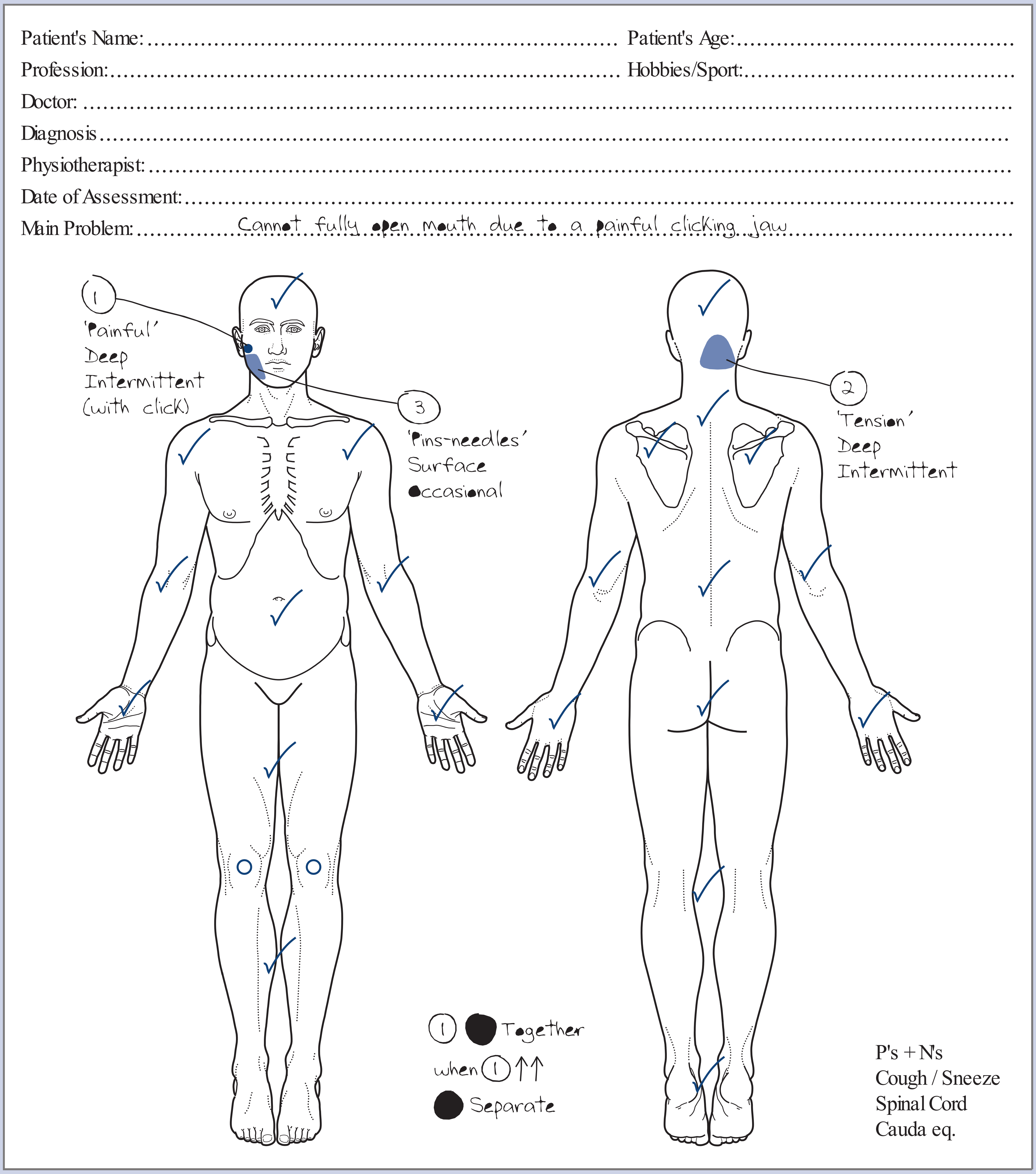


Figure 3.56 • Body chart of Mrs H.

Case study 3.1—cont'd

- There was no evidence of red flags or conditions mimicking TMJ disorders (Kraus 1985).

Physical Examination

Observation

- Long slender neck, poking chin with upper cervical spine in extension; correction of this caused a stretching sensation in the occiput. Further opening of the mouth did not reveal any functional instability of the cervical spine or any change in symptoms.
- Nasal airways – clear with inspiration right and left.
- Resting position of the mandible – deviated to the left, correction of this caused □.
- Bite – no overbite but front incisors maximally intercuspated, balance interference with more contact of the teeth on the left side.
- Inspection of tongue – indentations of the lower teeth evident around the edge of the tongue.

Present pain

Headache [2], neck feels stiff, jaw pain □ when opening the mouth only.

Functional demonstration***

Mouth opening 40 mm click and pain □ at 30 mm opening, 5° deviation to the left (Fig. 3.57), headache ISQ.

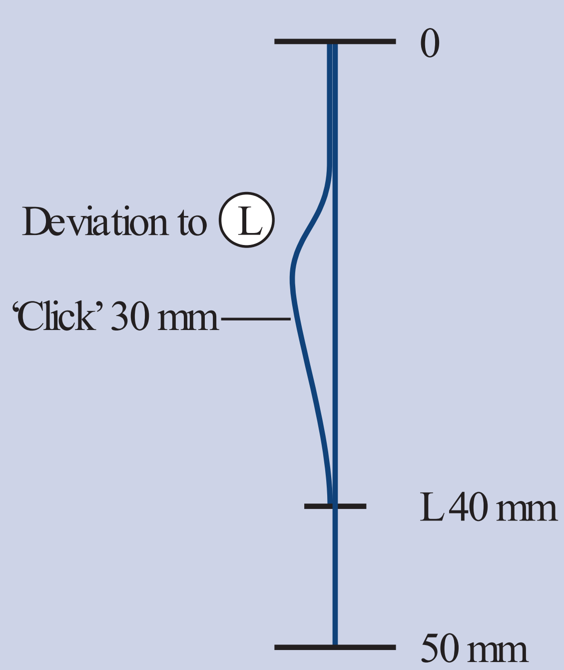


Figure 3.57 • Diagram showing mouth opening with deviation and click.

Active movements

- Cx Ext 30° stiff++, headache increased, change tongue position ISQ
- **Cx RR 50° stiff++, headache ISQ with right lateral deviation of the mandible added □++
- Clench teeth □, cotton wool ball in left side □++, cotton wool ball in right side □−−
- Lateral deviation of mandible to (L) □, □
- **Lateral deviation to the right 10 mm stiff □+
- *Retraction of the mandible 3 mm IV2 overpressure □
- Protraction □, □
- Hyoid, laryngeal movements, transverse and rotary □, □

Screening tests

Shoulder, thoracic spine □, □

Passive movements

- Unilateral PA (↓) C2 stiff/painful locally
- Mandible longitudinal caudad (R) and transverse lateral (R) stiff and painful □ (Fig. 3.58)

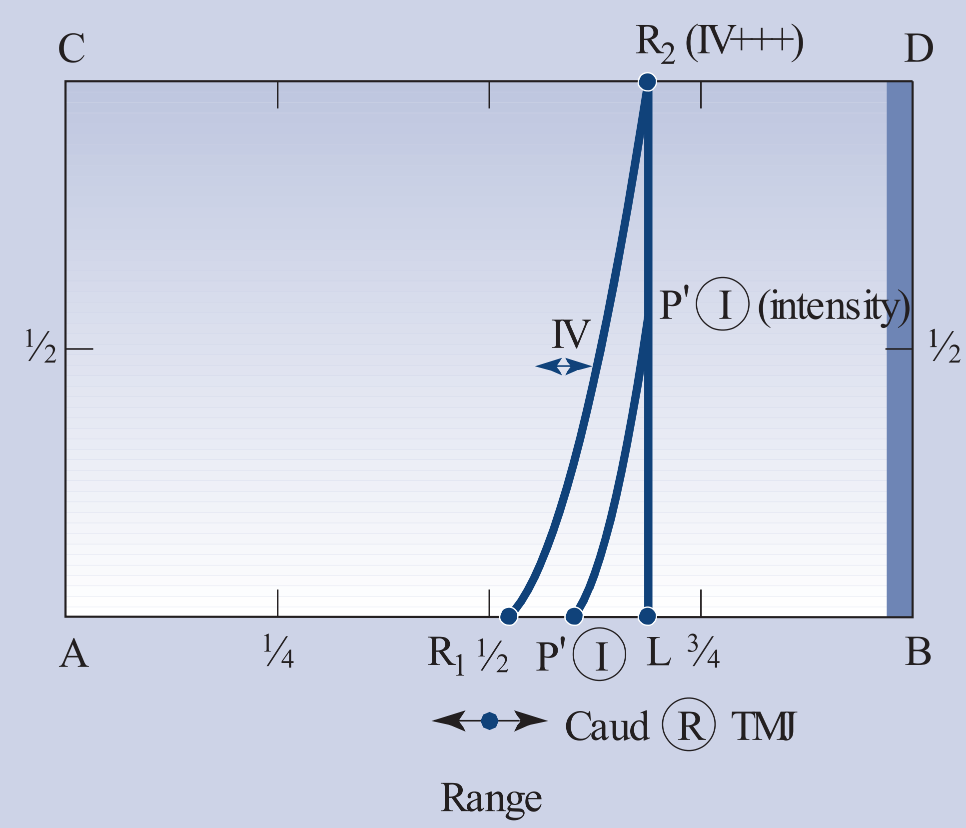


Figure 3.58 • Movement diagram showing stiff, painful limitation ←•→ of caudad of the right temporomandibular joint and grade IV mobilization technique.

Treatment/management

- Unilateral PA (↓) mobilization C2 (grade III) – with the effect of improving the pain and stiffness – free range of cervical extension and rotation and allowing a further 5 mm of pain-free opening of the mouth. Lateral deviation and retraction of the mandible were unchanged and the click remained the same although less painful.
- Longitudinal (←•→) and transverse lateral (—•→) movements of the mandible (R) (grade IV) with the mouth open with the desired effects of restoring the ideal pain-free status of the joint and stretching the structures to regain accessory range. This improved the range of opening further and the painful click was less obvious; the cervical spine also felt freer.

Case study 3.1—cont'd

- The desired effects of the cervical and mandibular mobilization were to act as an adjunct to the home programme (6 × 6) (Rocabado 1985).
- Mrs H continues to have dental treatment and still suffers from the clicking jaw but she has retained her range of mouth opening and suffers from fewer tension headaches now that her neck is less stiff and aching.
- Mrs H is less worried about her symptoms now as she has a home programme which gives her some confidence that she can control her symptoms.
- The resolution of the symptoms, long term, is dependent on the completion of her dental reconstruction.

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Management of shoulder and shoulder girdle disorders

4

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CHAPTER CONTENTS

Key words

Extended scope practitioner (ESP), medical diagnosis, physiotherapy diagnosis, screening, rotator cuff, impingement, glenoid labrum, glenohumeral joint, instability, acromioclavicular joint, imaging, contemporary practice, permeable brick wall

Introduction

> If I have seen a little further it is by standing on the shoulders of giants.
>
> Sir Isaac Newton (1676)

Sir Isaac Newton's words could not be more appropriate to describe the contribution made by Geoffrey Maitland MBE on the progression of the physiotherapy profession. He is one of the profession's giants and pioneers and has made an outstanding contribution to its development and recognition within the medical world. Maitland was passionate about postgraduate education for physiotherapists and significantly enhanced our knowledge base and practice in physiotherapy. This has helped to pave the way for our current position as autonomous practitioners, and indeed probably helped in the development of physiotherapists into traditional medical roles – roles now termed as extended scope practitioners (ESPs).

This chapter aims to demonstrate how many of the fundamental principles on which Geoffrey Maitland developed his concept are still applicable to contemporary physiotherapy practice both for those physiotherapists performing a traditional role and those undertaking an extended scope role. This discussion will be set within the context of disorders affecting the shoulder complex, repeatedly described as one of the most challenging areas in neuromusculoskeletal practice (Robb et al. 2009ab). The complexity of the shoulder and shoulder girdle combining articulation at the glenohumeral (G/H), acromioclavicular (A/C), sternoclavicular (S/C) and scapulothoracic (S/Th) joints together with the exceptionally large range of functional demands required and placed upon the shoulder complex provides the background to the challenges facing clinicians. The high prevalence of structural pathology in asymptomatic individuals and common occurrence of multiple co-existing structural pathologies further compounds this issue. Although limited to discussion of the shoulder and shoulder girdle, it is hoped that the reader is able to appreciate the applicability of the principles outlined and presented in this chapter to the other body regions affected by neuromusculoskeletal conditions.

The chapter is structured into five sections; these are best read as an entirety, consecutively. However, they can be read as stand-alone sections.

- The two introductory sections (A brief introduction to the role of the extended scope physiotherapist, and Diagnostic considerations – a perspective from the medical profession, an ESP role and the traditional physiotherapy role) discuss the development of extended scope physiotherapy roles and more specifically address diagnostic considerations as they relate to physiotherapists performing a traditional role and those undertaking an extended scope role.
- The third section (Diagnosis and diagnostic titles of shoulder conditions) considers the diagnosis and diagnostic titles of shoulder conditions from a biomedical perspective and discusses the implications for both ESP and traditional physiotherapy practice.
- The fourth section (Shoulder conditions – a perspective from an ESP role) and the fifth section (Shoulder conditions – a physiotherapy perspective) discuss the assessment and management of shoulder conditions from the perspective of an ESP and from a traditional physiotherapy role respectively.

A brief introduction to the role of the extended scope physiotherapist

The United Kingdom's Chartered Society of Physiotherapy (CSP) defines an ESP as 'a clinical physiotherapy specialist, in any recognized speciality, with an extended scope role, e.g. requesting X-rays, scans, blood tests, nerve conduction studies etc.' Traditionally tasks such as these would have been undertaken by the medical profession, but with additional training and development may be performed by physiotherapists with an extended role. In the UK, ESPs practice under the Chartered Society of Physiotherapists' fourth pillar of practice, 'kindred methods of treatment' (CSP 2008). This is providing that the member is competent in the activity and able to demonstrate that practice is also linked to the curriculum framework and the World Confederation of Physical Therapists' (WCPT) definition of physiotherapy (CSP 2008). Within the UK, physiotherapists who are able to demonstrate these requirements are therefore able to perform tasks in extended roles as part of their individual scope of practice and be covered to practice by the CSP's Professional Liability Insurance (CSP 2008). Recently, Syme (2009) has developed and published a document on behalf of the 'Chartered Physiotherapists working as extended scope practitioners', a clinical interest group of the CSP in the UK, entitled, 'A resource manual and competencies for extended musculoskeletal physiotherapy roles' (2009). This document serves as a framework for ESPs to assist individual clinicians in demonstrating their competence to practice specific tasks in extended roles and hence meet the requirements stipulated by the CSP.

ESPs working within the musculoskeletal speciality may perform any number of a variety of tasks traditionally undertaken by other professions (CSP 2008). These tasks vary from those with a therapeutic focus, to those with a diagnostic focus and are dependent upon both the needs of the service in which the individual works and the level to which the individual is educated, trained and competent to undertake the particular task (CSP 2008). As recognized by Syme (2009) ESPs 'are not homogenous groups of individuals, even within a specific speciality'. Some of the tasks typically undertaken by an ESP within the musculoskeletal speciality include:

- Screening referrals to the orthopaedic speciality.
- Undertaking orthopaedic assessments and managing General Practitioner (GP) referrals which previously would have been managed by orthopaedic consultants.
- Where appropriate and indicated, referring and interpreting investigations including as examples radiological studies, haematology, clinical biochemisty and electrophysiology.
- Referring the patient to a variety of other professionals.
- Listing the patient directly for orthopaedic surgery.

The acceptance of physiotherapists in these roles has largely been due to their ability to demonstrate sound clinical reasoning, forerunners of which were the concepts used by Maitland such as the permeable brick wall (discussed specifically in the sections on 'Diagnosis and the Maitland Concept', and 'The symbolic permeable brick wall') and the constant need for continual assessment.

Diagnostic considerations – a perspective from the medical profession, an ESP role and the traditional physiotherapy role

Although diagnosis within both the physiotherapy and the medical profession serves a common purpose, namely in determining decisions to be made relating to both the management and prognosis of the individual and also in conveying to the individual information relating to their condition, important differences must be acknowledged.

As Jette (1989) has discussed, the primary difference in diagnostic classification between the medical profession and the physiotherapy profession relates to the phenomena that are classified as follows:

- *Medical diagnosis* is concerned with 'the determination of the cause of a patient's illness or suffering by the combined use of physical examination, patient interview, laboratory tests, review of the patient's medical records, knowledge of the cause of observed signs and symptoms, and differential elimination of similar possible causes' (Mosby's Medical dictionary 2009).
- *Physiotherapy diagnosis* is concerned with classifying the consequences of a patient's disease, injury or disorder – the impairments, functional limitations and disabilities (WCPT 2007, Zimny 2004, Jette 1989, Gucione 1991). Figure 4.1 serves to highlight this distinction in the concept of diagnosis between the medical and physiotherapy professions, and sets within this, the position of the ESP which is discussed further in the section 'Diagnosis and the ESP in the neuromusculoskeletal specialty'.

Physiotherapy diagnosis

It is pertinent to revisit the position statement relating to the description of physical therapy (physiotherapy) published by the World Confederation of Physical Therapy (WCPT 2007) in specific regard to both the nature of the physiotherapy and consideration of diagnosis within the profession.

> Physical therapy provides services to individuals and populations to develop, maintain and restore maximum movement and functional ability throughout the lifespan. This includes providing services in circumstances where movement and function are threatened by ageing, injury, disease or environmental factors. Functional movement is central to what it means to be healthy.

Furthermore:

> Physical therapy is concerned with identifying and maximising quality of life and movement potential within the spheres of promotion, prevention, treatment or intervention, habilitation and rehabilitation. This encompasses physical, psychological, emotional, and social well being. Physical therapy involves the interaction between physical therapist, patients or clients, other health professionals, families, care givers, and communities in a process where movement potential is assessed and goals are agreed upon, using knowledge and skills unique to physical therapists.

Physician

Medical diagnosis
'the determination of the cause of a patient's illness or suffering by the combined use of physical examination, patient interview, laboratory tests, review of the patient's medical records, knowledge of the cause of observed signs and symptoms, and differential elimination of similar possible causes" Mosby's Medical Dictionary, 8th edition (2009)

Examples include:
1) WHO ICD 10, e.g. M75.0 adhesive capsulitis of shoulder
2) Other labels, i.e. full/partial thickness rotator cuff tear, SLAP tear, primary subcromial impingement

Physiotherapist with extended MSK role

Competency 3 "diagnostic reasoning" - 'generate a medical based pathophysiological diagnosis where appropriate or a physiotherapy diagnostic classification based on body structure and function impairments, activity limitations and participation restrictions" (Smye 2009)

Competency 4 'selection of diagnostic investigations" where 'the extended role physiotherapist selects appropriate 'medical' investigations to facilitate the diagnostic process where appropriate" (Smye 2009)

Competency 5 'selection of appropriate management strategies" where 'appropriate treatment management strategies are arranged at musculoskeletal/ orthopaedic clinics or within the physiotherapy outpatient department" (Smye 2009)

Examples as per physician/physiotherapist as appropriate

Physiotherapist

Diagnosis 'represents the outcome of the process of clinical reasoning and may be expressed in terms of movement dysfunction or may encompass categories of impairments, functional limitations, activity limitations, participatory limitations, environmental influences, abilities/disabilities or syndromes (WCPT 2007)

Examples include
1) WHO ICF categories to reflect functional status and activity level
2) Descriptive statement, i.e. functional limitation with putting coat on. Impairment of painful restriction to shoulder internal rotation in abduction 20 degrees. Predominant mechanical nocicpetive pain mechanism, with primary source of periarticular GHJ ie capsule. Contributing factors include apprehension to perform movement due to belief may cause harm and appreciation of possible underlying patho-anatomical lesion, i.e. stage 3 frozen shoulder
3) i.e. humeral anterior glide, scapular downward rotation (Sahrman 2002)

Figure 4.1 • Diagnostic considerations and distinctions between the medical and physiotherapy profession. WHO = World Health Organization, ICD = International Classifcation of Diseases, ICF = International Classifcation of Functioning.

Diagnosis is considered by the WCPT (2007) as a professional responsibility of physiotherapists and is described as:

> 'the result of a process of clinical reasoning which results in the identification of existing or potential impairments, functional limitations and abilities or disabilities …
>
> The purpose of the diagnosis is to guide physical therapists in determining the prognosis and most appropriate intervention strategies for patients or clients and in sharing information with them …'

This may be expressed in terms of movement dysfunction or may encompass categories of impairments, activity limitations, participatory restrictions, environmental influences or abilities or disabilities.

Physiotherapy diagnosis with specific regard to shoulder conditions is discussed in each consequent section in this chapter. Physiotherapy specific issues regarding the assessment, diagnosis and management of shoulder conditions are discussed in the section 'Shoulder conditions – a physiotherapy perspective'.

Diagnosis and the ESP in the neuromusculoskeletal specialty

As previously discussed in the first section of this chapter, ESPs in the neuromusculoskeletal speciality may perform any number of a variety of tasks traditionally undertaken by other professions (CSP 2008). A common task undertaken by ESPs is to assume the responsibility for establishing an appropriate *medical diagnosis* on which decisions regarding a patient's management and prognosis can be determined and communicated appropriately to other health professionals and the patient. With regard to this requirement, three competencies described by Syme (2009) are particularly relevant and are detailed in Figure 4.1. In contrast to the *physiotherapy diagnosis*, which seeks to guide decisions regarding the physiotherapeutic management of a patient, the *medical diagnosis* provided by the physician or the ESP seeks to determine the type of treatment required in the management of the patient. With respect to shoulder conditions, treatment options that are commonly employed include medications including analgesics, NSAIDs and oral steroids (Green et al. 1998, Buchbinder et al. 2006), corticosteroid injections (Buchbinder et al. 2003), physiotherapy (Green et al. 2003), arthrographic distension (Buchbinder et al. 2008), ultrasound guided barbotage, acupuncture (Green et al. 2005), topical glyceryl trinitrate (Cumpston et al. 2009) and a variety of surgical procedures (Singh et al. 2010, Coghlan et al. 2008, Pulavarti et al. 2009, Tamaoki et al. 2010).

The diagnosis and diagnostic titles of shoulder conditions

Diagnosis and the Maitland Concept

A fundamental principle central to the evolution of the Maitland Concept was Maitland's explicit understanding of the difficulties, limitations and obstructions to patient management should treatment be directed by the *medical diagnosis* alone (Maitland 1986). Maitland recognized that 'even within medicine, many diagnostic titles are sometimes inadequate, incorrect, or they may be merely linked with patterns of symptomatology, they may even be suppositions'. Acknowledgement of the incompleteness and controversies in the theoretical understanding of pathology further added to this contention. Furthermore, using evidence from Macnab (1971), Maitland demonstrated how a single clinical presentation may have several diagnostic titles and conversely how a single diagnostic title may present with several clinical presentations further supporting this opinion (Maitland 1986 p 6).

Maitland advocated that the manipulative physiotherapist should adopt a mode of thinking (two compartment) unique to the Maitland Concept. This has become the symbolic permeable brick wall which lies at the heart of the concept, whereby thoughts regarding the theoretical aspects of a patient's presentation (known and speculative) are separated from the clinical evidence in the clinician's mind. Maitland felt that such a mode of thinking 'prevents thoughts relating to the theory of a disorder overriding the clinician's decision-making processes and does not inhibit the clinician from discovering the patient's disorder in terms of its history, its symptoms and its signs in fine detail. It allows for safe and effective management of disorders where there is an incomplete or uncertain diagnosis'. This concept allows the clinician to base intervention primarily on clinical evidence, i.e. 'the primacy of clinical evidence', while acknowledging and drawing on evidence from the theoretical compartment for the purpose of hypothesis generation and testing and the choice of treatment technique. Maitland (1986) stated that 'by basing treatment on symptoms and signs useful treatment may be effected while the medical profession and its scientists continue to work towards understanding more in regard to diagnostic titles'.

Forty-six and forty years on, respectively, since publication of the first editions of *Maitland's Vertebral Manipulation* and *Maitland's Peripheral Manipulation*, and the initial development of the Maitland Concept, a wealth of research relating to problems and conditions affecting the shoulder complex has been published in specialties such as anatomy, biomechanics, pathology and diagnosis. A review and appraisal of the fundamental principles on which the Maitland Concept lies in light of contemporary scientific findings is therefore necessary to examine its role and applicability in the current evidence-based climate of health care provision. The issues surrounding the diagnosis and use of diagnostic titles in shoulder conditions is one such fundamental principle of the Maitland Concept which requires critical evaluation.

The biomedical perspective

Diagnostic labels and shoulder conditions

Beyond the broader concept of 'shoulder pain' numerous diagnostic labels have been applied to conditions affecting the shoulder. The derivations of these labels are varied such as 'painful arc syndrome', directly labelled from the clinical signs and symptoms, whilst others such as 'rotator cuff tendonitis' are derived from hypotheses regarding the pathology producing the clinical signs and symptoms. The pathoanatomical model on which the majority of diagnostic titles are derived seeks to explain the source of the patients presenting symptoms and signs based on the presence of specific structural pathology identified through isolated or combined physical examination, imaging and histopathological analysis. It has been proposed by some authors that identification of a specific structural pathological diagnosis on which clinical decisions regarding patient management can be made is essential to improving treatment outcomes (Green et al. 1998, Cyriax 1982). In contrast, as discussed, Maitland (1986) viewed the diagnostic or theoretical considerations related to a patient's presentation secondary in importance to the 'clinical evidence' (presenting signs and symptoms) on which the clinician's decision-making processes are based.

The nomenclature used to describe and define shoulder conditions in the international literature is extremely varied, as illustrated in Box 4.1. In 1998, Green et al. demonstrated and confirmed the lack of uniformity in the way shoulder conditions were labelled and defined for the painful shoulder. In a systematic review of 24 randomized controlled trials of interventions which specified a distinct diagnosis to characterize the study sample, only 16 provided definitions of the subgrouping strategy. Furthermore, the selection criteria used to define the shoulder disorders studied demonstrated no between-study standardization and indeed in many cases conflicting criteria were often used to describe the same type of condition in different studies. Ten years on since Green et al.'s (1998) observation and analysis, Schellingerhout et al. (2008) reported that the criteria used to define diagnostic labels for shoulder pain in randomized controlled trials (RCTs) which investigate treatment for shoulder pain with a specific diagnosis continue to fail to demonstrate uniformity. This variability in the criteria used to classify a diagnosis in research is illustrated in Table 4.1.

In recognition of this lack of uniformity of nomenclature, several attempts at standardizing the use of diagnostic labels using classification systems have

Box 4.1

Examples of terminology or diagnostic titles associated with shoulder problems

Read codes (used by GP practices to allow diagnosis to be recorded); the most commonly used include: shoulder syndrome, sprained shoulder, rotator cuff shoulder syndrome, shoulder joint pain, sprain shoulder/upper arm, arthralgia-shoulder (Linsell et al. 2006).

International classification of diseases (ICD-10, WHO 2010). M75.0 adhesive capsulitis of the shoulder (frozen shoulder, periarthritis of the shoulder), M75.1 rotator cuff syndrome (rotator cuff or supraspinatus tear or rupture (complete or incomplete) not specified as traumatic, supraspinatus syndrome), M75.2 bicipital tendinitis, M75.3 calcific tendinitis of shoulder, calcified bursa of the shoulder, M75.4 impingement syndrome of the shoulder, M75.5 bursitis of shoulder, M75.8 other shoulder lesions.

Other terms

Shoulder pain, non-specific shoulder pain, mechanical shoulder pain, capsular syndrome, acute bursitis, bursal reaction, acromioclavicular syndrome, subacromial syndrome, rotator cuff tendinitis/tendinosis/tendinopathy, supraspinatus tendinitis/tendinosis/tendinopathy, shoulder tendinitis, bicipital tendinopathy, rotator cuff tear, impingement syndrome, subacromial impingement, primary impingement, secondary impingement, rotator cuff disease, pain arc syndrome, calcifying tendinitis, calcific tendinitis, tendinitis calcarea, internal impingement, anterior internal impingement, posterior internal impingement, partial thickness/full thickness/massive rotator cuff tears also described by position or type, scapular dyskinesis, scapular dysfunction, numerous classification systems associated with lesion of the glenoid labrum, numerous classification systems associated with instability of the shoulder.

Examples: de Winter et al. (1999), Lewis (2009), Kibler and Sciascia (2010), Awerbuch (2008), Feeley et al. (2009), Beaudreuil et al. (2009), Kuhn (2010), Smith and Funk (2010).

Examples of diagnostic labels used within physiotherapy literature

Impaired joint mobility, motor function, muscle performance and range of motion associated with: capsular restriction, ligament or connective tissue disorders (shoulder instability), localized inflammation (Tovin & Greenfield 2001).

Scapular downward rotation syndrome, humeral anterior glide syndrome (Sahrmann 2002).
Derangement, dysfunction- articular, dysfunction – contractile, postural (McKenzie & May 2000).

Table 4.1 Criteria used to define a variety of shoulder diagnoses for research purposes

Diagnostic label/concept	Criteria used to define diagnostic label – examples
Shoulder impingement syndrome	More than 30 different inclusion and 40 different exclusion criteria identified across the 16 RCTs reviewed by Kromer et al. (2009) Only 4 of 15 RCTs (two of which were the same study at a different follow-up periods) which were reviewed by Schellingerhout et al. (2008) used the same combination of inclusion criteria
Adhesive capsulitis/frozen shoulder/painful stiff shoulder	Absence of consistent description of clinical presentation across 21 RCTs reviewed by Schellingerhout et al. (2008). Inconsistency with degree, type (active or passive) and direction of restriction of shoulder movement (Schellingerhout et al. 2008)
Calcific tendonitis	9/13 RCTs reviewed by Schellingerhout et al. (2008) used the Gartner radiological classification system, with a range of additional inclusion criteria between studies
Rotator cuff tendinopathy/ including terms such as rotator cuff tendonitis/ tendinosis/supraspinatus tendinitis	In a review of 13 RCTs by Schellingerhout et al. (2008) 5/13 studies failed to report inclusion criteria (physical examination findings), 3/13 studies used Cyriax classification, 3/13 studies' inclusion criteria included increasing pain with abduction, 2/13 studies used painful arc sign as inclusion factor
Rotator cuff tear	Poor detail of inclusion/exclusion criteria with all 4 RCTs reviewed by Schellingerhout et al. (2008)
Shoulder instability including terms such as voluntary, traumatic, unidirectional, multidirectional, bidirectional	Comparison of four classification methods on 168 patients led to diagnosis of 'multidirectional instability' between 1.2% to 8.3% dependent on classification system used; based on result of laxity testing range of diagnosis for MDI was 8.3% to 82.7% (McFarland et al. 2003) Kuhn (2010) identified 17 different classification systems of glenohumeral joint instability noting an absence of clear definition, a 'great amount of discordance' and 'different features' used in the variety of systems reviewed. Kuhn (2010) presented a further classification system

been made. Most classification systems have evolved from the pathoanatomical model such as those proposed by Cyriax (1982), Neer (1983), Waris et al. (1979), Viikari-Juntura (1983), Silverstein (1985), McCormack et al. (1990), Uhthoff & Sarkar (1990), ICD-10 (WHO 2010) and Palmer et al. (2000). Unfortunately, even in the presence of clearly defined operational definitions and criteria for inclusion of a patient to a discrete diagnostic category, studies of the proposed classification systems have demonstrated unsatisfactory levels of inter-rater reliability in all but two papers (Liesdek et al. 1997, Bamji et al. 1996, de Winter et al. 1999, Walker-Bone et al. 2002, Norregaard et al. 2002, Pellecchia et al. 1996, Palmer et al. 2000, Hayes & Peterson 2003, Hanchard et al. 2005). Other methodological shortcomings of these classification systems have been reported including a failure to be comprehensive and failure of classification categories to be mutually exclusive (Buchbinder et al. 1996; de Winter et al. 1999). In recognition of these findings the development of a reproducible classification system for shoulder disorders has been considered a research priority by numerous authors, including Kromer et al. (2010), Braun & Hanchard (2010), Kuhn (2010), Mitchell et al. (2005), Green et al. (2008), Schellingerhout et al. (2008), Green et al. (2003) and Buchbinder et al. (2003) to name but a few.

The variability in diagnostic classification should raise significant caution when interpreting results from studies which seek to investigate these labelled disorders. Furthermore, comparison of studies which seek to investigate treatment effects for a given group of patients is extremely difficult if not impossible to ascertain because of the heterogeneity (broad range of different pathologies) in the samples studied. Recognition of the contemporary issues relating to diagnosis and classification of shoulder conditions, appears to continue to support Maitland's acknowledgment in his seminal work more than 40 years ago of the difficulties, limitations and obstructions should management decisions be based on the diagnostic title alone.

When evaluating the literature, several reasons become apparent which help to explain most of the current issues surrounding the lack of uniformity of diagnosis and difficulties establishing links between shoulder pathology and clinical decisions regarding treatment. Issues relating to the use of terminology, physical examination procedures, imaging modalities, criterion standards, current understanding of pathologies and the complexity of problems around the shoulder are explored and discussed further.

Physical examination related to the differential medical diagnosis of shoulder conditions

Diagnostic accuracy – a brief review

Prior to reviewing the current evidence relating to the diagnostic accuracy of tests relating to shoulder conditions it is pertinent to briefly review the concepts and statistical tests associated with diagnostic test accuracy. Six of the most commonly used statistics are detailed in Table 4.2.

Diagnostic accuracy studies seek to compare the test of interest with a reference standard, the criterion which best defines the condition that is being assessed. For example, tests which seek to identify the presence of a rotator cuff tear would be best compared against a reference standard such as the observation of the involved rotator cuff tendon during surgery. The reference standard should have proven criterion validity – a measure already held to be valid. As will be discussed in relation to shoulder conditions some of the reference standards commonly used are yet to be fully validated which means caution is required when interpreting results from diagnostic accuracy studies.

Furthermore, when considering diagnostic accuracy studies, bias can significantly inflate the diagnostic value of a test. It is essential that the

Table 4.2 Some of the more common statistical concepts associated with defining the accuracy of diagnostic tests

Statistic	Description	Values	Other comments
Sensitivity	True positive rate Ability of test to identify a positive finding when the condition is present The probability that a patient with the disease will have a positive test result Helpful for ruling out a condition i.e. a test that has a high sensitivity, helps rule a condition out when the test result is negative	Range 0–1 (0–100%) As result gets closer to 1, certainty that a negative result rules out the presence of the condition increases	Useful to rule out a condition 'SnNOut' mnemonic – a test with a high sensitivity proves useful to help rule out the presence of a condition when the result from the test is negative
Specificity	True negative rate Discriminative ability of test to identify if the condition is absent when it truly is absent The probability that a patient without the disease will have a negative test result Helpful for ruling in the presence of a condition i.e. a test that has a high specificity helps rule in a condition	Range 0–1 (0–100%) As result gets closer to 1, certainty that a positive test result rules in the presence of the condition	Useful to rule in a condition "SpPin' mnemonic – a test with a high specificity proves useful to help rule in the presence of a condition when the result from the test is positive

Table 4.2 Some of the more common statistical concepts associated with defining the accuracy of diagnostic tests—cont'd

Statistic	Description	Values	Other comments
Positive likelihood ratio	Use when a test result is positive to provide a quantitative estimate that the condition is present The increase in the odds of having the disease after a positive test result	The higher the value, the greater the certainty that the positive result indicates the presence of the condition	+LR >10 Often conclusive increase in likelihood of condition +LR5–10 Moderate increase in likelihood of condition +LR 2–5 Small increase in likelihood of condition +LR 1–2 Minimum increase in likelihood of condition +LR 1 No change in likelihood of condition
Negative likelihood ratio	Use when a test result is negative to provide a quantitative estimate that the condition is absent The decrease in the odds of having the disease after a negative test result	The lower the value, the greater the certainty that the negative test result indicates the absence of the condition	−LR 1 No change in likelihood of condition −LR 0.5–1 Minimum decrease in likelihood of condition −LR 0.2–0.5 Small decrease in likelihood of condition −LR 0.1–0.2 Moderate decrease in likelihood of condition −LR <0.1 Often conclusive decrease in likelihood of condition
Pretest probability	The clinician's estimate of a patient having a condition given all the available information before a diagnostic test is performed. Pretest probability means putting a number on this estimate Considerations include the prevalence of the condition in the patient's pool and specific information about the individual patient, i.e. risk factors for the condition	Expressed numerically in the range 0–1 (0–100%), i.e. 100% certain the patient has the condition	
Post-test probability	The clinician's estimate of a patient having a condition given all the available information and with the additional result from a diagnostic test In other words does the result from the diagnostic test change the clinician's mind about the presence or absence of a condition? Dependent upon the sensitivity and specificity values of the diagnostic test	Expressed numerically in the range 0–1 (0–100%), i.e. 100% certain the patient has the condition	Example: Consider the situation where a clinician is uncertain regarding the presence of a condition in a patient on the basis of the history, signs, symptoms, demographics, etc. – the pretest probability is 50% or 0.5. If a diagnostic test possesses a high sensitivity and specificity then the results from the test will result in a large change from the pretest probability value to the post test probability value. E.g. A post-test probability 90% (0.9) – i.e. an uncertain clinical situation regarding the presence of a condition is changed to a clinical situation where the clinician can be relatively certain of the presence of the condition

quality of individual diagnostic accuracy studies in systematic reviews is undertaken and several quality assessment tools have been devised including the QUADAS (Quality Assessment of Diagnostic Accuracy Studies) (Whiting et al. 2003) and STARD (Standards for the Reporting of Diagnostic Accuracy Studies) (Bossuyt et al. 2003). Several systematic reviews of shoulder tests, the details of which are provided in following sections, have used such measures of quality.

Diagnostic accuracy of physical tests

In the evaluation of shoulder pain numerous physical examination orthopaedic special tests have been reported in the literature, which aim to differentially diagnose pathologies of the shoulder. For interested readers, Tennent et al. (2003ab) produced a detailed descriptive two-article review of these 'special tests' presenting them as described by the original authors. The diagnostic utility (usefulness) of these orthopaedic special tests has been an area of relatively high publication rate in recent years. In a recent, rigorous systematic review with meta-analysis of individual physical examination tests of the shoulder, Hegedus et al. (2008) critiqued 45 diagnostic accuracy studies. With respect to pathoanatomical diagnoses including impingement, rotator cuff integrity, glenoid labrum or long head of biceps pathology, instability and acromioclavicular pathology, there appear very few orthopaedic special physical tests that are diagnostically discriminatory. These results are supported by findings from other recent systematic reviews of the diagnostic accuracy of physical examination tests of the shoulder, including Beaudreuil et al. (2009), Hughes et al. (2008) and Lewis and Tennent (2007) with respect to rotator cuff pathology, and Dessaur and Magarey (2008), Walton and Sadi (2008), Calvert et al. (2009), Jones and Galluch (2007), Mirkovic et al. (2005) and Munro and Healy (2009) with respect to pathology of the glenoid labrum. As a general feature the tests appear to possess either high sensitivity/low specificity or low sensitivity/high specificity thereby compromising their diagnostic utility. Similar findings were reported with regard to the reliability of these orthopaedic special physical examination tests in a recent systematic review of 36 studies by May et al. (2010). May et al. (2010) concluded that none of the tests reached an acceptable level of reliability. Appraising the overall literature the authors stated that evidence regarding the reliability of these physical examination tests of the shoulder was contradictory (May et al. 2010). Furthermore, there is apparent poor reproducibility of results between studies and a general trend to suggest that as the methodological quality of the trial improves, the results relating to the diagnostic accuracy of the special orthopaedic physical tests worsens. Numerous methodological shortcomings have been identified with regard to this literature base including small sample sizes, use of inappropriate reference tests and bias. In particular, it is pertinent to note that in the systematic review by Hegedus et al. (2008) only two of the 44 studies included which investigated the diagnostic utility of special orthopaedic physical tests were adequately powered (sufficient sample size) to detect high specificity and sensitivity values.

Rotator cuff integrity and diagnosis based on physical examination tests

In respect to rotator cuff integrity, no tests demonstrated likelihood ratios to a satisfactory level to modify the post-test probability of diagnosing a rotator cuff tear by a moderate or large amount, thereby questioning their clinical utility (Hegedus et al. 2008) (see Table 4.2 for a description of statistical terms). At best, based on results from one underpowered and poorly designed study (Walch et al. 1998), Hornblower's sign may be diagnostic of 'severe degeneration or absence of the teres minor muscle' and the external rotation lag sign diagnostic of an 'infraspinatus muscle tear' (Fig. 4.2). The bear-hug and belly-press tests may assist ruling in a subscapularis tear (specificity 0.98), based on results from a well-designed but underpowered study (Barth et al. 2006) (Fig. 4.3). Similar findings were reported by Hughes et al. (2008) in a further systematic review of the diagnostic utility of physical examination tests to detect rotator cuff pathology. Slightly more promising results were reported in a single good quality study undertaken by Park et al. (2005) (QUADAS score 10/14) included in the meta-analysis by Hegedus et al. (2008). Park et al. (2005) used stepwise logistic regression analysis (a statistical method for making predictions of an outcome) and determined that if a patient was more than 65 years of age, and presented with a positive drop-arm sign and tested weak with the 'infraspinatus test' or external rotation lag sign (Fig. 4.4), the likelihood of a rotator cuff tear was >90%, with 28% likelihood of a full thickness tear.

Figure 4.2 • Hornblower's sign (Walch et al. 1998). With the arm in 90° scapular elevation and 90° elbow flexion, add resisted external rotation of the arm. Positive test = an inability to externally rotate the arm.

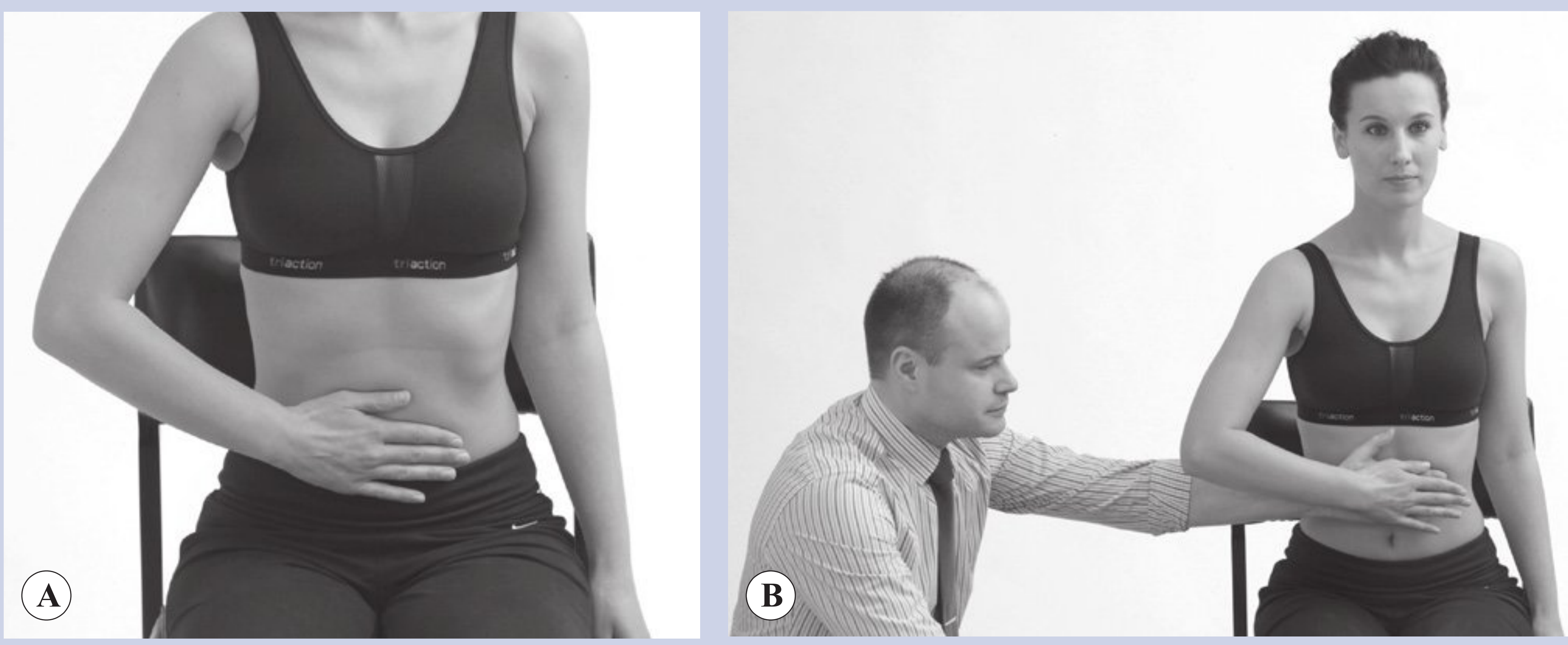


Figure 4.3 • Belly press test (Gerber et al. 1996). In sitting the patient exerts pressure against the abdomen A with or B without the therapist's hand in between whilst moving the elbow forwards to increase the internal rotation. Positive test = weakness demonstrated by the elbow dropping back.

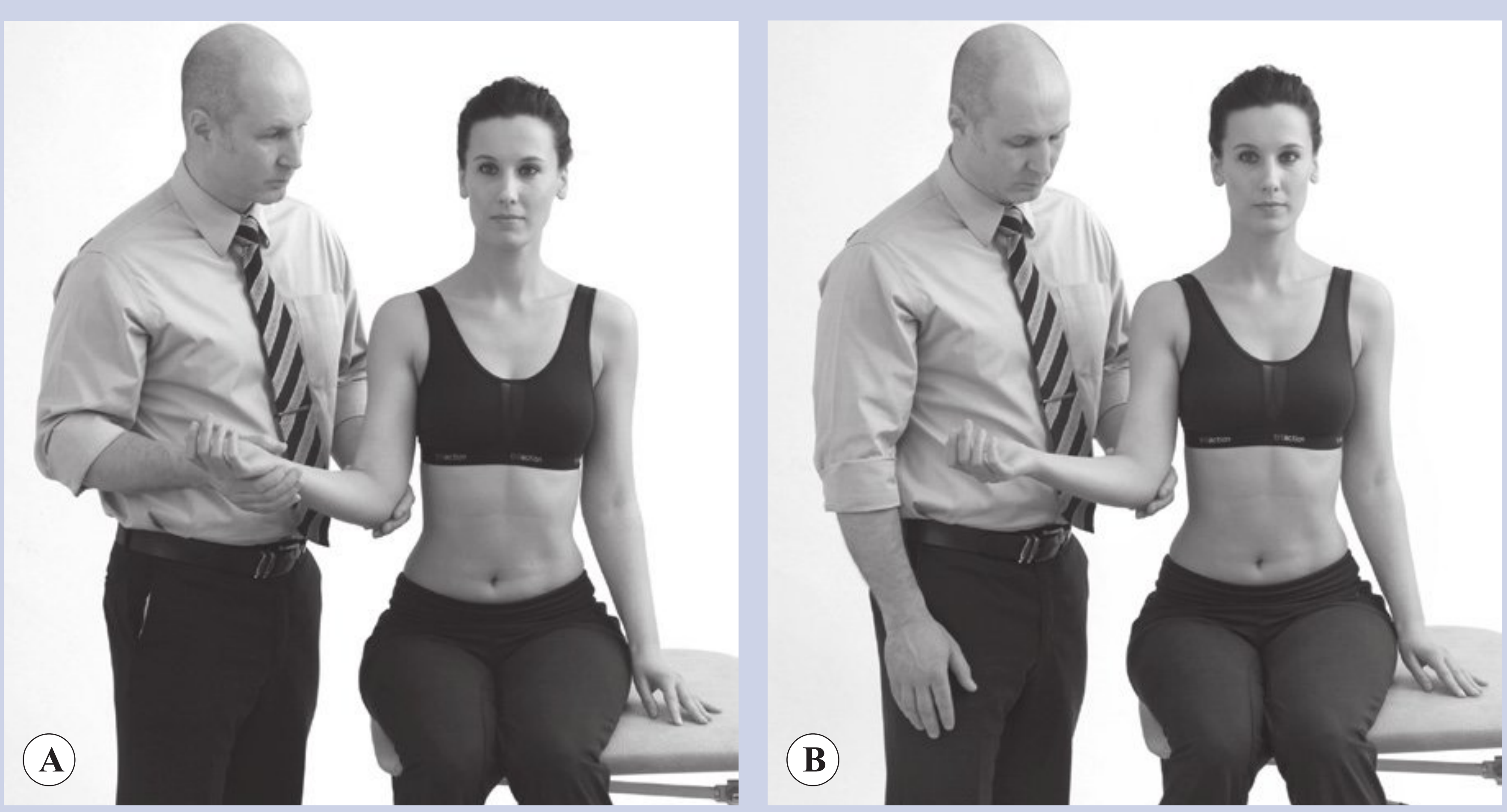


Figure 4.4 • External rotation lag sign (Hertel et al. 1996). A External rotation lag sign – in sitting, the elbow is passively flexed to 90°, and the shoulder is held at 20° scapular elevation and near maximum external rotation. B The patient is then asked to actively maintain the position of external rotation as the therapist releases the wrist while maintaining support of the limb at the elbow. Positive test = when a lag or angular drop occurs.

Impingement and diagnosis based on physical examination tests

In their systematic review with meta-analysis, Hegedus et al. (2008) considered studies investigating the biomedical diagnostic term of 'shoulder impingement' against a reference standard of tissue pathology thought to be associated with the concept including 'subacromial bursitis or tendonitis' or a 'partial rotator cuff tear' identified at surgery or with the magnetic resonance imaging modality. Unfortunately, meta-analysis was only possible on two tests (Neers and Hawkins–Kennedy, Fig. 4.5) due to a lack of statistical homogeneity (comparing like with like). Results showed that neither test had sufficient diagnostic utility. Based on the results from a single study, Park et al. (2005) report that at best the supraspinatus/empty can (Fig. 4.6) or infraspinatus tests may help confirm an impression of impingement due to higher specificity values (0.82 and 0.84 respectively). Lower sensitivity values (0.53 and 0.51) questions their clinical usefulness as screening tests. The validity of the use of the identification of tissue pathology as a reference standard for shoulder impingement is open to question given results from studies such as Frost et al. (1999) and Birtane et al. (2001), discussed further in the section 'Subacromial impingement and imaging'.

Caliş et al. (2000) used an alternative reference standard in their study of 120 patients with shoulder pain to identify the presence of 'subacromial impingement syndrome', namely the subacromial injection test (SIT). Caliş et al. (2000) considered a diagnosis of subacromial impingement in patients who reported 'marked relief of pain and almost total improvement in passive and/or active range of movement (ROM) values 30 minutes after injection' with an absence of calcific lesions identified on radiograph. Results demonstrated that the physical tests either possessed high sensitivity and low specificity (i.e. Hawkins–Kennedy – sensitivity 92.1%, specificity 25%) or low sensitivity and high specificity (i.e. painful arc – sensitivity 32.5%, specificity 80.5%) thereby compromising their diagnostic accuracy and utility. Considerations regarding the SIT as reference test for subacromial impingement syndrome are discussed in the section on 'Diagnosis of shoulder conditions based on physical examination tests'.

Glenoid labrum pathology and diagnosis based on physical examination tests

Of special orthopaedic physical tests purported to be able to diagnose pathology of the glenoid labrum, individual studies have demonstrated promising results of some physical examination tests, only to be confounded by poor reproducibility of the results by different authors under more stringent conditions. Numerous systematic reviews including those undertaken by Walton and Sadi (2008), Calvert

Figure 4.5 • Hawkins–Kennedy test (Hawkins & Kennedy 1980). Support the arm in 90° elevation with 90° of elbow flexion and forcibly internally rotate the arm. Positive test = pain reproduced in the subacromial space area.

Figure 4.6 • Empty can test (Jobe & Jobe 1983). With the arm in 90° scapular elevation and full internal rotation the patient is asked to resist downward pressure. Positive test = pain and/or weakness.

et al. (2009), Mirkovik et al. (2005), Munro and Healy (2009), Hegedus et al. (2008) and Dessaur and Magary (2008) all conclude that at present there are no good single physical examination tests that are able to accurately diagnose the presence or absence of a SLAP (superior labrum anterior posterior) lesion. Some examples are demonstrated in Figures 4.7–4.10.

One method used to improve the accuracy of clinical diagnostic physical examination tests is to combine them into clusters. Such an approach has been reported in other body regions with

Figure 4.7 • O'Brien's active compression test (O'Brien et al. 1998). In 90° frontal elevation, 15° horizontal adduction and full internal rotation, resisted elevation is applied. The test is then repeated with the palm fully supinated. Positive test = if deep pain or a click within the glenohumeral joints is elicited during the frst manoeuvre, and reduced or eliminated with the second.

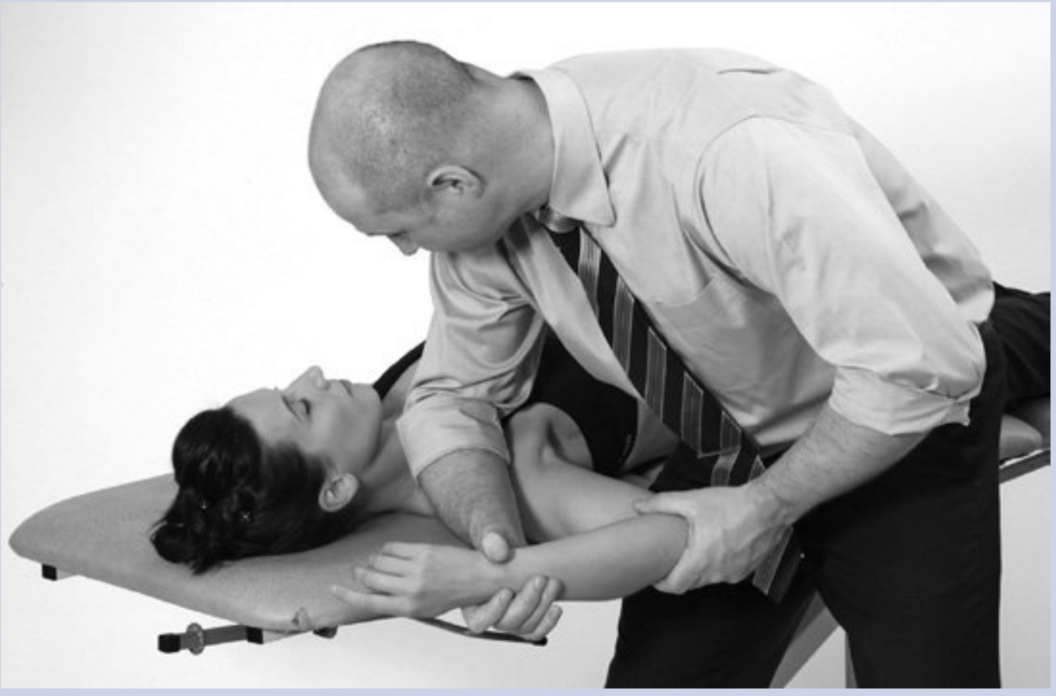


Figure 4.8 • Biceps load I test (Kim et al. 1999). In supine with the arm in 90° abduction the arm is externally rotated and the forearm supinated. The patient is then asked to flex the elbow while resisting the elbow flexion by the therapist. Positive test = if resisted elbow flexion is pain provocative.

Figure 4.9 • Biceps load II test (Kim et al. 2001). In supine with the arm in 120° abduction the arm is externally rotated and the forearm supinated. The patient is then asked to flex the elbow while resisting the elbow flexion by the therapist. Positive test = if resisted elbow flexion is pain provocative.

Figure 4.10 • Crank test (Lui et al. 1996). With the arm in elevation and 90° elbow flexion an axial load is applied to the arm while the arm is internally and externally rotated and circumducted. Positive test = pain, catching or clicking.

more positive tests increasing the likelihood of the presence of a given disorder (Laslett et al. 2005, Cook et al. 2010). Results from a single study of such an approach for clinical testing of the glenoid labrum (SLAP), unfortunately has failed to demonstrate any more impressive results (Guanche & Jones 2003). Positive results from combinations of two or three tests had the effect of only small increases in specificity but consequently reduced the sensitivity values of a single test. Further studies into such an approach are clearly required before any conclusions about the usefulness of combinations of physical tests for identifying SLAP lesions in clinical practice are made.

Shoulder instability and diagnosis based on physical examination tests

Results from diagnostic accuracy studies investigating the concept of instability appear more promising. Although there was insufficient data to perform meta-analysis, Hegedus et al. (2008) suggest that the apprehension (Fig. 4.11), relocation (Fig. 4.12) and anterior release tests (Fig. 4.13) are useful to diagnose anterior instability, especially when apprehension as opposed to pain is considered as the finding to indicate a positive test. A similar conclusion is reached by Fisher and Dexter (2007).

Acromioclavicular joint conditions and diagnosis based on physical examination tests

With regard to acromioclavicular joint pathology, again Hegedus et al. (2008) report of insufficient power to undertake meta-analysis. None of the tests studied appeared clinically valuable based on likelihood ratios. Suggestion was made that due to high sensitivity values (0.96) (Walton et al. 2004), an absence of pain on palpation of the acromioclavicular joint may prove beneficial as an exclusion test of acromioclavicular joint pathology. Results relating to the active compression test, although appearing promising, are confounded by results which indicate worsening of the diagnostic utility of the test as the methodological quality of the studies improve (Hegedus et al. 2008).

Frozen shoulder diagnosis based on physical examination tests

Restriction of passive movement of the shoulder, particularly lateral rotation is necessary to assist in

Figure 4.11 • Apprehension test (Rowe & Zarins 1981). In supine passively rotate the arm into maximum external rotation in 90° abduction and apply a posteroanterior force to the humeral head. Positive test = apprehension to the movement with or without pain.

Figure 4.12 • Relocation test (Jobe et al. 1989). Repeat the apprehension test with a posterior directed force on the humeral head. Positive test = an increase in the external rotation range before symptom/apprehension reproduction.

Figure 4.13 • Anterior release test (Gross & Distefano 1997). Repeat the relocation test and at the limit of external rotation release the posterior directed force. Positive test = a feeling of apprehension with or without a sudden pain.

the diagnosis of frozen shoulder (Bunker 2009, Hanchard 2011). A recent review by Hanchard et al. (2011) reported that reliability measuring lateral rotation using visual estimation, reflective of most clinical practice is difficult. Hanchard et al. (2011) cited evidence from studies including those by Croft et al. (1994) who found that visual estimation of external rotation range of movement was poorly reproducible between six experienced rheumatology primary care physicians (ICC 0.43), and Terwee et al. (2005) who demonstrated that a change of 35° or more of lateral rotation was required to establish between tester agreement of two physiotherapists. It must also be recognized that the clinical sign of restriction of shoulder external rotation is not exclusively a feature of frozen shoulder but also of other shoulder conditions (i.e. osteoarthritis). The diagnostic considerations of frozen shoulder and the other conditions described in this section are discussed in the section ‘Summaries of the most common shoulder disorders’.

Diagnosis of shoulder conditions based on physical examination tests – an appraisal

Numerous issues have been reported in the literature which may help explain the disappointing diagnostic accuracy and reliability of these orthopaedic physical examination tests and it is perhaps pertinent at this point to discuss briefly some of the findings.

Anatomical basis – Green et al. (2008) sought to review systematically the literature relating to the common clinical tests for the shoulder to establish whether a valid anatomical basis for the test has been established and whether it supported the conceptual theory on which the tests were developed. Of 34 orthopaedic special tests identified in the literature search only six had been studied with respect to anatomical validity, highlighting the dearth of investigation into theory on which the tests were developed. Interestingly, in this review only four orthopaedic special tests (active compression (O'Brien's test), shoulder quadrant, lift-off test and Hawkins–Kennedy manoeuvre) were identified with a degree of consensus to have a valid anatomical basis. Furthermore, Tucker et al. (2011) in a pilot study on one cadaver investigated the anatomical validity of the Hawkins–Kennedy test. This study failed to demonstrate evidence of supraspinatus compression within the subacromial space, which was the proposed mechanism by the original authors (Hawkins & Kennedy 1980). In contrast, Tucker et al. (2011) found evidence to suggest that the long head of biceps brachii and the rotator cuff interval, structures which are rarely implicated in impingement syndrome, were compressed. These findings are broadly consistent with the results of Yamamoto et al. (2009) who, in addition, also found the subscapularis tendon to be compressed during the Hawkins–Kennedy test.

Face validity – The face validity of orthopaedic special tests which seek to selectively stress individual tendons of the rotator cuff has also been disputed, given the anatomical interdigitation and confluence of the rotator cuff tendons (Lewis 2009, Burkhart et al. 1993, Clark & Harryman 1992).

Pain inhibition – Studies by Ben-Yishey et al. (1994), Steenbrink et al. (2006), Park et al. (2008) and Cordasco et al. (2010) have all demonstrated significant increases in muscle strength around the shoulder complex in subjects with a variety of diagnoses including full thickness rotator cuff tears, partial thickness rotator cuff tears and impingement syndrome following the administration of a subacromial local anaesthetic injection. These findings demonstrate the significant inhibitive effect pain has on the ability to generate muscle force in the shoulder and therefore challenges the face validity of physical examination procedures which purport to implicate the integrity of a specific muscle or tendon through strength testing.

Pain source – In a review article, Lewis (2009) acknowledges the evidence which appears to implicate the subacromial bursa as a potential source of shoulder pain. Work from authors such as Gotoh et al. (1998, 2002), Sakai et al. (2001), Voloshin et al. (2005) and Santavirta et al. (1992) have demonstrated a positive correlation between shoulder pain and levels of proinflammatory cytokines and the neuropeptide substance p contained within the subacromial bursa. Naredo et al. (2002) and similarly Lewis (2009) contend that many orthopaedic special tests which purport to differentially assess the rotator cuff tendons, subacromial bursa and subacromial space will lead to mechanical stimulation of the subacromial bursa and hence the nociceptors within. A positive pain response may therefore merely represent stimulation of the subacromial bursa as opposed to the selective structure the test is purported to stress and therefore lead to poor specificity of the examination procedure and inability to make a specific diagnosis.

Operational definitions – Hanchard et al. (2011) discuss how unclear operational definitions when assessing shoulder range of movement may affect both the intra-rater and inter-rater reproducibility of results. Considerations such as determination of the end point of range of movement, that is, onset, increase or where pain becomes intolerable, patient positioning during the assessment of range of movement and whether external stabilization of the trunk or scapula is provided are such factors (Hanchard et al. 2011). A lack of clarity with regard to the specific performance and interpretation of results (operational definitions) of the other physical tests discussed in this section must also be considered.

Reference test – As discussed, diagnostic accuracy studies seek to compare a given test against a reference standard. Many of the physical tests reported in the preceding sections have used observed findings at shoulder arthroscopy or imaging findings as the reference standards. As Mohtadi et al. (2004) note, the validity of surgical findings at arthroscopy is yet to be firmly established and additional research is required to determine the accuracy and reliability of findings at arthroscopy. Similar work remains to be undertaken with regard to imaging modalities including MRI and ultrasound. Furthermore, the use of pathoanatomical reference tests may not be the ideal choice as the relationship between pain and tissue pathology in shoulder conditions remains unclear given the high presence of asymptomatic tissue lesions in shoulder investigations.

Subacromial impingement as a clinical presentation also fails to possess a gold standard with which to compare physical examination tests. Some of the pertinent issues in respect of the use of imaging are discussed in the section 'Subacromial impingement and imaging'. The use of a subacromial injection test as a criterion measure is also open to problems as it is reliant on the accuracy of the injection and the anatomical integrity of the subacromial or subdeltoid bursa and the glenohumeral joint.

Medical diagnosis of shoulder conditions based on physical examination tests – a summary

It is evident that at this stage in scientific enquiry, physical examination tests which seek to evaluate the shoulder with regard to identifying pathoanatomical structural diagnosis are abound with uncertainty. In the majority of cases they appear to fail to demonstrate satisfactory diagnostic accuracy and reliability to make a discriminative diagnosis for which the tests were intended. This evidence provides the explanation for the unsatisfactory levels of inter-rater reliability of classification systems proposed based on a pathoanatomical model. Furthermore, the lack of uniformity of diagnostic labels on which management decisions are made is problematic as commonly patients are put into diagnostic groups based on the results of these special orthopaedic tests. There is an obvious need for further methodologically robust studies in the field of diagnostic accuracy of physical examination tests in shoulder conditions given the generally poor quality of the current literature base (Hegedus et al. 2008, Fisher & Dexter 2007, Beaudreuil et al. 2009, Hughes et al. 2008, Dessaur & Magarey 2008, Mirkovic et al. 2005, Munro & Healy 2009). It is clear, therefore, that clinical decision making regarding the conservative management of an individual with shoulder pain which is based on a clinical diagnosis and use of diagnostic labels arrived at using special orthopaedic tests is flawed. In recognition of these problems, several authors suggest a different model of assessment and treatment be considered, with abandonment of the diagnostic biomedical pathological model in conservative care (Lewis 2009, Hughes et al. 2008, May 2010, Schellingerhout et al. 2008).

In contrast to the biomedical model and perspective of diagnosing tissue pathology to determine management decisions, diagnosis within physiotherapy, which guides the prognosis and intervention strategies for patients, is considered at the level of impairments, functional limitations and abilities or disabilities (World Confederation of Physical Therapy (WCPT 2007). The requirement for such an impairment-based approach in the management of shoulder conditions is clear when considering the discussion in this and the next section 'Imaging and the diagnosis of shoulder conditions'. It is interesting to note some of the recommendations in the recent literature with regard to shoulder conditions. Hughes et al. (2008) have stated, 'perhaps clinicians should be describing signs and symptoms and speculating on pathology rather than trying to localize a specific pathologic structure'. Lewis (2009) proposes a model which helps the 'clinical decision making process' with regard to a patient's conservative treatment based on a patient's clinical response (symptom modification) to a variety of manual therapy techniques applied to the components of the shoulder complex, cervical and thoracic spine. It is particularly interesting to note how this contemporary stance appears to mirror the contention that Maitland arrived at more than 40 years ago, recognizing the problems associated with diagnosis and diagnostic titles. Maitland's concept allowed the clinician to base intervention on clinical evidence, i.e. 'the primacy of clinical evidence'. A quote from Maitland – 'by basing treatment on symptoms and signs useful treatment may be effected while the medical profession and its scientists continue to work towards understanding more in regard to diagnostic titles' – appears as valid today as the date when Maitland first developed his concept. A reinterpretation and redefinition of the special orthopaedic tests with respect to the Maitland Concept and their applicability to physiotherapy practice is proposed in the section on orthopaedic special tests on page 223.

Summary: physical examination relating to biomedical diagnostic titles

- Numerous special orthopaedic physical examination tests have been developed which aim to differentially diagnose pathologies of the shoulder.
- Several systematic reviews and meta-analyses have examined studies that have researched the usefulness of these tests to differentially diagnose shoulder pathologies.
- In general the tests appear to possess unsatisfactory reliability, poor reproducibility of results between different investigators, and demonstrate worsening diagnostic accuracy as the methodological quality of the studies improves.
- A number of issues may explain the broadly disappointing results, including the lack of an anatomical basis on which the tests are based, questionable face validity of some tests, the effect of pain inhibition on tests associated with strength assessment, questionable reference tests and operational definitions and poor methodological quality of studies.

Implications for physiotherapists

- Clinical decision making regarding the physiotherapy management of an individual with shoulder pain which is based on a clinical diagnosis derived from the use of special orthopaedic tests is flawed.
- Physiotherapy management should be directed towards addressing impairments considered to be linked to an individual's functional limitations and disabilities, rather than to broad biomedical diagnostic titles.
- A reinterpretation and redefinition of the orthopaedic special tests with respect to the Maitland Concept, the brick wall model and applicability to physiotherapy practice is discussed on page 223.

Imaging and the diagnosis of shoulder conditions

The use of imaging in the diagnosis of shoulder conditions

The use of radiological imaging modalities to improve the ability to reach a structural diagnosis or as a criterion standard for which to correlate findings from the physical examination brings with it many considerations which need to be acknowledged when examining the problems associated with the medical diagnosis and diagnostic labels in shoulder conditions. Similar considerations need to be acknowledged with respect to surgical findings.

The presence of abnormal morphology in asymptomatic individuals, anatomical variants which are clinically irrelevant, reporting error, inability of imaging to detect clinically significant pathology and technical factors have all been reported as explanation to signify caution when interpreting findings from radiological investigation (Khan et al. 1998).

Rotator cuff integrity and imaging

Results from a variety of studies suggest that both ultrasonography (USS) and magnetic resonance imaging (MRI) are accurate in the diagnosis of full thickness rotator cuff tears with pooled sensitivity values of 0.95/0.89 and specificity values of 0.96/0.93 respectively, with no statistically significant difference between the two imaging modalities (Ottenheijm et al. 2010, Shahabpour et al. 2008, de Jesus et al. 2009). For the detection of partial rotator cuff tears, accuracy is much lower. Pooled sensitivity values of 0.72 and specificity values of 0.93 for ultrasound have been reported, indicating that ruling out a partial thickness tear using this modality may be difficult (Ottenheijm et al. 2010). Similar results have been reported with respect to the ability of MRI to detect partial thickness rotator cuff tears (sensitivity 0.64/specificity 0.92) in a meta-analysis undertaken by de Jesus et al. (2009). Again no statistically significant differences were found between the MRI and USS for the detection of partial thickness rotator cuff tears. Combining MRI with gadolinium enhanced arthrography improves the ability to detect partial rotator cuff tears (sensitivity 0.86/specificity 0.96) (de Jesus et al. 2009).

Important considerations must however be acknowledged when interpreting these findings. Numerous authors have demonstrated the presence of a variety of pathoanatomical features using a variety of imaging modalities in shoulders of asymptomatic individuals. Using magnetic resonance imaging (MRI) Sher et al. (1995) reported an overall prevalence of rotator cuff tears of 34% in 96 asymptomatic individuals. The frequency of tears increased significantly with age, with a prevalence of 54% in those individuals aged over 60 years (28% full thickness, 26% partial thickness tears). In those individuals aged 19–39 none had a full thickness tear and only 4% had a partial thickness tear. Similar findings have been reported by Milgrom et al. (1995), Templehof et al. (1999), Worland et al. (2003) and Yamaguchi et al. (2006) utilizing ultrasonography. In asymptomatic individuals aged over 50, full thickness rotator cuff tears have a reported incidence of 40% (Worland et al. 2003), and a 50% prevalence of a combination of partial and full thickness tears (Milgrom et al. 1995). All these studies have reported a high correlation between increasing age and the presence of rotator cuff tears (either partial or full thickness), regarded by some authors as part of the 'natural ageing process' (Worland et al. 2003) or 'normal degenerative attrition, not necessarily causing pain and functional impairment' (Tempelhof et al. 1999). Lewis and Tennant (2007) eloquently conclude 'there is good evidence that both ultrasound and MRI are accurate at identifying full thickness tears in the rotator cuff and to a lesser extent diagnosing partial thickness tears. However the significance of these findings is open to interpretation as neither of the imaging modalities is capable of detecting a symptomatic tear from a tear not associated with pain or functional loss'.

Subacromial impingement and imaging

Subacromial impingement syndrome is classically described as an abnormal contact and compression of the rotator cuff, long head of biceps and subacromial bursa within the subacromial space (Bigliani & Levine 1997, Neer 1983). Current opinion suggests a vast array of possible causes which have been broadly grouped into intrinsic and extrinsic factors and further classified as of either primary or secondary etiology (Bigliani & Levine 1997) (see Table 4.4). As such, subacromial impingement syndrome encompasses a wide spectrum of possible pathologies with different aetiologies and has been considered by some authors to represent a clinical presentation as opposed to a diagnosis (Mohtadi et al. 2004).

MRI as an imaging modality provides only a static evaluation of the shoulder and as such is only able to provide an indirect suggestion of subacromial impingement based on the presence of pathology thought to be associated with the diagnosis such as subdeltoid or subacromial bursitis, rotator cuff tendinopathy and/or rotator cuff tears (Bureau et al. 2006; Birtane et al. 2001). Studies by Frost et al. (1999) and Birtane et al. (2001) demonstrate some of the potential problems with MRI and the diagnostic label of subacromial impingement. Lesions of the rotator cuff, especially supraspinatus, are widely believed to be associated with the clinical signs of impingement of the shoulder (Neer 1983, Iannotti 1991; Tan 1998). In a study of 42 patients with, and 31 age-matched individuals without signs of subacromial impingement (diagnosed clinically), Frost et al. (1999) demonstrated that 55% of subjects in the symptomatic group and 52% of subjects in the asymptomatic group possessed a pathologic supraspinatus tendon. As opposed to being related to the clinical sign of impingement, the pathologic supraspinatus lesions were associated with age. Similar findings were reported by Birtane et al. (2001) who used a physiological standard of reference, namely a subacromial injection of local anaesthetic (lidocaine) to investigate the value of MRI in subacromial impingement syndrome. MRI-based pathologic findings of lesions in the rotator cuff demonstrated a high sensitivity (98.85%) but low specificity (36.84%) in terms of discriminating the subacromial injection test based diagnosis of subacromial impingement syndrome (Birtane et al. 2001).

Although open MRI is able to offer dynamic evaluation, limited availability and restriction of evaluation to single-plane shoulder motion are cited as limiting factors at the current time (Bureau et al. 2006).

Dynamic ultrasonography has also been used to investigate subacromial impingement syndrome, with features such as bunching of the subacromial bursa or pooling of fluid in the subacromial bursa purported to represent the subacromial impingement (Read & Perko 1998, Bureau et al. 2006, Awerbuch 2008). Unfortunately, the reliability of dynamic ultrasonography is yet to be convincingly demonstrated in the diagnosis of subacromial impingement syndrome (Read & Perko 1998, Bureau et al. 2006; Awerbuch 2008). Furthermore, although MRI and ultrasonography have been reported to demonstrate high diagnostic accuracy in the identification of the soft tissue lesions associated with the diagnosis of impingement such as rotator cuff tendinopathy and tears and subacromial or subdeltoid bursitis, it must be remembered that these patho-anatomic features possess a high presence in asymptomatic individuals.

Radiographic evaluation may provide valuable information regarding the presence of features considered as potential causes of primary subacromial impingement (acromioclavicular osteoarthritis, os acromiale and acromion morphology). However, conflicting results have been reported regarding the relevance of such findings (Michener et al. 2003, Bigliani & Levine 1997, Lewis & Tennant 2007).

Lesions of the subacromial bursa are often considered to be associated with subacromial impingement syndrome and as such a possible source of shoulder pain (Bigliani & Levine 1997, Neer 1983). Unfortunately, at the present time, there appears to be a lack of standardization when assessing the status of the subacromial or subdeltoid bursa using ultrasonography (O'Connor et al. 2005, Awerbuch 2008). Furthermore, bursal changes have been reported with high incidence in the asymptomatic individuals in studies such as Naranjo et al. (2002) using ultrasonography and Zanetti et al. (2000) using MRI. van Holsbeeck and Strouse (1993) have demonstrated that abnormal fluid collection within the subacromial bursa may result from communication from the glenohumeral joint in the presence of rotator cuff tear, and therefore has the potential to be as common a finding as asymptomatic rotator cuff tears (Awerbuch 2008). Furthermore, Svendsen et al. (2004) consider that such bursal changes may be physiological reflecting the protective role of the bursa.

Glenoid labrum and imaging

Magnetic resonance imaging arthrography has been described as the gold standard imaging modality for identifying labral pathology (Abrams & Safran 2010). Sensitivity values such as 89% (Bencardino et al. 2000) and 82% (Waldt et al. 2004) and specificity values such as 91% (Bencardino et al. 2000) and 98% (Waldt et al. 2004) have been reported. Again however, several studies have illustrated the presence of labral pathology in asymptomatic individuals. Increases in signal intensity in glenoid labrum (which has been correlated with histological findings of fibrovascular disease, degeneration, calcification, ossification) has been reported in 46% and 50% of normal shoulders (McCauley et al. 1992, Chandnani et al. 1992) and 64% of asymptomatic professional baseball throwers (Miniaci et al. 2002). Features corresponding with a glenoid labral tear have been identified in 45% of throwing shoulders and in 36% of non-throwing shoulders in asymptomatic professional baseball throwers (Miniaci et al. 2002).

Other shoulder structures and imaging

Numerous other structural abnormalities have been reported in radiological imaging studies of shoulders of asymptomatic individuals. In an MRI study of 20 asymptomatic overhead athletes, aged 18–38 years (12 college baseball pitchers and eight professional tennis players), Connor et al. (2003) demonstrated 25% of the dominant shoulders to possess MRI evidence of a Bennett's lesion (an extra-articular ossification of the posteroinferior glenoid) compared with none of the non-dominant shoulders. Further findings included joint effusions (90%), subacromial fluid (22.5%), sclerotic or cystic changes in the greater tuberosity, tears of the anteroinferior or superior glenoid labrum (7.5%) and rotator cuff tears (partial or full thickness) (40%). Sixteen of the 20 participants were followed up with interview after five years. During this period none of the athletes had developed symptoms or required any assessment for shoulder-related problems. All had continued to play their sport at a competitive level without any noticeable reduction in ability due to their shoulder.

The limitations of imaging – an appraisal and some considerations

A few methodological considerations should be made at this stage. Obviously the inherent limitation in any imaging study of asymptomatic individuals such as those detailed in this section, is the absence of operative or histologic comparison to verify the findings. However, the criterion standard of surgical findings is also open to contention, as essentially it is reliant on the ability of an observer (surgeon) to determine the pathology identified. Kuhn et al. (2007) have demonstrated this contention when assessing the interobserver agreement in the classification of rotator cuff tears amongst experienced shoulder surgeons who reviewed a series of arthroscope videos. When distinguishing between full-thickness and partial thickness tears interobserver agreement was high (k=0.85). However, when classifying the depth of partial thickness tears agreement was poor (k=0.19). Further research to determine the accuracy and reliability of arthroscopic findings and the diagnosis of specific shoulder conditions is required (Mohtadi et al. 2004).

Findings such as these illustrate the caution required and difficulty when interpreting evidence from radiological imaging studies of shoulder problems. As Miniaci et al. (2002) summarized 'the mere presence of signal changes or abnormalities does not necessarily indicate pathologic symptomatic findings'. The high incidence of false-positive MRI and ultrasonographic findings, particularly in those aged over 50 and individuals who place significant stress on their shoulders such as throwers, emphasize the difficulties relating pathology identified on imaging with the source of symptoms in shoulder conditions.

The potential for misdiagnosis or misrepresentation of the source of a patient's functional problem in shoulder conditions is therefore significant.

When considering the relationship between radiological imaging findings and clinical symptomatology in shoulder conditions it is also interesting to recall Case study 4.1 provided by Maitland (1986) and used to demonstrate his contention urging clinicians to interpret the theoretical aspects of a patient's condition in a balanced way 'we must not get diverted by the theoretical aspects of a patient's disorder such that it is to the detriment of the clinical aspect' – a further feature of the Concept 'theory'.

Summary: the use of imaging in the diagnosis of shoulder conditions

- Radiological imaging is used to improve the ability to reach a structural diagnosis or as a criterion standard for which to correlate findings from the physical examination, however:
- A wide variety of structural lesions have been identified in the asymptomatic population.
- Radiological imaging may also be associated with identifying anatomical variants which are clinically irrelevant, reporting error and inability of imaging to detect clinically significant pathology.
- As Miniaci et al. (2002) summarized 'the mere presence of signal changes or abnormalities does not necessarily indicate pathologic symptomatic findings' and Lewis and Tennant (2007) '… there is good evidence that both ultrasound and MRI are accurate at identifying full-thickness tears in the rotator cuff and to a lesser extent diagnosing partial thickness tears. However, the significance of these findings is open to interpretation as neither of the imaging modalities is capable of detecting a symptomatic tear from a tear not associated with pain or functional loss'.

Implications for physiotherapist

- If results from radiological investigations are available to read or view, physiotherapists must interpret the results in a balanced way bearing in mind the symbolic permeable brick wall and the primacy of clinical evidence (Maitland 1986).

Surgical findings – some considerations with regard to specific diagnosis

Surgical studies also emphasize the difficulty in identifying the relationship between tissue pathology and clinical symptoms reported by patients.

Case study 4.1

Demonstration of the primacy of clinical evidence

A 74-year-old healthy lady, who, for six weeks, had been unable to comb her hair or reach far enough behind her back to do up her brassiere because of 'shoulder weakness and discomfort', was told that the only options open to her were 'major surgery' or 'put up with it'. She refused surgery, preferring to put up with it because her sister, who 'had had exactly the same problem' was 'cured by physiotherapy', she pressed for the same treatment. The diagnosis was 'marked osteoarthritis'. She certainly did have gross joint changes which were obvious both clinically and radiologically. Physically she had a 35% reduction in range, pain on stretching, and considerable painless dry crepitus during active movements. When moved passively with the glenohumeral joint surfaces compressed, crepitus was increased and discomfort (not pain) was provoked. Prior to the onset of symptoms six weeks previously, although she knew she had an arthritic shoulder, she did not consider she had any real disability. The 'major surgery' was based on the radiological findings which were interpreted academically. It would be unlikely that these radiological changes had occurred over the six-week period. In fact, they were more likely to be long-standing, although her symptoms were relatively recent. On clinical examination her problem was an 'end-of-range' problem rather than a 'through-range' (gross osteoarthritis) problem. Her shoulder responded quite satisfactorily by regaining its pre-exacerbation state.

(Maitland 1986)

Indeed, Snow et al. (2009) have acknowledged the paucity of evidence in the literature which has sought to demonstrate a correlation between arthroscopic findings and patients' pain.

In a series of 55 patients diagnosed with impingement syndrome who underwent subacromial decompression (resection of the anterolateral edge of the acromion, release and resection of the coracoacromial ligament from the acromion), Snow et al. (2009) reported that there was no statistically significant correlation between the severity of impingement identified at arthroscopy with the level of pain reported either pre- or postoperatively or the level of postoperative satisfaction (89% satisfaction). Similarly, Soyer et al. (2003) demonstrated that the amount of acromion resected (thus the severity of impingement) at surgery was not related to the level of improvement patients reported postoperatively.

Powell et al. (2009) reported that in 98 patients who underwent arthroscopic subacromial decompression for impingement, no statistically significant difference was found in both the pre- and postoperative outcome measures between those patients without a rotator cuff tear (n=75) and those with a rotator cuff tear (which was left unrepaired) (n=23). Such results add support to the difficulty in the current level of understanding as to the extent to which a rotator cuff tear contributes or causes symptoms. Such results suggest the source of pain in these patients was multifactorial and not solely related to the tissue pathology identified.

As part of the research undertaken, Mohtadi et al. (2004) reported the arthroscopy findings of 58 patients (43 men and 15 women) who presented with shoulder pain consistent with shoulder impingement from the clinical examination and whose symptoms had persisted for more than three months and proven resistant to a course of conservative management. Within the inclusion criteria was a more than 50% reduction in pain following injection of local anaesthetic into the subacromial space. Findings at surgery included abnormal tendons, supraspinatus (79.3%), infraspinatus (48.3%), subscapularis (32.8%) and long head of biceps (66%) including non-retracted ruptures in 5.7%. Tendon pathology was further defined as 'inflamed', 'frayed or partially torn' (in the case of supraspinatus on the bursal or humeral surface) or 'full thickness tear' (in the case of the long head of biceps 'complete rupture'). Other findings included pathology of the acromioclavicular joint (56.4%), abnormalities of the glenoid labrum (85.5%), glenoid articular surface (41.1%) and humeral head surface (65.5%). Furthermore, findings in five patients confirmed a diagnosis of either glenohumeral instability as evidenced by the presence of Hill–Sachs (five patients), Bankart (three patients) and SLAP lesions (two patients) with or without rotator cuff lesions, despite the study criteria specifically attempting to exclude patients with a history of instability. Such findings demonstrate that patients with a given clinical presentation, in this case features consistent with the concept of impingement, may have a variety of pathologic findings and concurrent specific diagnoses including those not necessarily associated with the classical concept of extrinsic compression of the rotator cuff. Mohtadi et al. (2004) contend that subacromial impingement is therefore a clinical presentation as opposed to a specific diagnosis, a view which is supported by numerous other authors. Indeed, the concept of subacromial impingement, thought to imply compression between the rotator cuff tendons and bursa between acromion and the humeral head has been brought into question through studies which have demonstrated a lack of contact between these two structures (McCallister et al. 2005, Goldberg et al. 2001).

Despite the advances with regard to shoulder diagnosis that imaging and arthroscopy have brought, the current understanding of the pathoaetiology of shoulder conditions remains incomplete. In particular, the relationship between patients' pain and tissue level pathology remains unclear, with suggestion that, certainly with regard to patients presenting with a clinical diagnosis of subacromial impingement and pathology of the rotator cuff, the origins of pain are multifactorial and not solely related to mechanical factors. Such evidence lends support to the contention that physiotherapeutic management which is based solely on a presumed pathoanatomical lesion and biomedical diagnostic label is flawed and highlights the need for a conceptual model which acknowledges the potential multidimensional nature of a patient's condition at the level of the individual, considering their impairments, functional limitations and associated abilities and/or disabilities.

Again, Maitland's contention regarding the potential difficulties and limitations should physiotherapeutic treatment be based on the medical diagnosis alone appears to continue to be as valid today despite the significant developments in understanding of pathology relating to shoulder conditions that scientific enquiry has made over the last 40 years since the origination of the Maitland Concept.

Summary: surgical findings – some considerations with regard to specific diagnosis

- Results from surgical studies further illustrate that the current understanding of the pathoaetiology and pathophysiology of shoulder conditions remains far from complete.
- In particular the relationship between patients' pain and tissue level pathology remains unclear, particularly relating to rotator cuff disorders and glenoid labrum lesions.

The impact of changing knowledge on the diagnosis of shoulder conditions – a clinical example relating to rotator cuff tendinopathy

As discussed, diagnostic labels in shoulder conditions are often derived from and used to explain the underlying pathology thought to be present which would explain the presenting signs and symptoms of a condition. Unfortunately, at present, despite significant advances in shoulder diagnosis there remains a significant lack of understanding of pathoaetiology and pathophysiology of shoulder conditions (Lewis & Tennant 2007, Lewis 2009, van der Heijden 1999). As Maitland (1986) acknowledged, 'within medicine today there is much that is clearly known and understood. There is much that is being discovered day by day as science progresses. Nevertheless, there is still much that is yet unknown. Also, there is a related facet which must be considered – there is much we THINK we know; yet as medical science progresses it may be proved wrong'.

A perfect example of this latter statement in regard to shoulder conditions relates to the understanding of pathology of the rotator cuff, reported to be one of the most common causes of shoulder pain (Lewis & Tennant 2007, Uhthoff and Sarker 1990;, Seitz et al. 2011). The diagnostic label of 'supraspinatus tendonitis/tendinitis' or 'rotator cuff tendonitis/tendinitis' has been widely reported in the literature. This label, in its truest sense is a pathoanatomic term which describes an inflammatory pathologic problem within the structure of the tendon. As such, traditional medical teachings have deeply entrenched a belief that anti-inflammatory treatment and rest will benefit patients with the condition (Khan et al. 2000). Advances in the understanding of the pathology of tendon disorders has, however, led to the demise of the primary inflammatory model with the recognition that the underlying pathology in the rotator cuff and other tendons commonly affected is predominantly tendinosis, a degenerative, non-inflammatory condition (Fukuda et al. 1990). Although the pathoaetiology remains unclear, pathological features of tendinosis have been considered by some as degenerative and others as a failed healing response (Cook & Purdam 2009). This paradigm shift in the understanding of tendon pathology has brought with it important implications for management. In recent years the term 'tendinopathy' has been advocated by numerous authors as the clinical diagnostic term of choice, encompassing the combination of pain and impaired performance, without assumption as to the underlying pathology (Maffulli 1998).

With specific regard to rotator cuff tendinopathy, significant developments have been made with regard to our understanding of the aetiology of the condition over recent years. Once attributed to an intrinsic lesion of the rotator cuff tendons by Codman (1934), later theories by Neer (1972) accredited almost all the pathology in the rotator cuff entirely to direct mechanical irritation and impingement from the undersurface of the acromion due to variations in the shape and slope, inferiorly protruding acromioclavicular osteophytes and changes in the coracoacromial ligament – extrinsic causes. Based on his theories Neer (1972) recommended a surgical procedure, acromioplasty, for those patients whose symptoms persisted despite conservative treatment, which has become one of the most widely used shoulder surgical procedures (Stephens et al. 1998). However, in a review by Iannotti (1991) subgroups of patients with unsatisfactory outcomes following acromioplasty were reported (5–50%). Although these results were attributed to inaccurate diagnosis or incomplete decompression, the understanding of the pathoaetiology of the condition was largely unknown. Since this classic publication by Neer (1972) the aetiology of rotator cuff tendinopathy remains unclear, with numerous authors proposing alternative theories involving both intrinsic, extrinsic or a combination of both factors, reviewed comprehensively by Seitz et al. (2011), Bunker (2002) and Lewis (2009). Tables 4.3 and 4.4 below summarize the main concepts and evidence presented from work undertaken by Lewis (2009), Seitz et al. (2011), Bunker (2002), Castagna et al. (2010) and Cook and Purdam (2009). These tables serve to demonstrate some of the arguments made both for and against the aetiology of rotator cuff being due to extrinsic factors (factors which cause compression of the rotator cuff tendons – subacromial impingement) or due to intrinsic factors (structural change within the tendon as a result of aging, overuse, etc. such as occurs in other tendons such as the common extensor origin at the elbow, Achilles tendon or patella tendon which are not enclosed within an anatomical space).

It is interesting to examine the course of developments in the scientific understanding of rotator cuff tendinopathy, particularly relating to the aetiological mechanisms, from a position where all pathology of the rotator cuff was attributed to extrinsic compression (subacromial impingement) (Neer 1972) to the current understanding which suggests that rotator cuff tendinopathy is not a homogenous entity, and also may possess a complex multifactorial aetiology with interplay of both intrinsic and extrinsic factors. Furthermore, with improved understanding of tendinopathy in other body regions, that is, the Achilles tendon and patella tendon, a growing body of evidence is now building supporting the recognition and importance of intrinsic factors in the development of rotator cuff tendinopathy. Indeed, some authors, including, Baring et al. (2007), summarize that 'the disease (rotator cuff

Table 4.3 The main theories and concepts relating to extrinsic mechanisms of rotator cuff tendinopathy

Rotator cuff tendinopathy – supporting evidence of extrinsic mechanisms	Rotator cuff tendinopathy – negating evidence of extrinsic mechanisms
Association between acromion shape and severity of rotator cuff (RC) pathology is well documented – associated with RC pathology with bursal-sided partial thickness tears and progression to full thickness RC tears	Presence of anatomical features such as acromion shape, AC joint arthritis, subacromial spurs may contribute, but be insufficient alone to an extrinsic RC tendinopathy mechanism, i.e. predispose to RC tendinopathy? Surgical studies have reported successful outcomes in patients undergoing rotator cuff repair alone without acromioplasty Of patients reviewed nine years following acromioplasty surgery, 20% have gone on to develop full thickness rotator cuff tears – this suggests mechanism other than mechanical compression involved These changes are considered by some authors as secondary reactive changes. Considered that the primary lesion develops intrinsically within the rotator cuff leading to poor control of the humeral head and secondary impingement between the bursal surface of the rotator cuff and the acromion
Movement disorders of the scapula have been demonstrated in patients with RC tendinopathy compared to asymptomatic individuals which may cause a relative reduction in the subacromial space, especially with some of the more obvious movement disorders (scapula dyskinesis) Impairments that produce movement abnormalities of the scapula could include soft-tissue restrictions, muscular control deficits and postural deficits	Movement disorders of the scapula which may cause a relative increase in subacromial space have been reported. Some differences in scapula movement between asymptomatic individuals and subjects with RC tendinopathy are small and question relevance to extrinsic RC compression Methods used to assess and describe scapula movement abnormalities possess unreported reliability The influence of movement disorders of the scapula on the relative size of the subacromial space remain speculative
Reduction in subacromial space theorized to be reduced through movement disorders of the humeral head and to contribute to compression of the rotator cuff Impairments that have been linked to excessive humeral head migration include (a) reduced posterior capsule length, with relationships identified between this impairment and patients with RC tendinopathy, (b) RC muscular control deficits	Superior humeral head migration through abnormal movement patterns may be compensated for by changes in scapular movement patterns (a) If a relationship does exist between posterior capsule length, it is likely not to be a contributing factor in all patients with RC tendinopathy, (b) conflicting evidence as to the effects or RC muscular control deficits have been published

Table 4.3 The main theories and concepts relating to extrinsic mechanisms of rotator cuff tendinopathy—cont'd

Rotator cuff tendinopathy – supporting evidence of extrinsic mechanisms	Rotator cuff tendinopathy – negating evidence of extrinsic mechanisms
Concept of internal impingement which has emerged over the last decade, suggests that the articular surface of the rotator cuff tendons can be compressed between the articular surfaces of the humeral head and the glenoid and, as such, provide an explanation for the observation of articular surface RC tendinopathy Lesions at the articular margin of supraspinatus insertion have been reported to be associated with scuf ng and injury to the posterosuperior labrum in throwing athletes – contact between these two regions during elevation/external rotation Contact between the biceps pulley and the anterosuperior labrum has been reported during elevation/internal rotation in sportsmen Proposed theories as to the cause of this type of impingement include microinstability of the shoulder, posterior capsule restriction, reduced humeral retroversion, scapula movement disorders, SLAP lesions	

Developed from Lewis (2009), Seitz et al. (2011), Bunker (2002), Castagna et al. (2010) and Cook & Purdam (2009).

Table 4.4 The main theories and concepts relating to intrinsic mechanisms of rotator cuff tendinopathy

Rotator cuff tendinopathy – supporting evidence of intrinsic mechanisms	Rotator cuff tendinopathy – negating evidence of intrinsic mechanisms
RC tendinopathy located on the articular side of the tendons, in the absence of pathology on the bursal side of the rotator cuff tendons suggests an intrinsic mechanism behind the development to RC tendinopathy	Internal impingement (an extrinsic mechanism) provides an alternative explanation for the presence of articular surface RC tendinopathy A small patient group exists where tendon pathology is based on the bursal side of the tendon as opposed to the articular side of the tendon Patients with primarily bursal-sided pathology of the rotator cuff have been demonstrated to always be associated with attrition of the acromion and coracoacromial ligament, whereas in patients with primarily articular-sided Rc tendinopathy there was an absence of attritional lesions on the acromion; however, again consider – are these secondary reactive changes to the intrinsic lesions within the rotator cuff?
Intrinsic factors result in morphological changes within the tendon structure considered by some as a degenerative process or by others as a result of failed tendon healing Morphological changes include (a) disorganization of hierarchical structure of collagen with thinner f bres, f bre separation and an abnormally high ratio of type III to type I collagen, (b) increases in ground substance with high concentration of proteoglycans, (c) variation in density of tenocytes, areas of increased numbers with increased protein production and other areas of acellularity, (d) increases in the tendon vascularity (neovascularization), (e) in general an absence of inflammatory cells inf ltrates	

Table 4.4 The main theories and concepts relating to intrinsic mechanisms of rotator cuff tendinopathy—cont'd

Rotator cuff tendinopathy – supporting evidence of intrinsic mechanisms	Rotator cuff tendinopathy – negating evidence of intrinsic mechanisms
Histological evidence has demonstrated that microscopic and macroscopic tearing at the articular surface of the rotator cuff precedes histological changes on the acromion	
Morphological change within the tendon structure results in a tendon which possesses inferior mechanical properties, less able to cope with tensile or shear loads and consequently susceptible to damage and tears	
Tendinopathic changes such as those demonstrated in RC tendinopathy are demonstrated in numerous other tendons including the Achilles tendon, patellar tendon, extensor carpi radialis brevis, tendons of the groin, all of which are not contained within a physiological space and therefore are not susceptible to extrinsic compressive forces	
Animal studies support a mechanical overload aetiology for the development of intrinsic tendon degeneration with changes consistent with human tendinopathy produced in rat supraspinatus tendons following an overuse running programme	Results from animal studies have demonstrated that greatest tendinopathic changes occurred in rat tendons which were exposed to both overuse and extrinsic compression
Aetiological factors associated with the development of RC tendinopathy include age, poor vascularity, genetic predisposition, mechanical overload	The extrinsic compression of the RC may be the factor that predisposes the tendon to tendinopathic changes
RC tendinopathy with an intrinsic mechanism may affect the function of the RC to stabilize the humeral head and thereby predispose to reduction of the subacromial space through superior migration of the humeral head	Reduction in subacromial space theorized to be reduced through movement disorders of the humeral head and to contribute to compression of the rotator cuff – an extrinsic mechanism may predispose the RC to tendinopathy

Developed from Lewis (2009), Seitz et al. (2011), Bunker (2002), Castagna et al. (2010) and Cook & Purdam (2009).

tendinopathy) is a purely intrinsically initiated phenomenon, with the changes in the surrounding structures being a secondary feature'. Intrinsic tendon degeneration is now considered as the principal factor in the development of rotator cuff tears (Seitz et al. 2011, Bigliani & Levine 1997, Castagna et al. 2010, Lewis 2009, Cook & Purdam 2009, Bunker 2002). It is also interesting to consider developments in understanding relating to different types of shoulder impingement, including internal impingement and the recognition that patients may present with a variety of different and concurrent tissue pathological findings (Castagna et al. 2010, Mohtadi et al. 2004).

This developing understanding appears to be reflected in the surgical literature, where surgical management of rotator cuff tendinopathy is driven by the link between observed tissue pathology (based on imaging and findings at surgery) and proposed mechanisms. With scientific understanding regarding the complexities of rotator cuff tendinopathy developing, authors such as Castagna et al. (2010) recognize the need to tailor surgical management to the individual. Such contentions appear supported in the literature with rotator cuff lesions thought to be attributable to internal impingement being treated surgically with debridement of the rotator cuff with subacromial decompression, considered by some authors as contraindicated in this condition. Other authors have also proposed surgical treatment of other conceptualized mechanisms in internal impingement including stabilization of anterior instability with capsular shift, repair of concurrent SLAP (superior labrum anterior posterior) lesions (thought to contribute to glenohumeral instability leading to internal impingement), removing bone fragments of Bennett's lesion and release of the posterior capsule in patients where this restriction was considered as the underlying mechanism producing the internal impingement (Castagna et al. 2010). Conversely, where a rotator cuff lesion is thought to be attributable to an extrinsic lesion subacromial decompression with acromioplasty remains the key component of surgery.

Despite these scientific developments many problems and challenges continue in the understanding of rotator cuff tendinopathy including:

- The controversies and continued lack of understanding of the underlying mechanisms and etiology
- The mechanisms of symptom production, especially given the scientific findings of a high presence of asymptomatic rotator cuff tendinopathy
- The limitations of the physical examination to identify specific shoulder conditions including rotator cuff tendinopathy not including the proposed subcategorisation of rotator cuff tendinopathy based on the underlying mechanism
- Whether subgroups of patients with rotator cuff tendinopathy, which is based on the proposed aetiological mechanism (i.e. intrinsic/extrinsic/combined), may respond to different tailored interventions.

In recognition of such evidence, decision making in physiotherapy management at this current time should continue not be driven by tissue pathology alone, but rather based on impairments, the key contention in this chapter (Seitz et al. 2011, Castagna et al. 2010). Such an approach supports Maitland's contention in his development of the Maitland Concept, namely the primacy of clinical evidence. Evidence is building in the literature providing assistance as to the relationship between impairments and clinical outcomes. Examples include work by Burkhart et al. (2003) who demonstrated a 38% reduction in the prevalence of shoulder problems in a group of competitive tennis players who addressed restrictions to shoulder internal rotation with daily stretches in comparison to a group who did not stretch.

Summary: the impact of changing knowledge on the medical diagnosis of shoulder conditions – a clinical example relating to rotator cuff tendinopathy

- As Maitland (1986) acknowledged, 'within medicine today there is much that is clearly known and understood. There is much that is being discovered day by day as science progresses. Nevertheless, there is still much that is yet unknown. Also, there is a related facet which must be considered – there is much we THINK we know; yet as medical science progresses it may be proved wrong'.

Implications for physiotherapists

- Physiotherapists must keep abreast of the developments in the theoretical understanding of conditions affecting the shoulder (and other body regions) (the left side of the symbolic permeable brick wall) but balance this knowledge with the clinical evidence which takes primacy in the clinician's decision-making processes (the right side of the symbolic permeable brick wall).

Shoulder conditions – a perspective from an ESP role

ESP role practice and the diagnostic task

As has been discussed in the preceding sections, the *medical diagnosis* of patients with shoulder conditions is a complex problem. Features such as severity of pain, chronicity, coexisting pathology, in addition to previously discussed issues relating to the uncertainties associated with orthopaedic special tests, asymptomatic pathology identified in a variety of radiological imaging, the common occurrence of multiple coexisting structural pathologies, a lack of uniformity of diagnostic labelling and classification systems provide significant challenges. Furthermore, the clinical manifestations of pathology may vary widely from individual to individual. Nevertheless, ESPs and physicians have a responsibility to the patient, to establish as specific a *medical diagnosis* as is possible in order to guide decisions relating to their management and prognosis.

When performing the medical diagnostic task, the ESP may function in triage capacity, defined as 'a process in which a group of patients is sorted according to their need for care' whereby 'the kind of illness or injury, the severity of the problem and the facilities govern the process' (Mosby's Medical Dictionary 2009). Such an approach is widely advocated in the literature relating to shoulder disorders including Mitchell et al. (2005), a best practice guideline entitled 'The diagnosis and management of soft tissue shoulder injuries and related disorders' published by the New Zealand Guidelines Group (2004) and in the UK, guidance for the assessment and management of shoulder conditions published by the NHS Clinical Knowledge Summaries (NHS CKS 2012) Figure 4.14 below summarizes this group of work. It is beyond the scope and not the intention of this chapter to provide a comprehensive discussion of all known pathological lesions relating to the shoulder complex, but rather to discuss the considerations and principles relating to diagnosis of shoulder conditions as they apply to both the physiotherapist performing a traditional role and the ESP performing the medical diagnostic task.

The importance of screening for red flags

As discussed in the fourth edition of *Maitland's Peripheral Manipulation* (Hengeveld & Banks 2005, page 82):

> physiotherapists employ highly complex clinical reasoning processes in which various paradigms to practice and different forms of clinical reasoning are followed. In some instances it will be a form of biomedical reasoning, in which the physiotherapist considers pathobiological processes mainly to detect precautions and contraindications to treatment.
>
> (Hengeveld 2000)

Screen for red flags →	Screen for conditions which require early medical attention →	Screen for extrinsic sources →	Establish diagnosis of shoulder disorder
• Tumour? – Hx of cancer, symptoms and signs of cancer, unexplained deformity, mass or swelling; lymphadenopathy. Progressive, well-localized pain, unrelated to movement, often night predominant, not reproduced by palpation or movement during examination • Infection? – Red skin, fever, systematically unwell • Neurological lesion? – Unexplained wasting, significant sensory or motor deficit • Pulmonary or vascular compromise?	• Acute rotator cuff tear? – Recent trauma, acute disabling pain and significant weakness, positive drop arm test • Unreduced dislocation? – Trauma, epileptic fit, electric shock, loss of rotation, abnormal shape • Young adult with acute traumatic primary anterior shoulder dislocation • Undiagnosed severe shoulder pain	• Cervical spine disorders • Thoracic spine disorders • Nerve disorders-radiculopathy, brachial neuritis (also known as neuralgic amytrophy, Parsonage-Turner syndrome), thoracic outlet syndrome, Nerve entrapments inc. suprascapular, long thoracic nerve • Inflammatory disorders-polymyalgia rheumatica, rheumatoid arthritis • Visceral disorders-heart, lungs, gallbladder, diaphragm, spleen, kidney • Complex regional pain syndrome	• Broad diagnostic titles include: • Rotator cuff disorders-rotator cuff tendinopathy, subacromial impingement, subacromial bursitis, rotator cuff tears-partial full thickness, massive, calcific tendonitis • Frozen shoulder • Ostoearthritis-glenohumeral, acromioclavicular • Glenohumeral instability, labral lesions • Acromioclavicular lesions

Figure 4.14 • A diagnostic triage process that may be used in the medical diagnostic process relating to shoulder conditions.

This aspect of physiotherapy practice has gained significant importance following the granting of autonomous status in the UK in 1977 under the terms of the Health Circular (77)33 (CSP 2008). Able to act as first-line clinicians, physiotherapists need not act as medical diagnosticians, but must be able to recognize whether or not the signs and symptoms of a presenting complaint have their origin within the neuromusculoskeletal system, and if not, take appropriate action through directing the patient to the appropriate medical practitioner (Hengeveld & Banks 2005, Maitland 1986, Grieve 1994). Red flags such as those identified by Mitchell et al. (2005), NHS CKS (2012) and the New Zealand Guidelines Group (2004) provide an aid to the identification of possible serious pathology in shoulder conditions and are equally applicable to physicians and physiotherapists who undertake a traditional role and those with extended role and indicate the requirement for immediate referral to an appropriate specialist. Refer to Figure 4.14 for a list of red flags.

ESPs who assume the responsibility for establishing an appropriate *medical diagnosis* of musculoskeletal pathology require the development of a sufficient knowledge base of conditions, their possible differential diagnosis including the possibility of masquerading serious pathology which in the early stages may not be evident as a 'red flag'. The condition of frozen shoulder serves as one such an example. In a recent retrospective case analysis, Sano et al. (2010) reported that 32% of patients in a tumour service who were diagnosed with either primary or metastatic tumors around the shoulder were initially diagnosed with frozen shoulder (n=9) or presented with symptoms characteristic of the condition (n=2) (3 males, 8 females, age range 51–77, mean 61 years). Secondly, in a review of 505 patients who presented to a shoulder service, 4 (0.8%) were diagnosed with malignant shoulder tumours (3 males, 1 female, age range 56–73, mean 67 years) (Sano et al. 2010). Interestingly, in six patients who were diagnosed with metastatic tumors, none presented with symptoms other than shoulder pain and restriction of range of movement and furthermore the tumors in this study were located inside the bone or in the scapular region in 73% of cases (Sano et al. 2010). Sano et al. (2010) consequently recommend that the possibility of musculoskeletal malignant tumour should always be considered in frozen shoulder, with the clinical diagnosis only being made in the presence of a normal X-ray. This contention is supported by numerous authors including Codman (1934), Bunker (2009) and Pearsall & Speer (1998), in addition to other authors who have reported other masquerading conditions including avascular necrosis (Wolfe & Taylor-Butler 2000), melorheostosis (Jermin & Webb 2010) and osteoarthritis (Mitchell et al. 2005). Furthermore, Sano et al. (2010) suggest that if patients fail to respond in a manner consistent with the natural course of the condition, the diagnosis should be reconsidered and the patient should be re-examined with repeated radiographs or further imaging studies, as in their study of nine patients with a tumour in which initial plain X-rays failed to identify the pathology. In contrast the New Zealand Guidelines Group (2004) recommends the use of investigation only if arthritis is suspected. This example serves to highlight some of the responsibilities and controversies that the ESP must contend with.

Screening for conditions which require early medical attention

> Although the physiotherapist will diagnose more frequently in terms of movement disorders than in structural diagnostics, attention needs to be given to acute symptoms due to posttraumatic situations, in which large structural lesions may have occurred and which may need the care of a medical practitioner.
>
> (Hengeveld & Banks 2005, p 152)

Again physiotherapists performing a traditional role need not act as medical diagnosticians, but must be sufficiently aware of shoulder conditions, where early medical attention is necessary and where delay in diagnosis of the structural lesion will be of detriment to the patient. Some of the key conditions are highlighted in Figure 4.14.

An example of such a condition relates to the patient with a previously asymptomatic shoulder, who sustains a direct injury to their shoulder, indicative of a possible acute full thickness rotator cuff tear. Although thought to account for less than 10% of all rotator cuff tears, early surgical intervention in this group of patients is recommended and has been associated with superior outcomes (Bassett & Cofield 1983, Moosmayer et al. 2010, Oh et al. 2006). As previously discussed, the orthopaedic special tests purported to identify this specific shoulder lesion do not demonstrate likelihood ratios that would modify the post-test probability of diagnosing a rotator cuff tear by a moderate or large amount, thereby questioning their utility (see Table 4.2 for description of statistical terms). At best, clinical evaluation, based on the results of one study by Park et al. (2005), has reported the likelihood of a rotator cuff tear to be more than 90% and a full thickness tear to be 28% in the patient who is more than 65 years of age, and presents with a positive drop arm sign combined with a weak 'infraspinatus' test. Nonetheless, as the only diagnostic tools available to the physiotherapist performing a traditional role, a clinical impression of a significant structural lesion can be established based on the history of the condition and the physical examination findings which is sufficient to warrant referral to an appropriate medical practitioner or ESP performing the medical diagnostic task. Based on such a clinical impression the ESP would seek to arrange further investigation in the form of either diagnostic ultrasound or MRI to assess the integrity of the rotator cuff. Pooled sensitivity values of 0.95/0.89 and specificity values of 0.96/0.93 for the ability of diagnostic ultrasound and MRI respectively to detect full thickness rotator cuff tears have been reported (Ottenheijm et al. 2010, Shahabpour et al. 2008). These values allow confident conclusions to be made to both rule in and rule out a full thickness rotator cuff tear (Ottenheijm et al. 2010, Shahabpour et al. 2008) and facilitate timely referral to a consultant orthopaedic surgeon should the patient be willing and medically fit to undergo rotator cuff repair surgery.

A second example relates to the young adult with acute traumatic primary anterior shoulder dislocation. The risk of recurrent instability (redislocation or symptoms/signs of shoulder instability) is high, up to 92–96% in the physically active, young individual (Robinson et al. 2006, Wheeler et al. 1989). Although, there is no common protocol to guide the management of this condition, numerous authors consider that there is ample evidence to suggest that a specific subgroup of younger athletes may benefit from early surgical stabilization, based on substantial reduction in redislocation rates and improved quality of life outcome measures (Gooding et al. 2010, Safran et al. 2007, Boone & Arciero 2010, Handoll et al. 2004). Findings from a longitudinal study with 25-year follow-up undertaken by Holvelius et al. (2008), however, suggest that if immediate surgical stabilization were undertaken in all patients under 25, 30% of the surgery would have been unnecessary as this group of patients spontaneously stabilized over time. Unfortunately, however, at this stage there does not appear to be any evidence relating to a method of predicting who would require surgical stabilization, although some authors have suggested young males (<25 years) involved in contact sports and overhead activity possess the greatest risk for future instability and redislocation (Gooding et al. 2010, Boone & Arciero 2010; Handoll et al. 2004). Numerous other considerations in the clinical decision-making process of surgeons as to the suitability of surgical stabilization have been reported, including the presence of the specific underlying pathoanatomical lesion(s), particularly the identification of bony defects in addition to a bankart lesion (typically seen in 86–100% of young first-time anterior shoulder dislocations) (Gooding et al. 2010, Boone & Arciero 2010). This group of patients requires, at minimum, a clear discussion of the surgical and conservative management options and risks with both approaches (Gooding et al. 2010, Boone & Arciero 2010). As Syme (2009) recognizes, ESP practice is guided in addition to the competencies detailed in Figure 4.1 by locally agreed protocols and referral pathways including recognition of the working practices and philosophy of the consultant teams. As such, the extent to which an ESP becomes involved in both the diagnostic work-up and discussions regarding the risks and benefits of surgery will vary.

Screening for extrinsic sources – analytical assessment and differentiation

Pain and problems experienced in the region of the shoulder have the possibility of being due to a myriad of extrinsically sourced pathology, with some of the key conditions illustrated in Figure 4.14 (Manifold & McCann 1999, Pateder et al. 2009, Mamula et al. 2005, Walsworth et al. 2004, Hattrup & Cofield 2010).

As discussed previously, it is not within the scope of practice of physiotherapists performing a traditional role to provide a medical diagnosis. Nonetheless, as with screening for red flags and clinical presentations which require early medical attention, physiotherapists need to possess an awareness of clinical findings and presentations which suggest a possible extrinsic source of shoulder pain and dysfunction. Some such sources may fall within the scope of practice to be managed and treated within physiotherapy practice, such as movement impairments in the cervical spine which cause or contribute to a patient's functional limitations. Other clinical presentations may suggest a possible underlying pathological condition which requires appropriate medical diagnosis and management and warrants contact with an appropriate medical practitioner. The clinical presentation of a winged scapula and scapula dyskinesis is one such example which may indicate a possible underlying neurological lesion as detailed in Table 4.5. Such screening is required by all physiotherapists performing a traditional role either when working as a first contact practitioner or when assessing and managing patients referred by a physician or the extended role physiotherapist undertaking the diagnostic role. Tables 4.5, 4.6 and 4.7 seek to provide some of the key features of extrinsic conditions which may present as shoulder pain or dysfunction in physiotherapy practice.

Cervical spine disorders – an example of an extrinsic source

The continued clinical utility of the principles of the Maitland Concept to contemporary physiotherapy practice has been eloquently discussed in the previous edition of *Maitland's Peripheral Manipulation* (Hengeveld & Banks 2005) and developed in this chapter with respect to shoulder conditions. Many of the principles of the concept are equally applicable to the ESP, such as that discussed in this current chapter, relating to the limitations and difficulties associated with diagnostic titles and labels which Maitland so clearly acknowledged.

The use of 'differentiation tests' and 'analytical assessment' as described by Maitland (1986) are considered of particular importance to the Concept, and serve as further examples, pertinent to the current discussion relating to screening for extrinsic sources by the ESP. As an example of such a possible extrinsic source, Manifold and McCann (1999) consider cervical spine disorders as the most important and perhaps one of the most difficult to differentially diagnose in patients with pain in the region of the shoulder and include conditions such as spondylosis, disc hernitation, radiculopathy and myelopathy. Furthermore, Manifold and McCann (1999) consider that the cervical spine should be excluded as a pain source in all patients with shoulder problems and recognize the possibility of coexisting pathology with the consequential diagnostic and therapeutic challenge that such a patient presentation brings. Rationale such as the anatomic proximity of the cervical spine and shoulder and similarity in both the clinical presentation and patient group demographics have been reported as some of the challenges to differential diagnosis (Manifold & McCann 1999, Pateder et al. 2009, Hattrup & Cofield 2010). Maitland's (1991) belief that a patient can have; 1. 'More than one kind of pain", 2. 'Different pains in overlapping

Table 4.5 Peripheral nerve entrapments around the shoulder

Conditions	Some key features
Brachial neuritis Also known as neuralgic amytrophy, Parsonage–Turner syndrome (Parsonage & Turner 1948), brachial neuropathy, neuritis of the shoulder girdle, shoulder-girdle syndrome	A rare condition, incidence rates 1.64 cases per 100,000 reported, typically affecting young adults, although a second peak of incidence in seventh decade also reported with male predominance 2:1–11.5:1 Unknown aetiology – has been associated with various factors proposed to cause the neuritis including trauma, infection, virus, heavy exercise, surgery, autoimmune conditions, vaccinations. Most common cause of brachial plexopathy Characteristically presents with three stages; 1. acute onset of severe pain in the shoulder which may refer both distally into the arm and proximally into the neck which may persist for days to weeks, 2. thereafter followed by resolution of pain and the onset of painless paresis, atrophy and sensory impairment of the shoulder girdle and/or upper limb due to involvement of the brachial plexus or its component nerves and finally 3. followed by gradual recovery Presentation can vary greatly dependent upon the predominant site of the lesion, i.e. upper, lower or whole brachial plexus, or the uncommon involvement of a single peripheral nerve. Typically the upper trunk of the plexus is affected with supraspinatus, infraspinatus serratus anterior and deltoid particularly vulnerable Management is conservative, prognosis is good with 75% fully recovered at two years Examples: Miller et al. (2000), Hussey et al. (2007), Gonzalez-Alegre et al. (2002), Sumner (2009), Mamula et al. (2005)

Table 4.5 Peripheral nerve entrapments around the shoulder—cont'd

Conditions	Some key features
Thoracic outlet syndrome (TOS) Other terms include cervical rib syndrome, costoclavicular syndrome, hyperabduction syndrome, pectoralis minor syndrome, thoracic inlet syndrome	Extremely controversial subject and syndrome as to its existence, diagnosis and management Considered broadly as neurovascular compression in a region correctly termed the thoracic inlet (the intersection of the neck and thoracic cavity, consisting of the upper end of the sternum (the manubrium), the first thoracic vertebra, and the first ribs and their cartilages) Associated with cervical rib, fibrous bands, clavicular fractures, first rib, enlarged scalene tubercles, posture to name but a few Due to the controversies regarding the syndrome, incidence also a source of controversy Physical tests are unreliable True vascular TOS-subclavian artery and/or vein is damaged or thrombosed demonstrated by arteriogram or venogram True neurogenic TOS-brachial plexus lesion identified by nerve conduction study or electromyography (EMG) studies Non-specific or disputed TOS-presence of symptoms but no corroborating abnormalities on arteriogram/venogram/NCS/EMG Highly variable set of symptoms possible with pain, paraesthesia, weakness in the upper extremity, often vague, ill defined Vascular symptoms include (a)- arterial compromise: pallor, arm claudication, coldness; (b) venous: edema, venous engorgement, cyanosis – consider Paget-Schroetter syndrome – (effort) thrombosis of axillary-subclavian vein, uncommon deep vein thrombosis related to excessive upper extremity activity (requires early and urgent medical attention for diagnosis), thrombolysis and anticoagulation Neurogenic symptoms dependent upon sites(s) of lesion and include sensory and/or motor pain, paraethesias, dysesthesia, weakness, loss of dexterity, clumsiness, heaviness. Typically involvement of the lower plexus (C8, T1) can also involve upper plexus (C5, C6, C7) Examples: Sucher (2009), Novak & Mackinnon (1996), Naidu & Kothari (2003), Watson et al. (2009), Oktar & Ergul (2007)
Suprascapular nerve entrapment	Uncommon, ?0.4%–2% of sufferers with shoulder pain Suprascapular nerve mixed motor and sensory, supplying supraspinatus and infraspinatus, sensory fibres to acromioclavicular and glenohumeral joint capsule, no cutaneous sensory innervation Neuropathy as result of compression or traction at the suprascapular notch or spinoglenoid region Causes include: space occupying lesions, direct trauma, virus, idiopathic, repetitive/forceful scapular movement Typically pain, weakness/atrophy of supraspinatus/infraspinatus Confirmed with nerve conduction studies, imaging may provide evidence of source of compression, i.e. ganglion cysts, other space occupying lesions Compressive lesions typically managed with surgery Examples: Walsworth et al. (2004), Pratt (1986), Ganzhorn et al. (1981), Coro et al. (2005)
Long thoracic nerve entrapment	Long thoracic nerve, a purely motor nerve, arises from branches of C5, C6 and C7, and innervates the serratus anterior Aetiology: non-traumatic including infection, virus, inflammatory, toxins, prolonged shoulder depression ?manifestation of brachial neuritis, traumatic thought to account for 53% of cases (May & Otsuka 1992) with vulnerability for injury from multiple sources Clinical presentation: severe burning, aching pain, followed by weakness of serratus anterior and medial scapula winging (accentuated during elevation with elbows extended), limitation of shoulder elevation Causes medial scapular winging Most recover serratus anterior function with conservative treatment but may take two years or more Examples: Pratt (1986), Aldridge et al. (2001), Duralde (2000), Waiter & Flatow (1999)

Table 4.5 Peripheral nerve entrapments around the shoulder—cont'd

Conditions	Some key features
Dorsal scapular nerve entrapment	Dorsal scapular nerve arises from C5, passes through the middle scalene innervating the rhomboids, may also innervate levator scapulae, no cutaneous sensory innervation Susceptible to entrapment through the middle scalene Typically scapular pain, possibly referring to the lateral shoulder, lateral scapular winging (best shown during return to neutral from elevation) Examples: Akgun et al. (2008), Pratt (1986), Aldridge et al. (2001)
Spinal accessory nerve entrapment	Otherwise known as cranial nerve XI, and is the sole innervator of trapezius Superficial course in the posterior cervical triangle makes it susceptible to injury Injury will cause dysfunction of trapezius, leading to a drooping shoulder, lateral winging scapula (best shown with shoulder abduction), weakness of elevation Iatrogenic injury to the nerve after a surgical procedure is one of the most common causes, other causes include penetrating injury, and idiopathic Confirmed with nerve conduction studies and EMG Idiopathic cause, treatment is conservative with >80% patients recovering within six to 12 months. Traumatic cause, surgical exploration indicated Examples: Sergides et al. (2010), Waiter & Bigliani (1999), Duralde (2000)
Axillary nerve entrapment	Arises from C5, C6 , supplying teres minor and deltoid, with a cutaneous branch supplying skin superficial to lateral aspect of deltoid Associated with anterior shoulder dislocation, direct trauma to shoulder, space occupying lesions, quadrilateral space syndrome Symptoms are usually vague, pain poorly localized around the anterolateral shoulder, with possible paraesthesia in a non-segmental pattern, weakness and atrophy of deltoid Confirmed with NCS or EMG; imaging may provide source of compression and demonstrate other features of the injury Examples: Aldridge et al. (2001), Duralde (2000)

Table 4.6 Spinal conditions which may prove to be an extrinsic source of shoulder pain and dysfunction

Conditions	Some key features
Cervical radiculopathy	Incidence highest in fourth and fifth decade – 2.1 cases per 1000 Nerve root compression due to encroachment from osteophytic spurs from the lateral aspect of the cervical disc, zygopophyseal joints, uncovertebral joints (hard disc) or acute disc herniation (soft disc) Nerve root perfusion affected through compression of radicular arteries within the dural root sleeves by osteophyte Can prove challenging to differentiate from a primary shoulder problem Pain is neuropathic – results from irritation of the spinal nerves and is referred along the distribution of the nerve and the related dermatome (area of skin supplied by a single spinal nerve) – and is characteristically sharp, burning, lancinating May also be presence of nociceptive referred pain (see below in other cervical conditions) Classically paraesthesia reported in a specific dermatomal distribution, myotomal motor weakness, dermatomal sensory loss Positive spurling tests, with limited cervical rotation, positive upper limb neural tissue pain provocation test (NTPPT) and relief of symptoms with cervical traction provides +LR 30.3 (Wainner et al. 2003) Examples: Slaven & Mathers (2010), Manifold & McCann (1999), Hattrup & Cofield (2010)

Table 4.6 Spinal conditions which may prove to be an extrinsic source of shoulder pain and dysfunction—cont'd

Conditions	Some key features
Cervical myelopathy	Cervical spondylotic myelopathy most common type of spinal cord dysfunction in patients >55 years Has been recognized as a cause of painless upper limb weakness without lower limb symptoms (anterior syndrome) Typically loss of upper limb dexterity; non-specifc upper limb weakness associated with gait disturbances, shoulder, neck and arm pain may also be present Typically lower motor neuron lesion signs at the level of the cervical lesion and upper motor neuron signs below the level of the lesion Clinical diagnosis investigated typically with cervical MRI Cluster signs of 1. gait deviation, 2. positive Hoffman's test, 3. inverted supinator sign, 4. positive Babinski sign, 5. age >45 years. 3 of 5 positive associated with +LR 30.9 (rules in presence of myelopathy), only 1 of 5 positive associated with −LR 0.18 (rules out presence of myelopathy) (Cook et al. 2010) Examples: Bernhardt et al. (1993), Cook et al. (2010)
Cervicobrachial pain syndrome – a clinical syndrome (after Elvey & Hall 1997)	Described as 'upper quarter pain in which neural tissue sensitivity to mechanical stimuli is a primary feature' (Elvey & Hall 1997) – a clinically based diagnostic label Absence of neurological defcit Presence of features suggestive of neural tissue involvement 'i) active movement dysfunction, ii) passive movement dysfunction, iii) adverse responses to neural tissue provocation tests, iv) hyperalgesic responses to nerve trunk palpation, v) hyperalgesic responses to palpation of related cutaneous tissues and vi) evidence of a related local area of pathology' (Elvey & Hall 1997)
Other cervical conditions - spondylosis, disc herniation, facet OA, zygapophyseal sprain, myofascial and postural pain syndromes	Somatic referred pain or /nociceptive referred pain Pain sourced from tissues in the cervical spine other than neural tissue, i.e. ligament, muscle, zygapophyseal joint, intervertebral disc but perceived elsewhere Pain is referred segmentally in a sclerotomal pattern (structures in the body wall and limbs which are innervated by a single spinal segment), which are different and more diffuse in their arrangement than dermatomes Sclerotomal distributions vary widely by individual – shoulder symptoms typically sourced from C5 but also can be produced by stimulation of levels C1 to C8 Examples: Seaman and Cleveland (1999), Bogduk (1988)
Thoracic conditions	Conditions include: thoracic outlet syndrome (previously detailed), postural syndrome, T4 syndrome, frst/second rib elevation, thoracic spondylosis, Scheuermann's disease, Tietze's Syndrome, ankylosing spondylitis Note: Maitland et al. (2005): '1. the upper/mid-thoracic spine, the ribs and their attachments can influence the scapulothoracic and shoulder regions. This can be done by directly referring the symptoms or by influencing the dynamic postural stabilization and relative mobility of the shoulder and shoulder girdle …' '2. The sympathetic chains are in close proximity to the costovertebral joints. Evans (1997) has suggested that arthritic costovertebral joints can cause mechanical irritation of the sympathetic chains. Subtle autonomic symptoms, especially in the limbs, may well be a consequence of such mechanical irritation'

Table 4.7 Other examples of possible extrinsic sources of shoulder pain and dysfunction

Conditions	Some key features
Visceral disorders	Referred visceral pain – pain which is stimulated from within the visceral structures but experienced elsewhere; referred nociceptive pain to the same segmental level as the visceral afferent neurons (convergence-projection theory (Ruch 1946, Robertson 1999) As discussed in the fourth edition of Maitland's Peripheral Manipulation (Hengeveld & Banks 2005), the textbook Differential Diagnosis in Physical Therapy (Goodman & Snyder 1995) provides a useful reference resource to help physiotherapists recognize systemic disease which may mimic musculoskeletal dysfunction Examples of visceral structures and systems which are capable of referring pain to the shoulder include: cardiovascular, i.e. cardiac disease referring to the left shoulder, similarly the diaphragm (Walsh & Sadowski 2001); pulmonary, i.e. Pancoast tumour or pleurisy; the liver or gallbladder is capable of referring pain to the right shoulder, scapula, chest wall; pancreas, or scapula region (Goodman & Snyder 2000)
Polymyalgia rheumatica	Characterized by ache, and morning stiffness (30 minutes or more) affecting the shoulders (70–95% of cases), pelvic girdle and cervical spine (50–70% of cases) and appears due to proximal joint synovitis, affecting those aged >50 years Closely related with giant cell arteritis Painful restriction of both active and passive shoulder movement without detectable joint swelling, ESR (erythrocyte sedimentation rate – a blood test indicative of inflammation) of >40 mmHg; however, has been reported normal in 7–20% cases Rapid response to glucocorticosteroids with near complete resolution of symptoms in a few days Salvarani et al. (2008)

areas", 3. 'Different pains with different behaviours', combined with the logical and methodical process of assessing cause and effect which are demands of the Concept, are important principles for the ESP undertaking the diagnostic task to consider in understanding the contribution of multiple-symptom sources to a patient's presentation, thereby establishing as specific a diagnosis as possible on which to base management decisions. Maitland (1986, 1991) further identified varying kinds of differentiation procedures, including those which attempt to 'determine whether a pain disorder is arising from the spine or a peripheral joint' and those which seek 'to determine whether a pain is arising from the spinal joints or the pain-sensitive structures in the vertebral canal or intervertebral foramen'. As an example, Maitland described a process of differentiation for the patient who reports 'symptoms in the deltoid area which require differentiation procedures to determine whether they are caused by a cervical spine disorder or a glenohumeral disorder'. The original text is reproduced below:

> It is not uncommon for a person to seek relief of pain in the area suggested above. The patient may never have had neck or shoulder symptoms before. On examination of the physiological movements, the shoulder may be painful at the end of range(s); and the cervical spine's physiological movements may be symptom free. Two other examination movements of the cervical spine must be tested before it can be said that the cervical spine is NOT affected:
>
> Compression of the cervical spine should be assessed by the therapist gradually increasing compression through the crown of the patient's head endeavoring to compress structures on each side alternately, positioning the patient's head and cervical spine in some extension, together with lateral flexion and rotation towards the side of the pain. If the cervical spine is implicated, performing the procedure towards the side of the pain will probably be more uncomfortable than when performed on the side opposite to the site of the pain (Fig. 4.15).
>
> The second test is the primary test. This uses careful palpation of the appropriate vertebrae. The intervertebral spaces are assessed to determine whether there is any abnormal position or thickening of related intervertebral levels. If there is a difference, such as thickened intervertebral tissue or prominence of relevant zygapophyseal joints, pain will probably be felt deeply when oscillatory unilateral pressure is applied in a postero-anterior direction through the zygopophyseal joint. This is classed as an abnormal finding.
>
> Confirmation of no cervical structure contributing to the patient's deltoid area symptoms will be evident if the

Figure 4.15 • Cervical compression test. With the patient sitting and the examiner standing behind the patient, the therapist cradles the top of the patient's head in their hands and takes the neck into slight extension, rotation and ipsilateral side flexion. A compression force is then applied axially down through the head. Positive test = symptom reproduction in the arm.

> cervical spine is treated at two consecutive sessions without producing any change in the symptoms. Conversely, successful treatment of the spine with palpatory techniques will produce favourable changes in:
>
> The test movements of the shoulder
>
> The symptoms felt by the patient
>
> The palpation signs of the cervical spine.
>
> Maitland 1991 p 37–8

Maitland (1991 p 38) further recognized the importance of differentiating 'the cause of shoulder (and arm) symptoms being from a shoulder disorder, a neurogenic or dural disorder' and acknowledged the pioneering work of Elvey (1979) in the development of the 'brachial plexus tension tests' within the Concept, as the procedure to facilitate this differentiation. Although later refined by authors such as Butler (1991, 2000) and Hall & Elvey (1999), reinterpreted in light of contemporary developments in understanding relating to pain science and relabelled as neural tissue provocation tests (Hall & Elvey 1999), the concept of structural differentiation in an attempt to clinically investigate the presence of neural tissue mechanosensitivity continues to inform contemporary clinical practice.

Case study 4.2 describes an ESP assessment of a patient with persistent shoulder pain.

Case study 4.2

An ESP assessment of a patient with persistent shoulder pain

History

Mrs R, a 67-year-old lady presented to an orthopaedic Clinical Assessment and Treatment Service (CATS) with a six-month history of insidious onset right shoulder pain. She described pain localized over the lateral aspect of the shoulder, intermittently radiating down the lateral aspect of the upper arm to the elbow (Fig. 4.16). The pain worsened when she lifted her arm above shoulder height and when trying to place her hand behind her back. She had difficulty washing and drying her hair. Her sleep was disturbed most nights due to the shoulder pain, which she felt was due to rolling onto the affected side. Since the onset of the shoulder pain she reported noticing that her shoulder had been clicking and that her arm felt heavy. Mrs R had initially undergone a brief course of physiotherapy at her GP practice arranged by her GP. She described a home exercise programme of various movements to the shoulder with the use of a theraband including resistive elevation and lateral rotation exercises. Unfortunately, this only served to aggravate her symptoms. Due to a failure to improve she attended her GP who consequently arranged an orthopaedic CATS referral. The GP referred Mrs R with a diagnosis of 'subacromial impingement syndrome right shoulder'.

Examination

The key features identified during the physical examination were painful restrictions of the right shoulder to active elevation and abduction at 160°. Lateral rotation was painfully restricted at 60° (in comparison to her left shoulder at 70°). Hand behind back was painfully restricted to the level of her posterior superior iliac spine in the affected right arm with the left able to reach to the mid-thoracic region. Using the restricted elevation of her shoulder as her functional demonstration, a noticeable change to her shoulder range of movement and pain was produced when repeating the movement in various different cervical spine positions. Special orthopaedic impingement tests including Hawkins–Kennedy and empty can tests were positive.

Case study 4.2—cont'd

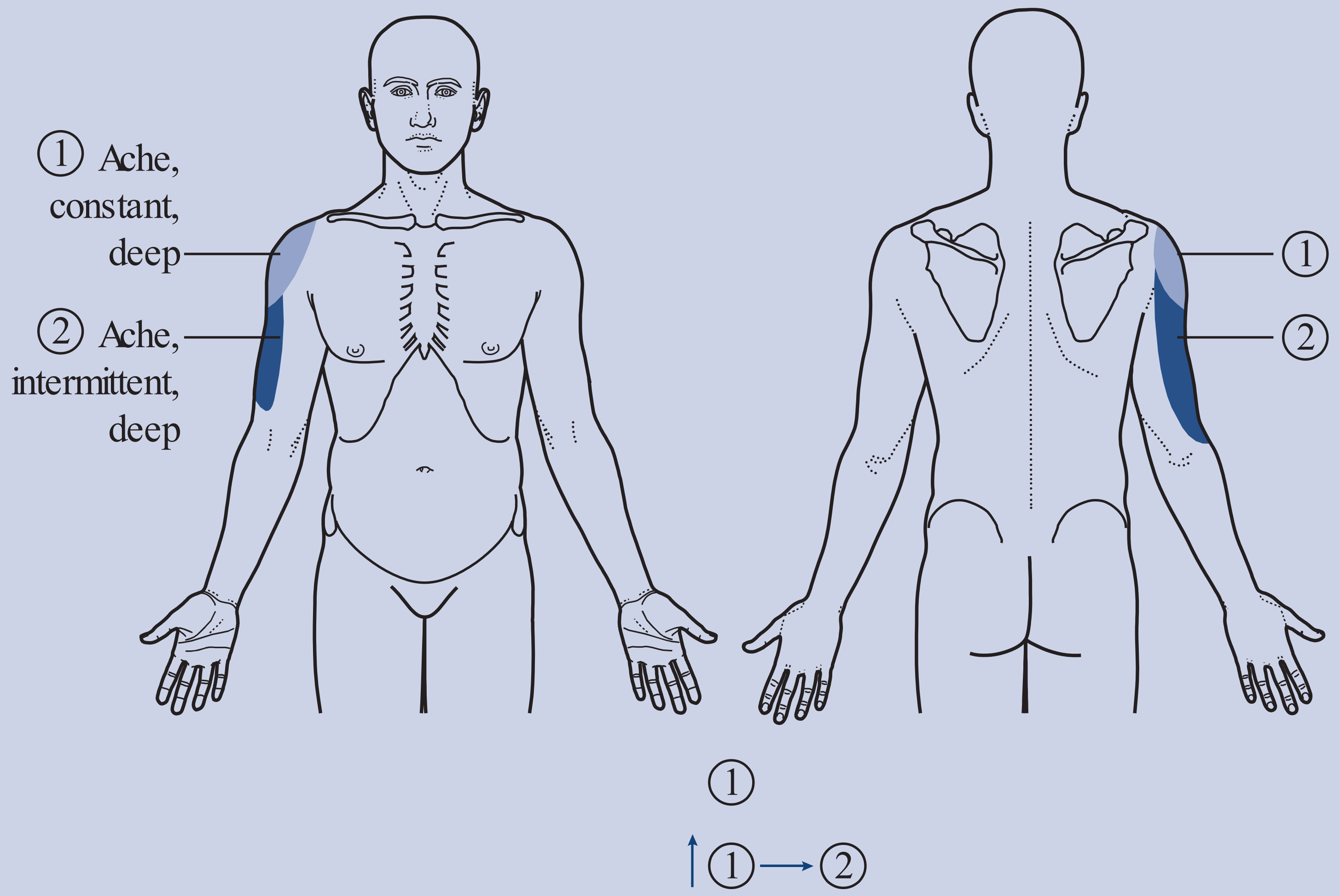


Figure 4.16 • Body chart of Mrs R.

Initial active range of movement assessment of the cervical spine was unremarkable with well-maintained active range of movement. However, on closer examination at the extreme of right rotation, right side flexion and extension local neck pain was produced. Despite various combinations of cervical active range of movement, reproduction of comparable shoulder pain was not achieved. Palpation of the cervical spine revealed marked localized tenderness in the region of the right C4, C5 and C6 facet joints. Unilateral posteroanterior mobilization of these levels was limited at half range by locally produced pain. Unilateral anteroposterior mobilization of the same levels was limited at quarter range by locally produced neck pain but also with provocation of comparable lateral shoulder pain.

A passive mobilization technique in a unilateral posteroanterior direction on the affected levels was applied in an attempt to analyze the affect that the impairments identified in the cervical spine had on the shoulder symptoms and signs. During the passive mobilization technique, the range of movement produced during the technique gradually increased in line with a reported easing of the locally produced discomfort. Following application of the technique, reassessment of active shoulder range of movement revealed restoration of full range with discomfort at the limit of both elevation and abduction. Mrs R reported feeling that her shoulder movement was substantially easier and 'lighter'. The discomfort that had been present at the limit of cervical right rotation, right side flexion and extension had eased. Interestingly, the clicking sensation that Mrs R had reported had also eased.

Mrs R reported being happy to try a further course of physiotherapy (aimed at addressing the previously unaddressed impairments in the cervical spine) having had a demonstrable improvement within the assessment session. She reported 'relief' that she was able to lift her arm with less pain and that her shoulder felt the most comfortable it had for six months.

Treatment

Mrs R underwent a further course of physiotherapy as recommended. Treatment consisted of posteroanterior and anteroposterior mobilization of the cervical spine (Fig. 4.17) with progressing grade of technique in line with the symptoms and sign response and a change of glenohumeral starting position from neutral to end-of-range elevation. Within three sessions the impairments in the cervical spine had cleared with full pain-free range of active movement achievable both on single plane and combined movements. The previously impaired range of movement to posteroanterior mobilization also resolved. In line with the

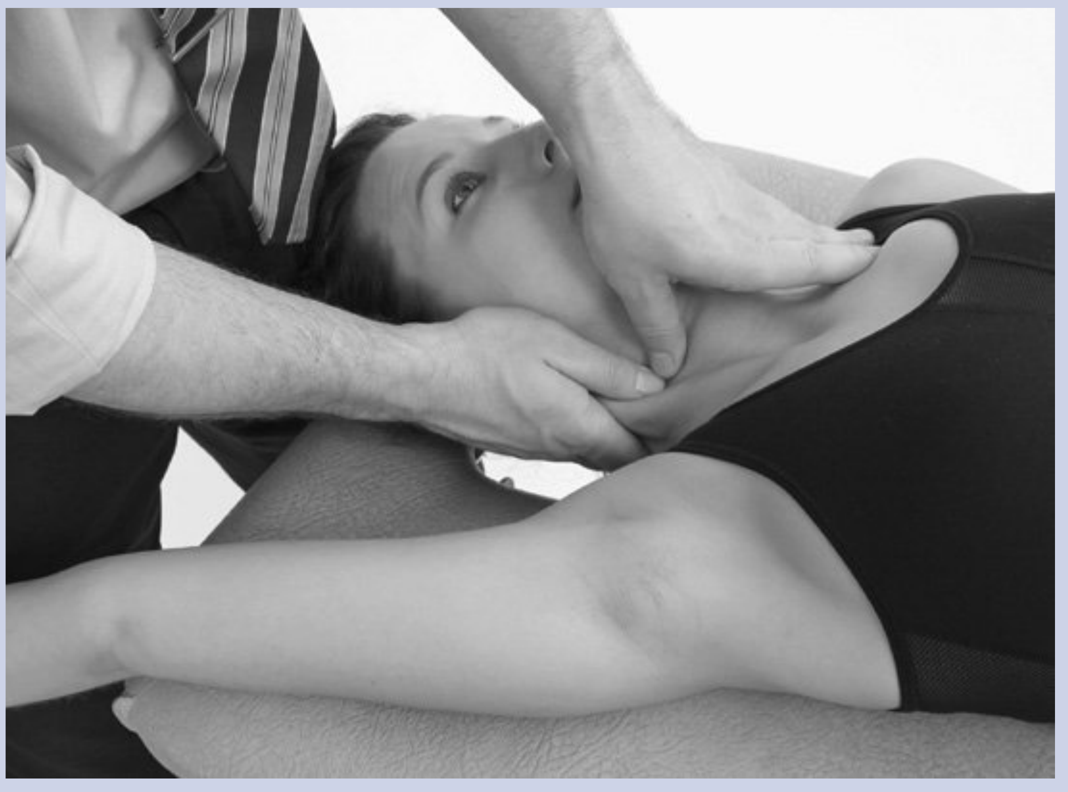


Figure 4.17 • Cervical anteroposterior accessory mobilization in cervical neutral in right shoulder elevation.

Case study 4.2—cont'd

improvements made in the cervical spine, the right shoulder restored full range to active elevation and abduction with overpressure. The hand behind back movement improved to the mid-lumbar region, but then failed to make any further improvement.

Further assessment of upper limb neural provocation test with a radial nerve bias (ULNPT 2b) revealed impairment to the range of movement in comparison to the unaffected left side. Range of movement was impaired by the onset of right lateral upper arm pain (comparable to Mrs R's reported pain location [2] which was reduced with structural differentiation of neural tissue (consistent reduction of lateral upper arm pain when moving the wrist from flexion to a neutral position in the ULNPT 2b position).

As other obvious impairments to neural interface sites in the upper quadrant were not identified, a gentle neural tissue gliding technique was applied. Reassessment of the impaired hand-behind-back movement demonstrated improvement in range. Continued treatment addressing this impairment over three consequent treatment sessions (increasing dosage as symptoms and signs allowed) led to restoration of hand behind back to the mid-thoracic region. At this stage Mrs R was happy with the outcome having made a full return to her previously limited functional tasks. She was placed on a review list. Her symptoms remained resolved two months later and she was able to sleep undisturbed and continued to be able to undertake her daily life without shoulder discomfort.

Comment

This case serves to demonstrate the importance of performing an in-depth and thorough assessment of the spine in patients with shoulder disorders. As advocated by Maitland et al. (2005) 'involvement of the cervicothoracic spine intervertebral motion segments should be considered in *all* disorders of the shoulder. Actual or potential movement impairment in these regions of the spine can contribute mechanically to the ranges of movement available in the shoulder, as well as physiologically to pain perceived in the shoulder but referred from cervicothoracic spine structures. Disorder of the cervicothoracic spine often results in movement restriction of the shoulder due to the presence of neurophysiological reflex arc. Mechanical irritation of the cervical or thoracic sympathetic ganglia may enhance sensitivity of nerves, resulting in further aching and heaviness in the shoulder and arm' (Butler 2000).

Interestingly, McClatchie et al. (2009) have also recently demonstrated significant reductions in shoulder pain and painful arc following cervical spine passive mobilization in a randomized, blinded, placebo-controlled, crossover trial of 21 patients. Similarly to the patient in this case study, the subjects in the study by McClatchie et al. had an absence of neck pain, no limitation to cervical movements and had previously been unresponsive to previous physiotherapy sessions 'addressing shoulder pain through "traditional" methods of movement patterns, strengthening and modalities such as ultrasound and cryotherapy'. McClatchie et al. (2009) summarize that their findings 'lends credence to the argument that the cervical spine might still be involved in shoulder pain in the absence of any objective cervical limitations or symptom reproduction'. Further support to this contention is provided by Haddick (2007) who demonstrated significant improvements in SPADI score (shoulder pain and disability index) – an outcome measure with both pain and disability domains which has been demonstrated to possess satisfactory validity, reliability and responsiveness for clinical use) from 83% to 1.5% over a five-week course of physiotherapy. Treatment addressed identified impairments to cervical spine accessory motion and mechanosensitivity of neural tissue that were clinically reasoned and thought to be contributory to the patient's symptoms of shoulder pain and pain-restricted limitations to shoulder movement. Interestingly again in this case, the impairments identified on accessory motion testing in the cervical spine (stiffness) did not directly reproduce the patient's shoulder pain. This lends further support to the need to search for all identifiable impairments, particularly with spinal accessory motion testing, to assess their effect on a patient's shoulder signs and symptoms.

Moreover, the case also demonstrates the usefulness of several of the principles of the Maitland Concept (some of which are listed below) to ESPs in musculoskeletal practice who perform a triage role such as undertaken in an orthopaedic CATS. The quotes are taken from the previous editions of *Maitland's Vertebral Manipulation* and *Maitland's Peripheral Manipulation* and appeared in sections detailing the principles inherent in the Maitland Concept:

- 'knowing the principles of differentiation tests and the methods of performing them';
- 'making use of the patient's functional movements, with which he/she can demonstrate his/her disability or disorder';
- 'the aim of examining movements to find one or more comparable "signs" of an appropriate structure or structures';
- 'the depth and detail of palpation examination of soft tissues and accessory movements';
- 'clinical proof of whether treatment is working or not is achieved by continually comparing the effects of the selected treatment forms on the patient's signs and symptoms';
- 'flawless analytical assessment' – the keystone to the concept – and 'validation-proving each step in the clinical situation'.

Establishing the medical diagnosis of the shoulder disorder

A diagnostic dilemma

Many of the pertinent issues including the controversies, limitations and difficulties relating to the *medical diagnosis* of shoulder conditions have been discussed in the preceding sections and as such require evaluation and integration into practice by the ESP undertaking the diagnostic task (see Figure 4.14). The medical diagnosis and management of conditions affecting the shoulder complex has been reported to be 'one of the most challenging areas of musculoskeletal medicine' (Robb et al. 2009a) because:

- Individual common shoulder pathologies vary widely in their clinical presentations
- It is common for various shoulder pathologies to coexist concurrently
- A high prevalence of structural pathology identified on imaging modalities has been identified in the asymptomatic population which means there is a significant chance of misrepresentation of a patient's problem should imaging modalities not be used judiciously
- Physical tests developed which aim to differentially diagnose pathologies of the shoulder, in general, at this stage, have been shown to have a poor ability to do so
- Studies have demonstrated, in the vast majority of cases, unsatisfactory reproducibility of a number of proposed shoulder classification systems
- There appears to be a lack of consensus on the diagnostic criteria which constitute a specific subclassification/diagnostic label.

Considerations relating to medical shoulder diagnosis in primary care

Studies have demonstrated that the vast majority of shoulder disorders are managed in the primary care setting. In the United Kingdom, Linsell et al. (2006) reported a prevalence rate of 2.36% of people who consulted their GP with regard to a shoulder problem in the year 2000 in their sample (15,534/658,469 patients). Of these patients 9215 incident cases were followed up over a three-year period. At the end of this three-year period 2061 (22.4%) cases had been referred onwards from the GP for further care. Of these only 6% of cases (n=554) were referred to an orthopaedic or rheumatology clinic. 1316 cases were managed by physiotherapists (14.2%). Similarly, van der Windt et al. (1996) reported a GP referral rate of only 10% to a shoulder specialist (consultant surgeon) in a Dutch study.

In recognition of the diagnostic challenges posed by the shoulder complex, simplified evidence-based classification systems have been proposed. Mitchell et al. (2005) contend that 'an overcomplicated approach to diagnosis is unlikely to alter early conservative management in primary care' and advocated that 'diagnosis should be pragmatic and based on clinical assessment'. This system is advocated and used in the UK by the Oxford Shoulder and Elbow clinic within primary care (Oakes 2009). In summary, Mitchell et al. (2005) recommended that patients are grouped into broad categories and provided with conservative treatment recommendations for each category based on best available evidence at that stage, essentially medication, steroid injections and physiotherapy. The broad classification groups were:

- Red flags (discussed on page 169)
- Rotator cuff disorders or impingement (ages 35–75)
- Glenohumeral disorders (adhesive capsulitis ages 40–65; osteoarthritis >60)
- Acromioclavicular disease (teenage to 50)
- Glenohumeral instability.

Unfortunately, at this stage, to the author's knowledge, there appears to be an absence of research studies examining the reliability and reproducibility of this classification system. It does, however, meet many of the recommendations made of proposed classification systems, most specifically with regard to its attempted simplicity. It is also interesting to note the use of broad generic clinical diagnostic titles, recognizing the limited ability to establish a more specific biomedical diagnosis based on the use of clinical examination alone reflective of the current evidence. Further research needs to be undertaken to examine whether such a classification system possesses more acceptable levels of reproducibility than those others previously discussed in the section 'Diagnostic labels and shoulder conditions'. Recently an audit of the concordance of biomedical diagnosis between extended scope practitioners and orthopaedic consultants in a specialist shoulder clinic in the UK using similar broad diagnostic groups has been published (Oakes 2009). Results demonstrated a fully comparable diagnosis in 65% of cases and partially comparable diagnosis in 31% of cases (most of the variance appeared to be from those patients with a mixed clinical picture who received more than one diagnostic label). Audits such as these demonstrate that ESPs possess the ability to categorize patients with a similar ability to orthopaedic consultant surgeons.

As discussed, ESPs work across a wide variety of settings, including those who work in primary or secondary care interface services and as part of their extended role assume the responsibility for establishing a medical diagnosis on which treatment decisions are made. Patients typically are referred to interface services such as these at various stages in the duration of their musculoskeletal problems with varying levels of previous management.

As Mitchell et al. (2005) discuss, for those patients with a recent onset of shoulder problems, once screened for red flags (see page 169) and indications of serious structural problems which would require early specialist medical consultation (see page 170), investigations such as ultrasound and magnetic resonance imaging to increase the specificity of the medical diagnosis are rarely indicated. Mitchell et al. (2005) contend that, at this stage, patient management in a broad range of shoulder conditions is conservative and that surgical intervention is seldom required. Furthermore, the early use of imaging modalities may:

- Paradoxically increase the referral rates to orthopaedic surgeons given the high prevalence of structural pathology even in the asymptomatic population (Mitchell et al. 2005)
- Increase the chance for misrepresentation regarding the source of a patient's functional problems
- Prove detrimental to conservative management – for example the identification of a partial rotator cuff tear, which is commonly initially managed conservatively, may in the patient's mind focus their attention on the necessity for a surgical repair.

The diagnostic labels and classification approach proposed by Mitchell et al. (2005) is one example which could be utilized by the ESP in this role at this early stage in a patient's management, on which to base treatment decisions and communicate both with medical colleagues and physiotherapy colleagues.

In contrast to this approach in a recent editorial, Cook (2010) highlights the dominance and increasing reliance on imaging and orthopaedic special tests to inform decision making which has developed in musculoskeletal practice over the past several decades. Factors such as time constraints, technology improvements, recognition of the poor capacity of clinical testing to capture specific conditions, litigation potential, the 'intolerance for uncertainty' and the 'pursuit of certainty in diagnosis' are cited amongst some of the reasons for this developing trend (Cook 2010). The potential problems and limitations of the approach to assessment which is associated with a dependence upon imaging and special orthopaedic tests have been discussed in this chapter and section. The utility of the Maitland Concept, the demands of which include 'a positive personal commitment to understand what the person (patient) is enduring' and a mode of thinking which encourages the 'primacy of clinical evidence' to the ESP, (undertaking the diagnostic task on which decisions regarding prognosis and management are made) is extremely valuable.

Considerations relating to patients with persistent symptoms

As discussed, ESPs may assess and manage patients at many different stages in the duration of their musculoskeletal conditions. For those ESPs working in primary or secondary care interface services or specialist secondary care centres, a common presentation is the patient with a shoulder complaint which has proven, at that stage, resistant to initial conservative treatment measures which may have consisted of medication, activity modification, steroid injections and physiotherapy (Burbank et al. 2008ab).

Persistence of symptoms in shoulder conditions is not an uncommon finding. As previously discussed, current understanding of the pathoaetiology and pathophysiology of shoulder conditions is limited. Studies have indicated that only 50% of all new episodes of shoulder problems recover completely by six months with only a further 10% resolving completely at one year (Croft et al. 1996, van der Windt et al. 1996, Winters et al. 1999, Bot et al. 2005). Various studies have sought to identify factors that are associated with persistence of symptoms in shoulder conditions and include; long duration of symptoms at baseline (Reilingh et al. 2008, Kuijpers et al. 2006), high level of pain severity at baseline (Reilingh et al. 2008, Kuijpers et al. 2006), musculoskeletal pain elsewhere (Keijsers et al. 2010, Feleus et al. 2008), a recurrent complaint (Keijsers et al. 2010), low social support (Keijsers et al. 2010), older age (Keijsers et al. 2010), high body mass index (Keijsers et al. 2010), unemployment (Keijsers et al. 2010) and a variety of psychosocial factors (Keijsers et al. 2010, Relingh et al. 2008, Kuijpers et al. 2006, George et al. 2008).

Essentially at this stage in a patient's management the ESP who is performing the diagnostic role on which future management decisions are based is faced with a number of questions:

- Are there identifiable reasons to explain the persistence of the problem at this stage – physical and psychosocial?
- Has the conservative management undertaken thus far been appropriate and thorough based upon the clinical impression of the shoulder condition?
- Are there any indications for a further course of conservative treatment?
- Is the patient willing to consider the surgical option for their shoulder condition?
- Is the shoulder condition one which would be helped by surgery? The indications for surgery require a specific diagnosis and structural information, which is gained from both the clinical history and examination combined with findings from a variety of imaging modalities.

Psychosocial considerations

Psychosocial factors have been associated with and thought to influence pain perception and the development of chronic musculoskeletal pain, particularly spinal pain (Linton 2000). With specific regard to shoulder conditions a variety of recent research studies point toward a similar association. For example, Badcock et al. (2002) and Kuijpers et al. (2006) have demonstrated associations between general psychological distress and shoulder pain.

More specifically associations between catastrophizing and pain levels have been reported (Reilingh et al. 2008, George et al. 2008). Catastrophizing is considered an ineffective and maladaptive coping style in which the patient views the pain as overly destructive, possesses a pessimistic view of their prognosis and is associated with the psychological concepts of magnification and rumination (a repetitive and passive focus on the symptoms of distress, its causes and consequences) (George et al. 2008, Relingh et al. 2008). Catastrophizing forms part of the fear–avoidance psychological model which also consists of a) fear of pain, b) kinesiophobia (fear of movement) and c) anxiety. Reilingh et al. (2008) demonstrated that catastrophizing, next to intensity of pain at baseline, was the strongest predictor of change in pain intensity at six months in a sample of 587 patients who presented to their general practitioner in the Netherlands (high levels of catastrophizing led to only small reductions of pain at six months). George et al. (2008) reported that only catastrophizing had a positive association with persistence of pain (>4/10 visual analogue scale) at three to five months postoperatively in a sample of 58 patients who underwent shoulder surgery for rotator cuff tendinopathy (with or without a rotator cuff tear), adhesive capsulits or SLAP lesion. Such evidence supports the need for a biopsychosocial approach to the management of shoulder conditions and points towards the limitations of a purely biomedical approach to shoulder pain and dysfunction. Further work needs to be undertaken to establish such links in other populations, and whether developing and implementing treatment aimed at addressing such belief systems is beneficial in improving outcomes for shoulder pain sufferers.

Conservative management considerations

As physiotherapists, ESPs are aware of the model of practice on which the physiotherapy profession is based (as discussed in the section 'Shoulder conditions – a physiotherapy perspective'). ESPs are therefore able to provide a link between the medical profession and the physiotherapy profession, understanding the requirement for medical diagnosis, but also able to recognize the limitations associated with the broad diagnostic labels and the usefulness and applicability of an impairment-based approach, just as advocated by Maitland (1986). In essence, such an approach seeks to address modifiable physical and movement-based impairments thought to contribute to a patient's functional limitation and disabilities as opposed to treating hypothesized specific tissue-based pathology.

Case Study 4.3 aims to demonstrate the limitations of a physiotherapy approach to management which is based on a hypothesized medical diagnosis by a physiotherapist. In both cases, following a failure to respond to initial physiotherapy, patients were referred by their GP to a musculoskeletal interface service such as CATS. Assessments were

Case study 4.3

Demonstration of impairment-based treatment

History

A 41-year-old gentleman was referred to physiotherapy by his GP with the diagnosis of a 'left-sided rotator cuff problem'. Mr H was a fit and healthy fireman with no medical history and no current drug history. He began with left-sided shoulder pain two months prior to being assessed by a physiotherapist. The pain began insidiously, in the absence of any trauma, and was described as an intermittent deep dull ache on the anterior aspect of the left shoulder joint area (Fig. 4.18). The symptoms were only aggravated by overhead lifting, for example, when carrying ladders above his head. The pain was immediate with the overhead movement but also eased quickly after returning his arms to his side. All other activities were unaffected and he continued to exercise in a gym but had to avoid overhead lifts.

Examination

On physical examination he was noted to have mild atrophy in the supraspinous fossa and minor winging of the scapula. Cervical movements were full and asymptomatic. Forward elevation and abduction of the left shoulder were painful from 90° to the end of range. No further differentiation was performed. Resisted internal rotation was found to be symptomatic. Special orthopaedic tests were then performed and the empty can test was deemed to be positive. On palpation Mr H was tender over the anterior aspect of the glenohumeral joint and in the biceps groove.

Treatment

A hypothesis of supraspinatus tendinopathy/a tear(?) was made by the physiotherapist. Mr H was then taught an exercise programme of eccentric loading exercise in flexion and abduction from end of range to 90°, using a theraband. On his return a week later the patient reported no change and friction massage of the supraspinatus tendon was commenced. He was then taught self-friction massage. Again he returned a week later with no change to his problem, at which point the physiotherapist started to question his compliance with the exercises and self-treatment. Friction massage to supraspinatus was performed again and he was taught scapula-setting exercises. Mr H was reviewed again four weeks later and still had not improved. His physiotherapist queried a rotator cuff tear and whether physiotherapy was appropriate. As a result, Mr H was discharged back to his GP with a recommendation for him to be referred onto orthopaedics for an opinion as to whether any further interventions would be necessary.

Outcome

A month later he was examined by an ESP in primary care, who found joint signs with unilateral posteroanterior accessory movements in the mid-cervical spine on the left. In addition the shoulder quadrant was examined and was found to be symptomatic at the peak. Further physiotherapy was requested with advice to address the signs found. Over the next two months Mr H was treated eight times with mobilization techniques applied to the cervical spine and to the shoulder quadrant. He was then discharged fully functional.

Analysis

This case study serves to demonstrate a situation where treating a specific biomedical diagnosis made following physiotherapy assessment was detrimental to the patient's recovery.

The physical examination by the physiotherapist in this case appeared to be biased towards making a structural and pathology-based diagnosis using special orthopaedic tests to generate the hypotheses. This

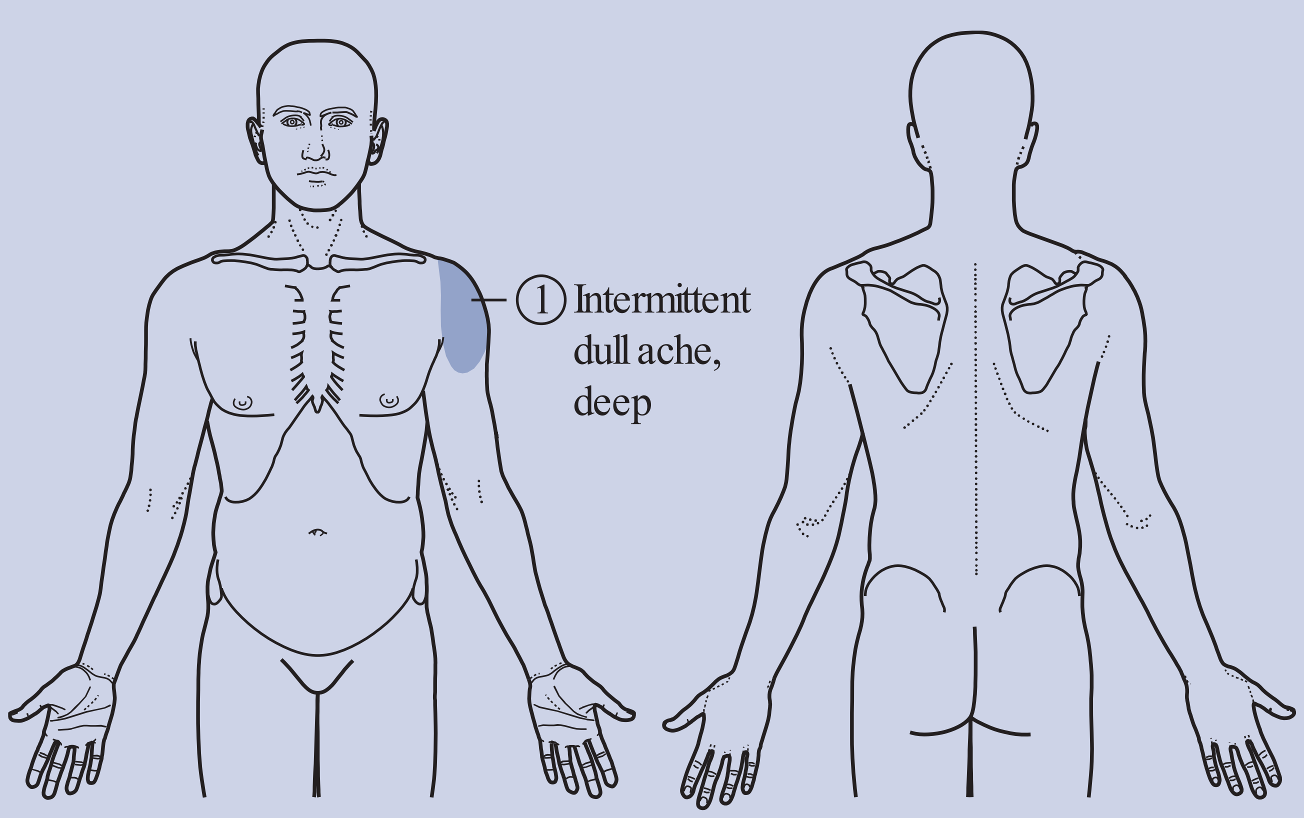


Figure 4.18 • Body chart of Mr H.

Case study 4.3—cont'd

medical diagnosis then formed the basis on which treatment was directed. There appear to be several clinical reasoning errors demonstrated in the initial physiotherapy management of this case worthy of note:

1. As discussed in the sections on differential medical diagnosis, special orthopaedic tests alone do not provide sufficient diagnostic accuracy to allow a medical diagnosis of rotator cuff tendinopathy. The treatment approach directed towards addressing this tissue-based diagnosis is therefore flawed.
2. Physiotherapy diagnosis as determined by the WCPT (2007) (see page 145) was not undertaken; this, therefore, limited recognition of the functional limitations of the patient and limited the search for associated physical impairments.
3. Initial treatment involved the use of eccentric exercise which has shown promise in the management of other tendinopathies, including Achilles, patellar and common forearm extensors (Woodely et al. 2007). Unfortunately, there is limited evidence of such an approach in the management of rotator cuff tendinopathy. In an uncontrolled pilot study Jonsson et al. (2006) reported five of nine patients with a clinical diagnosis of impingement had a satisfactory outcome at 12 and 52 weeks following treatment.
4. Although a physical impairment was identified (scapular dyskinesia), the effect with which this impairment contributed to the patient's functional limitations was not assessed within clinic (absence of analytical assessment [Maitland 1986]). It is interesting to note that following a further course of impairment-based treatment in physiotherapy the patient achieved a satisfactory outcome without the need to address the scapula dyskinesia directly.
5. During the patient's third treatment session the physiotherapist began to question the patient's compliance with the home exercise prescribed. Unfortunately, in the authors' experience, this is not an uncommon occurrence. It is worth noting at this point that, when considering communication, one of the fundamental principles of the Maitland Concept is to listen and believe the patient. In this case it was perhaps more comfortable for the physiotherapist to think that the patient was not being compliant than to believe the prescribed treatment was not being effective.
6. At the point of physiotherapy discharge following the initial course of treatment, the physiotherapist was still thinking and reasoning biomedically, in suspecting a rotator cuff tear to be the reason for the lack of improvement. The patient clearly had a functional impairment, which was only apparent on above-head activities. When examined by the ESP, using a functional impairment-based approach his symptoms were reproduced in the shoulder quadrant position. The ESP also found joint signs in the cervical spine, which were then mobilized with further treatment sessions. It is possible that these signs were the cause of the source or a barrier to recovery for the shoulder dysfunction. What is clear, however, is that when he was referred back to physiotherapy for an impairment-based approach his problem improved and he returned to function.

The shoulder quadrant – a brief appraisal

- The quadrant is a functional movement of the shoulder described by Maitland (in 1977 (and subsequent editions to 2005), and relevant to Mr H's symptoms, and is that position approximately 30° lateral to the fully flexed shoulder position where the arm has to move anteriorly and automatically rotate to achieve the fully flexed position.
- It can be used in both examination and treatment for minor limitations of shoulder movement. It is also useful as a screening test to implicate or rule out the shoulder as a source of arm pain and to restore the ideal functional shoulder range. It can also prove useful as a reassessment tool (Magarey & Jones 2005).
- The shoulder quadrant is not a diagnostic test, but Mullen et al. (1989) on examining four cadavers, identified the following structures as being compromised during examination of the quadrant:
  - contact between the humerus and the scapula, compression of the tendon of the long head of biceps at 120°–135°, the anteromedial part of the inferior surface of the acromion in contact with the humerus,
  - the coracoacromial ligament is stretched at 105°–135°,
  - The greater tuberosity (supraspinatus) is always impinged on the coracoacromial arch,
  - the coracoid process and the subscapularis area of the lesser tuberosity impinges at 120°–135° of abduction.
- When used as treatment technique to address movement impairment at the shoulder reasoned to be due to local symptom source, consideration is paid in particular to the severity and irritability of the individual patient's clinical presentation. Guidelines to help decision making regarding the amplitude and rhythm of the technique as it relates to different clinical presentations are detailed elsewhere, for example, in Chapter 6 of Hengeveld and Banks (2005).

Case study 4.3—cont'd

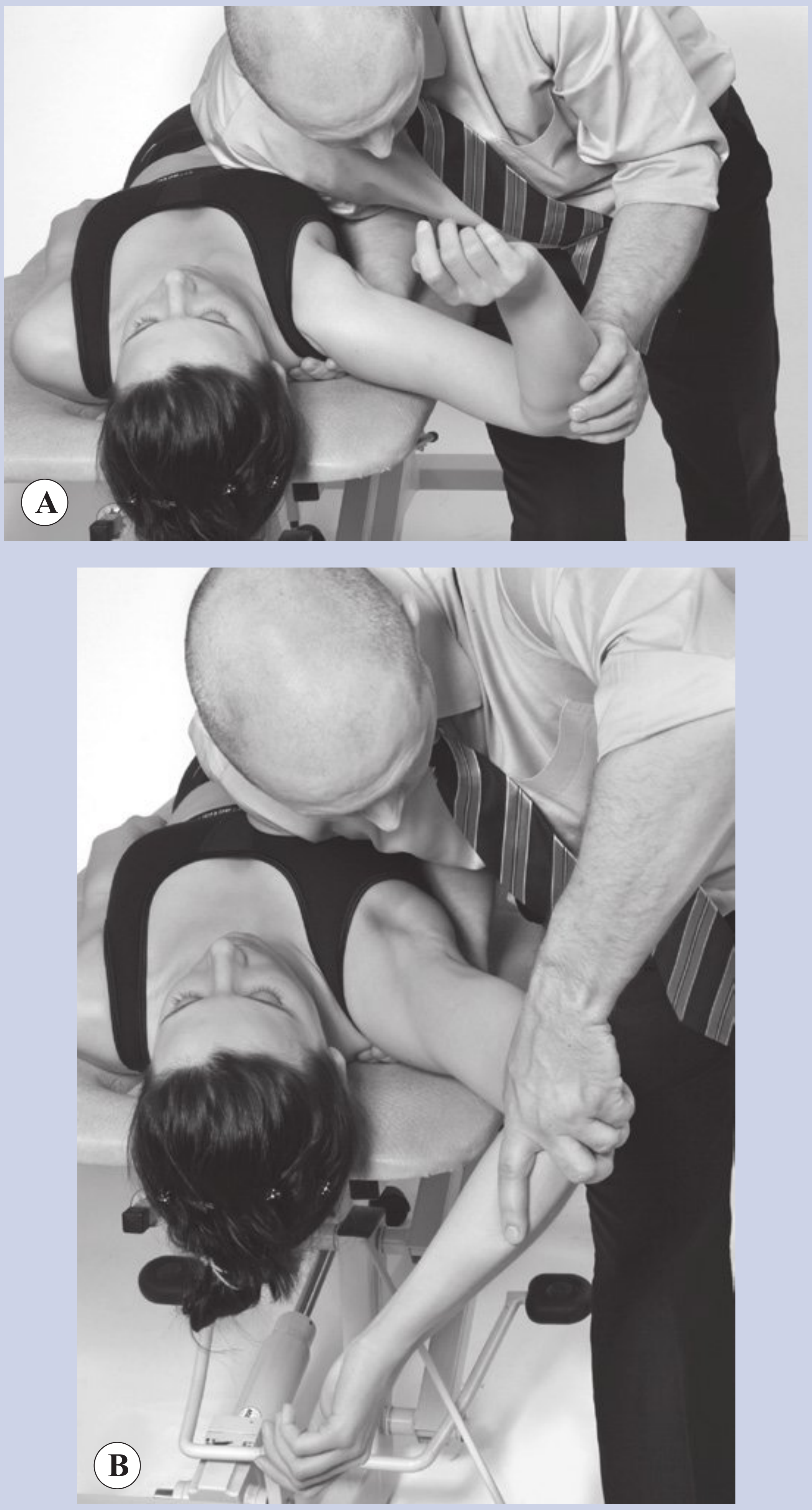


Figure 4.19 • A Mobilizations on the low side of the shoulder quadrant. B Mobilizations on the high side of the shoulder quadrant.

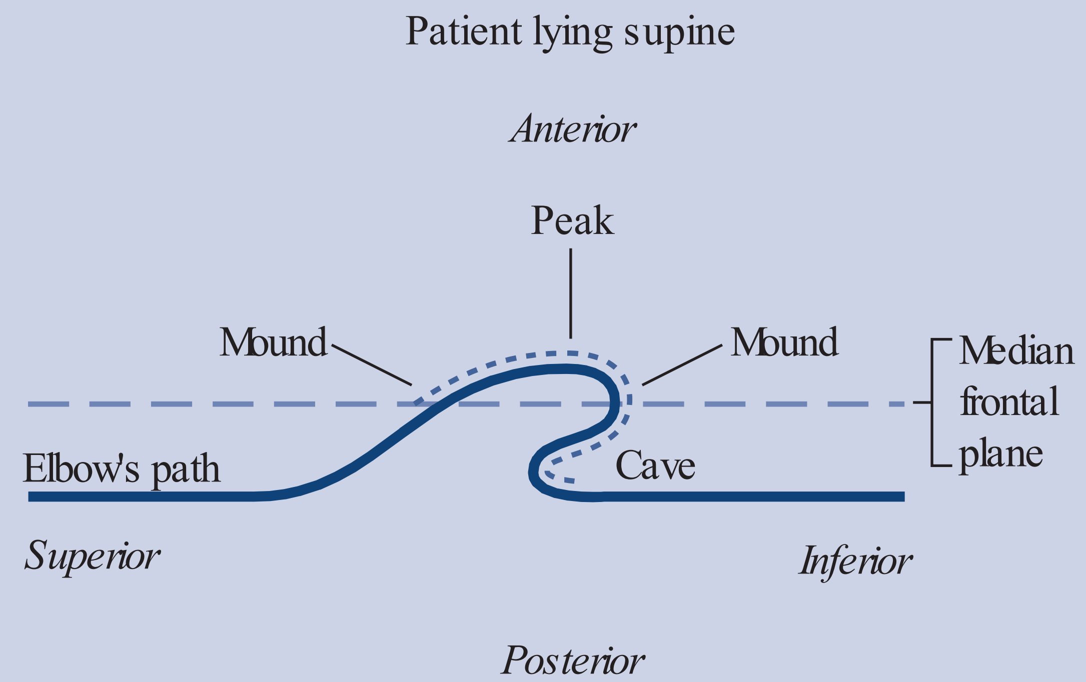


Figure 4.20 • Side-on view of the path of the right elbow as seen from the patient's right side looking horizontally towards the patient's left side. The path traverses a line into the 'cave' of the locking position, over the 'mound' of the quadrant passing the 'peak' of the quadrant.

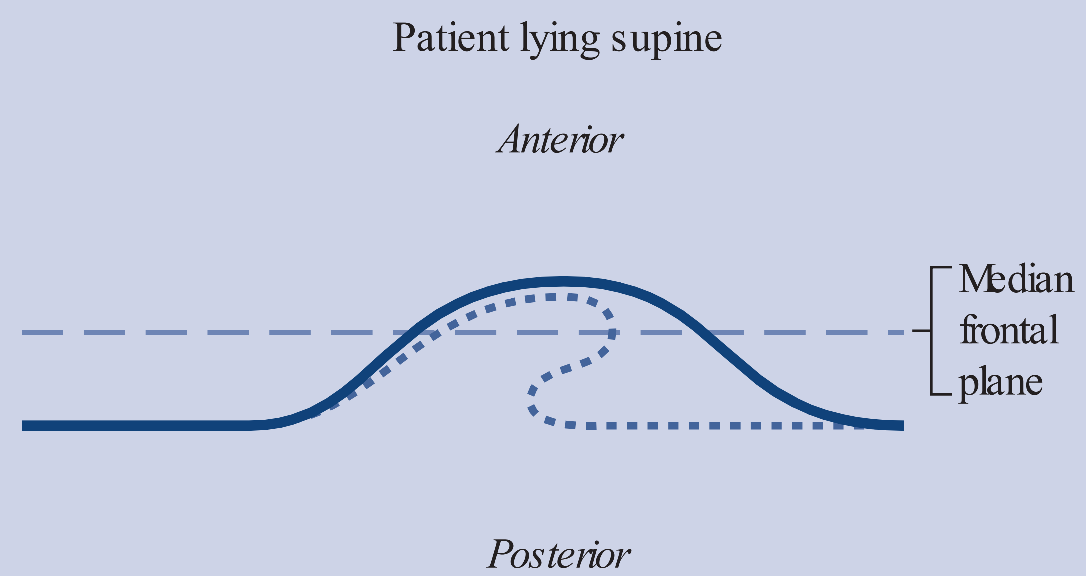


Figure 4.21 • Side-on view of the path of a patient's elbow when movements are restricted and the 'locking position' lost.

performed by ESPs who were consequently able to identify the presence of significant physical impairments that were hypothesized to contribute to the functional limitations of the individuals and which had not been previously addressed in physiotherapy. Satisfactory outcomes and a return to previously limited activities were achieved in both cases following a further course of physiotherapy directed to these specific physical impairments using principles inherent to the Maitland Concept, including 'analytical assessment', and 'clinical proof of whether treatment is working or not is achieved by continually comparing the effects of the selected treatment forms on the patient's signs and symptoms' (Maitland et al. 2005).

These examples serve to provide further evidence of the benefits of an impairment-based approach in physiotherapy as advocated by Maitland (1986). Further case reports by Haddick (2007) and Tate et al. (2010) lend further support to such an approach in the physiotherapy management of shoulder pain.

Surgical considerations

As discussed by Chaudhury et al. (2010) only a small proportion of patients with shoulder pain will require surgery. This opinion is supported in the light of evidence from work undertaken by Linsell et al. (2006) who demonstrated that of 15,534 patients who consulted their GP with regard to shoulder problems during the year 2000, only 554 (3.6%) were referred to either a orthopaedic or rheumatology clinic over a three-year follow-up period. Unfortunately, the design of the study did not report the conversion to surgery rates from these clinics.

Generally other than those conditions screened for with red flags (page 169) and those that require early medical attention (see page 170), the general indications for shoulder surgery include a failure to respond to conservative strategies over a three to six month period (Chaudhury et al. 2010). The indications for surgery are dependent upon a clear diagnosis and structural information, both of which are obtained from the patient's history, physical examination and findings from appropriate imaging modalities (Chaudhury et al. 2010). At this stage, a specific diagnosis (or as specific as possible) is required in order to inform decision making regarding a patient's suitability for surgery.

As previously discussed, ESPs may work in a variety of roles undertaking any number of a variety of tasks, traditionally undertaken by other professions (CSP 2008, Syme 2009). One such role undertaken by ESPs is the ability to refer patients to an orthopaedic consultant, or work on their behalf in identifying those patients who may benefit from the surgical option for their given shoulder condition. Case study 4.4 serves to demonstrate one example of a patient's journey to shoulder surgery. It is beyond the scope and not the intention of this chapter to detail and discuss all the surgical considerations relating to the shoulder; however, a brief

Case study 4.4

ESP assessment of a patient with persistent shoulder pain and dysfunction

A 33-year-old gentleman was referred to an orthopaedic primary or secondary care interface service (CATS) by his GP and was assessed by an ESP.

History

Mr A presented with an eight-month history of right shoulder pain and loss of function following an accident sustained at work. He worked as a car tyre and exhaust fitter in a garage and recalled pulling forcefully on a lever with his right arm in an attempt to replace a tight-fitting tyre onto a wheel. Mr A reported a sudden onset of severe anterior shoulder pain and a 'tearing' sensation deep within his right shoulder joint (Fig. 4.22). He reported ongoing problems with the shoulder from this time.

His problems at the initial assessment were reported as: 1. a deep-seated aching sensation within the anterior and lateral aspect of the shoulder; 2. an intermittent sensation of neck pain and stiffness on the right side, which had been present over the preceding one-month period; 3. difficulty and pain when attempting to elevate his arm above shoulder height; 4. pain and weakness when trying to lift, pull or push using the right arm. Consequently, he reported himself as 'struggling' at work although he had not taken any absence. On discussion it became evident that he felt something was wrong or loose deep inside his shoulder.

Case study 4.4—cont'd

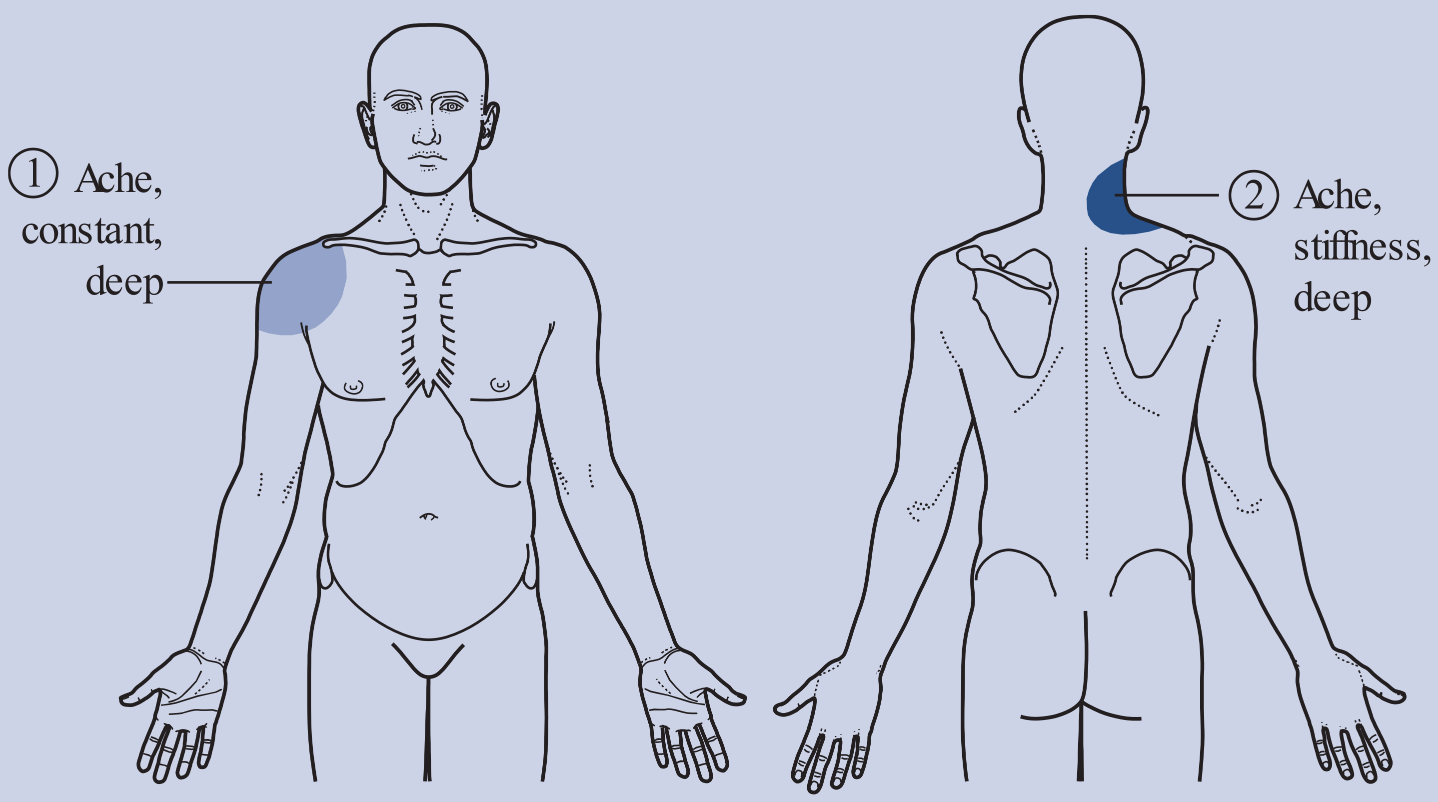


Figure 4.22 • Body chart of Mr A.

Mr A had undergone conservative management by the time of his initial assessment in the interface clinic. This had consisted of two steroid injections provided by his GP, two and three months after the onset of the problem and latterly a three-month course of physiotherapy. Mr A reported that neither injection had offered any relief of his pain. The anatomical site of the injection was not able to be established. The course of physiotherapy had also failed to ease his pain or improve his function. A shoulder X-ray arranged by his GP was reported as normal. His general health was good, and there were no other coexistent musculoskeletal problems. He had no history of previous shoulder problems.

Examination

Observation revealed a slightly depressed right shoulder girdle, rounded shoulders and a forward head posture. Shoulder active elevation and abduction were painfully limited at approximately 160°, with increased pain through range from around 60°. Passively with care near full range of elevation and abduction was achievable with pain through range. Through both active and passive range Mr A inconsistently reported a clicking sensation from within his shoulder. Lateral rotation range was well maintained and similar to the non-affected side. Abnormal scapula motion on the affected side (scapula dyskinesis) was clearly evident through active range of movement of the shoulder most notably when returning the arm to the side from elevation and abduction with prominence of the medial border. Strength testing of the rotator cuff revealed strong contractions of both medial and lateral rotation, with mild pain produced on lateral rotation maximal contraction. Glenohumeral accessory movements were painfully restricted. Glenohumeral and acromiohumeral joint compression were pain provocative. Cervical spine active range of movement was restricted most notably in right rotation, and right side flexion producing pain in the right mid- and lower cervical spine region with mild pain produced towards the right scapula. A neurological examination of the upper limbs was unremarkable. Special orthopaedic tests were undertaken. Positive results were associated with a number of impingement and SLAP tests.

Analysis

The pain in the region of the shoulder that Mr A was experiencing was causing him significant functional problems. He expressed concern that he had 'torn something' at the time of the injury and was frustrated that he had made little progress in (conservative) treatment thus far. He was keen to have a medical diagnosis and was prepared to undergo surgery should it be necessary to help his problem. The clinical picture was mixed, with many physical impairments evident. Considered within the differential medical diagnoses were: intra-articular glenohumeral disorder – SLAP, glenohumeral instability, acromiohumeral source – 'impingement' as a non-specific label with no evidence of a significant rotator cuff tear, capsuloligamentous tear, biceps tendinopathy, long thoracic nerve lesion or brachial plexopathy, concurrent and separate mechanical neck pain.

The patient consented to further investigation by the ESP in an attempt to improve the specificity of the diagnosis and upon which to base further management decisions. A nerve conduction study was arranged to exclude a brachial plexopathy or long thoracic nerve lesion. A MR arthrogram was arranged in consultation with an orthopaedic shoulder surgeon to assess for a possible SLAP lesion.

Case study 4.4—cont'd

Outcome

The results from the nerve conduction study were normal and revealed no electrophysiological evidence for a brachial plexopathy or long thoracic nerve lesion. The MR arthrogram reported 'SLAP lesion with involvement of the anterior superior labrum. No rotator cuff tear seen. ACJ degeneration with inferior osteophytosis'.

Based on the results of the history, physical examination, imaging, failure to respond to conservative management and willingness to undergo surgery, Mr A was referred via the primary or secondary care interface service to a specialist orthopaedic consultant shoulder surgeon. At arthroscopy a SLAP lesion was confirmed and arthroscopic SLAP repair was consequently performed without complication. The patient underwent postoperative rehabilitation in physiotherapy addressing physical impairments within the boundaries of tissue healing. Mr A made a return to full normal duties at work by week 16.

Comment

This case study serves as an example to demonstrate a situation where a specific medical diagnosis was required on which to base further decisions regarding a patient's management, a role traditionally undertaken by the medical profession, but now increasingly being performed by extended scope physiotherapists. It demonstrates the mixed clinical picture often associated with a SLAP lesion (detailed in Table 4.13) and the requirement to possess a broad and deep knowledge base of pathology, differential diagnoses and the consequent management required of ESPs in such a role (Syme 2009).

Moreover, it also serves to demonstrate the usefulness of a further fundamental component and principle of the Maitland Concept, that is the body's *inherent capability and capacity to inform*, part of the *patient-centred approach* to management that Maitland advocated. Maitland (1986) recognized that 'the patient's body can tell him things related to his disorder which we can never detect through objective examination'. Such a principle appears particularly relevant to this case, when acknowledging the current state of science indicating the lack of accuracy that clinical examination tests possess in differentially diagnosing pathologies at the shoulder. The patient's descriptions clearly indicated the possibility of a structural lesion within the shoulder joint, which he felt would not be able to improve with time or conservative treatment. Such a principle is an essential component of a clinician's practice whether the physiotherapist is performing a traditional role or extended role, providing 'vital information about his disorder, which is very important to assessment, treatment and prognosis' (Maitland 1986).

summary of some of the more common procedures for the most common shoulder conditions is included in Tables 4.8–4.15.

Summaries of the most common shoulder disorders – a biomedical perspective with implications for ESP and traditional physiotherapy practice

This section provides, in a table format (Tables 4.8–4.15), summaries of the main pathological conditions which affect the shoulder and shoulder girdle complex. Brief summaries of the current state of understanding of the pathology, aetiology, the typical presentations and associated medical management are included. In addition, and more specifically, the tables include comments that are directed at physiotherapists performing a traditional physiotherapy role as to the implications to consider for each of the shoulder conditions. The section 'Shoulder conditions – a physiotherapy perspective' further discusses how to integrate this knowledge into traditional physiotherapy practice.

The tables are not exhaustive but cover some of the more common conditions that may encountered in clinic and include:

- Rotator cuff lesions
- Shoulder impingement
- Calcifying (calcific) tendinits
- Frozen shoulder
- Glenohumeral osteoarthritis
- Glenoid labrum SLAP lesions
- Shoulder instability
- Acromioclavicular lesions.

Text continued on p. 213

Shoulder conditions – a physiotherapy perspective

An overview

As discussed in previous sections of this chapter, physiotherapy practice and the model of care on which the profession is based contrasts significantly with the biomedical model of healthcare. Whereas the biomedical model and framework of thinking is concerned with identifying pathology and diagnostic labels to specify a disease on which decisions are made regarding examination and treatment, physiotherapy practice is concerned with the identification of impairments which contribute to a patients functional limitations and possible disabilities with the aim of maximizing movement potential and quality of life. Readers are asked to revisit the second section of this chapter on diagnostic considerations (page 144) and Figure 4.1, in particular, to review the World Confederation of Physical Therapy (WCPT 2007) position statement with regard to its description of the physiotherapy profession and stance on physiotherapy diagnosis.

The limitations of an approach in physiotherapy management of shoulder conditions based solely on proposed tissue pathology identified using skills within the scope of physiotherapy practice, namely clinical examination, has been discussed in detail in previous sections in this chapter. Readers are asked to review Case study 4.3 in particular in this regard. Furthermore, the high prevalence of tissue pathology in asymptomatic individuals particularly relating to rotator cuff disorders, considered to be the leading cause of shoulder pain and dysfunction and labral lesions, also highlights the potential flaws should physiotherapy management only be based on the results of investigations arranged by a physician or ESP.

In contrast, physiotherapy practice and patient management is based upon addressing modifiable individual physical impairments which are clinically reasoned to be responsible and explain an individual's functional limitations. A recent study, using a Delphi approach of expert clinicians' clinical reasoning strategies in assessing and managing shoulder pain, demonstrates the primacy given to movement impairments, based on history and signs and symptoms established during the clinical examination as opposed to specific structural diagnoses using special orthopaedic tests in 26 expert therapists supporting this stance (May et al. 2008). Impairments may be present as the direct result of a pathological process or conversely, as discussed in greater detail by Sahrmann (2002) and other authors, may actually lead to tissue pathology. In cases where physical impairments are not modifiable, physiotherapists work with patients in a collaborative process to establish strategies to compensate, thereby maximizing their quality of life, movement potential and functional ability.

Physiotherapy diagnosis and shoulder conditions

Relating to shoulder conditions, diagnostic titles such as subacromial bursitis, rotator cuff tear, bicipital tendonitis, supraspinatus tendinosis, calcific tendonitis, glenohumeral osteoarthritis, labral tear, suprascapular neuropathy are examples of medical diagnoses which imply pathoanatomical lesions as the cause of a patient's disability. As discussed, clinical examination alone, utilizing a variety of orthopaedic special tests, does not appear to possess satisfactory diagnostic accuracy, and thus supplementary investigation such as X-ray, diagnostic ultrasound, MRI, magnetic resonance arthroscopy are used to aid the specific structural diagnosis to allow these diagnostic terms to be utilized. As diagnostic radiological investigation lies outside the scope of traditional physiotherapy practice, diagnostic labels such as these should not be established by physiotherapists. The limitations, difficulties and implications of specific medical diagnoses of shoulder conditions for physiotherapy practice have been previously discussed. Furthermore, the complexities associated with establishing a specific structural diagnosis in the shoulder, brings with it the potential for misrepresentation of the source of a patient's disability. This evidence appears to support the previous contentions of Maitland and other authors including Sahrmann (1988) that 'the medical diagnosis is not a sufficient diagnosis to direct physical therapy' (Sahrmann 1988).

Physiotherapy diagnosis is considered by the WCPT as a professional responsibility of physiotherapists and is described as:

> The result of a process of clinical reasoning which results in the identification of existing or potential impairments, functional limitations and abilities or disabilities …

> The purpose of the diagnosis is to guide physical therapists in determining the prognosis and most appropriate intervention strategies for patients or clients and in sharing information with them' …
>
> This may be expressed in terms of movement dysfunction or may encompass categories of impairments, activity limitations, participatory restrictions, environmental influences or abilities/disabilities.
>
> WCPT (2007)

Physiotherapy diagnosis and the ICF

In 2003, the WCPT supported the implementation and integration of the International Classification of Functioning, Disability and Health (ICF) within the physiotherapy practice. The ICF was developed in 2001 by the World Health Organization (WHO) to provide both a conceptual framework and a basis for classifying and describing human functioning and disability. The ICF captures the interaction of body structure and function (impairments) with activities (limitations) and participation (restrictions) within the contextual factors of the person, the individual's environment and health condition. The ICF offers a number of potential benefits to physiotherapy practice. It:

- Provides a framework with which physiotherapists are able to better understand the experience of the individual and how their health condition impacts on their functioning and disability.
- Facilitates the identification of impairments which could be addressed by a physiotherapist within their scope of practice and sets them within the context of activity limitations and participation restrictions experienced by the individual.
- Assists in determining appropriate goals, the prioritization of treatment selection and prognostic reasoning.
- Provides a common international language which facilitates communication surrounding many aspects of patient care and avoids many of the controversies and limitations associated with the pathoanatomical labels relating to shoulder conditions discussed in this section.
- Fulfils the role and requirement of a physiotherapy diagnosis as described by the WCPT.
- Provides a comprehensive classification system of functioning.

It is interesting to note how this contemporary stance fits with the central core or theme to the Maitland Concept namely 'a positive personal commitment to understand what the person (patient) is enduring' (Maitland 1986). 'It is inclusive and places the patient and their main problems at the centre of everything the manipulative physiotherapist will do or say' (Hengeveld & Banks 2005). Furthermore, Maitland advocated 'an open-minded attitude to treatment techniques, being able to innovate freely, unhindered by theory; and to relate the techniques to functional disturbances' (Maitland 1986). This thinking promotes the individualization of treatment techniques to each patient as appropriate. Of further note at this point is that the early Maitland texts were never intended to be read as technique books. Rather the most important message lay in the underlying principles on which the techniques were based. It is easy to see principles such as 'a patient driven model', 'using the body's capacity to inform' and emphasizing the 'primacy of clinical evidence' within the model of care based upon the ICF framework. The utility of the ICF in physiotherapy clinical practice has been demonstrated in a series of case reports by Rundell et al. (2009) and Helgeson and Smith (2008) relating to acute and chronic low back pain and patellar dislocation respectively. Furthermore, ICF-based practice guidelines have been published relating to neck pain (Childs et al. 2008), hip pain (Cibulka et al. 2009) and heel pain (McPoil et al. 2008) as a reference to guide and facilitate patient management in these groups. Upcoming guidelines relating to shoulder conditions are believed to be being developed at the present time (Godges & Irrgang 2008). The practicalities, challenges and opportunities of integrating and applying the ICF into physiotherapy practice have been discussed by Escorpizo et al. (2010) in a perspective article. Clearly, there is a requirement for future research to investigate the application of the ICF to other body regions and conditions. Although the ICF provides a powerful conceptual framework to underpin physiotherapy practice and a means of classifying and coding human functioning, it does not replace nor detract from other models of practice such as evidence-based care or clinical reasoning models like those proposed by Edwards et al. (2004). Rundell et al. (2009) demonstrates how models such as these can be integrated with the ICF in clinical practice. A conceptual model by Hengeveld (1999) demonstrates the integration of a manual therapy specific taxonomy of movement impairment analysis with the ICF (Fig. 4.23).

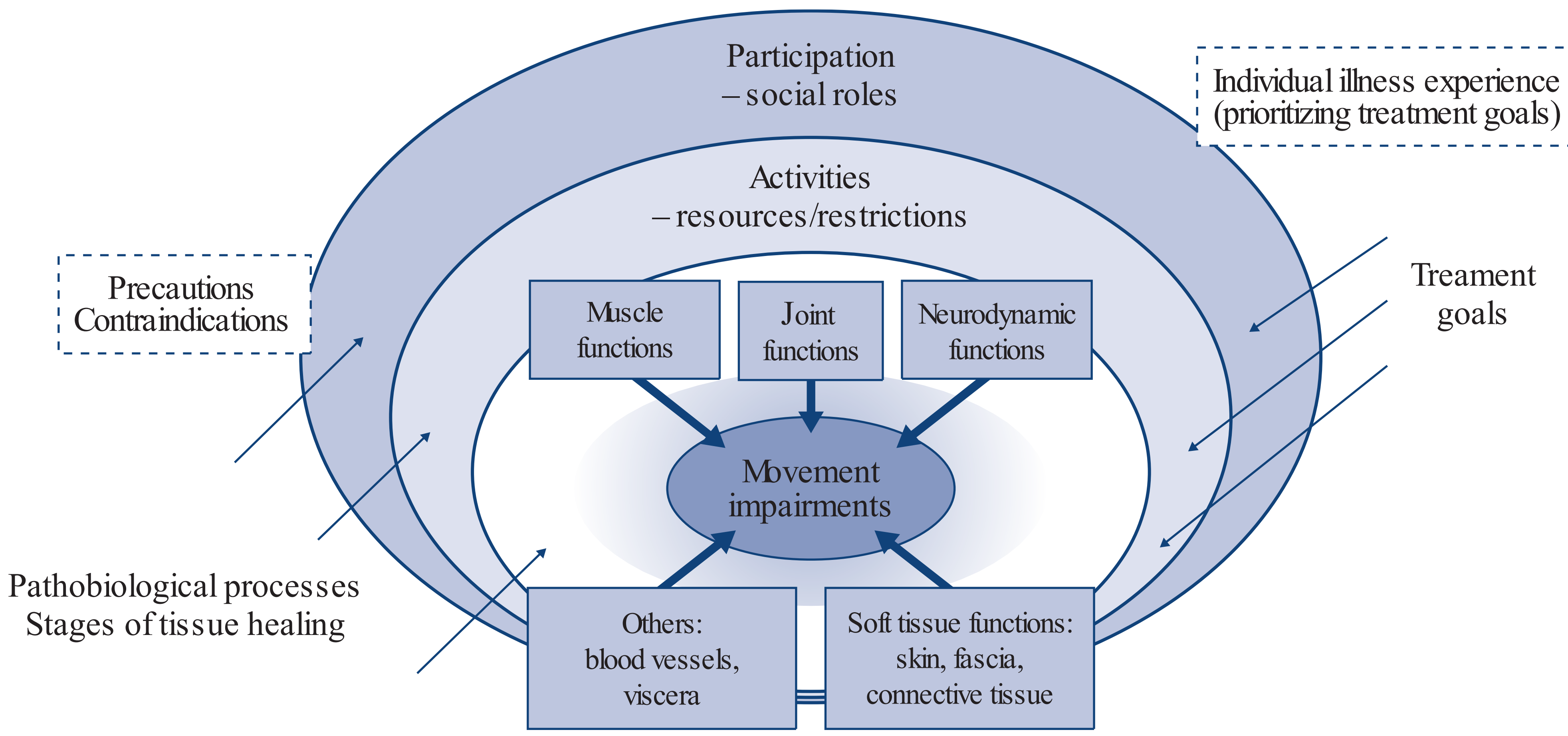


Figure 4.23 • Model of ICF with the integration of a manual therapy specifc taxonomy of impairment analysis. Adapted from Hengeveld 1999, with permission.

Physiotherapy diagnosis and shoulder conditions – the American Physical Therapy Association perspective

The disparity between the biomedical model of diagnosing tissue-based pathology and the physiotherapy model of assessing and treating impairments which contribute to an individual's functional limitations, was recognized by the American Physical Therapy Association (APTA) in the publication of their document – Guide to Physical Therapist Practice (the Guide) (APTA 1998). 'The Guide' sought to classify patients in 'preferred practice patterns'– diagnostic groups based on clusters of impairments as opposed to pathologies – in order to provide a framework for practice and on which clinical guidelines could be established that were within the scope of traditional physiotherapy practice. As such, patients with different pathologies and biomedical diagnoses may be classified within the same group. Conversely, patients with the same given biomedical diagnosis may be assigned to different groups. Tovin and Greenfield (2001) integrated this classification strategy, on which physiotherapy treatment is guided, to the principles of assessment and physiotherapeutic treatment of the shoulder identifying the 'preferred practice patterns' as:

- Impaired joint mobility, motor function, muscle performance and range of motion *associated with capsular restriction:*
  - the primary impairment in this category is limited shoulder movement, in a capsular pattern typically associated with either 1. structural changes in the shoulder in biomedical conditions such as frozen shoulder, arthritic conditions of the shoulder complex (i.e. osteoarthritis glenohumeral joint) or following immobilization post trauma, or 2. conditions with no associated structural changes in the shoulder complex where pain and protective muscle spasm restrict shoulder movement in a capsular pattern, for example, with acute inflammation within the shoulder complex or myofascial pain.
- Impaired joint mobility, motor function, muscle performance and range of motion *associated with ligament or connective tissue disorders (shoulder instability):*
  - primary impairment in this category is instability with secondary impairments, that is, poor neuromuscular control associated with a variety of possible underlying tissue pathology such as capsular and ligamentous laxity through trauma or hypermobility syndromes, glenoid labrum pathology, rotator cuff injury and bony (joint) geometry.
- Impaired joint mobility, motor function, muscle performance and range of motion *associated with localized inflammation:*
  - impairments of range of movement, motor function and muscle performance attributed to a protective tissue response due to

inflammation and pain are encompassed within this category. Biomedical diagnoses associated with this category include acromioclavicular, sternoclavicular sprain, rotator cuff tears, pathology of the glenoid labrum, tendonitis, bursitis, capsulitis or frozen shoulder (early stage), tenosynovitis and impingement.

- Referred pain syndromes: Impaired joint mobility, motor function, muscle performance and range of motion or reflex integrity *secondary to reflex sympathetic dystrophy, spinal disorders, thoracic outlet syndrome and peripheral nerve entrapments:*
  - impairments affecting tissues and structures in the upper quarter of the body which cause altered shoulder movement and/or pain are included within this category, associated with conditions such as cervical/thoracic dysfunction, adverse neural tension, thoracic outlet syndrome, sympathetic pain, myofascial pain syndromes and postural problems.
- Impaired joint mobility, motor function, muscle performance and range of motion *associated with fracture:*
  - primary impairments are the associated loss of range of movement of the shoulder complex and reduced muscle performance secondary to disuse.
- Impaired joint mobility, motor function, muscle performance and range of motion *associated with joint arthroplasty or surgical procedures:*
  - primary impairments include range of movement, motor function and muscle performance, the physiotherapeutic treatment of which must consider healing constraints.

It is interesting to review this contemporary stance held by the APTA detailing an approach to physiotherapeutic treatment of shoulder conditions (and other conditions) which is based on impairments and functional limitations, in respect of Maitland and the development of the Maitland concept which advocated just such an approach. A comparison to the clinical profiles detailed in the fourth edition of *Maitland's Peripheral Manipulation* (Hengeveld & Banks 2005) produces many similarities to this classification system. It is also worth noting that this contemporary stance can still sit nicely alongside Maitland's clinical grouping system. Maitland advocated classifying patient's symptoms and signs into recognizable groups for the purposes of selection and progression of mobilization or manipulation techniques. Maitland recognized that the individual groups should respond to appropriate mobilization/manipulation in a particular way, that is, group 1 – pain-dominated impairment, group 2 – stiffness-dominated impairment, group 3 – pain and stiffness-causing impairment and group 4 – momentary pain-causing impairment. Therefore, in a similar model to the APTA, patients with different structural pathology or medical diagnosis may be attributed to the same group. Patients with a given structural pathology or medical diagnosis may also be attributed to a different clinical group dependent upon the stage of the disorder. As an example, a patient with a medical diagnosis of subacromial impingement may present with signs or symptoms attributable to group 1 if there is an inflammatory component with their pain mechanism and therefore warrant very different physiotherapy treatment to a patient with the same medical diagnosis yet who has only momentary pain, for instance, when reaching into a particular position (group 4).

Other developments and considerations in the physiotherapeutic management of shoulder conditions

Physiotherapy diagnosis and the concept of non-specific shoulder pain and subgrouping classification

Given the difficulties associated with the diagnoses of subacromial impingement and rotator cuff tendinopathy, thought to be the principal cause of shoulder problems, alternative diagnostic terms such as 'mechanical shoulder pain' (Lewis 2007) or 'non-specific shoulder pain' have been proposed (Lewis 2009). Although such diagnostic labels clearly lie within the scope of practice of physiotherapy to utilize, these terms also fail to meet the requirement of a diagnosis as determined by the WCPT definition as they fail to 'guide physical therapists in determining the prognosis and most appropriate intervention strategies'(WCPT 2007). The issues surrounding the use of non-specific diagnostic categories have been well explored especially relating to low back pain (Fersum et al. 2010, O'Sullivan 2005). It is a widely held belief amongst primary care clinicians, including physiotherapists, that within the broad diagnostic category of non-specific low back pain (NSLBP), there may be several smaller subsets of homogenous groups which may respond to a particular intervention specific to that classification (Fersum et al. 2010). The search for such subgrouping classifications has become a research priority within low back pain. A similar belief appears to be present relating to shoulder conditions (Sahrmann 2002, Lewis 2009, Aina & May 2005, McKenzie & May 2000).

Although in its infancy there appear two discrete lines of scientific enquiry relating to the subclassification of patients with general shoulder pain within physiotherapy practice. Firstly, classification systems have been developed based on clinical experience and expertise, some of which are summarized below (Sahrmann 2002, Lewis 2009, McKenzie & May 2000). Such classification systems now require scientific evaluation relating to their reliability and validity and therefore clinical applicability. Secondly, treatment based-classification categories based on clinical presentation have shown promise in other body regions, for example the lumbar spine, through the development of clinical prediction rules (CPRs) (Stanton et al. 2010). There appear to be the early signs of similar developments relating to shoulder conditions (Hung et al. 2010), which are discussed in the section 'Physiotherapy diagnosis and the concept of clinical prediction rules'.

- Sahrmann (2002) proposes a classification system based on 'movement system impairments'. It is beyond the scope of this text to detail fully the concept and readers are directed to the companion text *Diagnosis and Treatment of Movement Impairment Syndromes* by Sahrmann (2002) for a full explanation. In summary, diagnostic categories are named according to alignment or movement impairments, which when corrected abolish the patient's symptoms, as opposed to the hypothesized pathoanatomical structural source (medical diagnosis). Assessment is therefore focused on identifying movements which reproduce pain as opposed to using special orthopaedic tests and imaging as used in the medical model. With regard to shoulder complaints, modifications to static posture, humeral and scapular movement impairments are made in an attempt to abolish the patient's symptoms. Modifications which consistently abolish the pain form the diagnostic label and basis for the treatment programme provided by the physiotherapist.
- Lewis (2009) has proposed a 'shoulder symptom modification procedure (SSMP)' model. Again a full explanation of the proposal is provided in the original article. In a similar model to that proposed by Sahrmann (2002) mechanical procedures are applied to the scapula, humerus or cervical/thoracic spine during a functional movement which most closely reproduces a patient's shoulder pain in an attempt to reduce the patient's pain. The procedure(s) which reduces the symptoms and/or increases movement then forms the basis for the treatment programme undertaken by the physiotherapist.
- McKenzie and May (2000) have proposed a classification system based on the application of mechanical diagnosis and therapy principles (which have been commonly applied to spinal conditions) to the peripheral joints including the shoulder complex. Classification categories of derangement, dysfunction and postural are based on a mechanical evaluation during which symptom response and mechanical response are evaluated (McKenzie & May 2000). Again, intervention is guided by the diagnostic category the individual patient is assigned to. Case studies by Aina and May (2005) and Littlewood and May (2007) demonstrate the utility of the approach.

Common to all these proposed classification systems, at this stage, is an absence of research relating to the reliability and validity of each of the classification categories. Validation of classification systems such as these has been described as a multistep process and recommended as a requirement prior to their widespread use in clinical practice (Dankaerts et al. 2006). Furthermore, the complexities associated with the development of diagnostic classification currently evolving in physiotherapy have been well documented by numerous authors including Zimny (2004) and Foster et al. (2011). Issues such as subjectivity, the lack of mutually exclusive and distinct, yet exhaustive, categories, the degree of specificity of the categories and the limited scope and unidimensional nature of classification systems such as those proposed by Sahrmann (2002) and McKenzie & May (2000) have all been highlighted as challenges facing researchers in the attempt at diagnostic classification within physiotherapy (O'Sullivan

2005, Zimny 2004, Foster et al. 2011). As Foster et al. (2011) summarize with regard to the subgrouping of low back pain 'the true picture is that no subgrouping approaches have yet passed the various tests for clinical value and robustness of evidence'. Furthermore, 'There is, as yet, a long way to go so be cautious of subgrouping approaches without robust evidence. The potential of this research to produce misleading results is high and attention to careful design issues is critical' (Foster et al. 2011). The classification of shoulder conditions is even more in its infancy than the work relating to low back pain, and such comments are as equally if not more applicable.

It is noteworthy, however, when reviewing these contemporary models of physiotherapy practice detailed above (Sahrmann 2002, Lewis 2009, McKenzie & May 2000), how closely associated the principles on which they are based are with the principles inherent to the Maitland Concept. In particular:

- The recognition paid to the difficulties, limitations and obstructions to patient management should physiotherapy treatment be directed by the medical diagnosis alone – a fundamental principle central to the Maitland concept discussed further in the section 'Diagnosis and the Maitland concept'.
- The use that the Maitland concept makes of patients' functional movements with which they are able to demonstrate their disability or disorder and/or provocation of pain (Maitland 1986).
- The importance paid to assessment; 'assessment has always been the keystone of this text, even during the writing of the first edition in 1964' (Maitland 1986). A logical and methodical process of assessing cause and effect are the demands of the Maitland concept whereby proof of whether treatment is working or not which is achieved by continually comparing the effects of the selected and progressed treatment techniques on the patients symptoms and signs (clinical proof).
- Flawless analytical assessment which is considered the keystone to the Maitland concept (Maitland 1986).

Physiotherapy diagnosis and the concept of clinical prediction rules

A second line of recent scientific enquiry within physiotherapy that has generated much interest, and a recent surge of research activity, relates to the ability to identify patients who respond best to a certain treatment. Indeed, with respect to shoulder problems, from a research perspective, it has been suggested that study of a broad heterogeneous population with 'general shoulder pain' may allow the identification of subsets of individuals with common characteristics which possess important treatment and prognostic implications (May et al. 2010, Schellingerhout et al. 2008).

Clinical prediction rules (CPRs) are designed to improve clinical decision making, and have been developed in establishing a diagnosis, prognosis and in matching individuals to a particular intervention. Recently within physiotherapy practice, clinical prediction rules have been developed, which aim to assist the clinical decision-making process with regard to treatment selection including as examples studies by Cleland et al. (2007), Currier et al. (2007), Flynn et al. (2002), Hicks et al. (2005), Vicenzino et al. (2010). Recently, Hung et al. (2010) have proposed a classification strategy for patients with a clinical diagnosis of 'subacromial impingement syndrome'. A prediction method based on three variables of scapular kinematics and impairment features was developed in order to predict improvement at six weeks following a standardized intervention regime including manual therapy, ROM exercise, stretching and strengthening exercise (Hung et al. 2010).

Although clinical prediction rules offer the potential to become a valuable clinical tool which influence decision making and improve outcomes in physiotherapy practice, particularly relating to treatment selection, it is important they are developed and fully validated prior to being applied clinically (Stanton et al. 2010, Childs & Cleland 2006). A full explanation of the validation proposal is provided by Childs & Cleland (2006) and Stanton et al. (2010). In a recent systematic review of 15 CPRs developed for assisting treatment selection in musculoskeletal conditions which have been developed to date, Stanton et al. (2010) urge caution with the clinical application of all but one CPR (spinal manipulation for low back pain) (Flynn et al. 2002, Childs et al. 2008, Cleland et al. 2007). Of the 15 CPRs studied only one had reached the validation stage (step II of III) with the other 14 CPRs at the derivation stage of development (step I of III). Numerous other methodological issues, particularly relating to the study design, support the contention that these published CPRs should not be used to predict treatment effects in clinical practice at this stage (Stanton et al. 2010). Nonetheless, with the appropriate rigorous methodological development, analysis and validation, CPRs offer the potential to assist the identification of subsets of patients who will respond to a given intervention strategy, thereby assisting in the clinical decision-making process of physiotherapists in relation to patient treatment.

Integration of the Maitland Concept into contemporary physiotherapy practice relating to shoulder conditions

Figure 4.24 demonstrates a triage process which may be used by physiotherapists when assessing an individual presenting with a shoulder disorder. Although it is not within the scope of physiotherapists to be medical diagnosticians they must possess the ability, equally as important as for ESPs, to recognize clinical presentations which require early medical attention. Details of the clinical presentation of such cases are discussed in the sections 'The importance of screening for red flags', 'Screening for conditions which require early medical attention', and 'Screening for extrinsic sources – analytical assessment and differentiation'.

Once the patient is screened for such presentations the focus of assessment aims to identify physical impairments which are the cause of or contribution to a patient's functional limitations and hypothesize where possible the underlying reasons for their presence. It is then the intervention, analytical assessment and meticulous reassessment of effect which drives further examination,

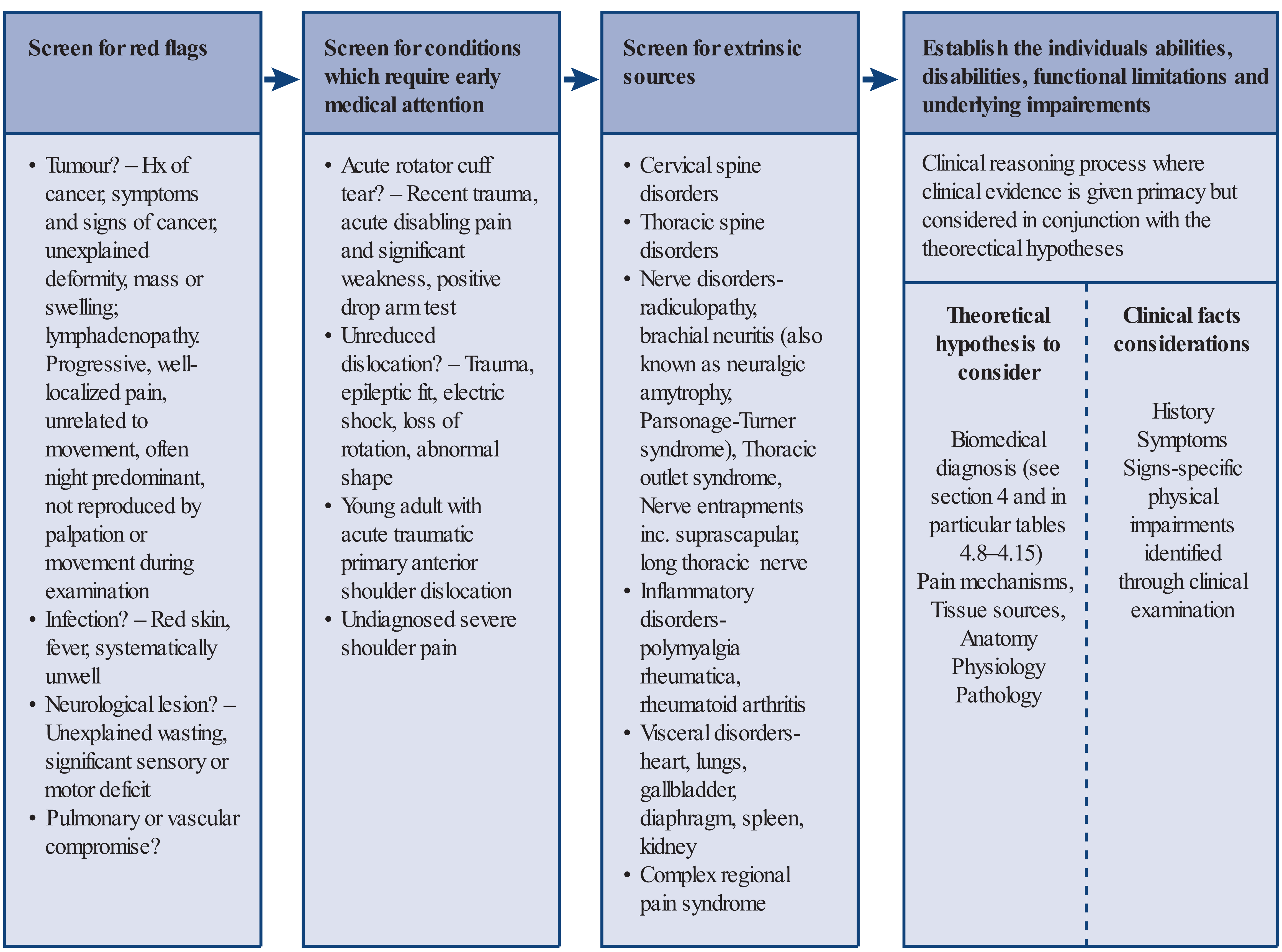


Figure 4.24 • Integrating the Maitland Concept into contemporary physiotherapy practice relating to shoulder conditions.

physiotherapy diagnosis and patient management (Maitland et al. 2005). Clinical reasoning models such as those proposed by Jones and Rivett (2004, p 4) provide a framework on which decisions regarding a patient's physiotherapy management and prognosis are based. Readers are encouraged to adopt such a patient-centred model of clinical reasoning to underpin their practice in combination with the use of hypotheses categories on which management decisions can be developed.

The utility of the Maitland Concept in the management of shoulder conditions appears as attractive today as when first developed particularly when considering the deficiencies of a pathologically based model, that scientific enquiry has discovered. Indeed, it is particularly interesting to consider recommendations in contemporary literature advocating conservative treatment of shoulder problems to be 'guided by the response to symptom modification' (Lewis 2009), 'signs and symptoms (Hughes et al. 2008) and 'based on symptom response' (May et al. 2008). It appears that ' the unique approach to clinical practice with the principles as worked out by Maitland more than four decades ago still seems applicable at the beginning of the twenty-first century' (Hengeveld & Banks 2005). We must continue to await further scientific enquiry and development especially with regard to the development of a categorization system to identify subgroups of patients with shoulder problems who may respond to a specific intervention.

The symbolic permeable brick wall

The unique mode of thinking advocated in the Maitland Concept, epitomized by the symbolic permeable brick wall remains an important cornerstone in physiotherapy practice. 'This thinking mode is not used in any other philosophy of manipulative therapy', which is a 'demand requirement' of the Maitland Concept and 'the security of the therapist whose primary concern should be the importance of the clinical compartment in the decision-making process'(Maitland 1991, Maitland et al. 2005) has been previously discussed specifically in the section 'Diagnosis and the Maitland Concept' earlier in this chapter. The requirement for the continued use of this mode of thinking by physiotherapists in contemporary practice is clear when considering the potential limitations and problems should physiotherapy treatment be directed by the biomedical diagnosis and diagnostic titles of shoulder conditions as has been previously discussed in the section 'The biomedical perspective' and throughout this chapter. Figure 4.24 illustrates the integration of the brick wall into the triage process, specifically with regard to the category concerned with establishing the individual's abilities, disabilities, functional limitations and underlying impairments relating to their shoulder problem. It must be remembered that the brick wall model can be applied equally to the first three categories concerned with screening the shoulder complex for signs of serious pathology, conditions which require early medical attention and have extrinsic sources.

Integrating evidence from Tables 4.8–4.15 into clinical physiotherapy practice using the brick wall model

The information relating to the biomedical diagnostic titles of some of the more common shoulder conditions presented in Tables 4.8–4.15 can be considered within the brick wall model. Figure 4.25 serves to illustrate this contention. Two clinical examples serve to highlight the benefits of such an approach.

1. Consider the patient referred to physiotherapy with a diagnosis of subacromial impingement. Tables 4.8 and 4.9 would help support the knowledge to form the left side of the brick wall (theory). With in-depth understanding of the concept of this condition physiotherapists are able to recognize the limitations of the diagnostic title and recall the vast array of possible underlying pathology and varying clinical presentations and impairments that may be associated with such a diagnostic title. In the words of Maitland:

   > It becomes apparent that if one is to base treatment on diagnosis alone, one must be aware of the real difficulties associated with making it precise and therefore meaningful.

   And:

   > 'it is not the diagnosis which indicates the kind of passive movement treatment required; it is the behaviour of the symptoms and signs during movement. This means that the symptoms and signs (the right compartment) combined with the knowledge of anatomy, biomechanics, pathology and the diagnosis (the left hand side of the compartments) guide the selection of initial treatment … such a plan avoids both the confusion caused by diagnostic titles calling to

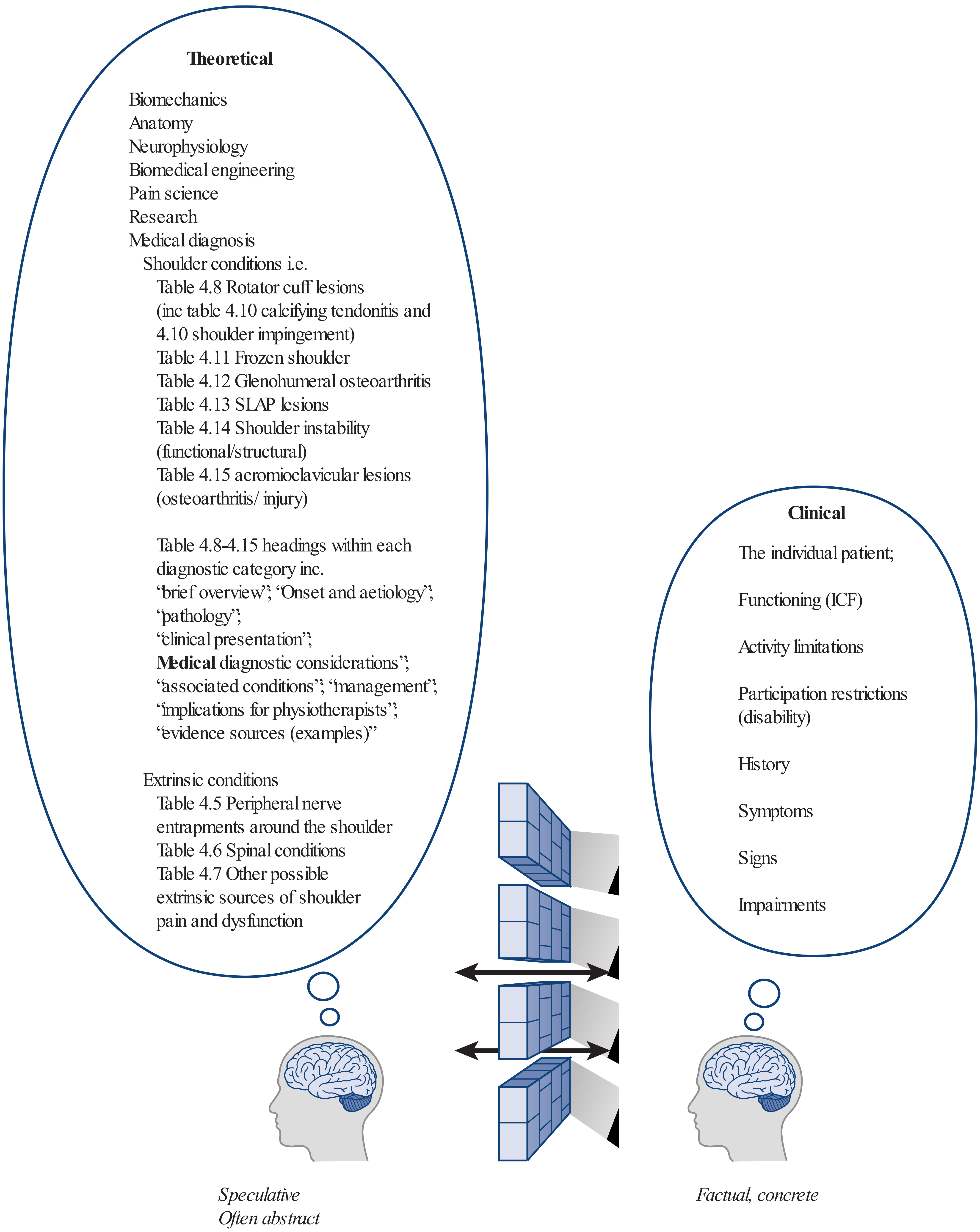


Figure 4.25 • An example of how the brick wall model can be used to integrate the evidence and knowledge presented in Tables 4.8–4.15 (which detail the most common conditions affecting the shoulder) into physiotherapy practice. The theoretical knowledge relating to the medical diagnoses of shoulder conditions forms the left side of the wall, with the clinical facts relating to the individual patient's case forming the right side of the wall.

> mind different symptoms to different people and the controversy over pathology.
>
> Maitland (1986)

2. Consider the patient presenting with shoulder pain and dysfunction where numerous physical impairments have been identified but have not been able to be modified with physiotherapy treatment, or following correction have not led to improvement in the patient's functional limitations. Knowledge of conditions which may prove less amenable to conservative treatment such as a SLAP lesion (Table 4.8) in a young, athletic individual, using Maitland's contention of 'making the features fit' would allow the physiotherapist to recognize such a clinical presentation. Referral for further biomedical diagnostic evaluation would therefore be able to be arranged in a timely manner.

Orthopaedic special tests – a reinterpretation and redefinition with respect to the Maitland Concept and the brick wall model

The orthopaedic special tests detailed and discussed in the section 'Diagnostic accuracy – a brief review' can also be considered within the two-compartment mode of thinking and be integrated into contemporary physiotherapy clinical decision making. As previously discussed and summarized in Table 4.1, in general, the orthopaedic special tests do not possess satisfactory diagnostic accuracy to establish a biomedical diagnosis. Nonetheless, during performance of these tests it is possible that the patient's comparable shoulder pain may be reproduced. Furthermore, the positions used in such special tests may relate to the patient's functional problems and hence allow the identification of movement impairments in the shoulder complex. This assists the physiotherapist in discovering the source and cause of the symptoms and facilitates the physiotherapist in their clinical decision making regarding the treatment of the individual in a way which addresses the movement impairment (and hence special tests) with the aim of improving the patient's associated functional limitation. The clinical information on the right side of the permeable brick wall can be used as physical examination asterisks for reassessment and/or as examination and treatment techniques from a movement analysis point of view. So, for example, the Hawkins–Kennedy test can be considered as an assessment of shoulder internal rotation in different positions of horizontal adduction and abduction. Considering the tests or movement procedures in this manner allows them to be integral to the Maitland Concept whereby they analyze movement rather than being diagnostic-specific. This approach also allows the 'orthopaedic special tests' to be utilized as treatment techniques for pain, stiffness or spasm in these functional positions and as examination of movement procedures. The Maitland Concept also emphasizes the prime importance of assessment and, indeed, when performing these techniques assessment during and after the treatment is essential to determine whether the procedure is beneficial to the patient and their functional limitation or not. If, for example, mobilization into medial and lateral rotation, under axial compression in elevation (the Crank test) aggravated the symptoms and did not produce any improvement in movement the treatment would be considered inappropriate.

Table 4.16 below demonstrates how examples of orthopaedic special tests can be interpreted from a movement impairment perspective as opposed to a medical diagnostic perspective utilizing the brick wall concept and consequently can be utilized within physiotherapy practice. Note how the theory of the orthopaedic special tests can be translated into clinical facts.

Physiotherapy examination, assessment and treatments of shoulder disorders

Box 4.2 provides a summary of the subjective examination of the shoulder and shoulder girdle complex. Boxes 4.3-4.9 (inclusive) provide a summary of the physical examination of each of the constituent components of the shoulder girdle complex. Information gathered from the subjective and physical examination serves to complete the right side of the brick wall and forms the basis on which physiotherapy management decisions are primarily based (the primacy of clinical evidence), in combination with information from the left side of the wall (Tables 4.8–4.15). The technical performance of physical examination (and treatment) techniques, including physiological and accessory mobilizations are demonstrated on the accompanying Maitland's website It is also worth recalling a pertinent quote from the fourth edition of *Maitland's*

Text continued on p. 232

Table 4.16 A reinterpretation of special orthopaedic tests with respect to the Maitland Concept and the brick wall model

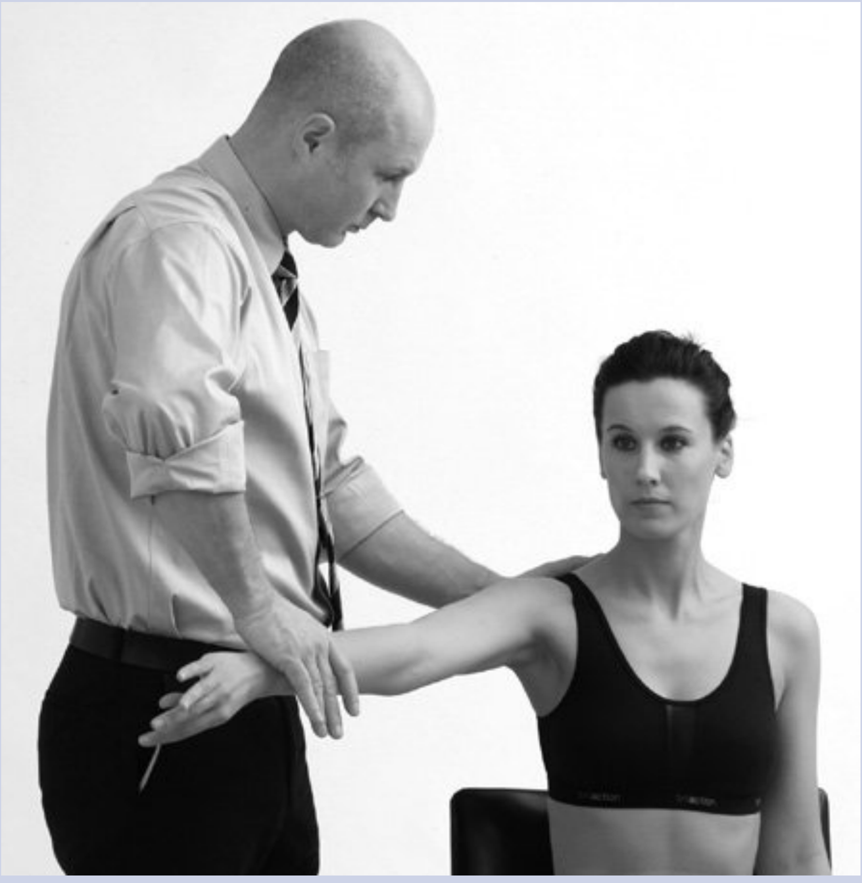
Theory (known, unknown, think we know)	Clinical (facts)
Pain or weakness on the empty can test may serve as a confrmatory test for impingement/supraspinatus tear. 	In 90° scapular elevation, resisted elevation internal rotation is painful and/or weak.
Painful Hawkins–Kennedy test maybe useful as a screening test for impingement or supraspinatus tendonitis. 	Internal rotation of the arm in 90° scapular elevation is painful.

Table 4.16 A reinterpretation of special orthopaedic tests with respect to the Maitland Concept and the brick wall model—cont'd

Weakness demonstrated by the Hornblower's test may be diagnostic of severe degeneration or absence of the teres minor muscle. 	Resisted external rotation of the arm in 90° scapular elevation and 90° elbow flexion is weak (pain inhibition?).
External rotation lag sign maybe diagnostic of an infraspinatus or rotator cuff muscle tear. 	With the elbow at 90° and the arm in 20° scapular elevation, external rotation is weak.

Table 4.16 A reinterpretation of special orthopaedic tests with respect to the Maitland Concept and the brick wall model—cont'd

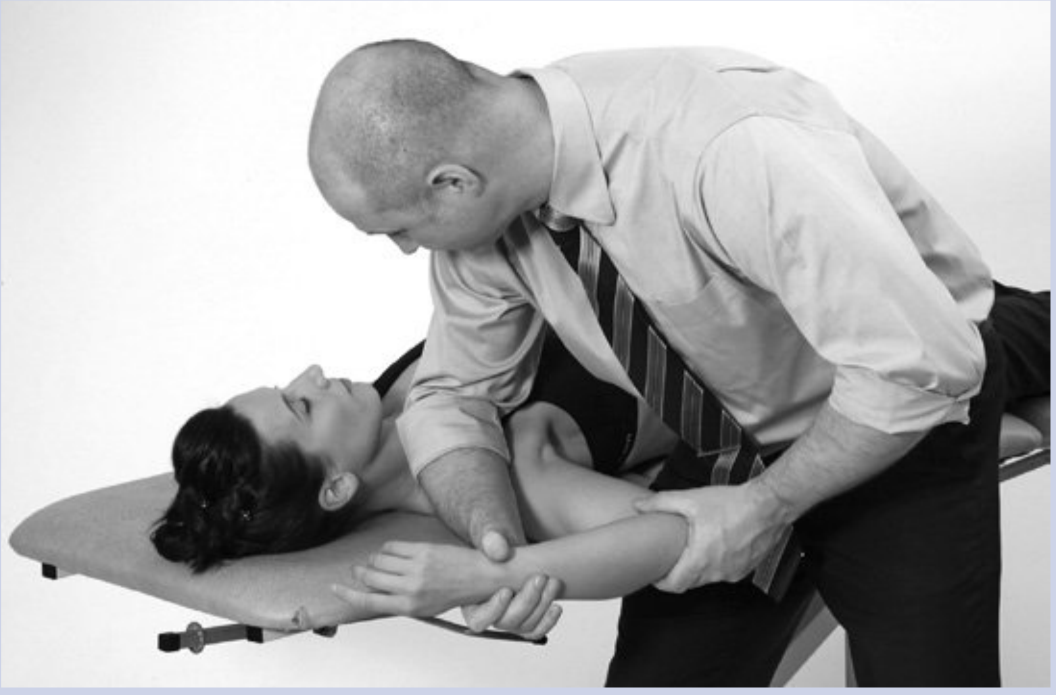
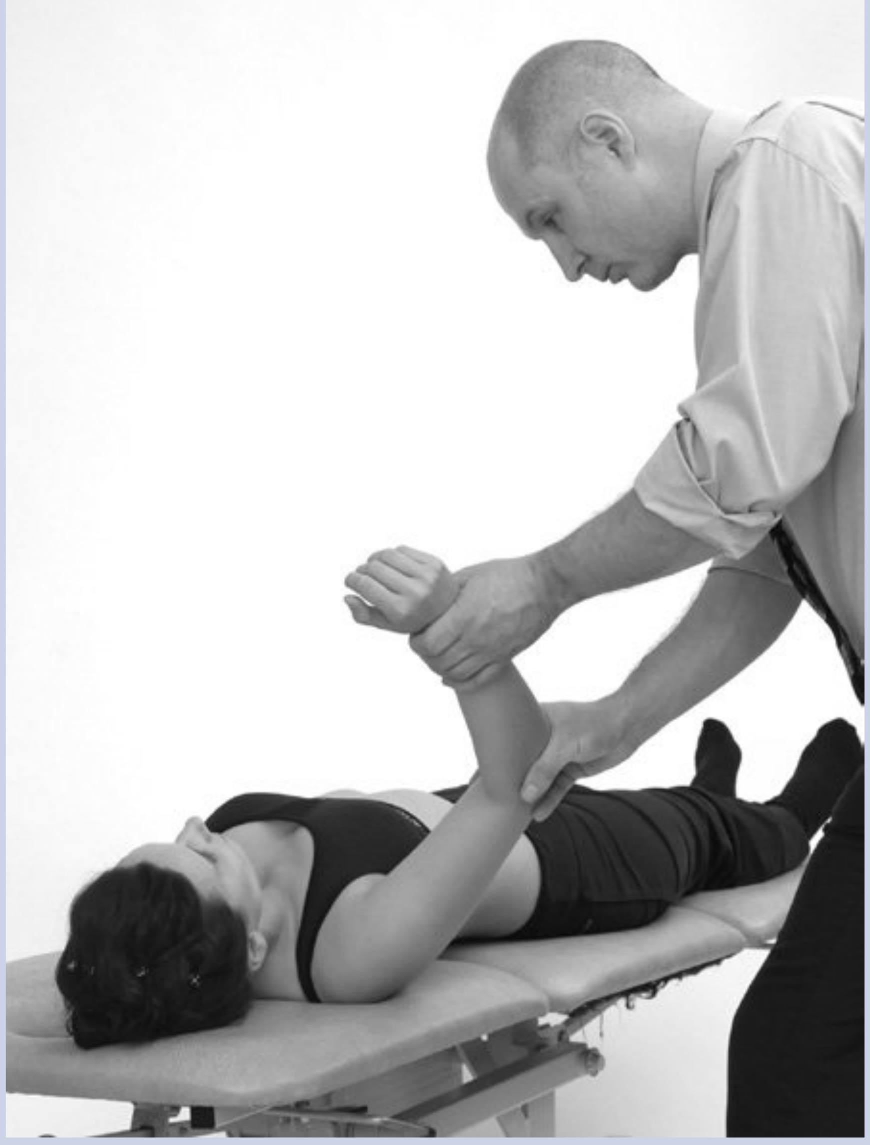
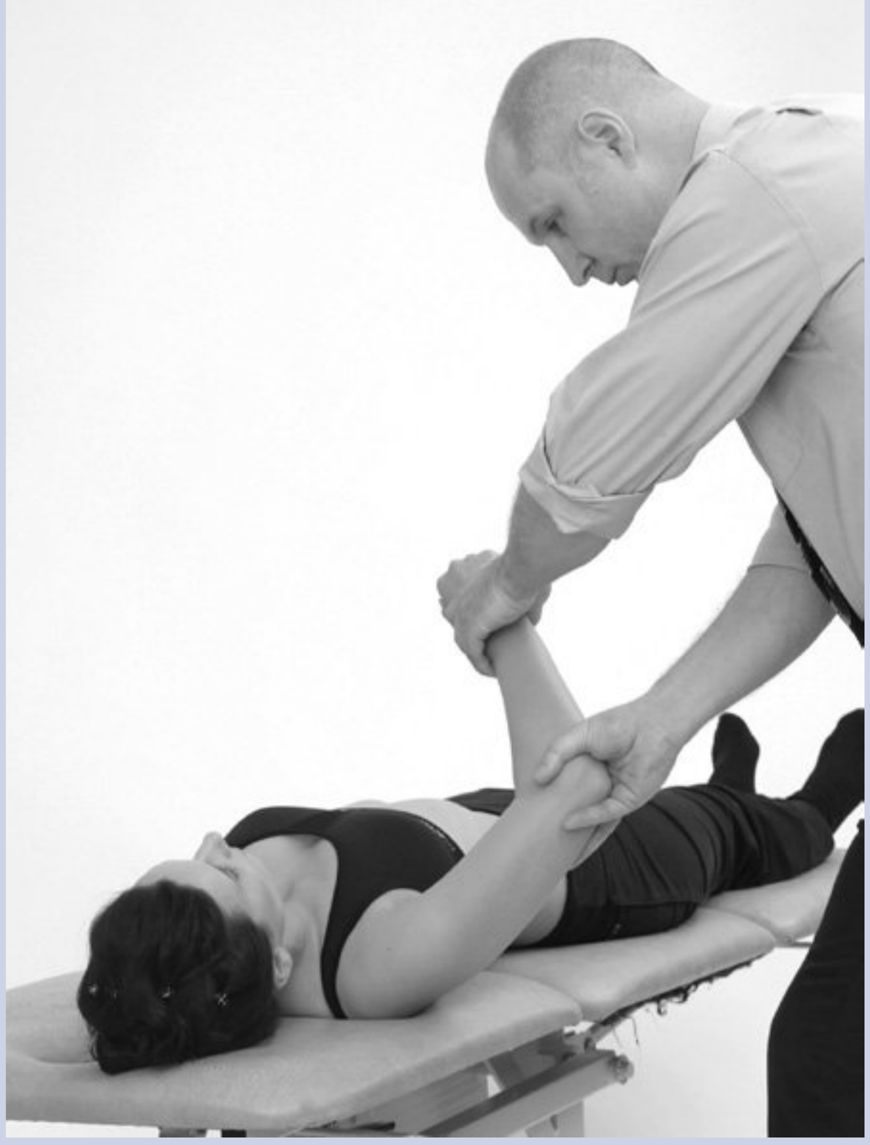
Belly press test may assist ruling in a subscapularis tear. 	Resisted internal rotation of the arm is weak.
Increased apprehension or symptom response with the Biceps load I and II tests may indicate a SLAP lesion. 	Resisted elbow flexion (in supination) in 90° and 120° abduction and full external rotation is pain provocative. 

Table 4.16 A reinterpretation of special orthopaedic tests with respect to the Maitland Concept and the brick wall model—cont'd

Pain, catching or clicking during the Crank test could indicate a labral lesion.	In elevation, internal and external rotation of the arm under axial compression is painful.
	
Deep pain or painful clicking during O'Brien's test could indicate a labral lesion.	In 90° frontal elevation, 15° horizontal adduction and full internal rotation, resisted elevation is painful.
	

Box 4.2

Subjective examination of the peripheral joints

The arrangement of the subjective examination is basically the same for all joints and is therefore only set out in detail for the glenohumeral joint.

'Kind' of disorder

- Start with first mandatory question ('Question 1')
- Establish why the patient has been referred for or sought treatment:
  a. pain, stiffness, giving way, instability, weakness, loss of function, etc.
  b. postsurgical, trauma, MUA, plaster, fracture, dislocation, etc.

History

1. Of this attack
2. Previous history
3. Socioeconomic history as applicable
4. Are the symptoms worsening or improving?
5. Any previous treatment? Effect?
6. Any contraindications?

Highlight main fndings with asterisks

Area

- Is the disorder one of pain, stiffness, instability, weakness?
- Record on the body chart:
  1. area and depth of symptoms indicating main areas and stating type of symptoms
  2. paraesthesia and anaesthesia
- Check associated areas:
  a. of vertebral column
  b. of joints 'above and below' the lesion
  c. other relevant joints

Behaviour of symptoms

1. When are they present or when do they vary? (constant, intermittent – frequency)
2. What provokes, what relieves?
3. Any pain at night? Need to get up because of it? Able to lie on it? (Is the night pain for mechanical reasons or inflammatory?)
4. On first rising c.f. end of day
5. Functional limitations (dominance of pain, stiffness, weakness, etc.)

Special questions

1. General health, relevant weight loss (medical history)
2. What tablets are being taken for this and other conditions? (steroids, painkillers, antiinflammatory drugs)

Planning the physical examination

'Planning the physical examination' is included as part of the total examination procedure as a teaching medium to encourage clear, methodical and purposeful thinking. It is the step taken, after the subjective examination, to formulate the requirements of the physical examination.

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Box 4.3

Physical examination of the composite shoulder

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

- F (spontaneous then sagittal)
- Ab (spontaneous then coronal)
- HF, HE

Box 4.3—cont'd

- Behind back (wrist mid-line)
- F and Ab in medial and lateral rotation

Isometric tests

- Cuff

Other structures in 'plan'

- Thoracic outlet
- Entrapment neuropathy
- ULNT

Passive movements

As indicated by site of pain and stiffness

Supine

1. G/H joint

   F, Ab, ↺, ↻, HF, HE or Q and locking position

   Arm-by-side, ↑, ↓, ←•→ caud and ceph, —•→ (gapping G/H joint)

   Arm abducted, ←•→ caud, ↑, ↓

   Arm in F/Q, ↓, ←•→ caud (and ceph)

2. A/C joint: squeeze, ↓, ↑, ←•→, caud and ceph, Rotn

   (repeat with compression)

3. S/C joint: as applicable ←•→ ceph and caud, ↓, ↑, Rotn, distraction and compression

   (repeat first five with compression)

4. Slump tests
5. Differentiation tests
6. ULNT

Prone

- Hand behind back, E, Ad, ↺
- Forehead resting in palms, G/H, ↓, ←•→, caud, cervical ↓ and ⌐↓ ↓⌐

Side lying

- Scapulothoracic: as applicable El, De, Protr, Retr, Rotn; as applicable add compression

Palpation

- \+ When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records, etc.
Highlight main fndings with asterisks
Instructions to patient

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Box 4.4

Glenohumeral joint – objective examination

What is sometimes referred to as an 'accessory joint', between the head of the humerus and the acromion process, forms part of the examination of the glenohumeral joint.

HIGHLIGHT MAIN FINDINGS WITH ASTERISKS AS YOU GO

Obervation

Watch for patient's willingness to move the arm when undressing.

Functional demonstration/tests

As applicable

1. *Their* demonstration of *their* functional movements affected by *their* disoder.
2. Differentiation of their demonstrated functional movement(s).

Brief appraisal

Note abnormalities of appearance, tenderness, temperature and fasciculation. Palpation may be performed here.

Active movements

Active quick tests (+ cervical).
Routinely (with all joints, always modified to suit 'kind of disorder').
F, Ab, (note 'drift'), behind back, HF
Note range, pain, repeated, and behaviour (note scapular rhythm)

As applicable
Speed of test movements
Specific movements which aggravate
The injuring movement
Movements under load

Box 4.4—cont'd

Thoracic outlet tests & ULTT
Muscle power
F & Abd in full medial & lateral rotation

Isometric tests

Rotator cuff
Other muscles in 'plan'

Other structures in 'plan'

Cervical spine
Joints 'above and below'
Thoracic outlet & ULNT

Passive movements

Physiological movements

Routinely

1. If pain severe ↓, ↔ Caudad, → lateral; (in neutral pain-free position).
2. F ↺, ↻, Ab, HF, HE, components of hand behind back and ↓ (if active tests positive) or
3. Quadrant and locking position (if active tests negative)

Note range, pain, resistance, spasm and behaviour.

As applicable

1. Canal's slump tests.
2. Differentiation tests.
3. ULNT (upper limb neural tests).

Accessory movements

As applicable

May be assessed at first session or as treatment progeresses:

1. By thumb pressures or arm leverage ↓, ↑, caud and ceph, ↔, laterally:
   (a) In different positions in the range.
   (b) With addition of compression and/or distraction.
2. Mid range Ab/Ad, Rotn, and F/E oscillations:
   (a) With glenohumeral compression.
   (b) With acromiohumeral compression.
3. 1st rib.

Note range, pain, resistance, spasm and behaviour.

Palpation

Temperature
Relevant tenderness (capsule, tendons, bursae, muscles)
Swelling, Wasting Altered sensation
Position
When 'comparable signs' ill – defined reassess 'injuring movement'.

Check case records and radiographs

Instructions to patients

1. Warning of possible exacerbation.
2. Request to record details.
3. Instruction re 'joint care' if required.

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Box 4.5

Physical examination of the acromiohumeral joint

The routine examination of the acromiohumeral (A/H) joint must include examination of the acromioclavicular joint and the glenohumeral joint.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Isometric tests

Differentiation tests (supine)

- Differentiating A/H joint:

1. from rotator cuff

   It is A/H if:

   a. isometric 30° Ab reproduces symptoms
   b. there is no pain with oscillatory Ab at 30° if A/H joint is distracted caudad
2. *from G/H joint* – oscillatory Ab (from 20° to 40°):

   It is A/H if:

   a. painful when A/H surfaces compressed and moved
   b. painless when A/H distracted caudad and moved
   c. painless when G/H compressed and A/H distracted during movement.

Box 4.5—cont'd

3. from A/C joint

   It is A/H if:

   a. HF, −ve

   b. ↕ clavicular head −ve

Other structures in 'plan'

- Thoracic outlet

Passive movements (supine)

- Test movements 1–3 below should:
  a. reproduce the symptoms when the humerus is compressed against the interior surface of the acromion process, compared with
  b. being painless when the head of the humerus is distracted caudad from the acromion process.

1. Oscillatory Ab (from 20° to 50°)
2. Oscillatory F/E, in slight Ab (from 0° to 30°)
3. Oscillatory Rotn, in slight Ab (30° arc in mid-range)

   c. ←•→ caud on acromion or clavicular head:

- reproduce pain when A/H surfaces compressed (A/C movement nil)
- are painless when A/H surfaces distracted while A/C movement is produced

As applicable

1. Slump tests
2. Differentiation tests
3. ULNT

Palpation

- As previously
- + When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 4.6

Physical examination of the acromioclavicular joint

When examining the acromioclavicular joint (A/C), the G/H, A/H and S/Th movements must be examined.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to *pain* or move to *limit*)

Routinely

1. G/H F, Ab, behind back, HF and HE
2. Scapular elevation, depression, protraction, retraction and rotation

Note range, pain, repeated (note scapular rhythm)

As applicable

- Speed of tests movements
- Specific movements which aggravate
- The injuring movement
- Movements under load

Isometric tests

- Rotator cuff
- Other muscles in 'plan'

Other structures in 'plan'

- Thoracic outlet

Box 4.6—cont'd

Passive movements

Physiological movements

Routinely

1. G/H F, Ab, ↺, ↻, HF and HE or Q and locking position
2. Scapular elevation, depression, protraction, retraction and rotation

   Note range, pain, resistance, spasm and behaviour

Accessory movements

Routinely

1. By thumb pressure ↑, ↓, ↔ ceph and caud
   a. over acromion
   b. over clavicle
   c. on the joint line
   d. repeat with joint compressed
2. Squeeze clavicle and scapula
3. Rotation at S/C and A/C joints
   a. transverse axis
   b. vertical axis (by scapular protraction/retraction)
4. As for G/H joint
5. Slump tests
6. Differentiation tests
7. ULNT

Palpation

- + When 'comparable signs' ill-defined, reassess 'injuring movement'

  Check case records etc.

  Highlight main fndings with asterisks

  Instructions to patient

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Box 4.7

Physical examination of the sternoclavicular joint

When examining the sternoclavicular (S/C) joint the A/C joint (including relevant G/H, A/H and S/Th movements) must also be examined.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

1. G/H F, HF and HE
2. Scapular elevation, depression, protraction, retraction and rotation

   Note range, pain and repeated

Isometric tests

Other structures in 'plan'

- Thoracic outlet

Passive movements

Physiological movement

Routinely

1. Supine: G/H, HF, HE and F
2. Side lying: scapular elevation, depression, protraction, retraction and rotation

   Note range, pain, resistance, spasm and behaviour

Accessory movement

Rroutinely

- By thumb pressures on clavicle ↑, ↓, ↔, caud and ceph, rotation, distraction and compression

  Note range, pain, resistance, spasm and behaviour

  As applicable

- Add compression (medial and caud) to above
- ULNT

Palpation

- + When 'comparable signs' ill-defined, reassess 'injuring movement'

  Check case records etc.

  Highlight main fndings with asterisks

  Instructions to patient

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Box 4.8

Physical examination of scapulothoracic movement

When examining scapulothoracic disorders the glenohumeral (G/H) joint must also be examined.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

1. G/H F, Ab, behind back, HF
2. Scapular elevation, depression, protraction and retraction

Note range, pain and scapular rhythm

As applicable

- Speed of tests movements
- Specific movements which aggravate
- The injuring movement
- Movements under load
- Muscle power

Isometric tests

- Rotator cuff
- Other muscles in 'plan'

Other structures in 'plan'

- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

1. G/H movements
2. Side lying: scapular elevation, depression, protraction, retraction and rotation (add compression as applicable)

Note range, pain, resistance, spasm and behaviour

As applicable

1. Slump tests
2. Differentiation tests
3. ULNT

Accessory movements

Routinely

1. Intercostal movements
2. Lifting scapula off thorax

Note range, pain, resistance, spasm and behaviour

Palpation

- + When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Peripheral Manipulation when considering issues relating to the physiotherapy examination of shoulder disorders:

> The ultimate aim of dealing with musculoskeletal disorders is to fully restore the patient's pain-free active functional movement. The initial aim of physical examination therefore is to identify the active functional movements which are not full and pain free (Fig. 4.26). Passive movements tested both through the available range and at the limit of the available range and which are found to be impaired by pain, stiffness or protective spasm can then form the basis of treatment techniques. This should include mobilization of joints, lengthening of contracted or fibrosed muscle and restoration of ideal neurodynamics.
>
> Hengeveld & Banks 2005

Demonstration through case studies

The case studies that follow serve to demonstrate the physiotherapy management of a broad range of presentations of patients with shoulder pain and dysfunction utilizing principles inherent to the Maitland Concept. Specifically the cases serve to highlight the importance of dealing with musculoskeletal pain and dysfunction at face value, addressing identifiable physical impairments thought to contribute to an individual's functional limitations. Readers are again encouraged to cross reference the techniques utilized in the treatment of each case with the demonstrations provided in the video clips that accompany this chapter.

Box 4.9

Physical examination of costal joints and intercostal movement

Thoracic intervertebral joints should form part of the examination.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

1. Inspiration and expiration, to maximum, quickly
2. Trunk F, E, LF, Rotn in F and E

Accessory movements

↓, ↑, →, ←, adding ceph and caud and other varying angles

Note range, pain, resistance, spasm and behaviour

Palpation

- For intercostal and thoracic interspinous spacing, prominence and thickening
  3. Full scapulohumeral F through F and Ab
  4. Side lying: arm through Ab to full flexion position
  5. ULNT and cervical/thoracic slump

Note range, pain and behaviour

As applicable

- The injuring or aggravating movements

Isometric tests

Other structures in 'plan'

Passive movements

Physiological movements

Routinely

As for 'routine active movements' above, with overpressure and localizing

- When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

Reproduced by kind permission from Maitland GD (1991) Peripheral Manipulation 3rd ed. Oxford: Butterworth-Heinemann, p 291.

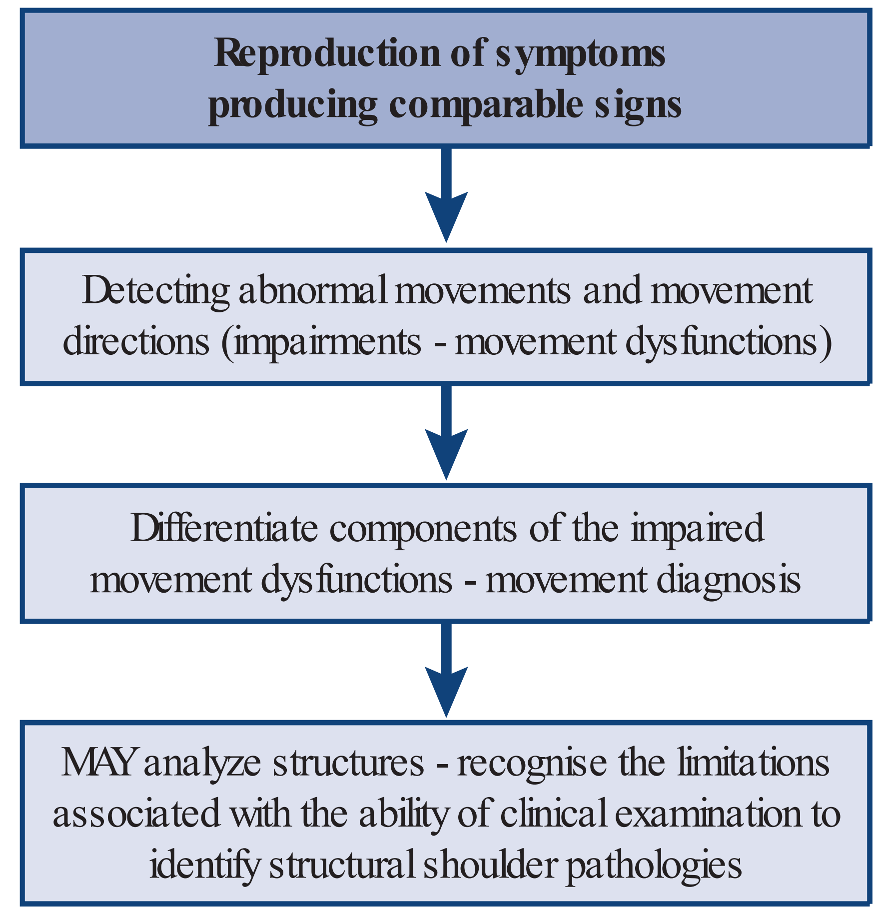

Figure 4.26 • Algorithm of physical examination objectives. Modifed from Hengeveld & Banks 2005.

- *The limitations and problems associated with allowing physiotherapy treatment to be primarily influenced by theory (the left side of the permeable brick wall):*
  - Readers are directed to review Case study 4.3.
- *The importance of assessing for shoulder symptoms sourced in the spine:*
  - Readers are directed to review Case study 4.4.
  - See also Case study 4.5.
- *Dealing with a shoulder problem with multiple physical impairments and components:*
  - Case study 4.6.
  - Case study 4.7.
  - Case study 4.8.
- *Dealing with a painful shoulder:*
  - Case study 4.9.
- *Dealing with a stiff shoulder:*
  - Case study 4.10.
- *Dealing with a shoulder which proves resistant to physiotherapy treatment:*
  - Readers are directed to review Case study 4.4.

Case study 4.5

The importance of assessing for shoulder symptoms sourced in the spine

Mrs M, a 48-year-old café owner

Kind of disorder

- Pain in the region of the left shoulder, particularly troublesome when trying to reach into cupboards above shoulder height at work.
- Mrs M was referred to physiotherapy by an orthopaedic consultant surgeon with a *medical diagnosis* of 'moderate subacromial impingement'.

Body chart features (Fig. 4.27)

- □ Felt as a dull aching sensation most of the time, and
- □ A sharper pain present intermittently. In addition, following discussion a third area of symptoms came to light with a report of a dull aching sensation felt in region □.

Activity limitations/24-hour behaviour of symptoms

- □ Increases when attempting elevatory activities such as reaching into cupboards in her café and dressing with superimposed □, settles within a 'couple of mins' when placing arm by side
- □ Increases when carrying, for example, when serving in her cafeé (trays), builds as day progresses but she was able to continue at work despite the pain (five hour shifts, five days per week).

Present and past history

- The shoulder pain □ and □ had been present for approximately *18 months, developing insidiously.
- *Six months prior to the development of the pain in the region of the shoulder, she mentioned having suffered a fall onto her left side following a slip on ice. She recalled suffering some bruising to her left upper arm and general soreness both of which settled over a couple of weeks.
- Following discussion, Mrs M was able to recall intermittently sensing an aching sensation in area □ for *a few years' although it was not particularly troublesome to her and she had never sought help.

Patient journey to physiotherapy

Mrs M had initially contacted her GP who arranged treatment in physiotherapy approximately 10 months into the course of the shoulder pain. Unfortunately, Mrs M felt that this course of physiotherapy served only to aggravate her symptoms and a mutual decision was made between the physiotherapist and patient to discontinue treatment after six sessions. Mrs M described the treatment as consisting predominantly of shoulder exercises, which she was taught to undertake at home using a theraband (patient simulated internal rotation or external rotation movement with her arm by her side). Her GP chose then to make the referral to the orthopaedic consultant, whom in turn recommended a further course of physiotherapy having diagnosed 'moderate subacromial impingement'. The patient expressed frustration at her lack of progress thus far, although agreed to a further course of treatment in physiotherapy. She was using paracetamol prn for the shoulder pain, and reported no other ill health.

Physical examination (pertinent findings)

Observation

Slight forward head posture, mild dowager's, noticeable thoracic kyphosis.

Functional demonstration

Left shoulder elevation AROM – full range of movement, increase 1 at 110° to EOR

+ in Cx RSF no effect 1

+ in wrist ext no effect 1

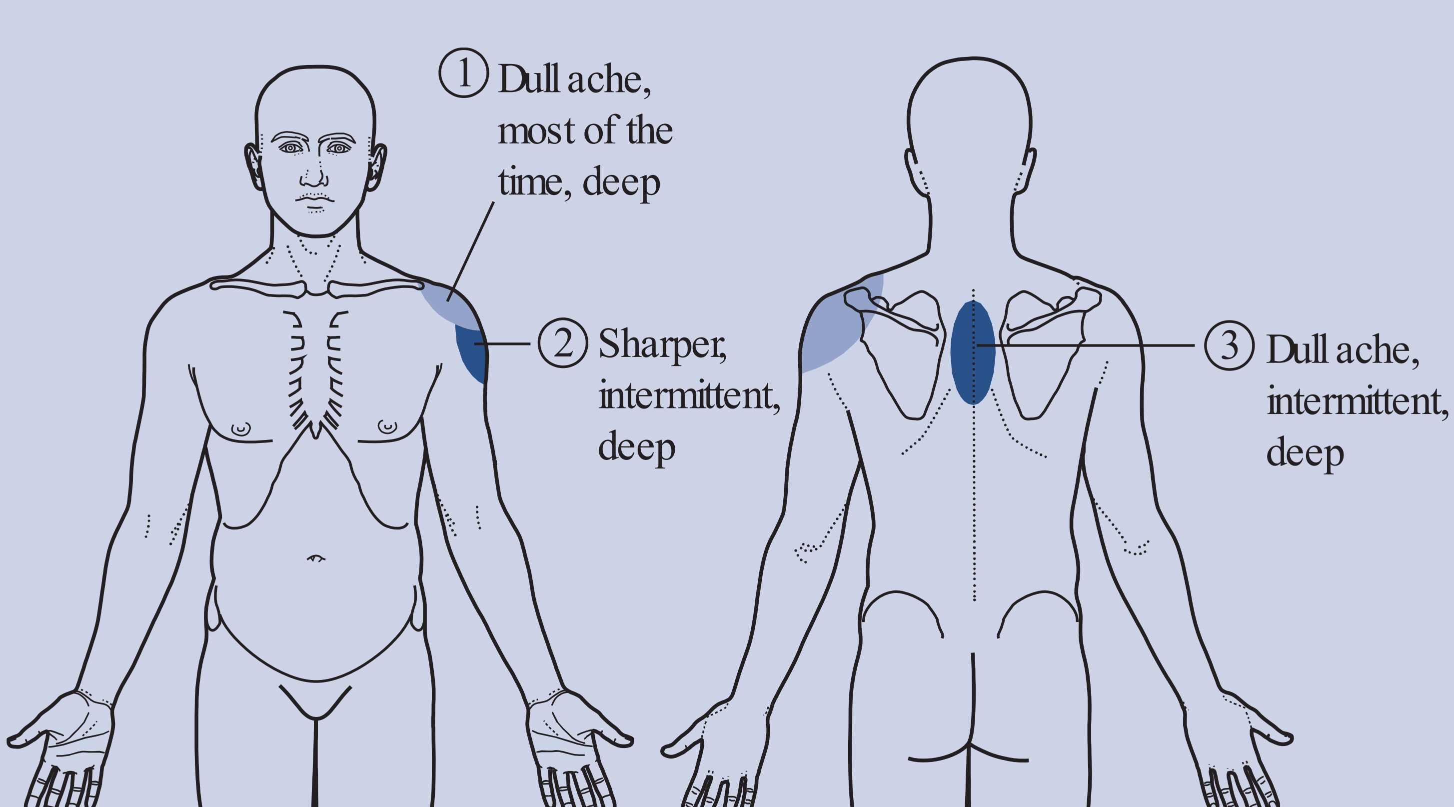

Figure 4.27 • Body chart of Mrs M.

Case study 4.5—cont'd

+ AH compression increase 1

+ ← T1, T2 reduction 1

Active movement

Shoulder abduction – full range of movement, increase 1 at 110° to EOR

Shoulder LR 50° increase 1 40° to EOR

Cervical RR, LR, RSF, LSF, full range pain free

*Cervical retraction OP 3 EOR

Lower Cx combined E +LSF+LR mild restriction R_2, no effect □, □, □

Passive movement

GH elevation as AROM full range achievable, increase 1 110° to EOR

AH compression in 90° abduction/elevation NAD

Unilateral and PA examination cervical spine – stiff left C7 later range, other NAD

*PA unilateral T1, T2 local pain, stiff, local pain limited mid-range, no effect □, □, □

* ← T1, T2 local pain, R_2 mid-range, no provocation □, □, □

*Unilateral rib 2 local pain, stiff, local pain limited mid-range

Other tests

Painfull Hawkins–Kennedy impingement test, empty can and full can tests painful and weak

Isometric lateral rotation pain provocative increase 1

Analysis

Strong stimulus response relationship still evident, indicative or suggestive of dominant nociceptive pain mechanism. Functional limitations of lifting or carrying and with pain during elevatory activities. Inconsistent response noted to movements purported to implicate the subacromial tissues – positive OSTs, positive AH compression in functional demonstration, but NAD in controlled passive testing procedure. Limitations associated with the biomedical diagnoses of subacromial impingement acknowledged. ?symptoms □ and □ being maintained elsewhere

Impairment to T1, T2 accessory motion in transverse, unilateral direction noted, and impairment to accessory motion unilateral rib 2

Plan

Address the impairment to accessory motion at T1, T2 and rib 2 with meticulous reassessment of the effect on the functional limitations, initially primarily pain associated with through-range shoulder elevation and abduction. Consider further assessment of shoulder complex impairments or neurodynamics as required dependent upon response to initial treatment.

Day 1,Rx1

← T1 and T2 grade III producing a mild degree of local discomfort, for 4 mins, prone, shoulder neutral

Reassessment:

Shoulder elevation full range, increase 1 only at 160° (prior to Rx 110°)

Day 6,Rx2

Felt much better. Resolution of constant 1 to intermittent with same activities. Noticeable reduction frequency 2.

← T1 and T2 repeated as day 1

Reassessment:

No further improvement to pain response during shoulder elevation

⤵ T1, T2 grade IV producing mild degree of local discomfort 4 mins, prone, shoulder neutral

Reassessment:

Shoulder elevation full range, 1 only with overpressure grade IV

⤵ T1, T2 grade IV producing mild degree of local discomfort 4 mins, prone, shoulder in end-of-range elevation

Reassessment:

Shoulder elevation full range, pain free with overpressure

GH IR in 90° flexion (Hawkins–Kennedy) pain free

Day 8,Rx3

Fine from last treatment with only minimal episodes of □ or □ and able to complete 5-hour shift at work largely pain free. Noticed able to reach to cupboards much more comfortably. □, □ still present when reaching to extremes (functional demonstration of end-of-range elevation/abduction)

⤵ T1, T2 grade IV producing mild degree of local discomfort 4 mins, prone, shoulder in end-of-range elevation

Reassessment:

Shoulder elevation full range, pain free with overpressure

⤵ 2nd rib angle grade IV producing mild degree of local discomfort 3 mins, prone, shoulder in end-of-range elevation

Reassessment:

Shoulder elevation full range, pain free, shoulder abduction full range pain free

Quadrant mild □, □ peak

Case study 4.5—cont'd

Figure 4.28 • Unilateral posteroanterior accessory mobilization T1 in cervical neutral in left shoulder end-of-range elevation.

Day 22

No problems since last treatment. Able to complete full day's work without pain undertaking all duties including lifting, carrying and reaching pain free. Felt twinge □ on one episode lifting heavy shopping bag into car.

Mrs M was satisfied with the outcome at this stage and did not feel that she required any further treatment. A two–month period during which the patient could return for further treatment should symptoms recur was established. No further contact was made by the patient during this time.

Comments

- As advocated by Hengeveld and Banks (2005) 'involvement of the cervicothoracic spine intervertebral motion segments should be considered in *all* disorders of the shoulder. Actual or potential movement impairment in these regions of the spine can contribute mechanically to the ranges of movement available in the shoulder, as well as physiologically to pain perceived in the shoulder but referred from the cervicothoracic spine structures'.
- This case serves to highlight the importance of this contention, where accessory passive mobilization treatment directed to the T1/T2 motion segment and second rib led to resolution of shoulder pain and the associated functional limitations in a 48-year-old lady.
- An anatomical study by Maigne et al. (1991) provides a plausible rationale to explain this phenomenon by demonstrating that the cutaneous medial branch of the dorsal rami from the second thoracic nerve courses laterally as far as the acromion. Maigne et al. (1991) describe the course of the thoracic dorsal rami from their origin of the spinal nerve passing directly posterior through a tunnel formed by the transverse process superiorly, the neck of the rib inferiorly, the facet joint medially and the superior costotransverse ligament laterally. Beyond this opening the nerve divides into medial and lateral branches, the cutaneous medial branch of the second dorsal ramus which extends in a long loop innervating the skin over the posterior and lateral aspect of the shoulder.
- Maitland et al. (2005 p 304) notes the importance of knowledge of the course and supply of the dorsal rami especially at T2, T7 and T12 to the manipulative physiotherapist.

Case study 4.6

Dealing with a shoulder problem with multiple physical impairments and components

Mrs P, a 53-year-old part-time cleaner

Kind of disorder**

Left shoulder pain and stiffness especially when putting the left hand behind the back, 'fibromyalgia' and arthritis of the spine and hips.

Body chart features (Fig. 4.29)

□ Left anterior shoulder pain of a deep intermittent aching nature; □ occasional superficial intermittent tightness across the top of the left scapula. At present the low back is stiff □ only in the mornings and the hips are symptom free. □, □ and □ seem unrelated.

Activity limitations/24-hour behaviour of symptoms

□ Increases with hand-behind-back movements; the movement feels limited and painful and settles within five minutes of stopping the movement.

Case study 4.6—cont'd

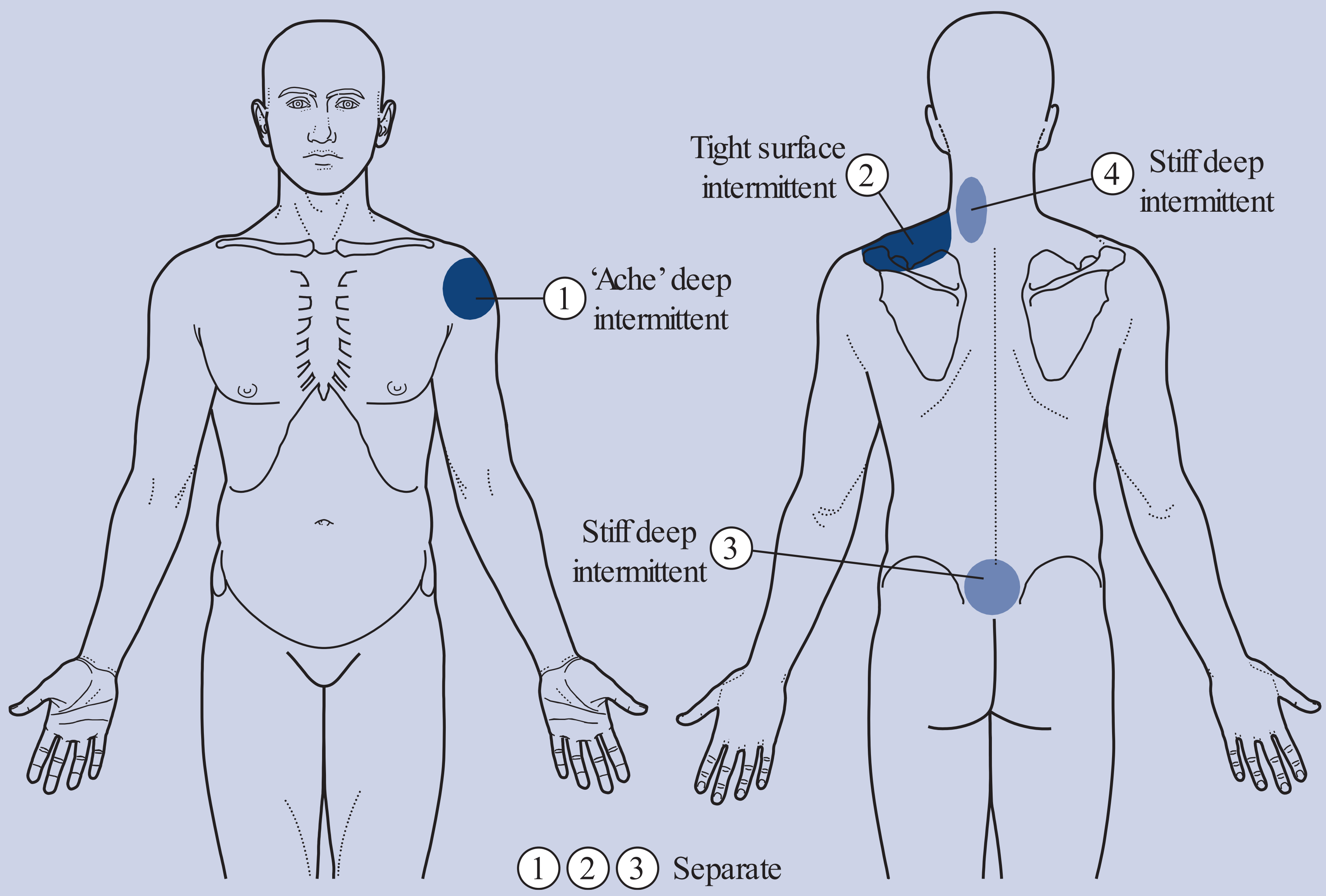

Figure 4.29 • Body chart of Mrs P.

 Increases with stiffness when reaching above head height, becomes tired within five minutes but goes off within one minute of stopping the movement.

 Disturbs sleep occasionally when lying on the arm (once or twice per night) but goes off with slight adjustment of position.

 Noticed at the end of the day or after a heavy shift of cleaning, still feels it when going to bed but has gone by the next morning.

 Stiff in the morning when rolling out of bed and when bending forwards.

Present and past history

 Came on spontaneously and gradually over the last six months with a gradually noticeable limitation of activity and movement, no previous symptoms in this area.

 Has had it on and off for the last few years since increasing her cleaning hours by 100%, occasional stiff neck in the past.

 Has had it for 10 years or more but cannot recall having an injury, just lives with it, this hasn't been any worse or better recently.

Special questions

Has been on prednisolone for asthma but not for several years. Doctor told her she has fibromyalgia with her arthritis and these aches and pains are helped by NSAIDs as and when required. Also suffers from peripheral vascular disease, type 2 diabetes mellitus for the last two years. She has had an X-ray of her shoulder and it looks normal. The rheumatologist injected the shoulder once without any effects.

Source/mechanisms of symptom production

More likely to be nociception, mainly from the glenohumeral, acromiohumeral or acromioclavicular complex, the cervicothoracic spine and the lumbar intervertebral joints.

The cause of the source/contributing factors

Look mainly for static and dynamic alignment faults of the spine as a cause of the source of the shoulder impairment and the general 'arthritic' state.

Observation

Left shoulder sloping more than the right, with the left scapula abducted relative to the right, loss of posterior deltoid and scapula muscle bulk, poking chin/head forward position with dowager's hump.

Functional demonstration/active movements

- Shoulder HBB (1) wrist to iliac crest:
  - + glenohumeral MR (1)+
  - + AH compression (1) ISQ
  - + AC squeeze (1) ISQ

Case study 4.6—cont'd

- Shoulder Ab 110° forward drift □ stiff, correct drift □+
- Shoulder flexion 170° stiff □ IV overpressure □+,□
- Shoulder H/Ad, □ □
- Shoulder LR 40° □, □

Other structures to test on D1

- Lower cervical quadrant E1LLF1LR 10°, stiff □
- Cervical compression, moderate □
- Forward flexion to mid-shin □ stiff + cervical flexion □ ISQ

Isometric testing – not tested on D1.

Muscle length testing – not tested on D1.

Neurological examination – not tested.

Neurodynamics – not tested.

Palpation

- Tenderness on palpation of the anterior shoulder adjacent to the acromion process, but otherwise no other significant palpation findings.
- Thickening of soft tissues and prominence at C7, T1, T2 interspinous and over the articular pillars on the left.

Passive movement

- Glenohumeral accessory movements in neutral ideal range and symptom free.
- Glenohumeral and acromiohumeral joint compression pain free.
- Acromioclavicular or sternoclavicular joint accessory movements ideal range and pain free.
- Glenohumeral medial rotation in 90° abduction, 50° of movement limited by stiffness and □.
- Shoulder quadrant low side and peak especially stiff and □, □ reproduced.
- Quadrant appearance (Fig. 4.30).
- Central and unilateral posteroanterior accessory movement of C7, T1, T2, stiff late range especially T2, local deep ache reproduced.
- Unilateral posteroanterior movement on the angle of rib 2, stiff mid-range □.

Plan

See how mobilization of the stiff second rib affects the shoulder pain as a cause of the source and a barrier to the recovery of ideal shoulder movement, then mobilize shoulder medial rotation eventually clearing the quadrant and locking position in conjunction with correction of postural alignment faults and muscle imbalance correction. Check neurodynamics later if necessary.

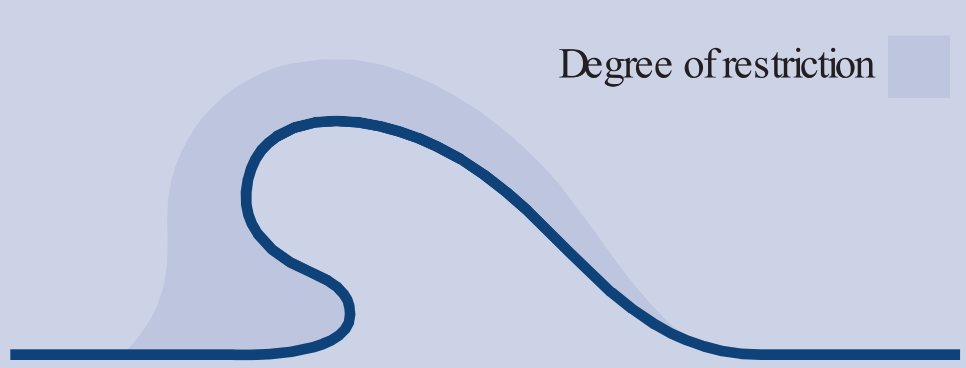

Figure 4.30 • Quadrant appearance (initial examination).

D1,Rx1

↓ On the second rib angle grade IV into a degree of □ for 3 mins	HBB quality better, range □ ISQ Shoulder Ab, F, LR ISQ Lower Cx Q/COMP □ □ FF ISQ □

D5,Rx2

□ ISQ, □ felt better less ache EOD, □ ISQ

↓ On the second rib angle grade IV+ into stiffness and local pain, 3 mins	HBB ISQ Shoulder Ab, F, LR ISQ FF ISQ
In 90° shoulder Ab did GH ↔ caud grade III into a degree of □ for 2 mins	HBB range increased, wrist to L5 Shoulder Ab, F, LR ISQ FF ISQ

D7,Rx3

□ easier, □ gone, □ ISQ. Main problem now is putting her coat on.

In 90° shoulder Ab did GH ↔ caud grades III/IV into a degree of □, interspersed for 5 mins	HBB, shoulder Ab, F, LR ISQ FF ISQ
In 90° of shoulder Ab and 50° of medial rotation ↻ did ↑ of the head of humerus grade □ for 3 mins	HBB wrist to L2 less stiff □ ISQ Shoulder ABD, F, LR ISQ FF ISQ III+ into a degree of

D12,Rx4

- □ felt easier for a few days (putting coat on and lying on arm) but returned to normal level of pain after, neck felt stiff after Rx4 and still feels a bit stiff.
- Shoulder movements ISQ, lower cervical extension stiff 40° □.

In prone did ↓ movement grade III on T1, T2 into □ for 5 mins	Cervical extension full range (55°) □ with overpressure (IV) HBB wrist to T10 less stiff □ Shoulder Ab, F, LR ISQ FF ISQ
In prone did ↓ movement grade III+ on T2 into □ for 4 mins	Cervical extension □ □ HBB, Ab, F, LR ISQ

Case study 4.6—cont'd

D30,Rx5 (away on holiday over Christmas)

- Shoulder feels looser to move and easier to lie on but □ remains troublesome with the same movements. The neck and shoulder blade are now fine, the back is a bit stiffer after all the sitting about over Christmas.
- Cervical spine □ □, shoulder HBB wrist to T10 □ stiff, shoulder lateral rotation is better 65° □ but Ab and F are ISQ, forward flexion is stiffer, hands to knees reproduces □.

In supine lying did shoulder quadrant scooping low side and peak grade IV− into a degree of □ for 4 mins	HBB better wrist to T7 stiff □ Ab 150° stiff □, less forward drift F 170° stiff no □, □

Figure 4.31 illustrates the quadrant appearance after Rx5.

D33,Rx6 and subsequent treatments

- The stretching of the quadrant had been followed up by a series of automobilizations for the shoulder into the quadrant position (throughout the episode of care concurrent programmes of automobilization, functional stability and muscle balance were carried out).

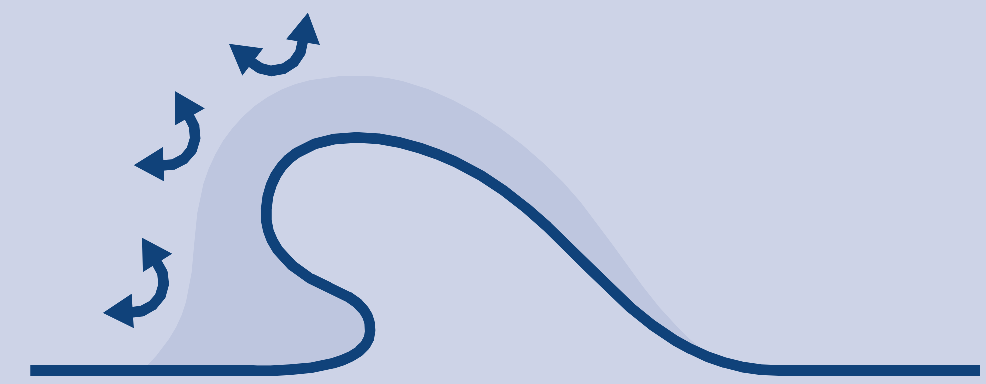

Figure 4.31 • Quadrant appearance (after treatment fve).

- Starting to feel as though the treatment is being effective, the neck has been fine, the shoulder is feeling looser and □ is less noticeable.

In supine did quadrant low side, locking position and peak scooping grade IV into discomfort for five minutes.

Further treatment did not result in any more improvement quickly. The quadrant roll-over technique was used but was too painful and did not result in any further gain in range. The patient was happy that her movements had returned and she would continue to exercise and use the arm normally until she felt there was no longer any restriction or until she had forgotten about it.

Case study 4.7

Dealing with a shoulder problem with multiple physical impairments and components

Mr H, 51-year-old debt collector

He does not partake in any sports or hobbies. He is right-handed.

Kind of disorder

**Right shoulder area pain with a pulling pain into the right side of the neck, especially when sat at work on the computer.

Body chart features (Fig. 4.32)

□ Right anterolateral shoulder pain of a constant/variable deep dull aching nature (VAS 6/10); □ an intermittent daily superficial 'bad toothache' like pain on the anterolateral aspect of the neck (VAS 5/10). □ and □ seem related. He also complained of achy knees which he felt were unrelated. There is an old laminectomy scar in the lumbar area.

Activity limitations/24-hour behaviour of symptoms

**□ and □ are aggravated by sitting for more than five minutes and can be eased off by putting his right arm up in the air 'to ease off the pressure' within five minutes.

□ and □ are also aggravated by five minutes of keyboard activity and can be eased off by getting up for a stroll around for less than five minutes.

On waking he is usually symptom free but feels the symptoms are activity related during the day. **In the evening the symptoms are aggravated when sat watching television (to his right). His sleep is not disturbed – he sleeps prone and finds it more comfortable with his head to the right. *If he lies with his head turned to the left it pulls in his neck □ and lying supine causes a pulling feeling in the throat.

Present and past history

Mr H feels the symptoms were related to an office move. *Seven months prior to the examination he moved offices and found he was seated near a cold air ventilation system which blows across the top of his right shoulder. A month later he insidiously developed □. This slowly deteriorated and another month later he

Case study 4.7—cont'd

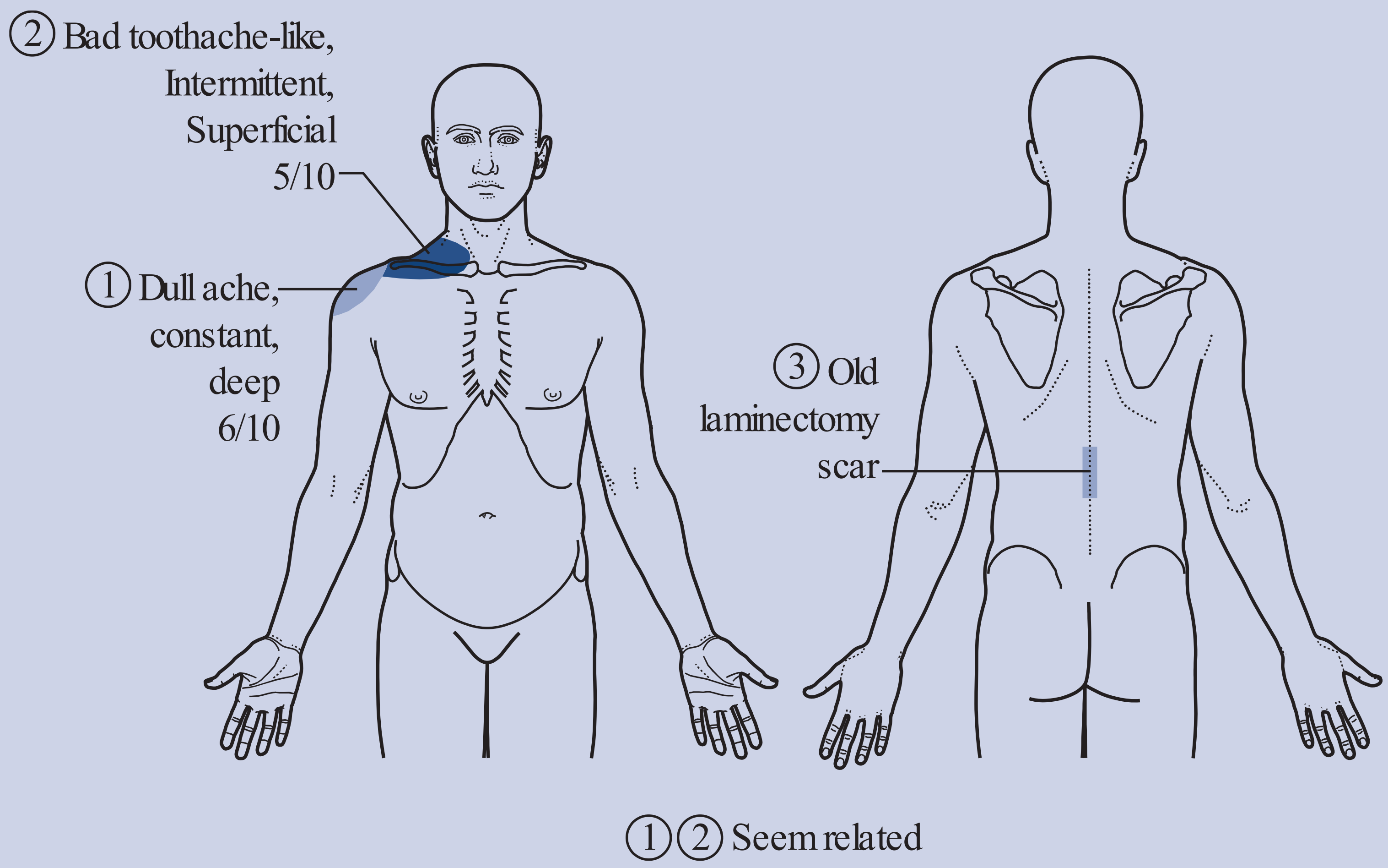

Figure 4.32 • Body chart of Mr H.

developed □. The symptoms were ISQ at the time of examination.

He had never had any previous neck or shoulder problems.

Past medical history

*Right leg symptoms 'trapped nerve' – had an operation 16 years ago and made a full recovery. *Baseball bat head injury six years ago.

Special questions

*Breathing difficulties, but not had any investigations. No other medical problems.

*Current medication includes cocodamol and ibuprofen which help the shoulder area symptoms.

Source/mechanisms of symptom production

Most likely to be chronic nociceptive pain with □ being from the acromioclavicular, acromiohumeral or glenohumeral joints and □ from the cervicothoracic spine, first rib, scalenes or upper trapezius muscle.

The cause of the source/contributing factors

There could be a postural predisposition when sitting at the computer causing compromised tissue health and the ventilation system could be relevant. His previous right-sided leg symptoms could also have predisposed the neural tissue to compromise.

Observation

Initial observations were performed in sitting. There was an increased thoracic kyphosis, correction of which did not change his symptoms. *A hinge at C6 and a poking chin posture when corrected reduced □ slightly. He was also sitting with increased weight on his left buttock with a trunk shift to the right, correction of which made no difference to his symptoms.

Functional demonstration/active movements

*In sitting + right shoulder depression + cervical lateral flexion left increased □ moderate.

**Cervical rotation left 50° tight □ moderate + assisted elevation of right shoulder girdle increased cervical rotation left to 60° □ 'strong'.

Cervical rotation left with right elbow extension and wrist extension decreased to 40° □.

Cervical rotation right □□

*Shoulder movements – flexion □□

Other structures to test on D1

*ULNPT1 right −20° elbow extension □, □ + cervical lateral flexion right increased elbow extension to −10°

Isometric testing/neurological examination

Not tested on D1

Muscle length testing

*Right upper trapezius muscle tight mid-range

Palpation

Generalized tenderness was found around the shoulder complex but nothing specific.

Plan

Correct alignment faults and integrate, fundamentally to effect healthy movement in the cervical and thoracic spine.

Check the first rib.

Check the thoracic spine for impairments.

Case study 4.7—cont'd

D1,Rx1

Rx 1 – In supine did sustained IV+ 30 seconds × 4 cervical flexion and lateral flexion left stretch to right upper trapezius muscle	C/O decreased □ slightly, P/E cervical rotation left ISQ, ULNPT1 increased range to -10° elbow extension, shoulder depression + cervical lateral flexion left □ mild.
Rx 2 – Repeated same treatment again.	All ISQ
Rx 3 – In supine did unilateral AP C4 on the right stiff and sore mid-range, grade III and IV– × 2 mins, twice	C/O decreased □ P/E cervical ration left increased to 65°, ULNPT1 □ □

D4,Rx2

- C/O increased □ a.m. day after examination, □ ISQ during the day, pain moved further up along the trapezius muscle. Not so much pain around the shoulder joint area and was OK lying prone with the head turned to the right in the night. Aware of an ache in the cervical spine area.
- P/E sitting weight bearing left greater than right (ISQ)
  Cervical rotation left ISQ
  Cervical rotation right □□
  ULNPT1 – 15° elbow extension
  Thoracic rotation left 30°, stiff
  Thoracic rotation right 20°, stiff++
  Palpation T3/T4 prominent, ULPA on the right at T4 stiff mid-range, ULPA T4 grade III sustained produced a pain travelling around the chest wall
  Reassessment postpalpation: all ISQ

Rx 1 – T4 rotation left and right grade V	C/O easier P/E cervical rotation left 70° □, ULPA T4 on the right stiff late range
Rx 2 – In sitting ULPA C4 grade III with rotation left × 12	C/O ISQ P/E cervical rotation left 80° (pull), ULNPT1 ISQ
Rx 3 – In supine Did ULAP on the right C4 grade III and IV × 2 mins, twice	C/O ISQ P/E cervical rotation left ISQ, ULNPT1 ISQ, ULAP C4 sore mid-range, stiff late range

D8,Rx3

- C/O Feels breathing has got easier up and down stairs. No □ in shoulder area. Has felt aching in the right neck area. Noticed anterior chest pain in bed at night. Neck symptoms still worse at work in the draught. Patient hoping to start swimming next week.
- P/E Observations, decreased hinge at C6. Cervical rotation left 75° pull □. Cervical lateral flexion left end of range pull □. Glenohumeral joint accessory mobilizations □□ left = right. First rib accessory mobilizations □□ left = right.
- Right ULNPT1 -5° elbow extension.

D12,Rx4

Rx1 – ULNPT1 tensioner grade III with left cervical lateral flexion × 3 mins C/O intermittent pull in rhythm	C/O easier P/E ULNPT1 ISQ, cervical rotation left decreased pull and □
Rx2 – cervical side glide to the left C4 grade III with right arm in ULNPT1 × 60 reps (Fig. 4.33 as example of technique)	C/O freer P/E ULNPT1 □ grade IV+ pull, cervical rotation left 80° tight but painless, cervical side flexion left □ tight
Rx3 – T4 rotation left and right grade □	C/O less tight P/E cervical rotation left 80° □□, right ULPA T4 □□

C/O breathing again feels a little better. No □ in the shoulder. □ easier in neck area. Also easier at night

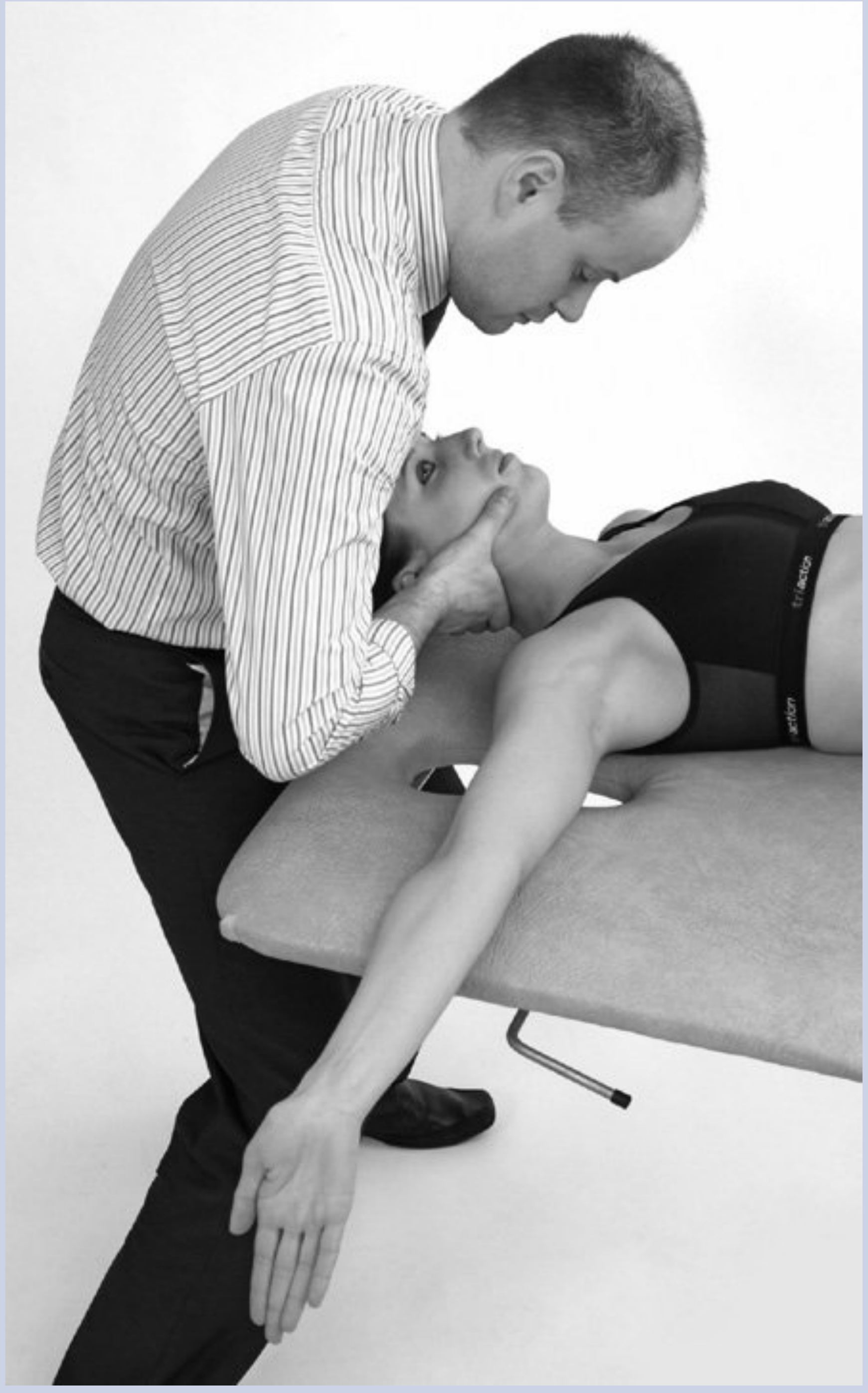

Figure 4.33 • Cervical side glide to the left C4 grade III with right arm in ULNPT1.

Case study 4.7—cont'd

– sleeping OK. Mild □ symptoms at work. 'Pleased with progress'.

P/E minimal hinge at C6. Weight bearing more equally.

Cervical movements – rotation left 80° □ tight, side flexion left end of range pull □.

ULNPT1 □ grade IV+ pull (ISQ).

Thoracic rotation left and right 40° stiff

ULPA T4 stiff late range

Rx1 – Cervical side flexion left PPIVM III++ mid Cx C/O OK, P/E R in rhythm	C/O easier movement P/E ULNPT1 ISQ, Cx Rot L 85° □ tight, SF L □□
Rx2 – T4 rotation left grade V	C/O OK P/E Cx Rot L 85° □□, Tx Rot □ tight Assessed SLR – left = right 70° □ No indication for treatment
Assessed slump – no significant differences left and right or with sensitization	ISQ

- *Rx3* – Home exercises – reinforced posture/alignment of spine deep-breathing exercises/Tx expansion, maintain cervical rotation gains.

Comments

The theory of this gentleman's pathobiological processes was long-term postural stresses leading to decreased tissue viability, which predisposed Mr H to nociceptive pain caused by the cold air ventilation system.

The SLR and slump were assessed in Rx4 because of his previous surgery and therefore potential neural tissue embarrassment, Note the 'double crush' phenomenon.

His condition was thought to be chronic, stable and non-irritable. The patient's aim was to reduce his pain. This was achieved by addressing all the signs in the cervical spine, thoracic spine and in the ULNPT1. Although Mr H's main pain was located in the region of the shoulder complex, his main functional impairment was related to sitting at work and using the mouse. Clues to there being other components to the problem were his problem with sleeping prone with his head turned to the left (cervical) and his breathing difficulties (thoracic).

Case study 4.8

Dealing with a shoulder problem with multiple physical impairments and components

Mrs G, a 53-year-old lady, referred to physiotherapy from an orthopaedic CATS clinic by an ESP

Present and past history

Mrs G reported an insidious onset of left shoulder pain □ around one year prior to her initial assessment in physiotherapy. She had been troubled with intermittent pain in the left side of her neck □ for the last five years but had it had not troubled her sufficiently for her to seek help. Over the preceding three months she then developed an insidious onset of intermittent pins and needles and numbness in the left arm (□, □) (Fig. 4.34). The concern over the pins and needles and numbness combined with the trouble that her left shoulder caused her day to day were the factors that took her to her GP, where a referral to an orthopaedic CATS was made. Consequently, a referral to physiotherapy was made by the ESP in CATS.

Mrs G worked as a legal secretary having done so for more than 20 years. She reported that her workload continues to increase year on year. Her main hobby was attending a gym typically three or four times per week, which she had done for the past few years. Although initially her training was unaffected despite the presence of □ over the last six months she found upper limb weights increasingly difficult due to □ and had stopped these activities over the last three months when she developed □ and □.

Activity limitations/24-hour behaviour of symptoms

The primary functional problem reported was difficulty lifting her bag from the passenger seat of her car due to □. □ was also reported at work when lifting filing work into filing drawers and also when dressing and putting her arm into shirts, jackets and jumpers.

□ was present whilst using the computer worsening with increased duration forcing her to stop and change position after one hour. □ had a tendency to worsen as the day progressed. □ and □ had no identifiable pattern that Mrs G was able to recognize.

Case study 4.8—cont'd

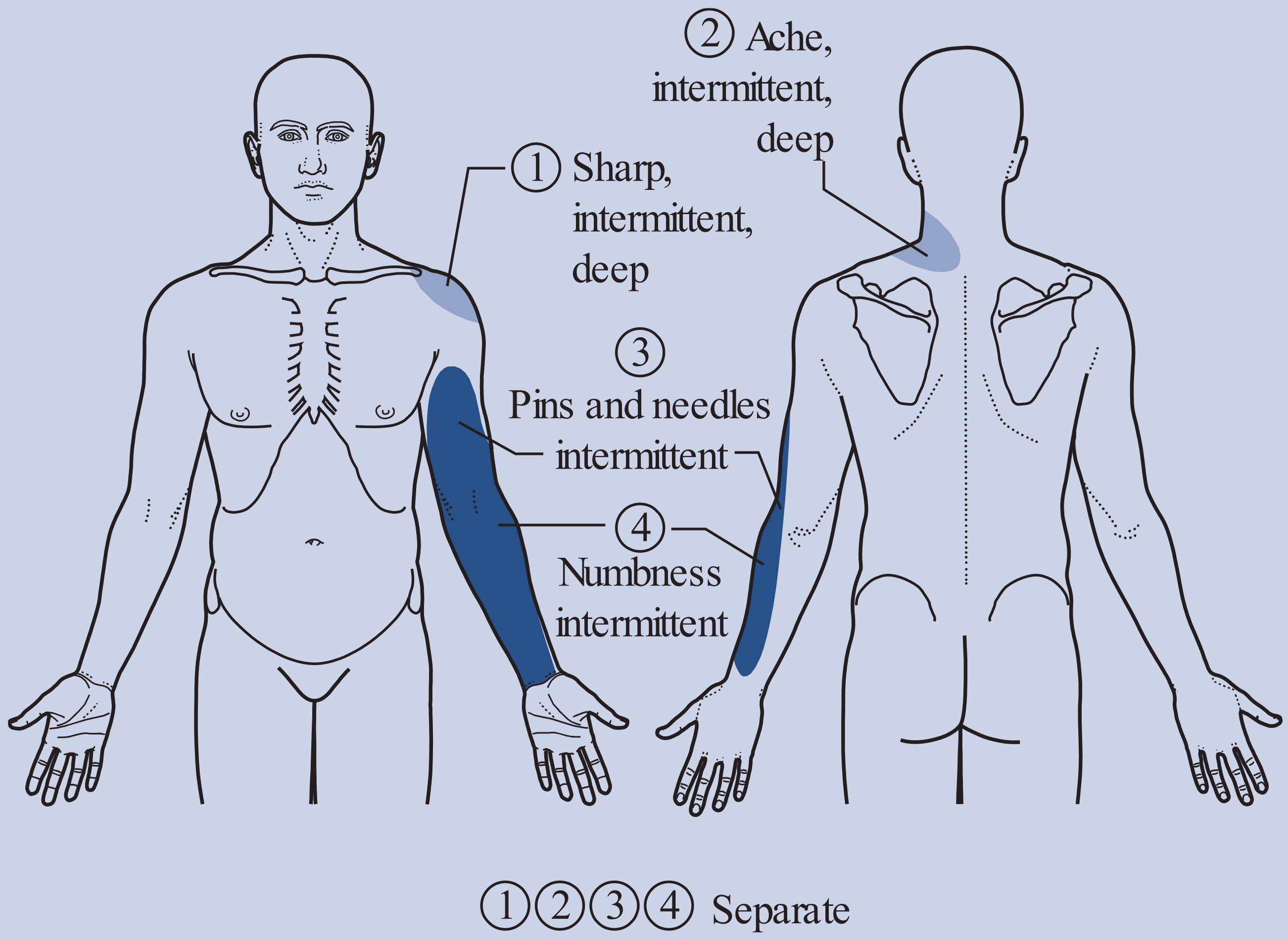

Figure 4.34 • Body chart of Mrs G.

Examination

Initial examination revealed multiple physical impairments. Most notably:

- The functional demonstration of active abduction (to simulate lifting bag from passenger seat of car) increased □. An increase in □ was produced with acromiohumeral compression in this position and with isometric abduction and lateral rotation muscle contraction. No effect on □ was produced with alterations to cervical positions or posture or with modified neurodynamic testing in this position.
- Cervical left rotation was restricted to 60° with an increase in □ at end of range- sustaining this position for 10 seconds produced □ and □. Cervical left side flexion was restricted to 40° and extension to a moderate degree both of which produced the same symptoms response as left rotation including the response to sustained positioning.
- Cervical right rotation, right side flexion and flexion were full and pain free.
- Accessory motion testing of the cervical spine revealed stiffness in the motion segments C4-7 on the left with comparable provocation of □ on unilateral posteroanterior mobilization in the region of the left C5/C6 and C6/C7 facet joints.
- Accessory motion of the first and second ribs with a variety of directions revealed range of movement comparable to the unaffected right side and no symptom provocation.
- Neurological testing revealed no evidence of compromise to conduction.
- Neurodynamic testing revealed a positive response to ULNPT 2a producing □ (desensitized moving the wrist from extension to neutral) and □ (desensitized moving the shoulder from abduction 30° back to the patient's side).
- The left shoulder revealed full range to elevation and abduction with an arc □ through both movements and again slight increase □ at limit of range. Passively the left shoulder revealed full range to elevation and abduction with mild increase □ at the limit of range.

Sessions 1–3

Treatment was aimed at addressing the impairments in the cervical spine to physiological and accessory movement. Passive accessory unilateral posteroanterior mobilization on the left C4-7 motion segments initially in neutral then progressing to a starting position of left rotation produced restoration of full pain-free active cervical left rotation and left side flexion. By the end of session 3 a concurrent resolution of □ and □) had also been produced. □ persisted to a mild degree only at the end of a working day, but to a satisfactory level as deemed by the patient. Active cervical range of movement exercise was prescribed at the end of each treatment session to maintain the improvements in range gained in treatment. Advice regarding posture and encouragement of regular changes to position through a working day was encouraged. Mrs G was encouraged to avoid lifting her bag from the passenger seat of her car to prevent provocation of □. Reassessment of shoulder range of movement and response of □ remain unchanged at the end of session 3. The previously impaired ULNPT 2a and later assessed ULNPT 1 resolved without the need for neurodynamic mobilization.

Case study 4.8—cont'd

Sessions 4 and 5

The problems related to □ persisted at this stage including provocation during dressing (putting on jumpers, shirts and coats), lifting files into and out of filing cabinets at work. Mrs G had not returned to upper limb exercise at the gym at this stage due to the persistence of □. Consistent with the initial assessment a painful arc (increase □) through elevation and abduction was present with an increase in □ at the limit of range of elevation and abduction. Differential testing continued to reveal an increase in □ with acromiohumeral compression indicating a possible subacromial source to the symptom. □ was produced with isometric contraction of both abduction and lateral rotation no matter the starting position of the left shoulder although a more intense provocation was present when the shoulder was in 90° abduction. In this position, acromiohumeral distraction (longitudinal caudad humerus) did not relieve or improve the pain response with □. Longitudinal caudad mobilization of the humerus in a variety of starting positions failed to improve □ during active abduction. Mobilization into the restricted quadrant position was not tolerated well. Assessment of a number of other possible impairments that have been associated with extrinsic sources of subacromial impingement was undertaken. These factors have been discussed in previous sections of this chapter and are summarized in Tables 4.3 and 4.4. In particular, motor control assessment revealed satisfactory scapula stability and dynamic control. Indeed, scapulothoracic movement facilitation failed to affect the presence of □. Glenohumeral medial rotation range of movement was unimpaired in comparison to the unaffected right side. Thoracic mobility was addressed with mobilization. □ remained unchanged.

Session 6 and onwards

The impairment to resisted contraction during both abduction and lateral rotation persisted and a hypothesis of a tensile lesion of the scapulohumeral muscles was consequently established. Extrinsic compressive impingement secondary to poor humeral head control was also considered a possibility secondary to poor rotator cuff function. Consequently, a graded loading programme of exercise was prescribed with an emphasis on maintaining good glenohumeral movement control.

Initially progressive isometric contractions of both lateral rotation and abduction were undertaken with the arm by the side with a strength of contraction insufficient to produce □. Attention was paid to the starting position of the shoulder complex to provide an optimal alignment and prevention of compensatory strategies, that is, loss of starting position, shoulder shrugging, loss of scapula control etc. Over a one-week period of repetitive exercise strong, painless isometric contractions were gained.

Treatment progressed to isometric contraction through range particularly towards the provocative position of 90° abduction again with the avoidance of □. By the end of the third week of training strong painless isometric contractions were achievable of both abduction and lateral rotation in a variety of starting shoulder positions. Mrs G reported that the intensity and frequency of □ had improved by 80%. The previously restricted shoulder quadrant, at this stage was reassessed and felt to be largely comparable to the unaffected right side and the pain previously present at the end of shoulder elevation had also resolved.

Treatment progressed to slow, isotonic concentric contractions of lateral rotation (with external resistance provided by theraband) again initially with the arm by the side moving quickly into the provocative position of 90° abduction. Again the strength of contraction and range of movement produced was undertaken in a pain-free manner. Strength, range and change of shoulder starting position was only undertaken as symptoms allowed. At review six weeks following commencement of the exercise loading programme Mrs G was asymptomatic with regard to □ with daily activities. She was able to demonstrate through range lateral rotation concentric control with resistance.

She expressed being keen to return to the upper limb gym work she had previously undertaken prior to her shoulder, neck and arm problem. Rehabilitation was progressed to a higher level with changes of speed, types of contractions and starting positions of shoulder elevation and abduction. At a three-month review Mrs G had returned to her upper limb gym rehabilitation program without symptoms. Previous training errors were addressed, that is, consecutive days training changed to alternate days, etc. She was discharged at this stage and asked to contact the department should she experience any recurrence over the following three-month period. No contact was made.

Comments

Physiotherapy management of shoulder disorders is often multimodal in nature, with passive movement forming one component of intervention. This case aims to demonstrate the integration and role of passive mobilization in a patient presenting with a multicomponent neck, shoulder and arm disorder in the wider context of their overall management.

The case also serves to demonstrate where hypotheses regarding the pathobiology (mechanisms related to the tissues) combined with advancing knowledge regarding the pathology (in this case tendinopathy) (the left side of the permeable brick wall)

Case study 4.8—cont'd

may be integrated with the clinical evidence (the right side of the permeable brick wall) from the patient assessment to inform physiotherapy management decisions. As stated by Maitland (2005), 'the decision making process of the Maitland Concept is primarily on the clinical evidence side of the brick wall although diagnostic and theoretical considerations will influence the exact nature and dosage of the intervention'.

In this particular case a persistent impairment to resisted abduction and lateral rotation was reasoned to be the physical impairment most closely related to the functional limitations of the patient following the resolution of others with physiotherapy treatment. Integrating scientific evidence relating to rotator cuff pathology such as detailed in Tables 4.3 and 4.4 allowed a hypothesis to be generated regarding rotator cuff tendinopathy as a *possible explanation* for the clinical presentation at this stage (theory). Current evidence has demonstrated that mechanical loading of tendon tissue can promote cellular level structural change to promote tendon healing and repair via the concept of mechanotransduction (Khan & Scott 2009). The case for such an approach in rotator cuff tendinopathy at this stage of scientific understanding is continuing to build given that the pathological features of the condition appear related to either a failed healing response or as a degenerative process as has been discussed in more detail in the section covering a clinical example relating to rotator cuff tendinopathy on pages 164–168 (Cook & Purdam 2009). Despite the difficulties that have been associated with the interpretation of research relating to the physiotherapy treatment of 'impingement syndrome' which have been thoroughly discussed in other sections of this chapter and Table 4.9, exercise combined with manual therapy has been shown to be an effective treatment for this clinical presentation in four recent systematic reviews (Kelly et al. 2010, Braun & Hanchard 2010, Kromer et al. 2009, Kuhn 2009).

Obviously when considering the lack of diagnostic accuracy that special physical orthopaedic tests possess in identifying structural pathologies in the shoulder (as discussed earlier in the chapter) it was not possible to suggest with any certainty that this was indeed the pathological lesion in this particular case. Furthermore, even if imaging evidence had been made available the management decisions would not have changed given the high prevalence of rotator cuff pathology in asymptomatic individuals. Nonetheless, addressing the impaired contractile component of the shoulder problem hypothesized as a rotator cuff tendinopathy warranted testing supported by 'clinical proof of whether treatment is working or not is achieved by continually comparing the effects of the selected treatment forms on the patient's symptoms and signs.' Maitland (2005). 'At the same time, hypotheses about the cause of the problem, the structures at fault, the pathobiological mechanisms involved, expectations for recovery and appropriate management strategies can be confirmed discarded or re-ranked."(Maitland et al. 2005). In this particular case the clinical outcome was favourable supporting the contention of the link between the contractile impairment with the patient's functional limitations.

Case study 4.9

Dealing with the painful shoulder

Mr G, a 79-year-old gentleman was referred to physiotherapy by a consultant orthopaedic surgeon with a medical diagnosis of right shoulder subacromial impingement.

Kind of disorder

Right shoulder pain and associated painfully limited range of movement.

Present and past history

Mr G had suffered a fall onto an outstretched hand seven months prior to his attendance in physiotherapy. He suffered an immediate onset of pain in the region of his right shoulder and opted initially to self manage his problem. Mr G recalled pain in the region of □ and □ following the fall. □ and □ were reported to have become noticeable over the three months preceding his physiotherapy initial assessment (Fig. 4.35). Unfortunately, his symptoms persisted and he consequently sought help from his GP who chose to investigate the problem with X-ray and ultrasound scan, the results of which are detailed below. Based upon the results the GP referred the patient directly to a consultant orthopaedic shoulder surgeon for opinion without accessing an orthopaedic CATS. The patient was assessed by the consultant who referred the patient for physiotherapy.

Prior to the fall Mr G had experienced no previous problems with his right shoulder. He regularly attended a gym and played golf but had been unable to do since

Case study 4.9—cont'd

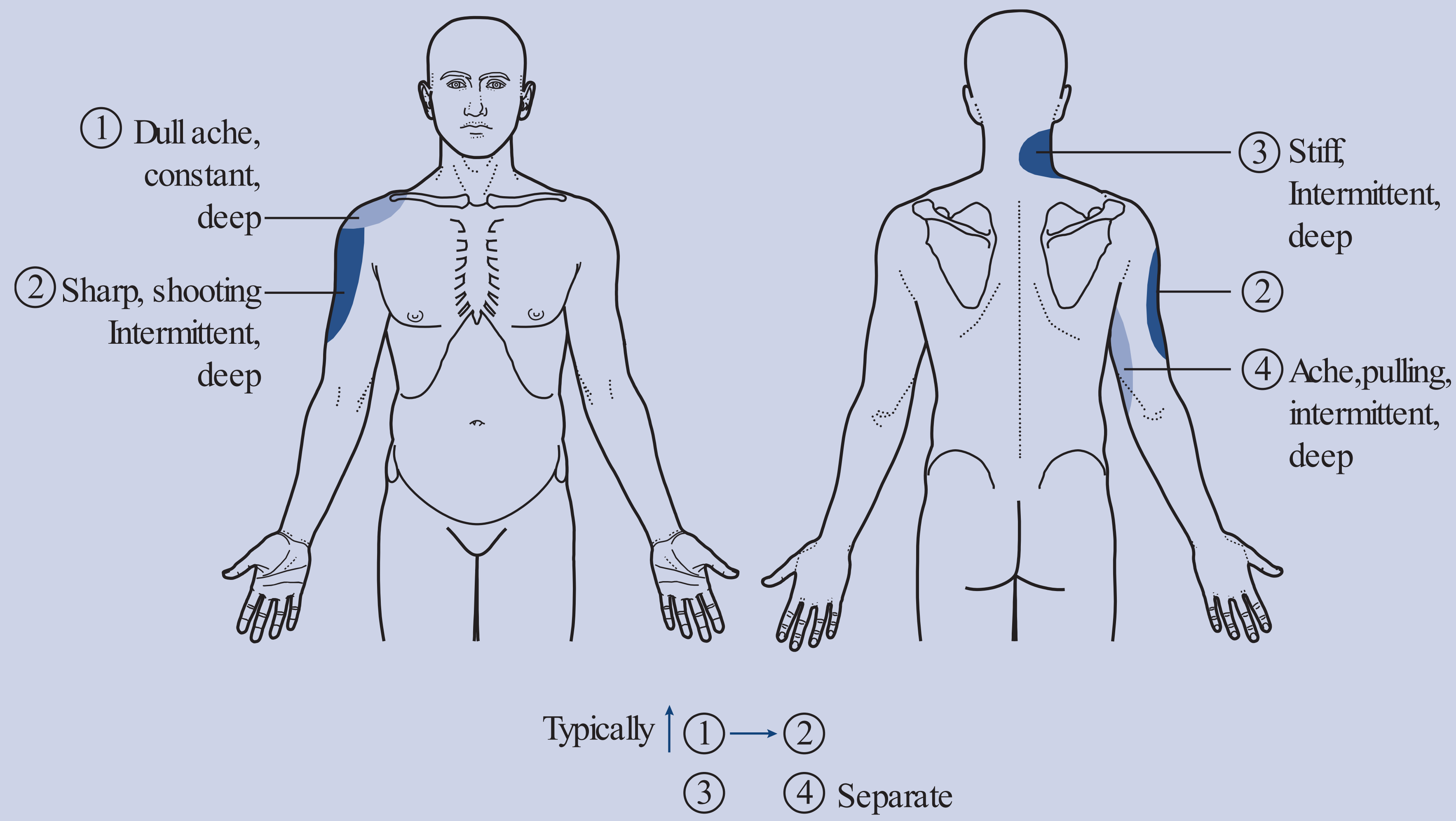

Figure 4.35 • Body chart of Mr G.

the time of the fall. His main aim in physiotherapy was to be able to return to these activities.

Activity limitations/24-hour behaviour of symptoms

The principal functional limitation was elevation of right arm due to severity of □ and □ which increased rapidly nearing the end of the available range of movement, taking a couple of minutes to settle when placing the arm back by the side. Consequently, problems with dressing and reaching activities were reported.

Sleep was disturbed most nights due to □, □ and □, when lying in the right side, settling within five minutes when changing position.

Mr G was able to note an increase in □ particularly when trying to place his right hand behind his back and when sitting for more than 30 minutes.

Medical imaging investigation

Ultrasound right shoulder

Moderate mechanical changes in the AC joint with capsular thickening. Biceps tendon appears intact with a normal subscapularis. The supraspinatus is slightly thickened with some heterogeneity of architecture compatible with tendinosis. There is thickening of the subacromial subdeltoid bursa and on elevation there is clear evidence of impingement with effusion in the subacromial subdeltoid bursa (SASD). The infraspinatus is normal with no evidence of rotator cuff tear.

Comment: Impingement changes right supraspinatus tendon with SASD bursitis. Bursal effusion. No rotator cuff tear.

X-ray of right shoulder

There is some calcification in the soft tissues at the acromioclavicular joint suggesting pseudo gout. The glenohumeral joint has a normal appearance. There is no fracture or dislocation

Interpretation- imaging results allowed information regarding the state of the tissues in the shoulder complex to be acknowledged and provide evidence for the left side of the brick wall. Points of particular interest noted were degenerative changes to the acromioclavicular joint, evidence of subacromial impingement and bursal effusion, supraspinatus tendinosis and a normal glenohumeral joint. This knowledge was tempered with consideration that prior to the fall Mr G had experienced no previous symptoms in his right shoulder.

Note: readers are directed to use information from Tables 4.8 and 4.9 to review the considerations relating to these medical findings.

Examination

Initial examination was limited due to the severity of symptoms.

The primary impairments identified initially were painful restrictions to right shoulder active range of movement to elevation 80° (1) (2), abduction 60° (1) (2) and lateral rotation 40° (1) (2).

Passively around 10° further range was achievable with care but again pain limited at this stage (1) (2).

Cervical spine range of movement revealed restriction at 50° rotation in both directions due to stiffness with an increase of □ at the limit of available range.

Case study 4.9—cont'd

Accessory motion testing revealed painful restriction of the shoulder to both anteroposterior and posteroanterior directions. Accessory motion testing of the cervical spine revealed stiffness from the mid to lower regions with provocation of □ on unilateral posterioanterior mobilization of the right C5, C6 and C7 facet joints.

A modified neural tissue provocation test (2a) did not influence the symptoms □, □, □ or □.

A peripheral nociceptive pain dominant presentation with sources from the glenohumeral/?acromiohumeral/ cervical spine and ?acromioclavicular complexes was felt to be the most likely mechanism at this stage.

Rx1

At this early stage several impairments had been identified including painful restriction to both physiological and accessory movement of the shoulder complex and impairments of the cervical spine to physiological and accessory motion due to stiffness. As such, several options for treatment existed.

A clinical judgement was made to commence treatment directed to the painfully restricted ranges of movement at the shoulder complex. The patient was positioned in an antalgic position of supine with two pillows under the upper right arm supporting it by the patient's side. Accessory movements of the humerus were applied initially in a posteroanterior direction and longitudinal caudad direction using pain modulating grade I and II techniques applied in a slow and gentle manner avoiding the provocation of pain (Fig. 4.36). Within a few minutes the amplitude of the movement was able to be increased and the patient reported a reduction in their resting level of pain.

The patient appeared more relaxed to movement of his shoulder and passive physiological flexion was able to be applied again in a slow, supported and gentle manner highly respectful and avoidant of provoking the patient's shoulder pain. Within the treatment session passive movement of the shoulder had improved from 80° up to approximately 150°. The patient was taught pendular exercise in an attempt to maintain the improvements in the passive range of movement of the shoulder. The patient stated that he was reassured that he should begin to move his shoulder again as to date he had largely avoided movement and activity due to fear of causing more harm and pain.

Figure 4.36 • Posteroanterior accessory mobilization right humeral head with the arm supported in the most comfortable position.

Rx2 and Rx3

The passive movements applied during session 1 were repeated in sessions 2 and 3. Impairments to scapulothoracic elevation, depression, protraction and retraction were addressed through passive mobilization. Active assisted range of movement of the shoulder was commenced in a supine position. By the end of session 3 160° active elevation of the shoulder was achievable in supine and in standing 140° was reached, both being limited by pain □ and □. The patient progressed to active range of movement to elevation of the shoulder both lying and in standing with the elbow flexed (short lever). He reported gaining confidence again with movements of his shoulder and arm.

Rx4 and Rx5

The impairments in the cervical spine noted at initial assessment were addressed with accessory unilateral mobilization which led to improvements to both cervical range and shoulder range of movement. By the end of session 4, active shoulder elevation and abduction range of movement had improved to 170° limited by □ alone. Mr G reported resolution of □ and □ with only intermittent □ on stretching for example when putting his jumper over his head. On further examination of passive elevation □ was identified at the limit of range along with □. The shoulder quadrant was impaired on assessment with provocation of □ and □. Differentiation procedures identified possible source to □ both at the acromioclavicular joint and acromiohumeral joint. A clear differentiation between these two sources was not possible. Examination of the upper thoracic spine with unilateral posteroanterior mobilization of the right T1 and T2 revealed impairment with local pain and stiffness. A hypothesis of a possible symptom source of □ and contributing factor to □ was generated and tested with strong accessory mobilization techniques applied to address the segmental stiffness. On reassessment the range of shoulder movement was unaffected although □ was not reproducible during the quadrant or at the limit of elevation as it had been.

Rx6

Impairment to accessory motion of the right acromioclavicular joint was felt important as a possible remaining source to □ and reason for the impairment to

Case study 4.9—cont'd

full shoulder elevation and abduction, which was limited actively at 170° and passively in the last few degrees. In end-of-range elevation accessory movement of the acromioclavicular joint was applied in both an anteroposterior and longitudinal caudad direction using initially pain relieving grade II techniques progressing to stronger grade IV techniques as able. Reassessment revealed full passive and active range to shoulder elevation and abduction, however □ persisted at the limit of range. The shoulder quadrant also continued to reveal mild restriction with provocation of □. Two further applications of mobilization in a similar manner to the acromioclavicular joint failed to improve matters any further. Differentiation testing was again applied in this end of range which continued to suggest an acromiohumeral source with a reduction in □ when a longitudinal caudad accessory movement was applied to the humerus (subacromial distraction) (Fig. 4.37). At this stage, the irritability and severity of the problem was judged to be low and gentle use of the impaired quadrant as a mobilization technique was applied. This technique provided further improvement such that the patient reported full pain-free range of movement to shoulder elevation and abduction with strong overpressure.

Rx7

Mr G reported feeling extremely happy with his shoulder. He was able to undertake most tasks on a daily basis that used the right shoulder and arm without pain or difficulty. He reported only a very occasional twinge 1 when putting the arm into 'awkward' positions

Figure 4.37 • Longitudinal caudad accessory mobilizations to the ACJ in elevation.

and occasionally when lying on the right shoulder. Mild restriction to the right shoulder quadrant persisted; otherwise shoulder movement was full and pain free. A judgement was made to stop treatment at this stage and monitor the symptoms over a period of one month. Mr G demonstrated a golf swing within session which was pain free and was advised to make a graded return to this activity.

Rx8 – one-month review

At this stage Mr G remained happy and satisfied with his outcome. He had returned to golf and was now playing at his preinjury level. He felt that no further treatment was required at this stage and was consequently discharged from physiotherapy. No contact was made over the following two-month period indicating no recurrence of problems to an extent which required input as was agreed.

Comments

This case serves to highlight the importance physiotherapists should pay to identifying all possible sources and contributing factors in any individual clinical presentation. Although a specific medical diagnosis supported by the use of imaging which demonstrated several pathological tissues was present in this case, many other sources and contributing factors were identified using an impairment-based approach which when addressed contributed (evidenced by reassessment of effect) to resolution of the patient's problems. This case supports the contention that physiotherapists must possess 'an open minded attitude to treatment techniques being able to innovate freely, unhindered by theory' supported by meticulous reassessment (Maitland 1986). The specific limitations associated with the medical diagnosis of 'subacromial impingement' have been thoroughly discussed in preceding sections in this chapter. Maitland's recognitions of the difficulties, limitations and obstructions to patient management should physiotherapy treatment be directed by the medical diagnosis alone are particularly pertinent to this diagnosis (Maitland 1986).

The case also demonstrates the utility of using gentle, controlled passive mobilization in a patient with a pain dominant presentation. Such an approach is considered by Maitland (1986) as of particular importance for the Maitland Concept, which demands therapists develop 'a clear understanding of how to treat pain by using oscillatory techniques which are totally painless and do not include any stretching whatsoever'.

Case study 4.10

Dealing with a stiff shoulder

Mr C, a 57-year-old power station worker

History

Mr C was a 57-year-old power station worker referred to physiotherapy with a four-month history of a painful and stiff right shoulder. The problem began insidiously in the absence of any trauma and was in status quo at the time of examination. The pain was described as intermittent on the anterior and lateral aspect of the right glenohumeral joint area (Fig. 4.38). It was aggravated by reaching into forward elevation and by applying pressure against a wall in elevation such as when using a screwdriver. At night he was unable to lie on the right side due to aggravation of the pain.

His general health was unremarkable and he was not currently taking any medication. His work at the power station involved heavy work, climbing and fine tool work. He was right-handed.

Examination

On examination his pain was present prior to any movement. His functional demonstration was active flexion which was further symptomatic and stiff at 120°. Differentiation in this position highlighted his glenohumeral joint to be the most affected component. His pain was also increased with abduction at 90°, lateral rotation was stiff at 20° and hand-behind-back movement (medial rotation, extension and adduction) was painful with hand to buttock. Further differentiation of this movement found the medial rotation component to be the most affected. This pattern of restriction is commonly referred to as a capsular pattern, as termed by Cyriax (1978).

Resisted movements were generally uncomfortable with no specific findings. The addition of acromiohumeral distraction prior to performing the resisted movements did not change the symptom response.

Treatment

Due to the findings so far the passive accessory movement examination was concentrated on the glenohumeral joint. This was found to have stiffness in the mid-range in all directions.

As a result, treatment consisted of mobilizations of the glenohumeral joint into the stiffness (grade IV–). Glenohumeral posteroanterior, anteroposterior and longitudinal caudad mobilizations were performed (Fig. 4.39). The arm was initially positioned in neutral but because there was no aggravation of the symptoms after reassessment and because his problem was stiffness dominant and not irritable, the same techniques were performed in end-range abduction and then in flexion and then in lateral rotation. The immediate effect was an increase in his active range of flexion and abduction with less intense pain. Interestingly his hand-behind-back movement also improved.

Outcome

The above mobilizations were progressed to grade IV+'s as the symptom response allowed and combined with end-of-range physiological techniques. Posteroanterior pressure to the inferior angle of the right scapula in prone with the hand behind the back was also found to be effective at further improving the hand-behind-back function. After five sessions of treatment Mr C was discharged with a return to full function in elevation and hand-behind-back movements.

Comments

This case study serves to highlight the importance of assessing the joint signs and treating them appropriately. When stiffness in the glenohumeral joint accessory movements was addressed the patient's function was improved. This patient also highlights that a capsular pattern of restriction may not always mean a 'frozen shoulder' which is often unresponsive to physiotherapy treatment.

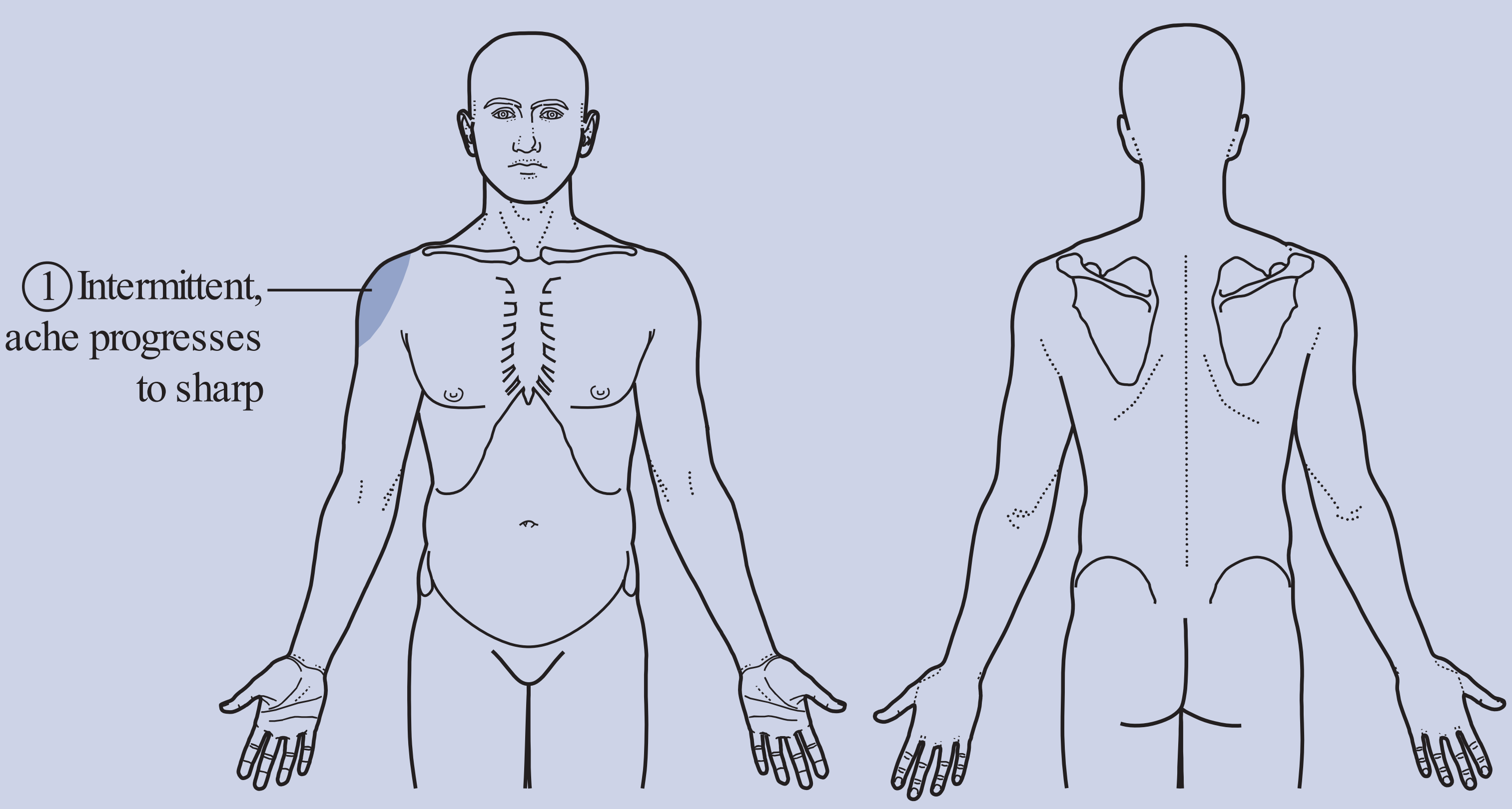

Figure 4.38 • Body chart of Mr C.

Case study 4.10—cont'd

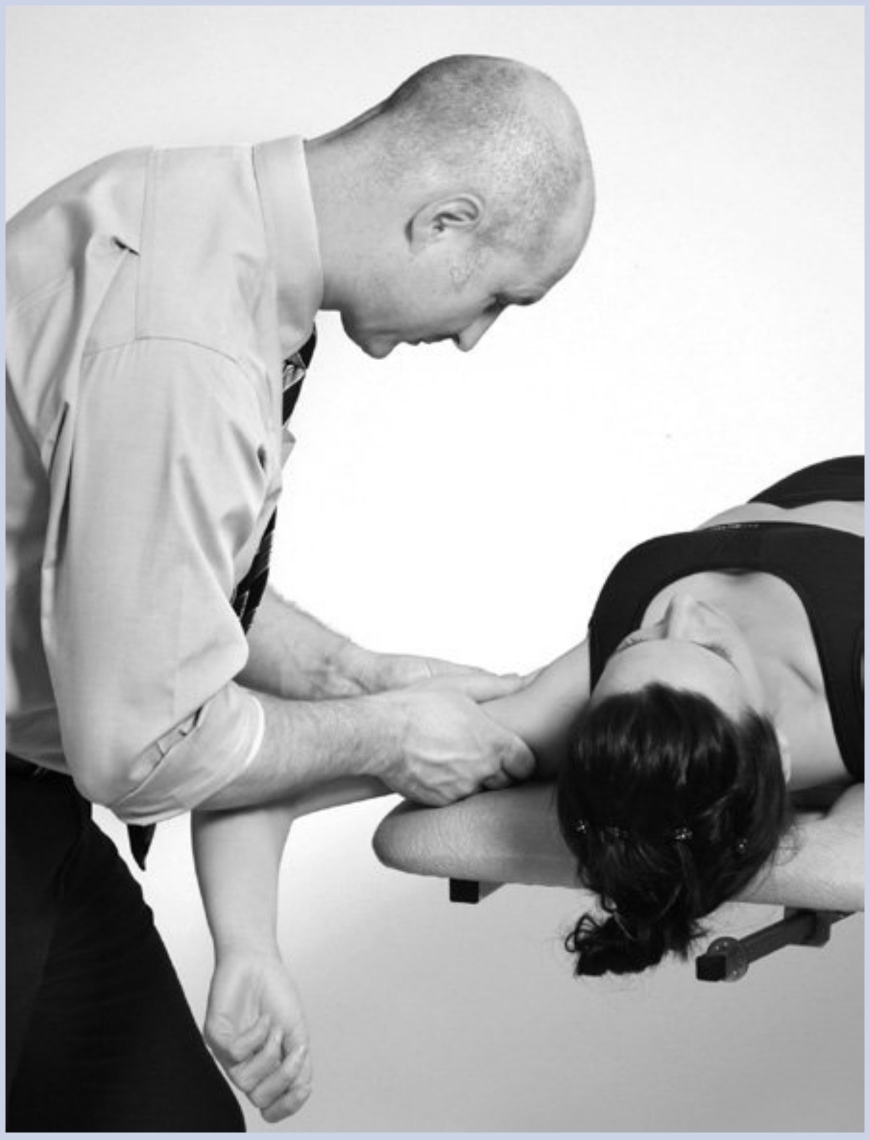

Figure 4.39 • Glenohumeral posteroanterior mobilizations of the humeral head with the arm in 120° abduction whilst maintaining full external rotation.

Figure 4.40 • Posteroanterior mobilizations applied to the inferior angle of the scapula in the hand-behind-back position.

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Management of elbow disorders

5

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CHAPTER CONTENTS

Key words

Superior radioulnar joint, humeroulnar joint, radiohumeral joint, radial nerve, ulnar nerve, median nerve, extensor carpi radialis brevis, common extensor origin, common flexor origin

Introduction

Potential sources of pain in the elbow region are diverse, ranging from the joints, bone, muscles, nerves, fascia, bursae and other soft tissues. Hence, evaluation of a person presenting with pain in the elbow region requires a comprehensive examination procedure encompassing all potential pain sources. The intention of this chapter is to provide an integrated approach incorporating the articular, neural and muscle systems. Comprehensive manual examination procedures will be presented with clinical reasoning processes to enable the clinician to identify with as much clarity the source of elbow pain. Consequently, the astute, proficient clinician will be able to treat and manage a wide range of pain disorders affecting the elbow region.

It cannot be overstated that elbow symptoms may arise from local structures such as the humero-ulnar joint, as well as remote structures such as the cervical and thoracic spine. The potential for spine involvement in elbow pain has long been reported (Berglund et al. 2008, DeFranca & Levine 1995, Haker 1993, Noteboom et al. 1994, Yung et al. 2011). Failure to address remote structure involvement is likely to reduce treatment effectiveness or prolong therapy. There is some evidence to indicate that manual therapy applied to remote structures can influence elbow symptoms. For example, in subjects with lateral epicondylalgia, Vicenzino et al. (1996) demonstrated that a cervical lateral glide technique, when compared to a control and placebo condition, had immediate positive effects on pain, pain-free grip strength, elbow pressure pain thresholds, and the neurodynamics of the upper limb. Furthermore, it has been shown that for lateral epicondylalgia, local elbow management together with treatment directed at the spine achieved a successful long-term outcome in significantly fewer visits than local elbow management alone (Cleland et al. 2004).

Difficulty arises when trying to identify from where pain may originate (Curatolo et al. 2006). For example, people who suffer with chronic lateral epicondylalgia demonstrate widespread areas of proximal and distal referred pain (Slater et al. 2005), a hallmark feature of central sensitization. The presence of central sensitization distorts the clinical picture, making a definitive diagnosis difficult (Curatolo et al. 2006). In addition, there may be referred pain from proximal structures, particularly the spine. Berglund et al. (2008) compared a cohort of factory workers with and without lateral epicondylalgia. They reported a much higher frequency of cervical and thoracic spine pain (70%) in subjects with elbow pain than those without (16%). They also found a much higher incidence of positive findings to upper limb neurodynamic testing and pain provocation tests of the spine in subjects with elbow pain. The presence of spine pain together with pain in the elbow region does not definitively indicate the cause of the elbow symptoms will be the proximal structures. However, this evidence indicates the importance of careful subjective and physical examination in patients presenting with elbow pain. Particular care should be given to identifying symptoms throughout the upper limb, as well as the spine. Patients with elbow pain will often have more than one pain. On careful questioning, it may be possible to identify a difference for each pain with respect to movement-related behaviour. Consequently, each pain may have different origins and may need treating in different ways.

Anatomical and biomechanical considerations

The elbow region is a complex of articulations, which comprises the humeroular joint, radiohumeral joint and proximal radioulnar joint. While the proximal radioulnar joint is not strictly involved in the elbow motion of flexion and extension, it is included in this chapter because of its anatomical position and proximity to the radiohumeral joint.

The superior radioulnar joint is concerned primarily with the movement of pronation and supination. The articular surfaces include the convex, cylindrical-shaped rim of the radial head and the reciprocally shaped osseofibrous concavity created by the radial notch of the ulna and the annular ligament. Normal range (age 20–44) for pronation is reported as 82° for females and 77° for males; supination is 91° for females and 85° for males respectively (Soucie et al. 2010). Pronation range increases in extension, and vice versa for supination (Shaaban et al. 2008). Range is also inversely related to age.

The humeroulnar joint is a uniaxial hinge joint formed between the trochlear notch of the ulna and the trochlea of the humerus. The joint surfaces are saddle-shaped, being concave in the sagittal plane, and convex in the frontal plane (Standring 2008). The axis of movement for flexion and extension is asymmetrical, which accounts for the carrying angle in the terminal range of extension with the forearm supinated. The carrying angle in this position is 17°, with no significant difference between men and women according to a recent large-scale survey (Kumar et al. 2010). Consideration of the carrying angle is important, particularly when mobilizing the elbow in the end-range of extension and supination.

The primary active movements available at the humeroulnar joint are flexion and extension with a small range of pronation and supination. For people aged 20 to 44, normal range for flexion in females is 150° and in males 145°; extension is 5° for females and 1° for males (Soucie et al. 2010).

The asymmetry and saddle-shaped nature of the humeroulnar joint surfaces allow small range of internal and external rotation around the long axis of the ulna (Lockard, 2006). Hence, rotation of the ulna can contribute towards forearm pronation and supination. Coupled internal and external rotation of the ulnar also occurs during flexion and extension (Armstrong et al. 2000): external rotation during flexion in supination; internal rotation during flexion in pronation (Bryce & Armstrong 2008).

Altered ulnar rotation may account for pain and/or limitation of elbow extension (particularly in chronic and recurrent elbow pain disorders, such as throwing injuries). Altered rotation may alter the trochlea articular contact area during movement. In this way, the olecranon moving on the humerus can be likened to the patella moving on the femur. Just as altered patellofemoral dynamics is a commonly postulated cause of anterior knee pain, so altered dynamics of ulnar rotation may also be a common cause of pain and movement limitation at the elbow. In the Mulligan Concept (Mulligan 2010), subtly altering ulnar rotation through mobilization with movement (MWM) can be a potent treatment option to manage some elbow movement disorders.

The radiohumeral articulation is a triaxial ball and socket joint, which lies between the convex-shaped capitulum of the humerus and the concave-shaped radial head. Movements occurring at this joint are flexion and extension as well as pronation and supination. The axis of pronation and supination lies approximately about a line drawn from the centre of the humeral head to the distal head of the ulnar (Bryce & Armstrong 2008). This joint may be dysfunctional in movement-related joint disorders inducing pain in the lateral elbow.

Although the elbow is not typically considered a weight-bearing joint, there are significant compressive and shear forces at the elbow during certain movements. For example, performing a simple press-up induces a compression force of 45% of body weight across the elbow joint (An et al. 1992). Greater force is transmitted through the radiohumeral joint, with only 43% borne by the ulna (Bryce & Armstrong 2008). Hence, weight-bearing function may need to be considered in some patients with elbow pain.

Various nerve trunks pass across the elbow joint, and may be susceptible to abnormal compression loading, or repetitive micro-trauma invoking inflammatory change, at a number of vulnerable sites (Hariri & McAdams 2010). For example, the posterior interosseous nerve is a branch of the radial nerve, which is vulnerable to stress in the radial tunnel, but is most commonly affected as it passes through the tendinous arcade of Frohse on the proximal edge of the supinator muscle (Clavert et al. 2009).

The ulnar nerve may be compressed, inflamed or irritated in the cubital tunnel. The ulnar collateral ligament, the medial edge of the trochlea, and the medial epicondylar groove form the boundaries of the cubital tunnel, with the roof formed by the arcuate ligament complex. A further four sites of ulna nerve compression have been reported in the elbow region (Hariri & McAdams 2010).

The median nerve may be compressed at four sites (Hariri & McAdams 2010): the ligament of Struthers (originates at the supracondylar process and inserts on the medial epicondyle), the bicipital aponeurosis, the pronator teres muscle, and the proximal arch of the flexor digitorum superficialis. The most frequent cause of median nerve compression is dynamic compression of the nerve between the two heads of the pronator teres muscle, exacerbated by forearm pronation and elbow extension.

There are a large number of muscles arising from the elbow, whose main function is to control movement of the wrist and hand. Many muscles merge to attach to the medial and lateral epicondyles, through common tendinous attachments. These structures are susceptible to overload and degeneration that frequently result in pain. Lateral epicondylalgia is reported as up to four to seven times more common than medial epicondylalgia, or golfer's elbow (Rineer & Ruch 2009). The higher prevalence of lateral elbow pain may be due to a number of factors, including differences in forces generated by the extensor muscles as well as differences in size of the tendons area of insertion.

Subjective examination

The first questions the therapist should ask the patient are: 'what is your main problem?'; 'what do you think will happen to you?'; 'what do you think therapy can do for you?'; and 'do you fear harm from physical activity?'. Knowing the patient's attitudes and beliefs towards their problem frequently directs the rest of the examination. These simple questions may alert the astute therapist to the possibility of yellow flags, or psychosocial issues, which require further questions and ultimately to more formal psychosocial screening instruments. Psychosocial factors of a feeling of low job control and low social support are associated with symptoms of lateral epicondylalgia (van Rijn et al. 2009). Further more significant anxiety and depression were detected in 55% and 36% of patients with chronic lateral epicondylalgia, respectively (Alizadehkhaiyat et al. 2007a).

Physiotherapists have been shown to have difficulty in detecting intuitively psychological risk factors such as fear avoidance (Calley et al. 2010). In contrast a simple question such as 'Are you afraid physical activity will cause an increase in your pain?' has been shown to be helpful in identifying people with fear avoidance and catastrophization (Calley et al. 2010). Failure to identify these issues is likely to lead to treatment failure, as is the case in other musculoskeletal disorders such as low back pain.

Body chart

A detailed body chart is an important first step to identify the potential source of the patient's symptoms. The nature of the symptoms and their location may help the therapist to decide which pain mechanisms are predominant (nociceptive, peripheral neuropathic, central mechanisms) (Smart et al. 2010). In the previous edition of this book

(Hengeveld & Banks 2005), it has been suggested that local sources are more likely to be the origin of the symptoms if the symptoms are collectively:

1. Consistent (predictable pain response to activity)
2. Familiar (described as being a joint-like ache)
3. Specific (easily localized in areas of recognizable neuromusculoskeletal structures).

In contrast, referred pain from remote sources will be vague, and more difficult to localize, with spread proximally. Symptoms should follow a predictable response to activity involving the spine or shoulder.

Pain with a dominance of central mechanisms may be suspected (Smart et al. 2010) if the symptoms are collectively:

1. Inconsistent and activity provokes exaggerated responses
2. Diffuse, non-specific, widespread and spreading to other body regions outside the upper limb affected
3. Spontaneous and paroxysmal.

In addition to the words the patient uses to describe the symptoms, non-verbal cues may also enhance the physiotherapist's hypothesis about the disorder. For example, the patient may point precisely to the location of the pain or may use the whole hand to describe a broad area of symptoms or one finger may follow the course of a peripheral nerve. These non-verbal cues may provide further evidence for a local or remote structure as the pain source.

It may be possible for the patient to determine the depth of symptoms. Deep pain over a particular joint line may give indication about structural involvement. Superficial pain over a muscle belly or tendon may be one factor in determining a structural diagnosis. Pain arising from sensitized neural tissue is felt deep, probably because the axons that become mechanosensitized are those that supply deep structures (Bove et al. 2003, 2005). While it is tempting to believe that physiotherapists can identify the pain source from detailed questioning, the validity of these assumptions has not been tested.

Certain areas of symptoms are quite common to specific local elbow structures and are described in Table 5.1.

Where pain is referred into the elbow from other sources a relationship between symptoms and movement in these other areas and the elbow symptoms should be established.

Table 5.1 Elbow symptoms associated with local structures

Elbow symptoms	Local structures
Medial part of the lateral epicondyle	Common extensor origin
Radiohumeral joint line/ posterior aspect of the head of radius	Radiohumeral joint, annular ligament, radioannular joint
Band of pain across the elbow	Radiohumeral, humeroulnar joints
Deep anterior pain	Radiohumeral, humeroulnar, superior radioulnar and median or radial nerves
Surface anterior	Anterior capsule, biceps
Medial epicondyle	Common flexor origin
Ulnar notch	Ulnar nerve

Behaviour of symptoms

A detailed knowledge of the behaviour of the patient's elbow symptoms with movement will help the clinician to decide which movements are impaired and which are likely to reproduce the patient's pain when examined. Furthermore, the ease with which the symptoms are reproduced provides information about the scope the therapist has to examine the elbow and the care required to avoid excessive provocation of the symptoms.

The aggravating activities provoking pain may give clues that can help establish whether the problem is movement related or not. Consequently, those activities causing symptoms may also help to identify the pain source. For example, the patient may report difficulty when: flexing the elbow to dress independently; supinating the forearm to take coins out of a pocket; or extending the elbow to reach to a high shelf or to push open a door. All these functions indicate potential for local joint dysfunction.

An example of pain arising from tendon or contractile structures is a report of medial or lateral epicondyle pain when wringing out a wet towel, or gripping and twisting a heavy door handle. An example of remote structure involvement is lateral elbow pain brought on by a neural provocative position, such as reaching through to the back seats of the car or carrying a heavy bag on one shoulder, or in one hand. Less specific pain, such as aching around the elbow that is not brought on by specific elbow movements or activities, is more likely to be referred pain. Where possible the most specific provocative movement should be identified as this provides information about the movement that should be examined in detail. It also provides information regarding treatment efficacy and direction for progression.

Where possible the level of functional impairment that the patient is experiencing must be quantified. This information is invaluable in determining the level of disability at the outset of the treatment programme and serves as a measure of change or treatment progress. There have been at least five patient self-rated questionnaires described to evaluate elbow disability; however, not all have been validated (Longo et al. 2008). Useful questionnaires include the Disabilities of Arm, Shoulder, and Hand (DASH) and Patient Specific Functional Scale (PSFS). The PSFS is not specific to the elbow and can be used for any body region, and is therefore easy to remember and easy to score.

Construct validity has been demonstrated for the DASH scale (Gummesson et al. 2003, Slobogean et al. 2010). Likewise the PSFS has been shown to be a valid and reliable measure of disability and has been shown to be more sensitive to change following treatment than other measures of disability, pain and physical impairment (Donnelly & Carswell 2002, Pengel et al. 2004). The minimal clinically important change for the PSFS has been reported as 2.0 (Cleland et al. 2006). For the DASH questionnaire the minimal detectable change is 10.5 and the minimal clinically important change is 10.2, where full function is 100.0 (Roy et al. 2009). A short form of the DASH questionnaire has been developed which is more useful than the long form, in the rush of daily clinical practice (Angst et al. 2009).

If the patient can consistently demonstrate an activity or movement that reproduces the symptoms, the potential for structural differentiation is enhanced. For example, if a patient experiences lateral elbow pain, while clenching the fist with the elbow extended and the forearm pronated, the following tests may be considered to isolate the pain source:

- In standing, ask the patient to make a fist with the arm by the side, then with the arm in 90° shoulder abduction and internal shoulder rotation, followed by contralateral cervical flexion and scapula depression. Successive changes in arm position increases the stress on the neural structures in the upper limb, in particular the radial nerve. If the symptoms increase with the concomitant increase in stress applied to the neural system then peripheral nerve sensitization may be postulated and further examination should focus on this (Hall & Elvey 2011).
- In a supine lying position, push the radius cephalad, so that the head of the radius is compressed against the capitulum. If this manoeuvre increases the symptoms significantly, the radiohumeral joint may be considered for further examination.
- If the only factor which alters the patient's symptoms is the strength of the grip and pain is only reproduced on active contraction of the extensor muscles, and during palpation of the common extensor origin, the most likely source of impairment will be of the extensor muscle apparatus.

Pain and stiffness produced in the elbow primarily with a flexion or extension movement would suggest further investigation of the radiohumeral and humeroulnar joints in particular. Pain and stiffness with activities involving pronation or supination suggest that further investigation of the radiohumeral, and radioulnar joints is warranted.

Elbow pain associated with prolonged computer keyboard use or other relatively fixed postural activity is often associated with poor postural and motor control of the spine and scapula. Alternatively peripheral entrapment or mechanosensitization of nerve trunks around the elbow, or in more proximal sites, must also be considered.

Elbow pain with weight-bearing activities through the arm may indicate the need to use compression tests of the elbow joints within examination and possibly treatment to have a better chance of reproducing and affecting the pain experienced.

High-speed movement of the elbow may be the only pain-provocative activity. Pitching in baseball, hurling a javelin, or throwing a cricket ball often causes pain in the posterior and medial elbow. Careful examination of the throwing action will be required, together with analysis of the humeroulnar joint. Elbow collateral ligament stability testing may also be required.

History (present episode and its progression since onset and past episodes and their natural histories)

There are numerous and varied causes for the onset of elbow symptoms. For example, traumatic intra-articular fractures or osteochondral defects cause immediate pain and disability, but may also alter the geometry of the elbow joint, leading to long-term pain and joint stiffness (Nandi et al. 2009). Alternatively, degenerative arthropathies or tendinopathies may result in recurrent episodes of pain, which usually recover over a period of time. Episodes of elbow pain and dysfunction may also follow unusual, prolonged, repetitive or forceful activity such as throwing a ball for the first time, repeatedly or with excessive force. Overuse of the wrist and hand, such as in industrial or repetitive manual tasks, may explain proximal forearm and elbow symptoms (Silcock & Rivett 2004). A previous history of upper limb injury or pain, not just in the elbow, may explain why the elbow has become symptomatic in individual cases.

As is the situation with other musculoskeletal pain disorders, in the majority of cases of elbow pain, the cause of the problem is not specific and there is no recognizable pathology. If symptoms are prolonged or there is recurrence with little evidence of mechanical or stressful triggers, then the identification of the actual and potential barriers to recovery should be considered. Potential barriers to the recovery of severe pain include work-related disease, length of history of the disease, ergonomic risk exposure, job stress, level of job support and pain-coping style (Feuerstein et al. 2000). Other reports of barriers to recovery also include the psychological status of the patient. Alizadehkhaiyat et al. (2007a) found elevated levels of depression in 55% and anxiety in 36% of people suffering from lateral epicondylalgia. Hence, it is important to view elbow problems as a biopsychosocial disorder, rather than a purely biological dysfunction. The psychological status of the patient must be considered.

In addition to the psychosocial status, there may be the potential for prolonged symptoms due to a number of related physical issues, which detailed examinations may identify. The presence of neural symptoms in the arm and cervical joint signs has been associated with poor short–term outcome following local elbow treatment for lateral epicondylalgia (Waugh et al. 2004). Hence, examination of the spine including the rib cage, is important at least in the management of lateral epicondylalgia (Cleland et al. 2004). Altered posture of the upper limb and abnormal patterns of motor control may be risk factors for the development of pain and maybe involved in prolonging recovery. Kelley et al. (1994) identified in subjects with lateral epicondylalgia marked dysfunction of forearm muscle activation, especially of the extensor carpi radialis muscles, along with qualitatively determined altered kinematics of the upper limb when compared with healthy controls. Quantitative evidence of altered postural and motor control in lateral epicondylalgia has also recently been demonstrated (Bisset et al. 2006b).

Special questions

Routine special questions provide information about the potential for serious pathology and should be included in the screening of the patient's condition. Of interest are the patient's recent general health status, related weight loss, the medication they have been prescribed and any medical imaging procedures that have been undertaken. Further information regarding special questions is given in Chapter 1.

Evidence-based practice with reference to manual therapy

Manual therapy for the elbow consists of a wide range of different mobilization or manipulation techniques (MWM), as well as taping procedures and exercise. Although no studies have directly investigated the efficacy of the Maitland Concept for the management of elbow pain disorders, a number of studies have investigated other forms of manual therapy. Lateral epicondylalgia is the most common elbow condition in adults (Hong et al. 2004) affecting up to 3% of the general population, with higher incidence in manual occupations (Shiri et al. 2006). It is not surprising that this condition has been most commonly investigated for manual therapy interventions, probably in part due to the ease in identifying subjects for study inclusion.

Mulligan MWM is the most frequently studied manual therapy intervention for lateral epicondylalgia (Herd & Meserve 2008). These studies had the highest quality research methodology rating scores (PEDro score 6.2/10) when compared to studies investigating other forms of manual therapy (Herd & Meserve 2008).

Pagorek (2009) reviewed the evidence for MWM and found overall that there was strong evidence that MWM reduces pain and increases grip and other muscle strength parameters in people who suffer from lateral epicondylalgia. This review was limited to studies published between 2001 and 2008. From a database search the author identified two randomized controlled trials, one cohort study and two case series meeting the inclusion criteria. Not included in this review was a randomized controlled trial comparing MWM with exercise, to therapeutic ultrasound with exercise and to a control group (Kochar & Dogra 2002). The MWM group showed significantly greater improvement than both the ultrasound group and the control group on pain, weight-lift test, and grip strength. The MWM group showed improvement on most parameters from the first week onwards. An additional investigation compared the effect of MWM combined with Mulligan taping techniques to traditional forms of treatment (Amro et al. 2010). Consistent with previous investigations, this study revealed significantly greater improvement in pain and grip strength in subjects who received the Mulligan approach.

Evidence is available to support beneficial effects of cervical mobilization and manipulation for the treatment of lateral epicondylalgia. Two studies have demonstrated (Vicenzino et al. 1996, 1998) that a cervical mobilization has immediate positive effects on pain-free grip strength, pressure pain threshold and neurodynamics. In addition, it has been reported (Fernandez-Carnero et al. 2008) that a single application of a cervical high velocity thrust had similar effects. However, no long-term follow-up assessment was included. One study (Cleland et al. 2004) of high methodological quality (Herd & Meserve 2008) demonstrated that the addition of cervical spine mobilization to a treatment regimen including manual therapy and exercise directed at the elbow and wrist resulted in significant improvements in pain-free grip, pain, disability, and patient-rated treatment satisfaction when compared with local treatment to the elbow. Outcomes for the cervical mobilization group were found to be superior both at discharge and at six-month follow-up. Thus, the inclusion of the cervical spine in management of lateral epicondylalgia is supported.

Evidence is also available to support the use of manipulative techniques at the wrist for managing lateral epicondylalgia (see Fig. 5.65). Struijs et al. (2003) examined the effectiveness of wrist manipulation compared to local elbow management consisting of friction massage, ultrasound and exercise. This study's findings supported the use of wrist manipulation in management, with significant benefits demonstrated for at least six weeks following treatment.

In terms of manual therapy directed to the elbow region, one study, rated as only fair methodological quality (Herd & Meserve 2008), examined the effectiveness of neural mobilization combined with radial head mobilizations when compared to standard treatment for lateral epicondylalgia (Drechsler et al. 1997). AP radial head mobilization was carried out in a degree of neural provocation for the radial nerve (in elbow extension with shoulder internal rotation and abduction). Results favoured the combined treatment over standard treatment at discharge and up to three months' follow-up.

Exercise has also been shown to be beneficial for lateral epicondylalgia (Bisset et al. 2005). The primary physical impairment is a deconditioning response to pain (Vicenzino 2003). Hence, general strengthening exercises should be considered for the whole upper limb. At least exercises should include strengthening of the forearm muscles controlling wrist/finger flexion and extension, as well as supination/pronation and radial/ulnar deviation. Furthermore, stretching exercises for the muscles around the forearm should be considered, in addition to re-education of motor control of the wrist during gripping activities (Bissett & Vicenzino 2011).

An eight-week exercise programme provided positive benefits in a chronic population, who had failed other conservative treatments, including corticosteroid injection (Pienimaki et al. 1996). Similarly researchers found that, compared with an ultrasound treatment, exercise resulted in fewer medical consultations, less surgery and fewer sick days (Pienimaki et al. 1998). Likewise, a randomized controlled trial revealed that a supervised exercise programme brought about the largest reduction of pain and improvement in function through a six-month follow-up period, compared with Bioptron light therapy and Cyriax physiotherapy techniques (Stasinopoulos & Stasinopoulos 2006).

Hence, it is apparent from this brief review of the literature that lateral epicondylalgia may be managed by a number of different treatment approaches. This is in no way a weakness of manual therapy. Rather, it probably indicates that lateral elbow pain is a multisystem problem affecting the local elbow and remote articular, neural and musculotendinous structures. Different manual therapy concepts and treatment techniques may address different components of lateral epicondylalgia. Further research is required to investigate whether treatment matched to clinical assessment findings of all potentially involved structures provides any additional benefit over a more prescriptive approach.

Recently it has been shown that pain accounts for between 41–66% of the variability in disability following elbow trauma (Doornberg et al. 2005, Lindenhovius et al. 2008). In contrast, physical impairment in elbow movement only accounts for between 17–35% (Doornberg et al. 2005, Lindenhovius et al. 2008). This evidence strengthens the case for a multisystem biopsychosocial approach to the examination and management of elbow disorders. Clinical evaluation should encompass evaluation of pain, disability, psychosocial barriers to recovery, as well as a detailed physical examination. Physical examination includes the elbow joints accessory, physiological and combined movements. In addition, evaluation should encompass upper quarter dynamic postural and motor control, as well as simple tests of elbow muscle function. Including detailed examination of the cervical and thoracic spine, upper limb neurodynamic tests and neurological function will only serve to enhance the diagnostic, treatment and management role of manual therapy in elbow disorders.

Physical examination: elbow region

The following is a checklist for an integrated approach to the physical examination of the elbow region, as summarized in Boxes 5.1–5.4 (Maitland 1992).

Box 5.1

Physical examination of the composite elbow

Observation

***Functional demonstration/tests**

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)
- Dynamic upper limb motor control

Brief appraisal

Active movements (move to *pain* or move to *limit*)

- F, E (as applicable, bouncing F and E in full pronation and supination)
- Sup, Pron (as applicable, performed in F and E)
- Active neurodynamic screening tests

Isometric/muscle length tests

Other structures in 'plan'

- Thoracic outlet/cervical radiculopathy
- Peripheral nerve involvement

Passive movements

As applicable

- F, E; Sup and Pron as IV− to IV+ to III++

Differentiating as required

1. F and E as IV+ at limit of range
   a. F/Ab, F/Ad, E/Ab, E/Ad. Ab and Ad in the first 5° of F and full E
   b. ↔ (in line with humerus) ceph and caud
      (i) on radius (radiohumeral) (R/H) joint or superior radioulnar (R/U) joint add superior R/U compression to differentiate between R/H and superior R/U
      (ii) on ulna (humeroulnar joint)
   c. ↔ (in line with radius) ceph and caud
      (i) on radius (R/H or superior R/U joint) add superior R/U compression to differentiate between R/H and superior R/U
      (ii) on ulna (humeroulnar joint)
2. Sup and Pron as IV+ at limit of range
   a. ↓, ↑ on head of radius (superior R/U or R/H joint)
      add compression of superior R/U joint to differentiate between radiohumeral and superior R/U joint.
   b. ↓, ↑ on ulna (humeroulnar joint)

Box 5.1—cont'd

3. Other differentiating tests
   - **(a)** ↓, ↕, ↙, ↑, ↖, ↗ on head of radius in different positions of elbow F and E
   - **(b)** →•→, ←•— on olecranon and coronoid
4. Combined movements
5. Differentiation tests
6. Neurodynamic tests for the median, radial and ulnar nerves

Palpation

- + When 'comparable signs' ill-defined, reassess 'injuring movement'
- Relevant tenderness (ulnar and median nerve)

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 5.2

Physical examination of the radiohumeral joint

The routine examination of this joint must include examination of other joints forming the elbow.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)
- Dynamic upper limb motor control

Brief appraisal

Active movements (move to *pain* or move to *limit*)

Routinely

- F, E; Sup and Pron in F and E
- Note range, pain
- Active neurodynamic screening tests

As applicable

- Speed of tests movements
- Specific movements which aggravate
- The injuring movement
- Movements under load
- Cervical radiculopathy tests
- Muscle power

Isometric/muscle length tests

- Muscles in 'plan' including clenching fist in different positions of elbow

Other structures in 'plan'

- Thoracic outlet/cervical radiculopathy
- Peripheral nerve involvement

Passive movements

Routinely

1. F, E; Sup and Pron in F and E
2. ←•→ ceph and caud (by wrist deviations) in different angles of elbow from full F to full E, and full supination to full pronation
3. ↓, ↑ in different positions of F, E, Sup, Pron, without compression and with compression

Note range, pain, resistance, spasm and behaviour

As applicable

1. Differentiation tests
2. Neurodynamic tests for the radial nerve

Palpation

- + When 'comparable signs' ill-defined, reassess 'injuring movement'
- Relevant tenderness (radial nerve)

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 5.3

Physical examination of the humeroulnar joint

The routine examination of this joint must also include examination of the superior radioulnar (R/U) joint as supinator/pronator torsion is possible at the humeroulnar joint.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)
- Dynamic upper limb motor control

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

- F, E; Sup and Pron in F and E
- Note range, pain
- Active neurodynamic screening tests

As applicable

- Speed of tests movements
- Specific movements which aggravate
- The injuring movement
- Movements under load
- Thoracic outlet/cervical radiculopathy tests
- Muscle power

Isometric/muscle length tests

- Muscles in 'plan' including clenching fist in different positions of elbow

Other structures in 'plan'

- Thoracic outlet/cervical radiculopathy
- Peripheral nerve involvement

Passive movements

Physiological movements

Routinely

- F, E; Sup and Pron in F and E

Note range, pain, resistance, spasm and behaviour

As applicable

- E/Ab, E/Ad, F/Ab, F/Ad, Ab and Ad in 5° F and E

Accessory movements

As applicable

1. →•→, ←•← (i) on olecranon
   (ii) on coronoid
2. ←•→ caud. (humeral line) in 90° elbow F
   - (i) on olecranon (thumbs)
   - (ii) on coronoid (thumbs)
   - (iii) general humeral line
3. F over wrist in anterior elbow line
4. ←•→ ceph, caud ulnar line (with wrist deviations) in different angles of elbow F and E

   Note range, pain, resistance, spasm and behaviour
5. Differentiation tests
6. Neurodynamic tests for the median, radial and ulnar nerves

Palpation

- Altered sensation
- Relevant tenderness (ulnar, radial, and median nerve)
- When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records etc.

Highlight main findings with asterisks

Instructions to patient

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In standing

- Observation of:
  - alignment faults: from front, back and side
  - asymmetry: adaptive and protective deformity
  - soft tissue changes: swelling, thickening
  - bone structure: olecranon, epicondyles.
- Present pain.
- Functional demonstration/active functional movements and differentiation.
- If necessary tests – elbow.
- Brief appraisal/screening of shoulder range of movement and dynamic control.
- Active screening for median, radial and ulna nerve peripheral sensitization (Hall & Elvey 2011).

In sitting

- Cervical spine brief appraisal/screening tests of single plane and combined movements.
- Screening for cervical radiculopathy using lower cervical quadrant (Maitland et al.

Box 5.4

Physical examination of the superior radioulnar joint

The routine examination of this joint must also include examination of the humeroulnar and radiohumeral joints.

Observation

***Functional demonstration/tests**

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)
- Dynamic upper limb motor control
- Active neurodynamic screening tests (radial nerve)

Brief appraisal

Active movements (move to *pain* or move to *limit*)

- As described for the elbow joint

Isometric tests

Other structures in 'plan'

- Thoracic outlet/cervical radiculopathy
- Peripheral nerve involvement

Passive movements

Physiological movements

- As for elbow joint

Accessory movements

Routinely

1. Ab and Ad of elbow in 5° F (Sup R/U)
2. ↔ ceph, caud (ulnar line) in different angles of elbow F and E and different angles of Sup and Pron (using wrist deviations) without compression and with compression
3. ↑ and ↓ and each in full pronation and full supination
4. Supination/pronation with compression

As applicable

1. Differentiation tests
2. Neurodynamic tests for the radial nerve

Palpation

- \+ When 'comparable signs' ill-defined, reassess 'injuring movement'
- Relevant tenderness (radial nerve)

Check case records etc.

Highlight main findings with asterisks

Instructions to patient

Reproduced by kind permission from Maitland 1992.

2001), incorporating axial compression if required.

- Thoracic spine brief appraisal/screening (Maitland et al. 2001).
- Grip strength, pain provocation and pattern of motor control in full elbow extension with forearm pronation.

In supine

- Palpation for hyperalgesia (joint lines, peripheral nerves, common flexor and extensor origins in particular).
- Isometric testing: (1) grip strength in elbow extension; (2) wrist extension; (3) individual metacarpal extension, especially the third, which is the insertion site for extensor carpi radialis brevis.
- Muscle length: (1) finger extensors; (2) wrist extensors; (3) finger flexors; (4) wrist flexors; (5) biceps length; (6) triceps length.
- Elbow passive movements.
- Elbow extension, extension/adduction, extension/abduction.
- Elbow flexion, flexion/adduction, flexion/abduction.
- Pronation/supination.
- Differentiation tests in flexion/extension or pronation/supination.
- Accessory movements: radiohumeral, radioulnar, humeroulnar.
- MWM: pain-free accessory glide combined with dominant dysfunctional elbow movement or activity.
- Cervical anteroposterior movement (Maitland et al. 2001).
- Shoulder quadrant and locking position.
- Brief appraisal tests/screening wrist and hand and inferior radioulnar joint.
- Upper limb neurodynamic and nerve palpation tests (Hall & Elvey 2011).

- C3–C7 passive physiological intervertebral movements (PPIVMs) (Maitland et al. 2001).
- Neurological examination for peripheral nerve compression or radiculopathy.

In side lying

- C7–T4 PPIVMs (Maitland et al. 2001).

In prone lying

- Olecranon accessory movements in elbow flexion.
- Posteroanterior movement of the head of the radius in elbow extension.
- Passive accessory intervertebral movements (PAIVMs) cervical and thoracic spine.
- Rib accessory movements, rib springing (Maitland et al. 2001).

Precautions and planning

- *Explanation*: The patient should be informed at every stage of examination and treatment. The therapist should inform the patient, as far as is possible, about the nature of the problem, the options for treatment (including benefits and risks) and the expected responses to treatment.
- *Warning*: After examination (and first treatment) the patient should be warned that there may be some treatment soreness over the next day or so. This is because the joint has been moved, both during examination and treatment, in ways that it has not been moved before or for a while.
- The therapist should check the case notes and medical imaging and plan treatment and reassessment.

Physical examination: the elbow complex

Observation

- In most cases patients with insidious onset elbow pain will have no obvious visual abnormalities of the elbow itself. However, there may be evidence of poor posture of the shoulder girdle and spine.
- Fractures or definite trauma often present with swelling or bony deformity.
- Prominence and local swelling of the medial or lateral epicondyle may be a feature of acute epicondylalgia.
- Antalgic postures may include holding the elbow flexed to avoid painful extension or keeping the forearm pronated to avoid painful supination. Antalgic postures for sensitized neural structures include holding the elbow flexed, with the shoulder girdle elevated and adducted.

Functional demonstration/injuring movements/active functional movements and differentiation of these movements (to P_1 or limit)

Observe for abnormalities in quality of movement and common alignment faults; for example, the patient may externally rotate and adduct the shoulder to avoid having to supinate the forearm. For overuse disorders there may be subtle signs of poor control, involving the whole upper limb kinetic chain (Ellenbecker et al. 2010a), and these should be evaluated in detail.

If elbow pain is reproduced during grip strength testing, but is relieved by MWM, such as a lateral glide or PA glide on the radius, this should be incorporated into functional rehabilitation.

Active movements or *brief appraisal* of the elbow should include flexion, extension, pronation and supination (Figs 5.1–5.4). If active movement is pain free, the patient can be asked to flick the elbow further into the movement as a means of applying natural overpressure.

Only if the patient has a consistent, reproducible functional demonstration will further differentiation be possible.

A patient with deep anterior elbow pain may demonstrate that the pain is always felt when the elbow is flexed from 75° to 95°. If the painful movement is repeated with compression or distraction of the radiohumeral joint, compression or distraction of the humeroulnar joint or repeated flexion/extension movement in different positions of pronation/supination, a more accurate localization of the source of the symptoms will help in the choice of treatment technique (Figs 5.5–5.8).

Figure 5.1 • Elbow flexion.

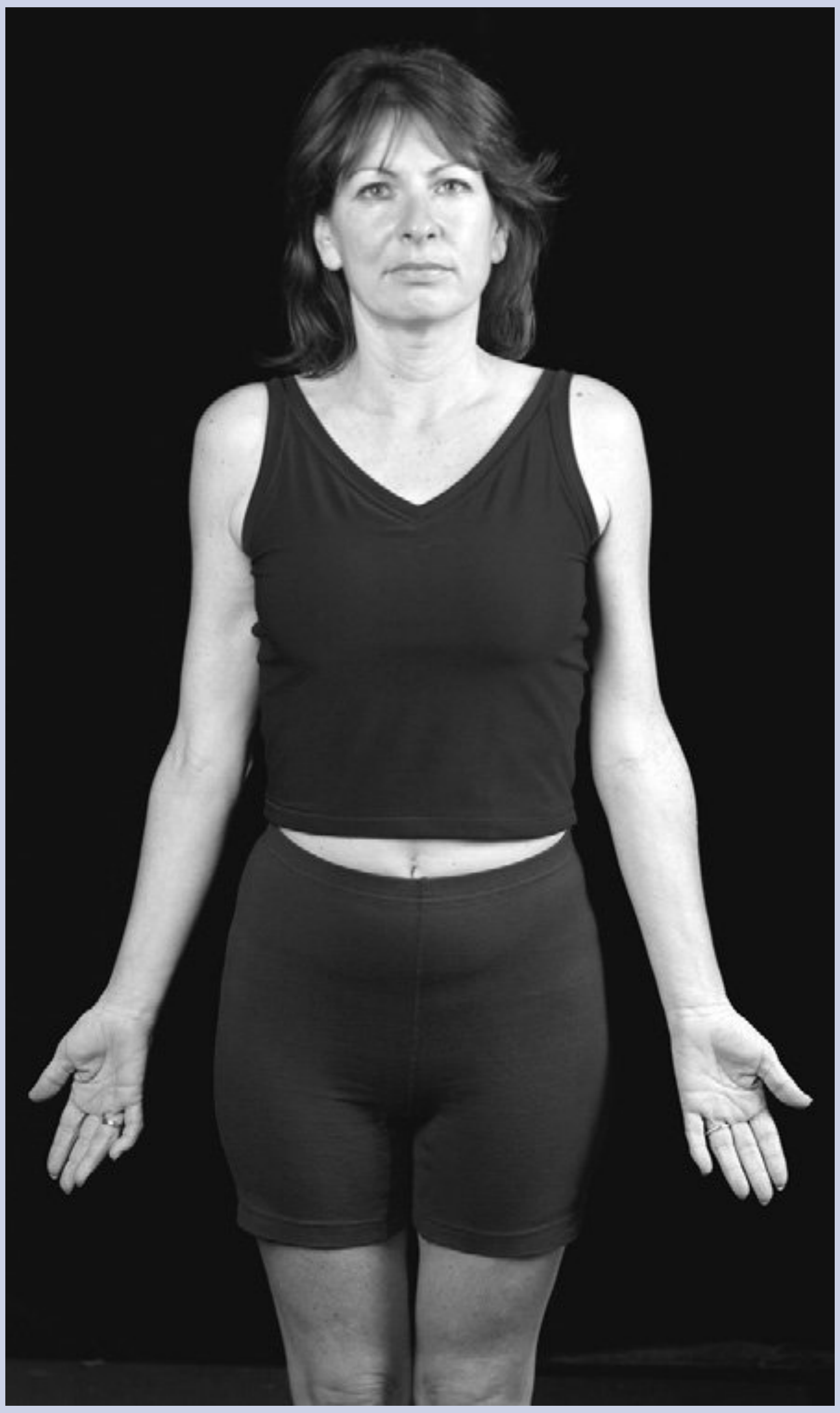

Figure 5.2 • Elbow extension.

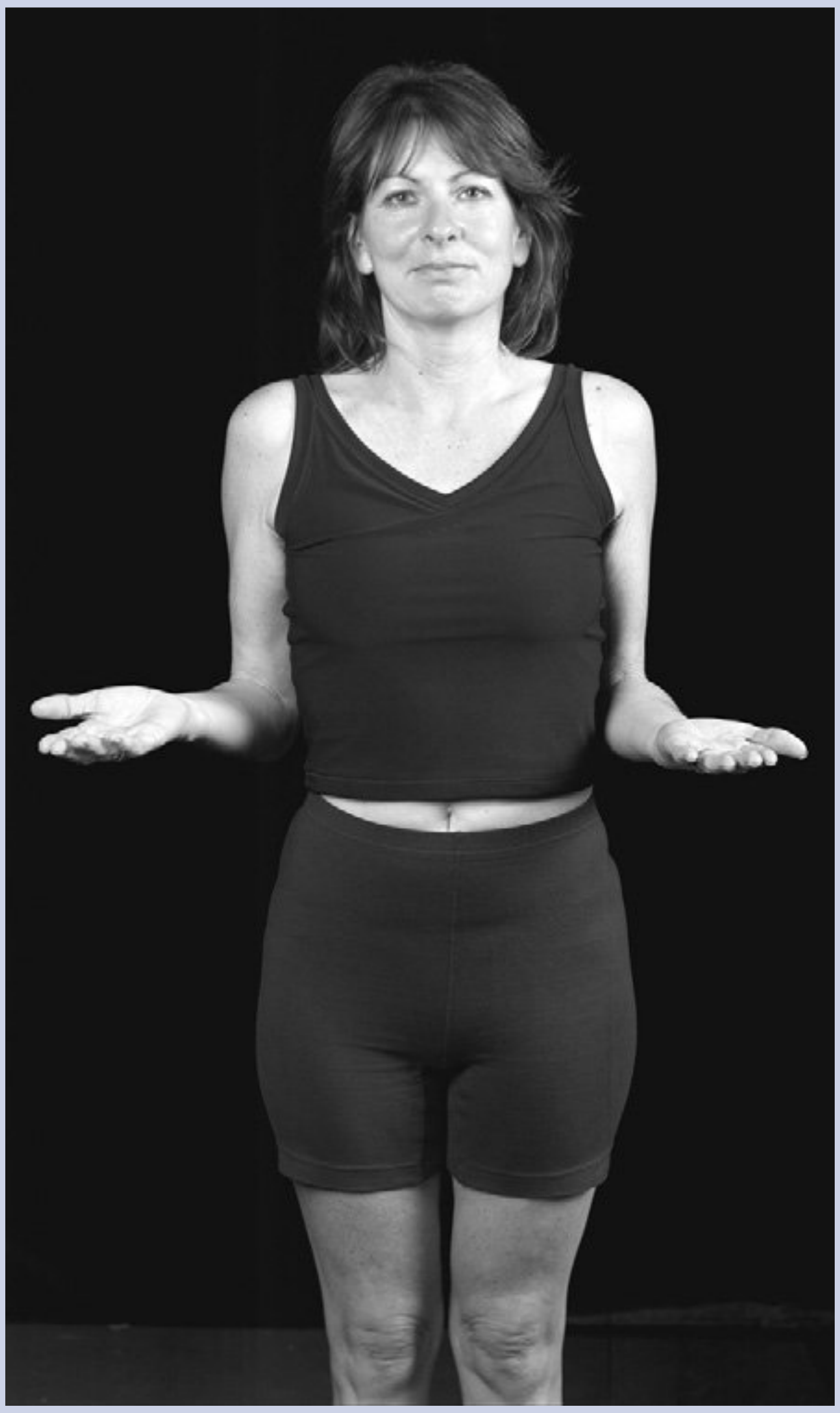

Figure 5.3 • Elbow supination.

Figure 5.4 • Elbow pronation.

Figure 5.5 • Elbow flexion to 75°.

Figure 5.6 • Radiohumeral compression.

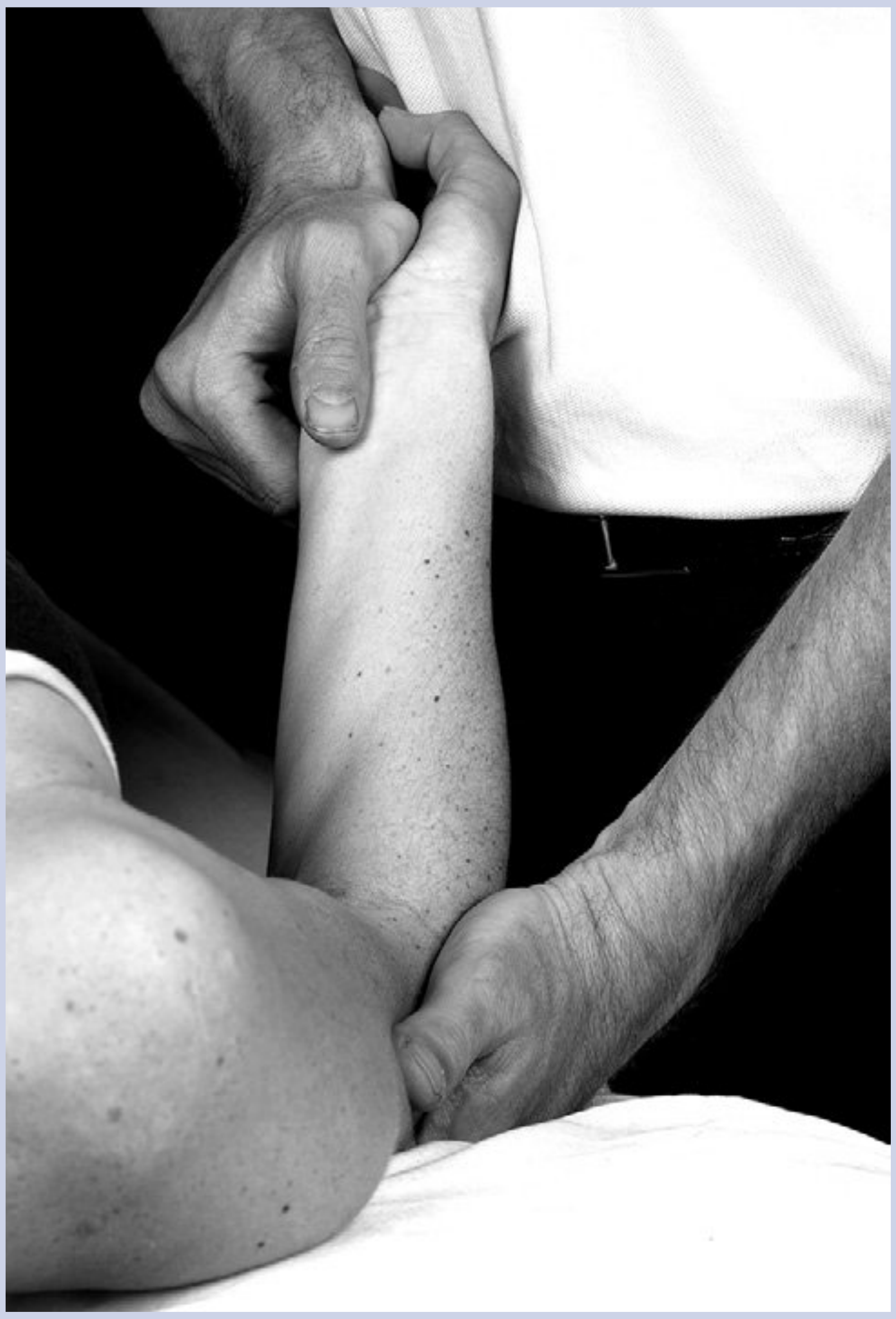

Figure 5.7 • Humeroulnar compression.

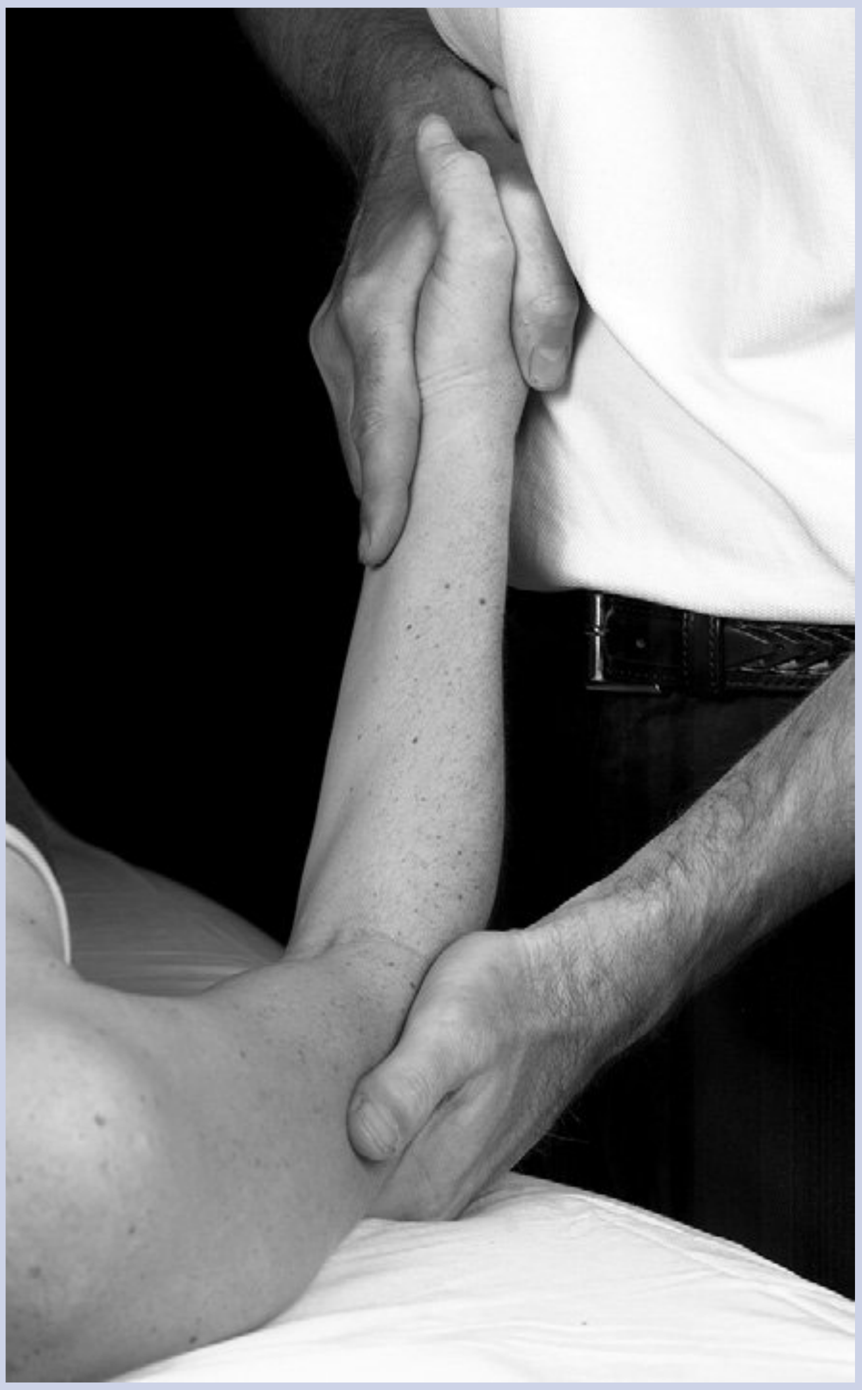

Figure 5.8 • Different positions of pronation/supination.

A patient with lateral elbow pain may demonstrate that the pain is always felt when twisting (pronating) the forearm while using a screwdriver (loaded). If the painful movement is performed with radiohumeral compression or distraction, superior radioulnar joint compression or in different positions of flexion and extension, an accurate treatment technique can be determined (Figs 5.9–5.13).

A patient with lateral epicondylalgia may complain of pain when gripping a golf club. The patient may be able to demonstrate, consistently, the reproduction of this pain. In the painful position accessory movements on the head of the radius may reveal pain or stiffness, indicating articular involvement. Likewise, pain elimination while eliciting a sustained glide on the radius (Fig. 5.14) or ulna (Fig. 5.15) indicates the potential for MWM in management. Hence, any change in pain on gripping, when mobilizing the radius, is important. In the painful position, the addition of shoulder depression and contralateral cervical lateral flexion may reveal abnormality of radial nerve mechanosensitivity (Fig. 5.16). Dysfunction of cervical active range of motion in the cardinal planes or of combined movement tests raises the importance of further tests of the cervical spine. An increase in pain with isometric testing of wrist and finger extension (in the absence of any other movement-related signs or neural involvement) may suggest musculotendinous origins to the patient's symptoms.

If necessary tests

Frequently elbow pain is associated with vigorous sporting activity or injury. In such cases it may only

Figure 5.9 • Radioulnar pronation.

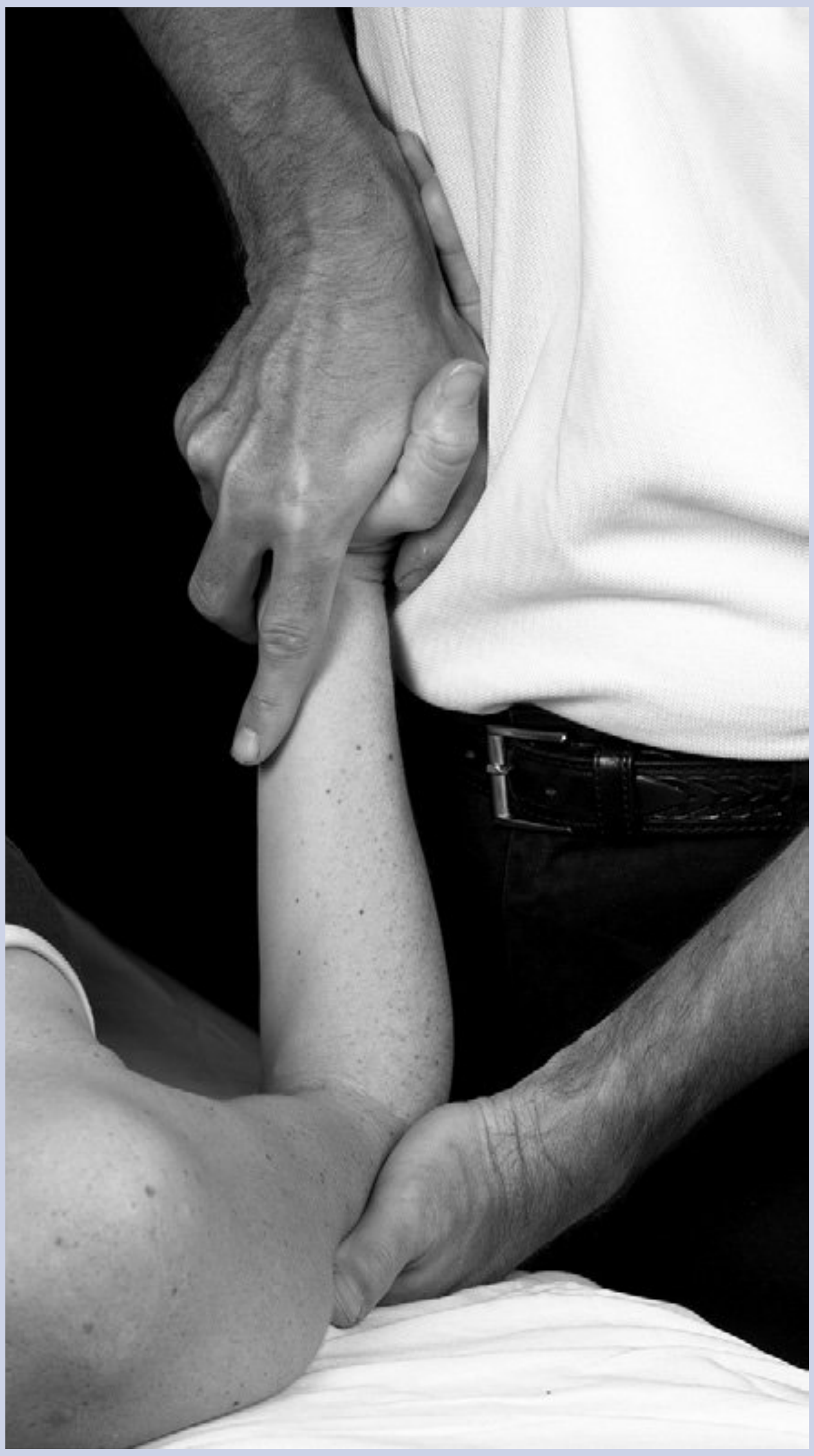

Figure 5.10 • Radiohumeral compression added.

Figure 5.11 • Radiohumeral distraction added.

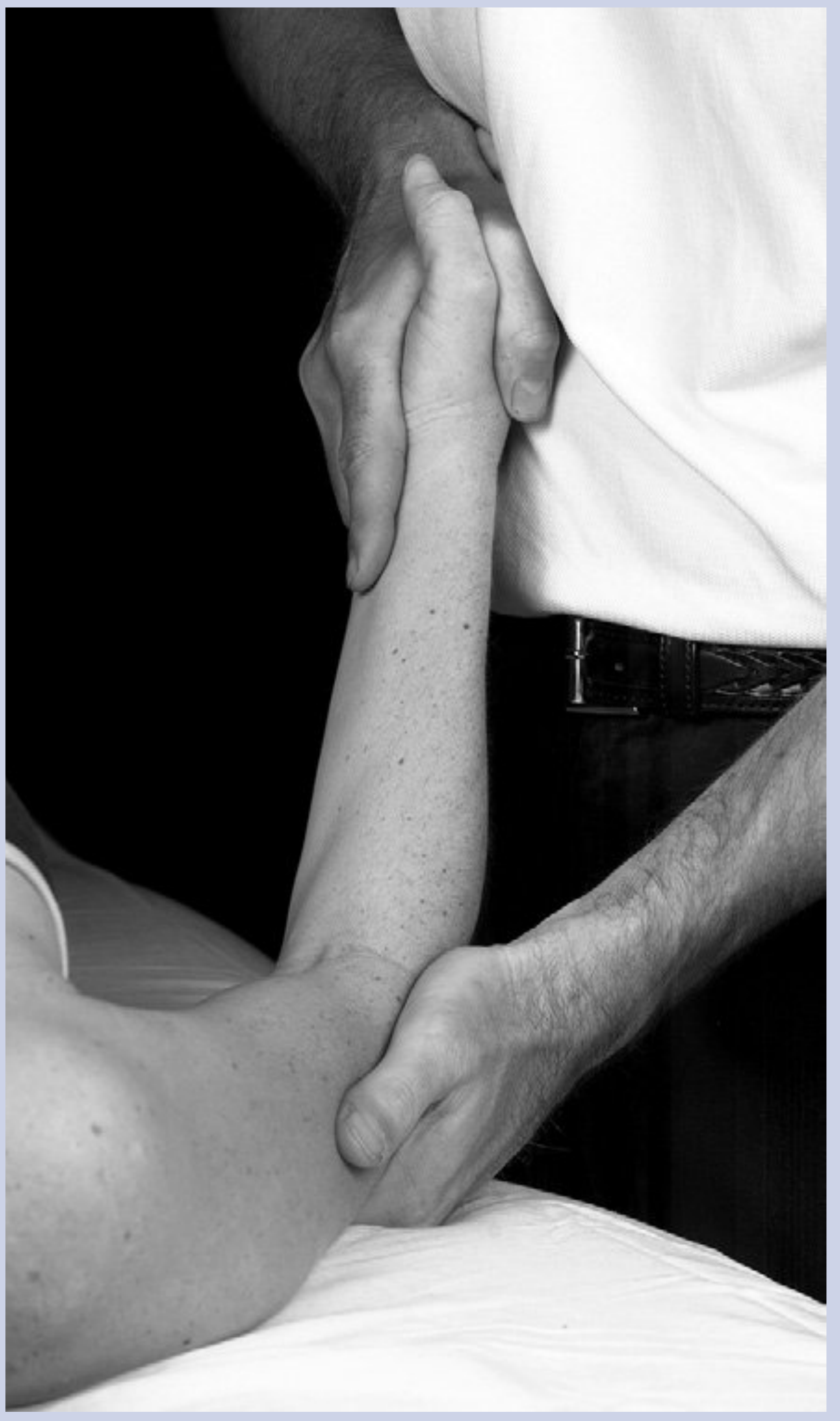

Figure 5.12 • Different positions of flexion/extension.

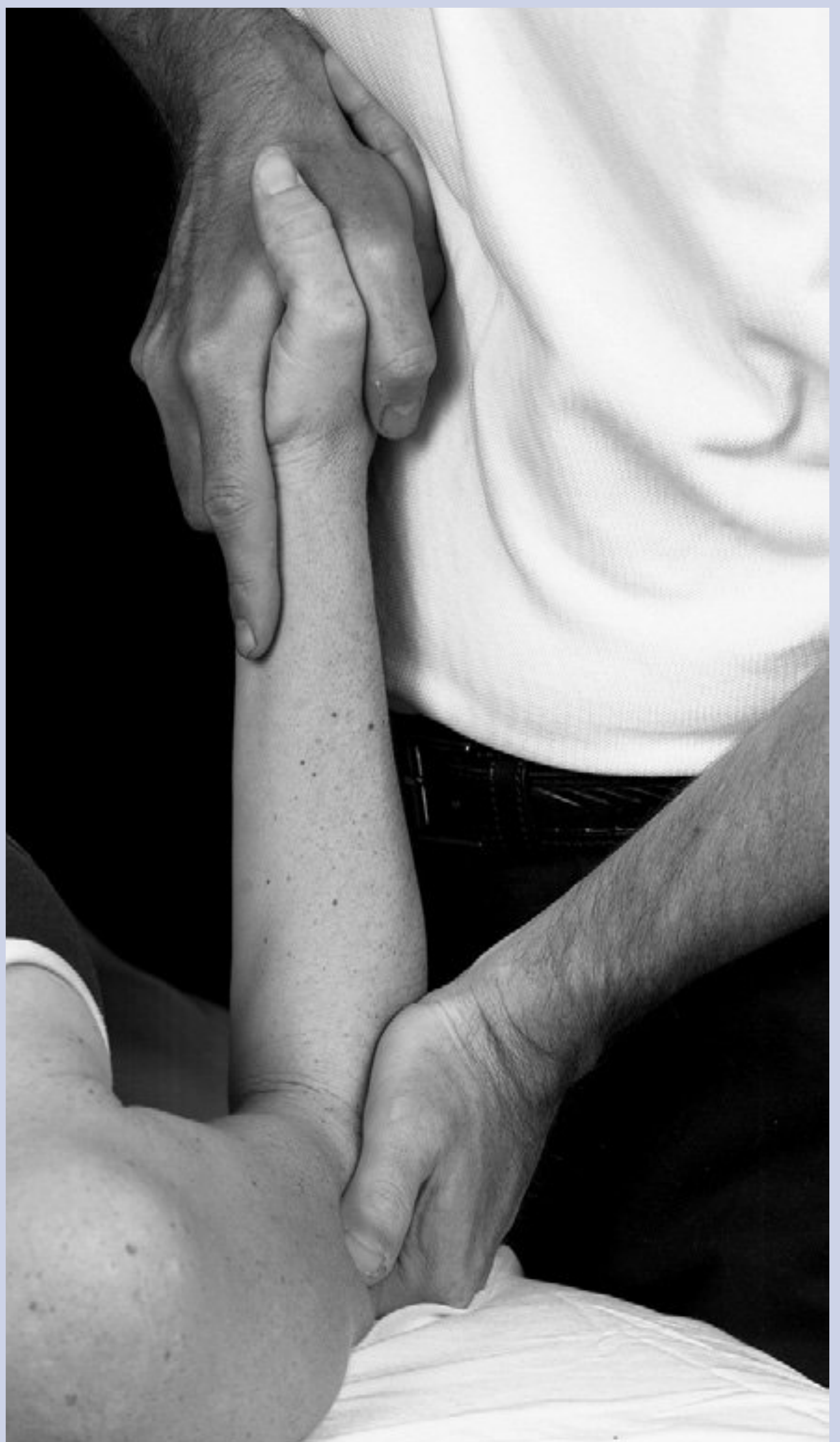

Figure 5.13 • Superior radioulnar compression added.

Figure 5.14 • MWM radius pain on gripping golf club – PA radius.

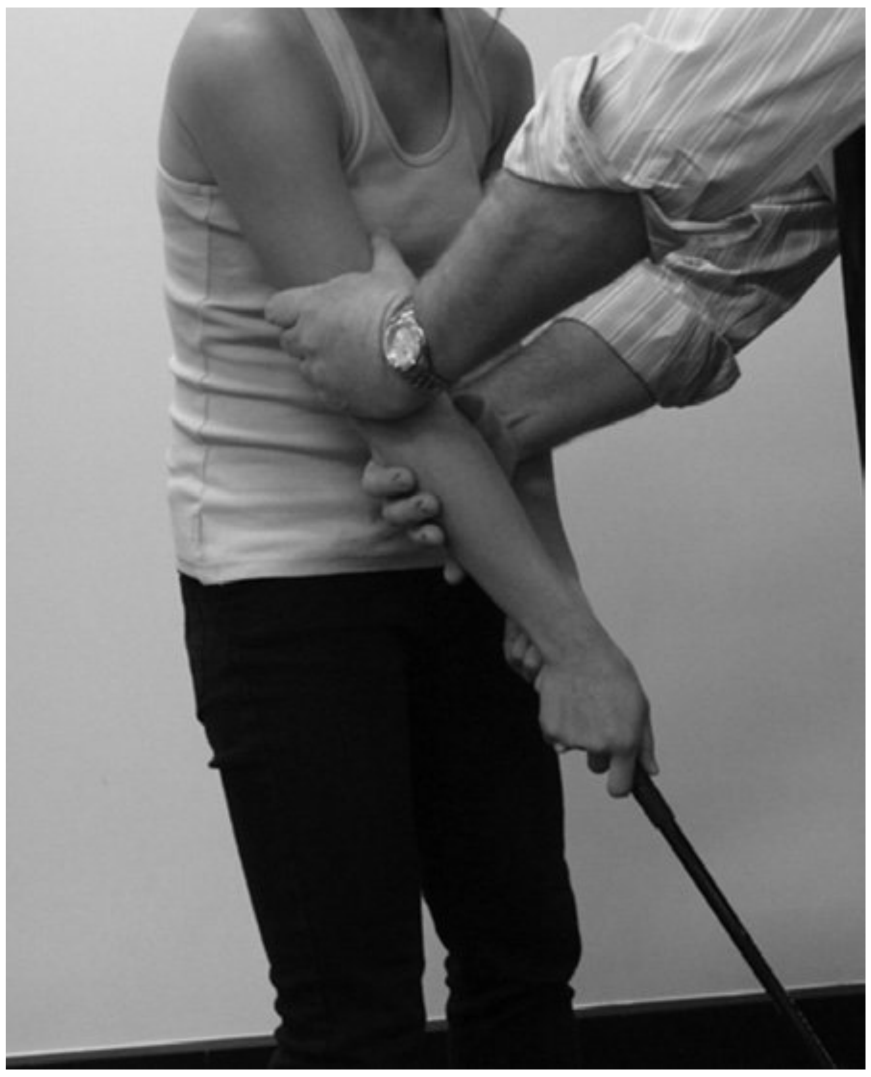

Figure 5.15 • MWM ulna pain on gripping golf club lateral glide.

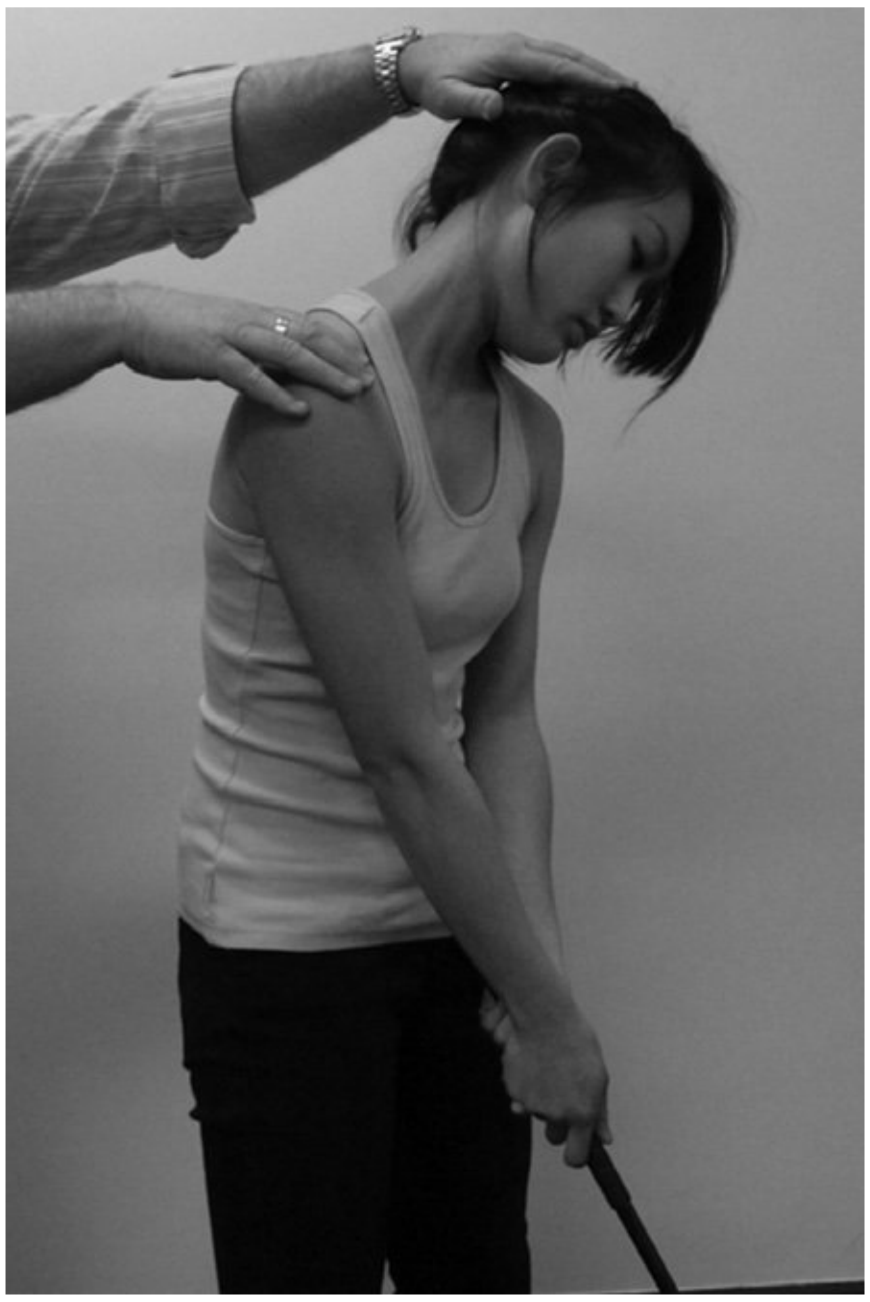

Figure 5.16 • Neural differentiation.

be possible to reproduce the patient's pain by asking them to perform the offending activity at speed (throwing a cricket ball or equivalent), repeatedly (table tennis backhand) or for a sustained period (gripping a ski pole).

Upper limb dynamic control

In those people where elbow pain arises from repetitive stress or overuse, careful consideration should be given to the posture and dynamic control of the whole upper kinetic chain (Ellenbecker et al. 2010ab). Such poor control may place abnormal stress on the elbow, hence may be a contributing factor towards the cause of the problem or may also provide a barrier towards recovery. There is evidence to support this idea. Silcock et al. (2003) found evidence of altered upper limb muscle activity during various arm movements in people with lateral elbow pain when compared to asymptomatic controls. Dysfunctional muscles included those around the elbow and wrist, but also included pectoralis major and middle trapezius. Other studies have also found evidence of altered motor control in people with lateral elbow pain (Bisset et al. 2006b, Pienimaki et al. 1997). It is unclear whether poor control is a consequence or cause of pain. However, it would appear logical that poor posture and dynamic control of the upper limb impacts on the elbow. Indeed, poor cervical and shoulder girdle posture has been linked with a range of upper limb disorders including the elbow (Pascarelli & Hsu 2001) in addition to more distal problems such as carpal tunnel syndrome (De la Llave Rincon et al. 2009, Pascarelli & Hsu 2001).

Evaluation of scapula dynamic control can be determined through the observation of shoulder elevation through flexion and abduction (Tate et al. 2009, Uhl et al. 2009). Increasing load during these movements with small hand weights may also be beneficial in emphasizing poor scapula control. This method of determining poor control has been shown to be reliable (McClure et al. 2009).

In addition to the shoulder girdle, it is important to evaluate the control of the wrist during gripping activities. During grip strength tests, patients with lateral epicondylalgia typically flex the wrist by an average of 11° more than asymptomatic people (Bisset et al. 2006b). This may be due to weakness of the extensor carpi radialis (Alizadehkhaiyat et al. 2007b). People who suffer with lateral epicondylalgia are generally weaker in selected upper limb movements, probably due to pain inhibition or disuse (Alizadehkhaiyat et al. 2007b). Consequently, caution should be taken when interpreting strength differences on the symptomatic side compared to normal values or the non-involved side. Bisset et al. (2006b) found increased strength values on the non-involved side in lateral epicondylalgia compared to healthy controls. This finding may indicate a compensatory mechanism or may reflect an underlying cause of this condition.

Muscle isometric and length testing

The goal of muscle isometric and length testing is to evaluate for the presence of muscle disorders, either of the contractile fibres or of the muscle origin and insertion. Caution is necessary when interpreting pain as a consequence of isometric muscle tests. Muscle contraction may stress sensitized neural tissue or compress painful joints. These tests should be viewed in the context of the whole physical examination.

Isometric testing as a pain provocation procedure is required in cases of medial and lateral elbow pain when gripping and/or loaded wrist or finger flexion or extension are pain provocative.

The best position for isometric testing is with the patient lying supine. For pain over the lateral epicondyle the elbow should be fully extended and pronated. Pronation is thought to exert more tension on the common extensor origin. Commonly the middle finger reproduces lateral elbow pain most readily when resisted isometrically in wrist extension. Extensor carpi radialis longus and brevis attach to the third metacarpal and provides the most extensive component of the common extensor origin (Standring 2008). High levels of stress in the extensor carpi radialis brevis musculotendinous unit, has been suggested to be the cause of pain in overuse disorders of lateral epicondylalgia (Coombes et al. 2009). For medial elbow pain the flexor carpi radialis is most commonly involved and testing should involve wrist flexion and pronation.

Muscle length testing should be undertaken as required for muscles passing over the elbow such as the finger extensors and flexors, as well as muscles acting on the elbow such as biceps and triceps.

Palpation

Palpation requires an accurate knowledge of surface anatomy. Figure 5.17 shows some relevant sites for palpation of the elbow, including joint lines, peripheral nerves and myofascial structures.

Abnormal sensitivity to gentle palpation (allodynia, secondary hyperalgesia) at sites around the elbow in the absence of signs of tissue damage or inflammation may be due to central mechanisms, with an increase in central sensitization, or may be referred tenderness from the spine (Blake & Beames 2012).

Upper limb neurodynamic tests, nerve palpation and neurological examination

There is potential for neural disorders to contribute to elbow pain and functional disability (Hariri & McAdams 2010). Such disorders need to be differentiated according to underlying pathophysiological mechanisms (Hall & Elvey 2011). Neural disorders can be classified according to clinical examination criteria into three categories: neuropathic sensory hypersensitivity (NSH); compressive neuropathy (CN); and peripheral nerve sensitization (PNS) (Schäfer 2009a). Classification is important because each subgroup has been shown to respond differently to neural mobilization. In the lower limb at least, PNS responds favourably to neural mobilization, while NSH does not (Schäfer et al. 2011).

Similarly in the upper limb, people with clinical features of NSH have been shown to respond poorly to manual therapy (Sterling et al. 2006). Neuropathic sensory hypersensitivity encompasses major features of neuropathic pain, comprising sensory sensitization such as allodynia, hyperalgesia and paroxysmal pain. CN arises from significant axonal and fascicular compromise with marked sensory and/or motor deficits. PNS develops from nerve trunk inflammation, which causes nervi nervorum and axonmechanosensitivity (Bove & Light 1997, Bove et al. 2003, Dilley et al. 2005).

Clinical classification of neural pain disorders is hierarchical. First the Leeds Assessment for Neuropathic Symptoms and Signs (LANSS) scale (Bennett 2001) is used to determine the presence of positive features of NSH. If the LANSS scale is negative (less than 12), then the neurological examination (Blake & Beames 2012) is used to identify the presence of CN. Finally in the absence of CN, collectively active neurodynamic screening tests, passive neurodynamic tests and nerve palpation (Blake & Beames 2012) indicate the presence of substantial PNS. Reliability of this classification system has been demonstrated in the lower limb (Schäfer et al. 2009b) and there is some evidence of validity at least in people with lumbar related leg pain (Schäfer et al. 2009c, 2013).

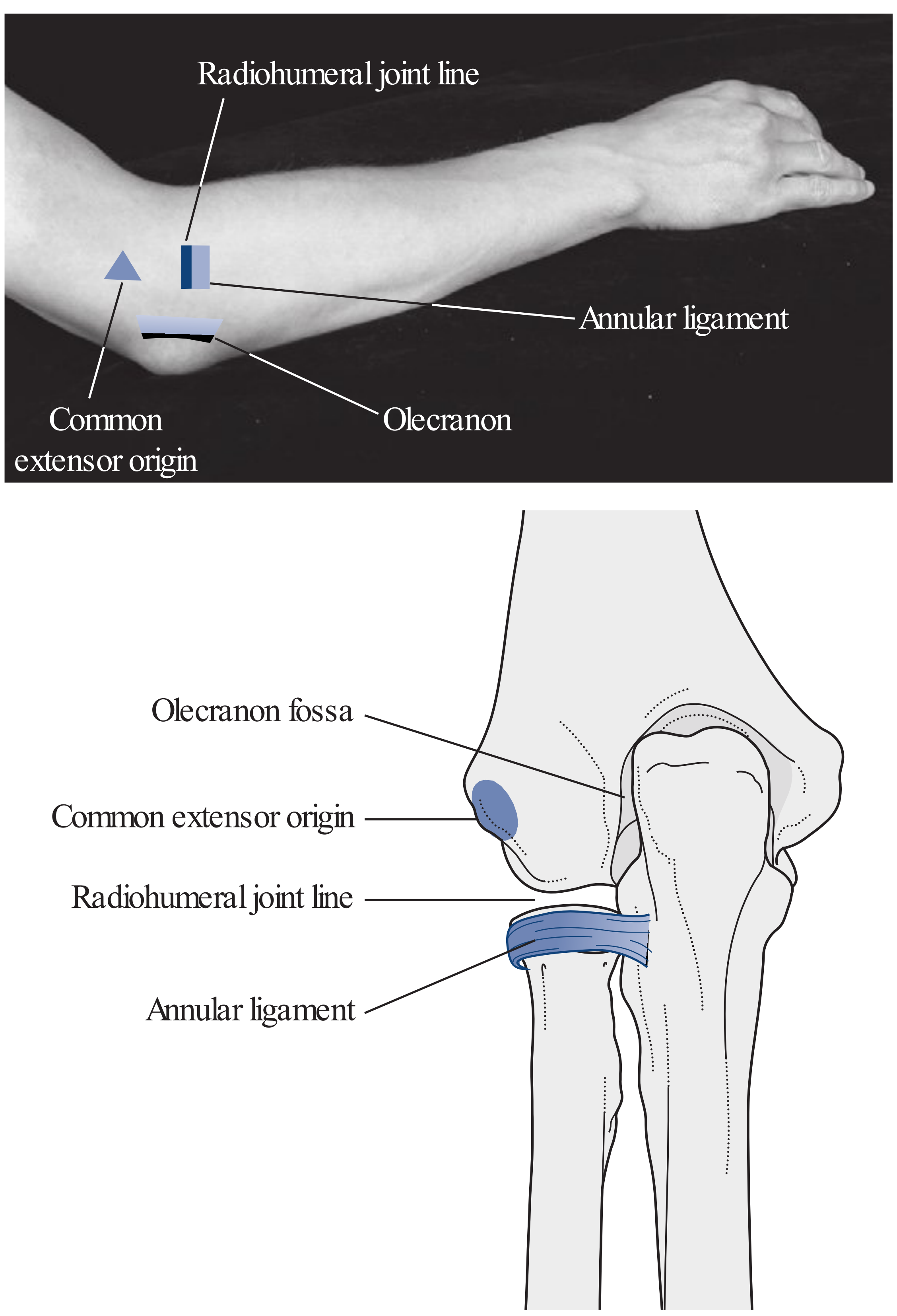

Figure 5.17 • Palpation sites, lateral elbow pain.

With respect to symptoms in the elbow region, the most relevant categories are CN and PNS. All three major nerves cross the elbow where they may be vulnerable to compression forces and/or inflammation (Hariri & McAdams 2010). Hence it is important to consider neural disorders of the median, radial, and ulnar nerves.

The *ulnar nerve* should be examined if the patient complains of medial elbow pain and symptoms in the distribution of the ulnar nerve. For example, a patient may complain of medial elbow pain and paraesthesia in the little finger as a result of throwing a baseball, thus suggesting a potential for ulnar nerve involvement. Distinguishing between a true compression neuropathy (CN) and PNS of the ulnar nerve requires comprehensive examination of the elbow and cervical spine. A neurological examination must be conducted to determine the presence of CN, which may arise from localized compression in the cubital tunnel, or more proximally in the cervical spine or thoracic outlet. In the absence of neurological deficit, the presence of PNS can be ascertained. An active neurodynamic screening test for the ulnar nerve is carried out first (Fig. 5.18) and a positive test would be indicated by limitation of movement or reproduction of symptoms (Hall & Elvey 2011). Following this, if the ulnar nerve neurodynamic test (Fig. 5.19) reproduces the patient's symptoms (in the absence of such signs for the median and radial nerve) and the ulnar nerve is maximally hyperalgesic on palpation along its course (see Fig. 5.30), at points immediately distal and proximal to the cubital tunnel, sensitization of the ulnar nerve can be confirmed.

A recent study evaluated 70 consecutive patients with cubital tunnel syndrome, who had clinical features of ulnar neuropathy at the elbow (Svernlov et al. 2009). All had medial elbow/forearm pain and medial hand paraesthesia, a positive Tinel's sign at the cubital tunnel, cubital tunnel hyperalgesia and a subjective feeling of weakness of the hand. Ulnar nerve motor and sensory conduction studies were normal in 76%, indicating no evidence of CN. This study's findings highlight the low frequency of CN,

Figure 5.18 • Ulnar nerve active screening test.

Figure 5.19 • Ulnar nerve test.

even in the presence of significant features of compressive neuropathy. The prevalence of PNS could not be determined in this sample as neurodynamic tests were not included in that study. Interestingly, sustained nerve-tensioning exercises did not provide any significant benefit over advice and reassurance or a night-resting splint for the immediate or long-term recovery (Svernlov et al. 2009). This is another example of the importance of matching neural classification to appropriate treatment (Hall & Elvey 2011).

The *median nerve* should be examined if the patient complains of anterior elbow pain with symptoms in the distribution of the median nerve. For example, a patient may complain of pain in the region of the bicipital aponeurosis with spread into the forearm, associated with tingling symptoms on the radial side of the hand when lifting heavy weights at work or in the gym or in sports associated with gripping such as archery (Rehak 2001). As with the ulnar nerve, diagnosis of PNS is based on three parts as follows. Active neurodynamic screening for the median nerve should reproduce similar symptoms (Fig. 5.20). In addition, the neurodynamic test of the median nerve (Fig. 5.21) should also provoke similar symptoms. Finally, the median nerve should be maximally hyperalgesic proximal and distal to the pronator tunnel. In this case it is clear that PNS of the median nerve is a significant contributing factor to the elbow problem. The most likely site for the origin of the sensitization is the pronator tunnel. It would be important in this example to examine conductivity of the median nerve, through the neurological examination, to rule out CN. Tinel's test at the pronator tunnel might also be helpful in localizing the problem. In cases of forearm pain and distal symptoms such as paraesthesia, it would be important to examine the cervical spine and carpal tunnel, in order to rule out cervical radiculopathy and carpal tunnel syndrome.

The *radial nerve* should be examined if the patient complains of lateral elbow pain with symptoms in the distribution of the radial nerve. For example, a patient may complain of lateral elbow pain, radiating distally from the lateral epicondyle, during extended computer keyboard use. Again CN must be differentiated from PNS or musculoskeletal pain by the neurological examination and tests for PNS. For PNS, active neurodynamic screening for the radial nerve must reproduce similar symptoms (Fig. 5.22). In addition, the neurodynamic test of the radial nerve (Fig. 5.23) must also provoke concordant symptoms and will be limited in range. Finally, the radial nerve and its distal branches must be maximally hyperalgesic immediately proximal and distal to the elbow. If this is found to be the case, then it is clear that sensitization of the radial nerve is a dominant feature of the condition. Some degree of radial nerve sensitization, evidenced by the radial nerve neurodynamic test, is a common finding in people with lateral elbow pain (Berglund et al. 2008, Buzzi & Moskowitz 2005, Waugh et al. 2004, Yaxley & Jull 1993). Berglund et al. (2008) reported that in 58% of their sample with lateral elbow pain, forearm pain was reproduced during the radial nerve neurodynamic test. In addition,

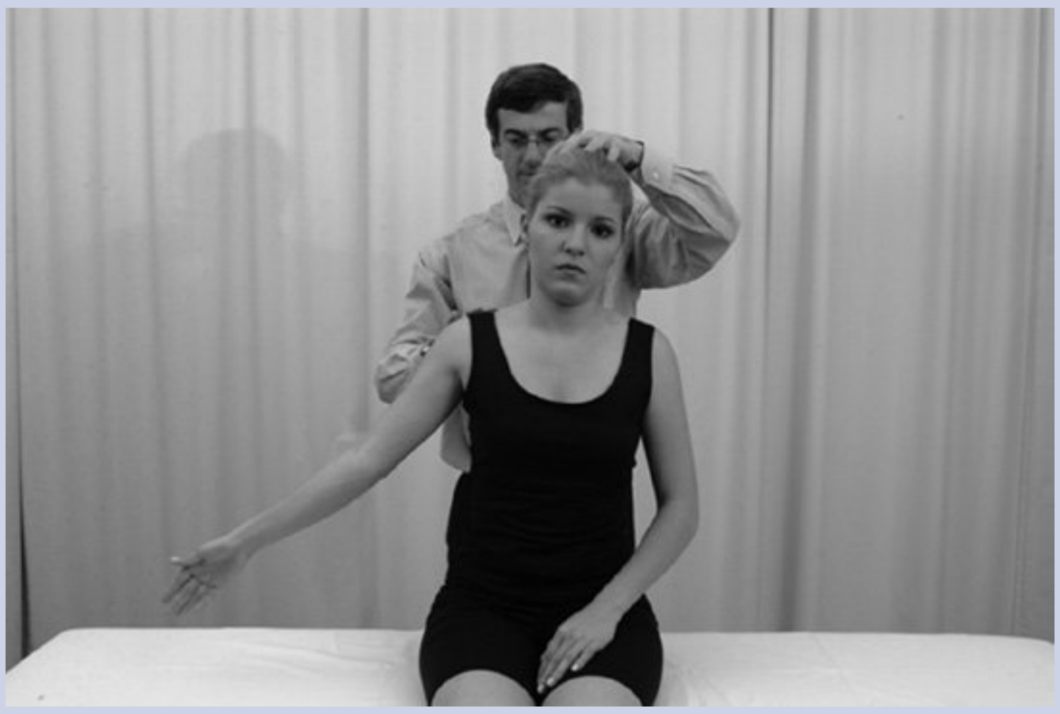

Figure 5.20 • Median nerve active screening.

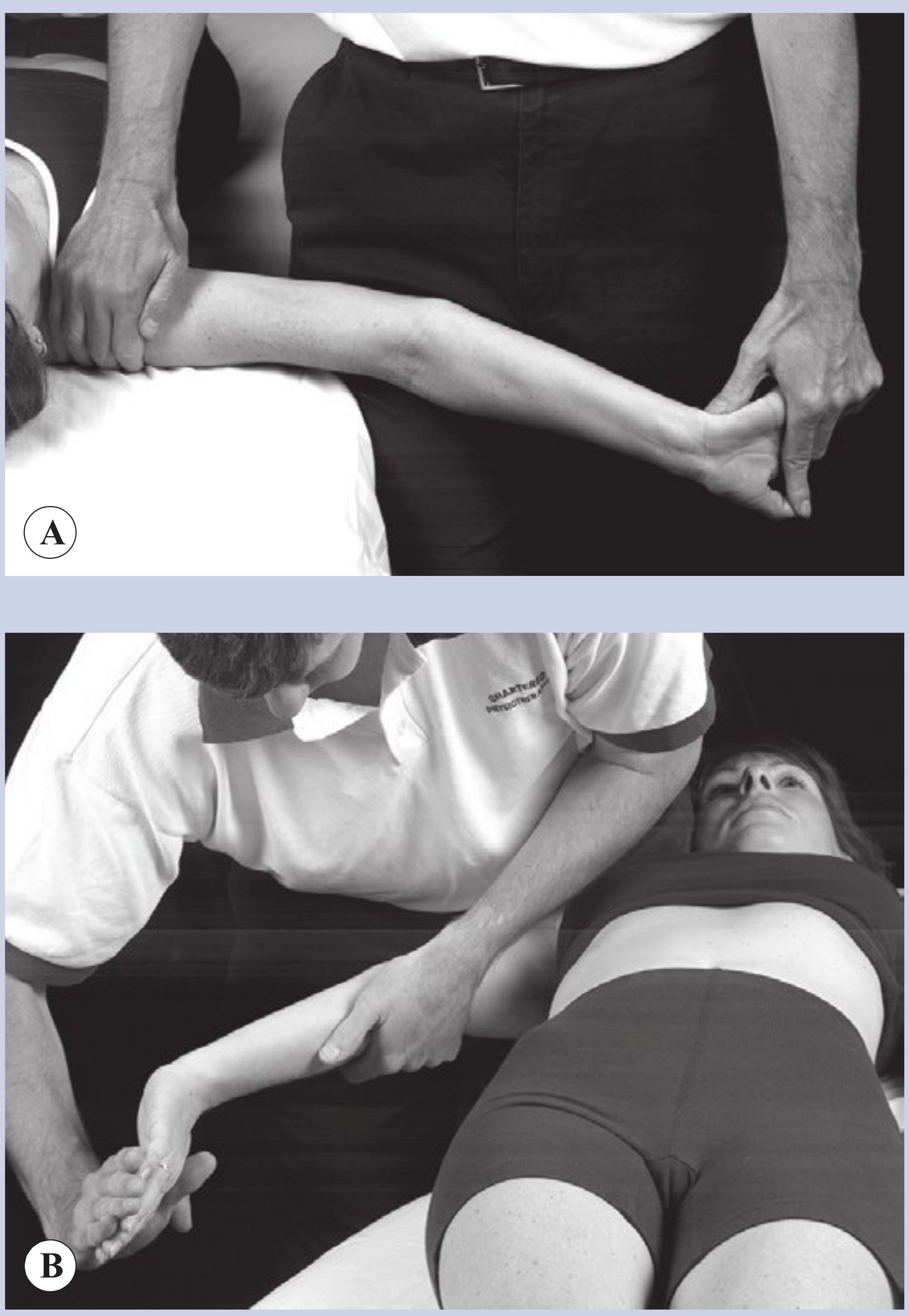

Figure 5.21 • Median nerve test: A ULNPT 1; B ULNPT 2a.

approximately 50% of their sample reported hyperalgesic responses to nerve trunk palpation.

The radial nerve divides into two branches at the elbow (Standring 2008): the radial nerve superficial branch and the posterior interosseous

Figure 5.22 • Radial nerve active screening.

Figure 5.23 • Radial nerve test.

nerve. For the two branches, five sites of compression have been described, although these comprise only 2% of all upper limb compressive neuropathies (Hariri & McAdams 2010). Confirmation of a radial nerve compression neuropathy is difficult because of the similarity with lateral epicondylalgia, and the lack of clinical discerning features (Van Hofwegen et al. 2010). For instance, the radial nerve sensory branch has no motor supply, and the posterior interosseous nerve no sensory supply, thus limiting discerning features of neurological deficit. Rosenbaum (1999) reviewed the evidence for radial tunnel syndrome and found only seven of 534 cases had objective evidence of neurological conduction loss. Furthermore, the presence of nerve compression does not usually cause pain (Zusman 2008) and radial nerve compression has been noted on dissection of cadavers, where there was no history of arm symptoms before death (Rath et al. 1993). Hence the potential for lateral elbow pain to arise from a CN disorder of the radial nerve is extremely uncommon.

Passive movements (joints)

The elbow complex consists of the humeroulnar, radiohumeral and radioulnar/radioannular joints (Fig. 5.24). Any of these joints can be a source of elbow pain. Differential examination of each joint is an important skill:

- If the elbow is held 10° short of full extension, there is an amplitude of abduction and adduction movement. During this abduction/adduction movement, the olecranon process swings from side to side in the olecranon fossa, the head of the radius being compressed and distracted from the capitulum as the radius moves cephalad and caudad in the superior radioulnar joint (Fig. 5.25). The clinician should be aware of the potential for excessive joint laxity during these tests, which may be associated with medial and lateral collateral ligament damage (Ellenbecker et al. 2010a).
- Also note that when the elbow joint is in extension and overpressure is added to supination and pronation, the olecranon process rotates in the olecranon fossa (Fig. 5.26).

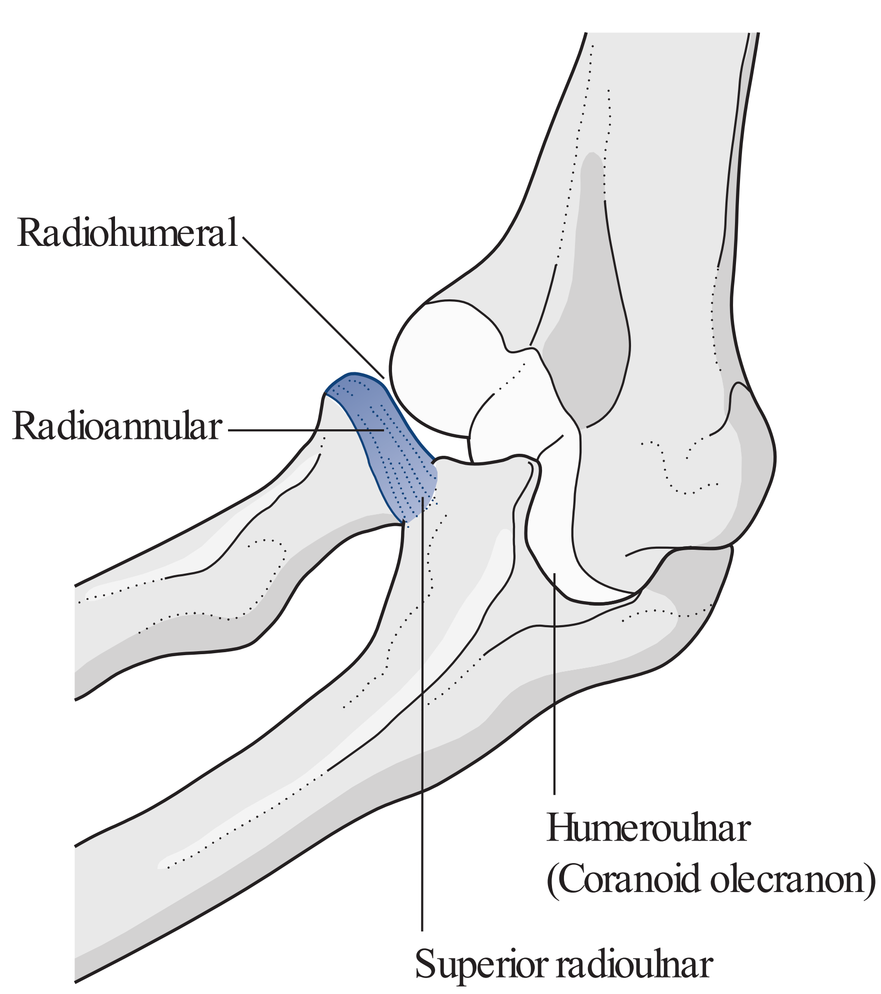

Figure 5.24 • Joints of the elbow complex.

- When the elbow is in full flexion there is also an additional degree of abduction and adduction movement.
- When the wrist is ulnar deviated the radial head moves caudad; during radial deviation it moves cephalad.

It is also important to produce movement in any one of the three joints without producing movement in the other. Testing movement of one bone on the other (e.g. radius on ulna) must be done by the physiotherapist's fingers and thumbs. When movements are tested, the site of the pain felt by the patient is a guide to determining the joint(s) at fault. Examination of flexion, extension, pronation and supination alone is insufficient to determine the normality or otherwise of the elbow joints.

Full use of accessory and joint play movements must be examined in detail if important comparable signs are not to be missed. It is important to assess the range of lateral movement of the elbow when it is held a few degrees from the extended position.

Extension in adduction and extension in abduction are also important movements of the elbow to examine, as is flexion in both abduction and adduction. Figure 5.27 represents the degree of adduction and abduction possible in full extension (line X_2, Y_2), 10° of flexion (line X_1, Y_1) and all points in between. There is a greater degree of adduction/abduction in 10° of flexion than in full extension of the elbow. If the elbow, firmly held in adduction, is moved from extension through 10° of flexion, that is from X_2 to X_1, it will be felt that the movement is not a straight line but has a curve near the limit of extension. The flexion movement in abduction from Y_2 to Y_1 also follows a slight curve though it is less marked. The procedures adopted to examine and treat these movements are the techniques of extension/adduction and extension/abduction.

If a patient subconsciously demonstrates a through-range painful disorder with elbow pronation and supination, the therapist should be alert to the possibility of the radioulnar joint being the problem. As well as pronation and supination, the superior radioulnar joint has passive accessory movements of the head of the radius on the ulna: these posteroanterior and anteroposterior movements can be performed with the forearm in any degree of elbow pronation or supination, flexion or extension. Longitudinal movements cephalad and caudad of

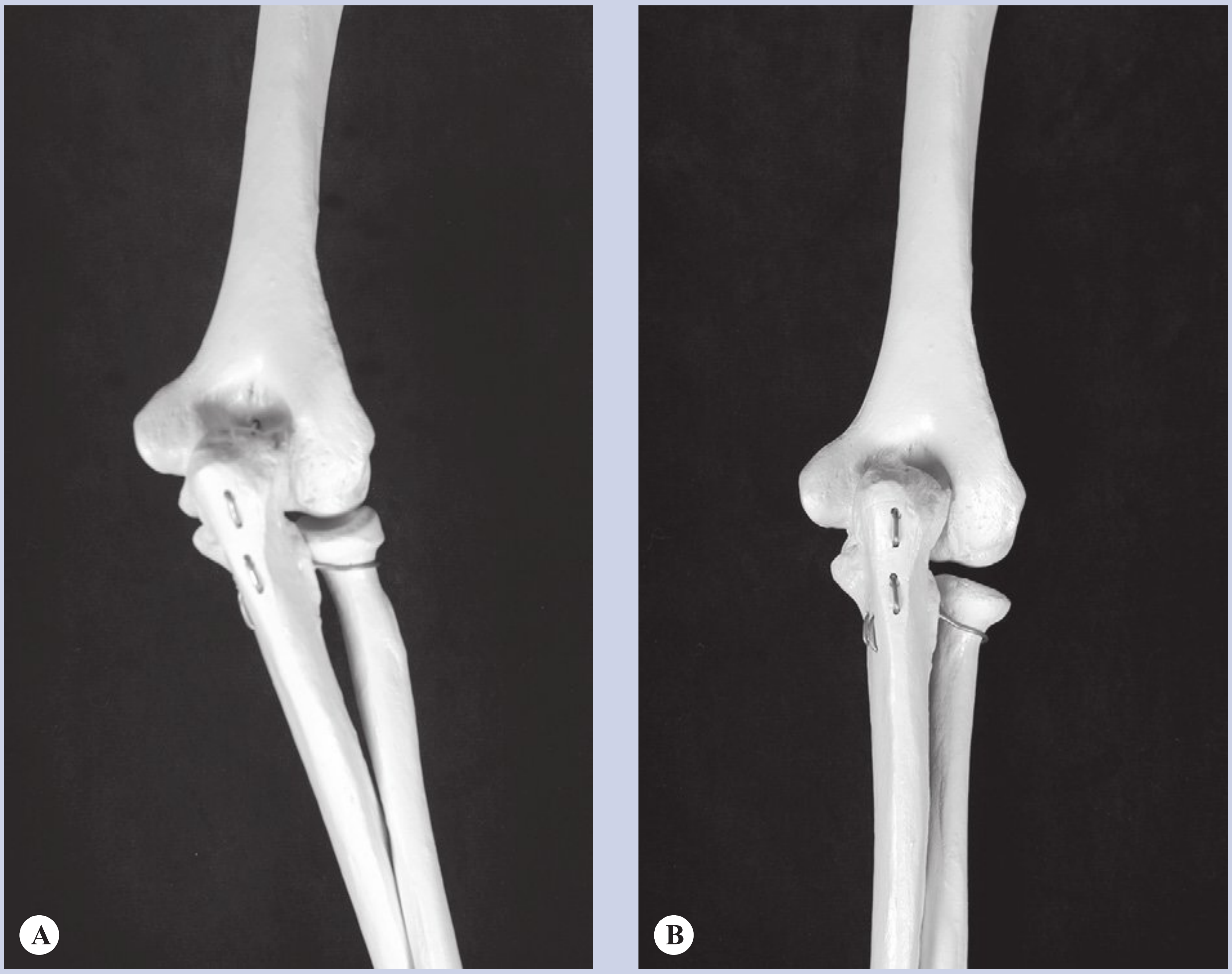

Figure 5.25 • Elbow joint: A abduction, humeroulnar approximation and olecranon abduction in olecranon fossa; B adduction, humeroulnar distraction and olecranon adduction in olecranon fossa.

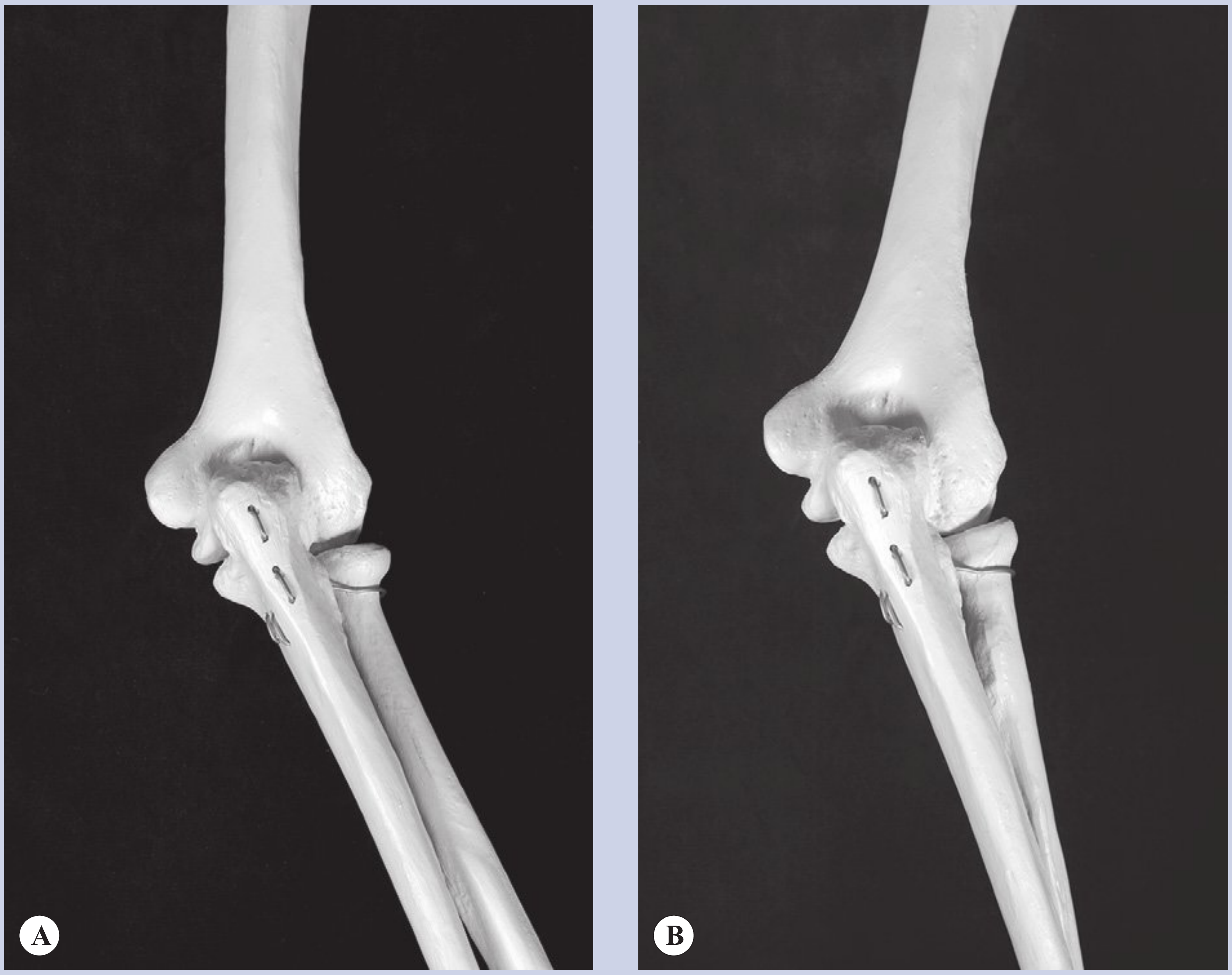

Figure 5.26 • Elbow joint: A supination of olecranon process in olecranon fossa; B pronation of olecranon process in olecranon fossa.

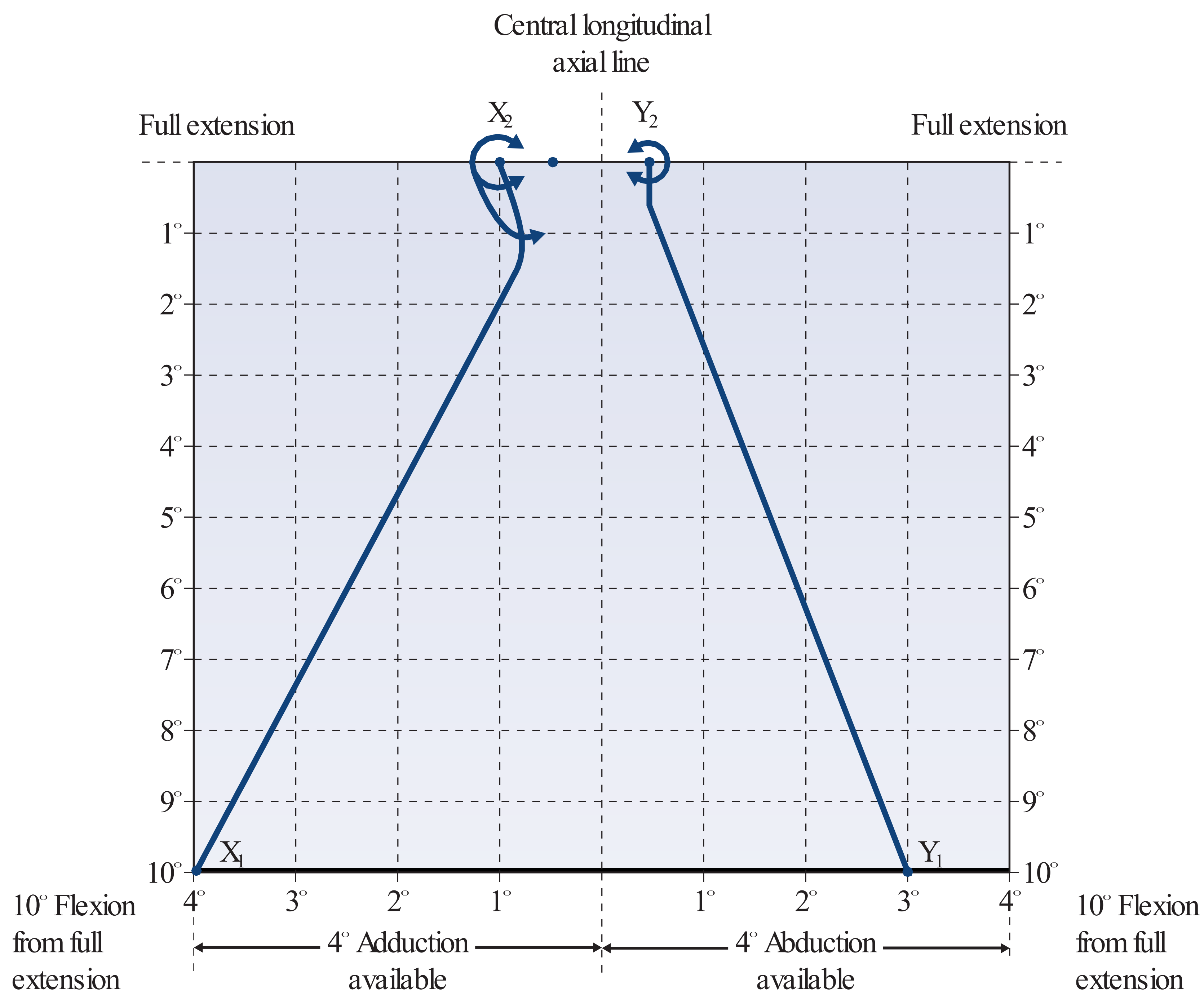

Figure 5.27 • Range of elbow abduction/adduction in the last 10° of elbow extension (only approximate degrees used) viewed from the anterior aspect of the wrist in the anatomical position. The complete line represents the path traversed by the wrist during passive extension (a) with the elbow pressured into adduction (X_1 X_2) and (b) with the elbow pressured into abduction (Y_1 Y_2). The arrowed circular areas represent the scouring movements (E/Ad at X_2; E/Ab at Y_2) used in examination and treatment.

the radius on the ulna are the two remaining accessory movements, though they have limited practical application. All of these movements can be performed with or without compression of the head of the radius against the ulna (Box 5.4).

If the patient has pain within the elbow posteriorly and this is only reproduced with extension overpressure, or with frm overpressure to supination or pronation, this could be due to swinging of the olecranon process in the fossa. Such pain may be due to an abnormal 'tracking' of the olecranon in the trochlea fossa, similarly to the patella maltracking on the femur in patellofemoral pain syndrome. In such cases the olecranon should be examined with thumb pressure against the olecranon process in the neutral or pronation/supination positions. In addition MWM (see Figs 5.56 and 5.57) using an olecranon tilting movement (rotation around the long axis of the ulna) can also be explored during the provocative active movement.

The radiohumeral joint can be painful in pronation, supination and flexion/extension. To the painful movement (see Fig. 5.10, flexion 90°) should be applied a compressive force through the patient's hand so as to compress the head of radius against the capitulum. To localize the movement as much as possible to the radiohumeral joint the pressure should be transmitted through the patient's thenar eminence with the wrist deviated radially, directing the force through the radius. The compression technique should be performed through as large a range of elbow flexion to extension or pronation to supination (in different positions of flexion/extension) as is possible.

Mobilization with movement (MWM)

To evaluate the potential for MWM in therapy for elbow disorders requires two factors (Vicenzino et al. 2011). The frst is to identify a comparable sign at the elbow or a client-specific outcome measure, which might be a limitation of active movement or pain due to isometric muscle contraction (for example making a fist). The second is to evaluate accessory movements at the elbow to isolate a pain-free glide direction. Typically, the glide found to be effective is in a medial or lateral direction (Vicenzino et al. 2011). The clinician then applies the pain-free glide while asking the patient to perform the comparable sign. A significant improvement in pain-free movement or muscle contraction force indicates the potential for MWM in therapy.

In the Mulligan Concept, the glide component of MWM is graded according to the tolerance of the patient and the effect the glide has on the comparable sign (Mulligan 2010), rather than the I–V system used in the Maitland Concept. If gentler force does not improve the comparable sign then greater force is applied or the technique is altered in some way until improvement is achieved. For example, a substantial level of force, at least 66% of maximum, is required to adequately change lateral elbow pain associated with gripping (McLean et al. 2002). A significant increase in the grip force as a result of MWM indicates the potential for treatment. Vicenzino et al. (2008) found one of the univariate predictors for success for a MWM was at least a 25% increase in pain-free grip strength following a MWM.

Differentiation tests

When supination or pronation provokes the patient's symptoms and it is necessary to differentiate between the radiohumeral and the superior radioulnar joints as the source, the rotary movement is performed with the wrist held in ulnar deviation (to lessen the stress on the radiohumeral joint) and then repeated with the wrist in radial deviation. Different positions of flexion/extension may also help to make the differentiation. Also, if there is intra-articular involvement of the superior radioulnar joint, adding medially directed pressure against the proximal end of the radius during the rotary movement will increase the pain response (see Fig. 5.13).

When flexion or extension provokes the patient's symptoms, the position (of flexion or extension and ulnar deviation) should be held while the head of the radius is moved back and forth (AP–PA). If the disorder lies in the humeroulnar articulation, movement of the radius will not make any difference to the pain response.

Examination and treatment techniques: elbow complex

Neurological examination

Neurological examination is an important component of the evaluation of elbow region neural tissue pain disorders, particularly CN. Such testing should incorporate both subjective inquiry and physical tests of nerve conductivity.

The subjective examination must clearly identify the specific type and area of symptoms, including paraesthesias and sensory loss. These areas can then be compared with typical dermatomal and cutaneous sensory innervation maps. The clinician should not rely purely on dermatomal charts when determining the segmental origin of pain because these charts are not the ideal diagnostic reference (Bove et al. 2005), given the significant overlap of innervation from adjacent nerve roots and the great variability among individuals (Slipman et al. 1998, Wolff et al. 2001).

Physical neurologic examination procedures include tests for sensation (light touch, pin-prick, two-point discrimination and vibration), tendon reflexes and muscle strength. The pattern of sensation loss, reflex change and specific muscle weakness enables the clinician to determine the location of nerve injury. For example, compression neuropathy of the ulnar nerve at the elbow would be indicated by weakness of flexor digitorum profundus and abductor digitiminimi, together with sensory loss of the tip of the fifth finger (Jepsen et al. 2006, Jepsen & Thomsen 2006).The pattern of neurological deficit would be different for a C8 nerve root disorder, although pain may be in a similar distribution.

Although some studies have investigated the reliability and diagnostic validity of the neurologic examination (Jepsen et al. 2006, Jepsen & Thomsen 2006, Schmid et al. 2009), its value has been questioned (Viikari-Juntura 1987, Viikari-Juntura et al. 1989, Wainner et al. 2003, Wainner & Gill 2000). Despite good levels of reliability having been demonstrated for individual items of the neurological examination in the upper limb (Jepsen et al. 2006, Jepsen & Thomsen 2006, Schmid et al. 2009), greatest confidence in the neurological status is achieved by incorporating the subjective history together with the physical examination findings (Viikari-Juntura et al. 1989, Vroomen et al. 2000). Wainner et al. 2003 investigated the diagnostic accuracy of a range of cervical physical tests (including aspects of the neurological examination) to identify cervical radiculopathy and reported that a cluster of physical tests was more useful than was any single test item. Similarly it has been shown, based on the complete neurological examination, that there is good agreement between examiners in identifying the location of a specific peripheral nerve disorder in the upper limb (Jepsen et al. 2006, Jepsen & Thomsen 2006).

Nerve palpation

Nerve trunks can be selectively palpated to determine a heightened state of mechanosensitivity. While there is evidence that such palpation is reliable, in both the upper limb (Jepsen et al. 2006, Jepsen & Thomsen 2006, Schmid et al. 2009) and lower limb (Walsh & Hall 2009), nerve palpation requires a sound knowledge of anatomy to be certain of palpation accuracy.

In the elbow region the three major upper limb nerve trunks are accessible and can be palpated as distinct entities. Neural tissues of the uninvolved or least affected side are palpated first to allow the patient to make a comparison. Gently and precisely, gradually increasing pressure is applied until deemed sufficient to complete the examination. In some patients the elbow may be hyperalgesic to the point that a specific tissue diagnosis may not be possible. In such a case the neural system should be palpated more proximally, perhaps in the upper arm or axilla.

Median nerve (Fig. 5.28)

- *Patient starting position*: Supine with the forearm supinated and the elbow flexed to 90°.
- *Therapist starting position*: Standing by the patient's elbow facing the patient's head.
- The median nerve lies with the brachial artery, immediately medial to the biceps tendon. Anterior elbow soft tissue tension is reduced in flexion, allowing greater ability to isolate the structure of the median nerve.

Radial nerve (Fig. 5.29)

- *Patient starting position*: Supine with the shoulder medially rotated and elbow flexed to 90°.
- *Therapist starting position*: Standing by the patient's elbow facing the patient's head.

The radial nerve can be palpated on the lateral side of the biceps tendon, proximal to the elbow, prior to bifurcation into the radial sensory branch and posterior interosseous nerve. At mid-humeral level, the radial nerve can be palpated as it passes through the lateral intramuscular septum, a few centimetres below the deltoid in the spiral groove (Fig. 5.29). The radial sensory branch and posterior interosseous nerve are most readily palpated distal to the elbow. The posterior interosseous nerve lies deep and is best palpated from the lateral side, displacing the lateral extensor muscle mass below the elbow, to identify the nerve on the anterolateral aspect of the neck of the radius.

Ulnar nerve (Fig. 5.30)

- *Patient starting position*: Supine with the forearm supinated and elbow flexed to 90°.
- *Therapist starting position*: Standing by the patient's elbow facing the patient's head.

The ulnar nerve is palpated posterior to the medial epicondyle, or immediately distal to the elbow on the medial side of the ulna. Access to the nerve is increased when the elbow is flexed.

Passive movements

Extension/adduction (Fig. 5.31)

- *Direction*: Elbow is flexed 10° from full extension and held in adduction. During the first few degrees of extension held in adduction the forearm moves parallel to the elbow sagittal plane. A point is reached where the elbow abducts and adducts again (similar to the mound of the shoulder quadrant). There is no locking position but the feel is similar to that of the shoulder as the point of abduction on the roll-over is reached (see Fig. 5.27) and the extension in adduction continues to X_1. Once the point of roll-over is passed the glenohumeral joint will automatically medially rotate if the adduction pressure is maintained sufficiently.

Figure 5.28 • Median nerve palpation.

Figure 5.29 • Radial nerve palpation.

Figure 5.30 • Ulnar nerve palpation.

- *Symbol*: Elbow E/Ad.
- *Patient starting position*: Supine, lying far enough from the edge of the couch for the patient's elbow to lie just beyond the edge when the arm is abducted 30°.
- *Therapist starting position*: Standing by the patient's right shoulder facing the patient's feet.

Localization of forces (position of therapist's hands)

- The left forearm rests in front of and just medial to the patient's shoulder.
- The f ngers of the left hand support the patient's elbow posteriorly from the medial side.
- The thumb of the left hand extends around the medial epicondylar ridge of the humerus to reach the front of the patient's elbow.
- The back of the left hand rests against the surface of the couch at its edge.
- The left hand medially, the f ngers and couch posteriorly, the thumb anteriorly and the left thigh laterally, f rmly f x the patient's elbow.
- The right hand grasps the patient's supinated right wrist.
- The right thumb is placed over the anterior surface of the wrist.
- The f ngers are placed over the dorsum of the wrist.
- The supination is not held strongly at the limit of the range.

Figure 5.31 • Elbow joint: extension/adduction.

- The patient's glenohumeral joint is medially rotated to stabilize the elbow more easily during the adduction. Therefore the abduction counterpressure afforded by the therapist's left hand is being assisted by the edge of the couch.

Application of forces by therapist (method)

- The part of the extension/adduction range which has been lost should be sought; the examination or treatment is directed at this particular part of the range. Lateral collateral ligament damage, and subsequent laxity, would lead to excessive range with a soft end-feel and would be a contraindication to the use of this technique in management.
- The limited movement is approached: (1) by an adduction or extension/adduction movement or (2) by a scouring circular movement (see Fig. 5.27):
  1. performed as a grade III or IV: III – the pressure maintaining adduction is almost completely released to allow the joint to relax to the position almost midway between abduction and adduction before oscillating back to the adduction position; IV – the pressure maintaining adduction limits the oscillation to a small amplitude; or
  2. performed by maintaining the adduction pressure while flexing and extending the elbow across the limitation.
- If the limitation is painful the adduction pressure can be eased as the pain and limitation are approached.
- The arc of movement can be performed when extending towards the limit or adducting towards it.

Uses

- The extension/adduction movement is only used in the treatment when grade III or IV is required.
- When the elbow joint is the source of minor symptoms and its movements appear to be normal, this accessory movement or *functional corner position* may be diminished and painful.
- In treatment, the movement of extension/adduction can be scoured in much the same way as was described for the glenohumeral joint. The scouring movement is represented at X_2 by the arrowed circular arcs in Figure 5.27.
- Often found to be painful and restricted in patients with chronic lateral epicondylalgia (Hyland et al. 1990).
- Particularly valuable for minor but troublesome disorders of the humeroulnar and radiohumeral joints.
- A test which can be used when the elbow needs to be excluded as a source of symptoms.

Extension/abduction (Fig. 5.32)

- *Direction*: Extension/abduction should be checked from the fully extended position through the first 10° of flexion. As with extension/adduction, a point is reached during this range of flexion where the arm must be allowed to adduct if the flexion movement is to be continued. Beyond the point of maximum abduction the arm moves laterally again, but this lateral movement will be a lateral rotation of the glenohumeral joint rather than an abduction of the elbow. There is not the same feel of a locking position with this movement as there is with adduction but it is still obvious that the movement from Y_1 to Y_2 in Figure 5.27 is not a straight line but is slightly curved. Any loss of the smooth contour of the curve can be appreciated and can be treated by movement into this position.

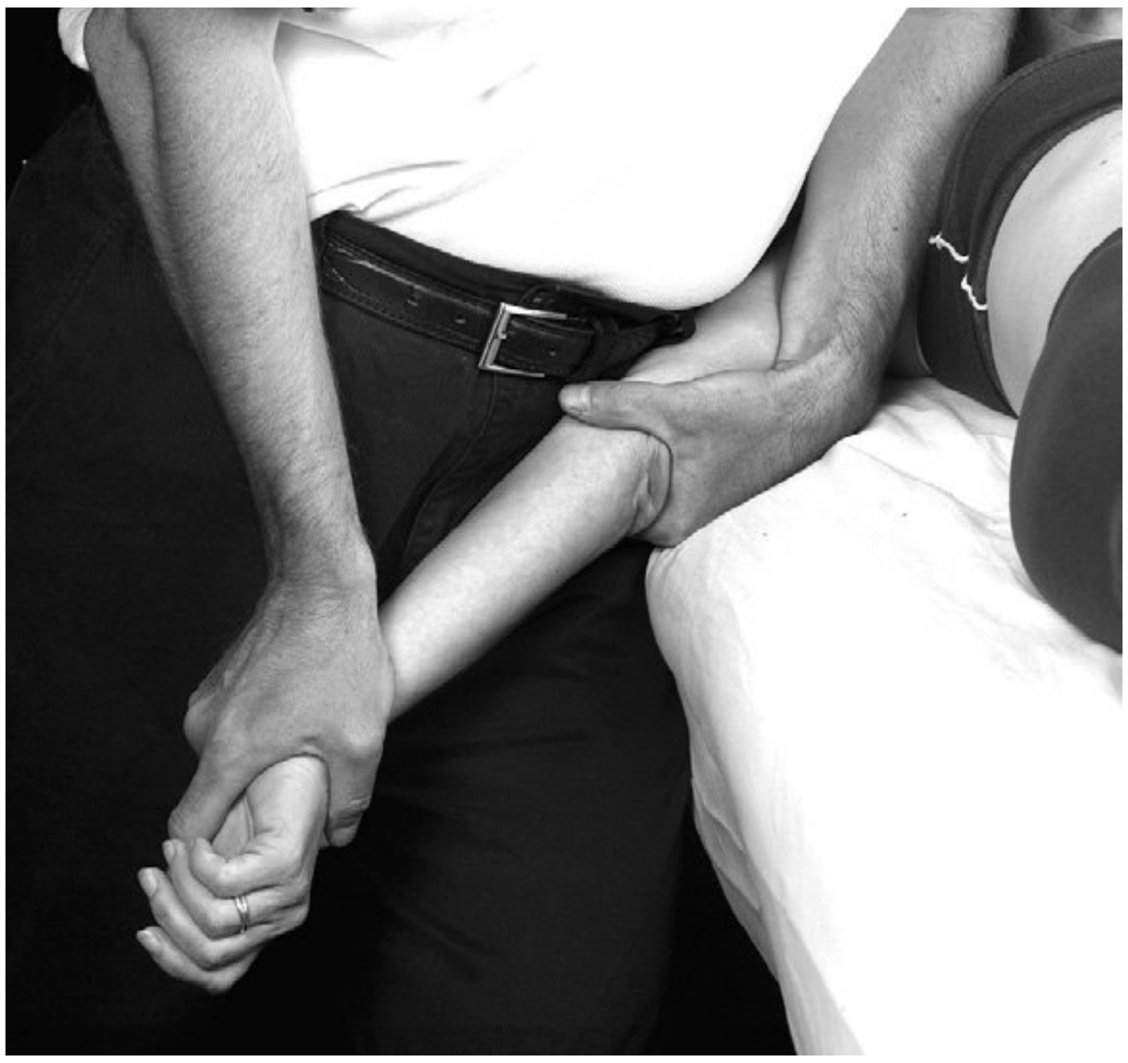

Figure 5.32 • Elbow joint: extension/abduction.

- *Symbol*: Elbow E/Ab.
- *Patient starting position*: Supine, lying far enough from the edge of the couch for the patient's elbow to lie just beyond the edge when the arm is abducted 30°.
- *Therapist starting position*: Standing by the patient's right shoulder facing the patient's feet.

Localization of forces (position of therapist's hands)

- The left forearm rests in front of and just medial to the patient's shoulder.
- The fngers of the left hand support the patient's elbow posteriorly from the medial side.
- The thumb of the left hand extends around the medial epicondylar ridge of the humerus to reach the front of the patient's elbow.
- The back of the left hand rests against the surface of the couch at its edge.
- The left hand medially, the fngers and couch posteriorly, the thumb anteriorly and the left thigh laterally, frmly fx the patient's elbow.
- The right hand grasps the patient's supinated right wrist.
- The fngers of the right hand spread over the front of the patient's wrist to hold the patient's supinated wrist from the medial side.
- The right thumb is placed over the posterior surface of the wrist.
- The supinated wrist is not held strongly at the limit of the range.
- The patient's glenohumeral joint is held in slight lateral rotation so that the abduction movement can be directed against the therapist's thigh which then acts as a fulcrum.
- The patient's elbow must be fully fxed by the therapist's hand against a very frm fulcrum.

Application of forces by therapist (method)

- The part of the extension/abduction range which has been lost should be sought; the examination or treatment is directed at this particular part of the range.
- The limited movement is approached: (1) by an abduction or extension/abduction movement or (2) by a scouring circular movement (see Fig. 5.27):
  1. performed as a grade III or IV: III – the pressure maintaining the abduction is almost completely released to allow the joint to relax to the position almost midway between adduction and abduction before oscillating back to the abduction position; IV – the pressure maintaining the abduction limits the oscillation to a small amplitude; or
  2. performed by maintaining the abduction pressure while flexing and extending the elbow across the limitation.
- If the limitation is painful the abduction pressure can be eased as the pain and limitation are approached.
- The arc of movement can be performed when extending towards the limit or abducting towards it.

Uses

- The extension/abduction movement is only used in the treatment when grade III or IV is required. Medial collateral ligament damage, and subsequent laxity, would lead to excessive range with a soft end feel and would be a contraindication to the use of this technique in management.

- When the elbow joint is the source of minor symptoms and its movements appear to be normal, this accessory movement or *functional corner position* may be diminished and painful.
- In treatment, the movement of extension/abduction can be scoured in much the same way as was described for the glenohumeral joint. The scouring movement is represented at Y_2 by the arrowed circular arc in Figure 5.27.
- Particularly valuable for minor but troublesome disorders of the humeroulnar and radiohumeral joints.
- A test which can be used when the elbow needs to be excluded as a source of symptoms.

Flexion/adduction (Fig. 5.33)

- *Direction*: Adduction movement in full elbow flexion.
- *Symbol*: Elbow F/Ad.
- *Patient starting position*: Supine in the middle of the couch and the elbow fully flexed and pronated.
- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Figure 5.33 • Elbow joint: flexion/adduction.

Localization of forces (position of therapist's hands)

- The left hand holds the patient's fully pronated wrist.
- The fngers of the left hand are placed over the back of the patient's wrist.
- The thenar eminence and thumb are placed over the front of the patient's wrist.
- The right hand grasps frmly around the patient's upper arm at the junction of the middle and lower thirds from the medial side in such a way as to hold the upper arm laterally rotated.
- The slack in the soft tissues of the upper arm must be taken up fully.
- Both forearms (therapist) are rotated opposite to each other.

Application of forces by therapist (method)

- The flexion/adduction movement is performed entirely by the therapist's left hand and arm while medial rotation of the glenohumeral joint is prevented by the frm grasp of the patient's upper arm with the therapist's right hand.
- If medial rotation is not prevented the adduction strain at the patient's elbow will be lost.
- The treatment movement can be performed as a large amplitude oscillation through 10–15° (III) or a small amplitude movement through 3–4° (IV).

Uses

- Flexion/adduction is used when a grade III or IV movement is required.
- Minor elbow symptoms, particularly of the humeroulnar and radiohumeral joints.
- When the elbow needs to be excluded as a source of symptoms.

Flexion/abduction (Fig. 5.34)

- *Direction*: Abduction movement in full elbow flexion.
- *Symbol*: Elbow F/Ab.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow fully flexed and supinated.

Figure 5.34 • Elbow joint: flexion/abduction.

- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Localization of forces (position of therapist's hands)

- The right hand grasps the patient's supinated wrist from the medial side.
- The fngers spread across the front of the wrist.
- The thumb is placed across the back of the patient's wrist.
- The left hand grasps the patient's upper arm at the junction of the middle and lower thirds (with the patient's glenohumeral joint in medial rotation) in such a way as to prevent lateral rotation of the glenohumeral joint.
- The slack in the soft tissues of the upper arm must be taken up fully.
- Both forearms (therapist's) are rotated opposite each other.

Application of forces by therapist (method)

- The flexion/abduction movement is produced by the therapist fully flexing the patient's elbow and then displacing the patient's wrist laterally with an abduction movement of the elbow, while applying an equal counterpressure with the left hand to prevent any lateral rotation of the glenohumeral joint.
- If this counterpressure is not applied adequately the sideways movement of the patient's wrist will consist of lateral rotation of the glenohumeral joint without there being any abduction of the elbow.

Uses

- Flexion/abduction is used when a grade III or IV is required.
- Minor elbow symptoms particularly of the humeroulnar or radiohumeral joints.
- When the elbow needs to be excluded as a source of symptoms.

Extension (Fig. 5.35)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E.

Grade II

- *Patient starting position*: Supine, lying in the middle of the couch.
- *Therapist starting position*: Standing by the patient's right hip facing the patient's head with the right knee on the couch.

Localization of forces (position of therapist's hands)

- The left hand supports laterally around the patient's right arm just above the elbow.
- The thumb is placed anteriorly.
- The fngers spread posteriorly.
- The right hand grasps the palm of the patient's supinated hand.
- The right thumb reaches between the patient's thumb and index fnger to the back of the patient's hand.
- The medial three fngers reach around the patient's hyperthenar eminence to the back of his hand.
- The index fnger points proximally over the anterior aspect of the patient's wrist.
- Moving close to the elbow the thigh is used as a stop at the required angle.

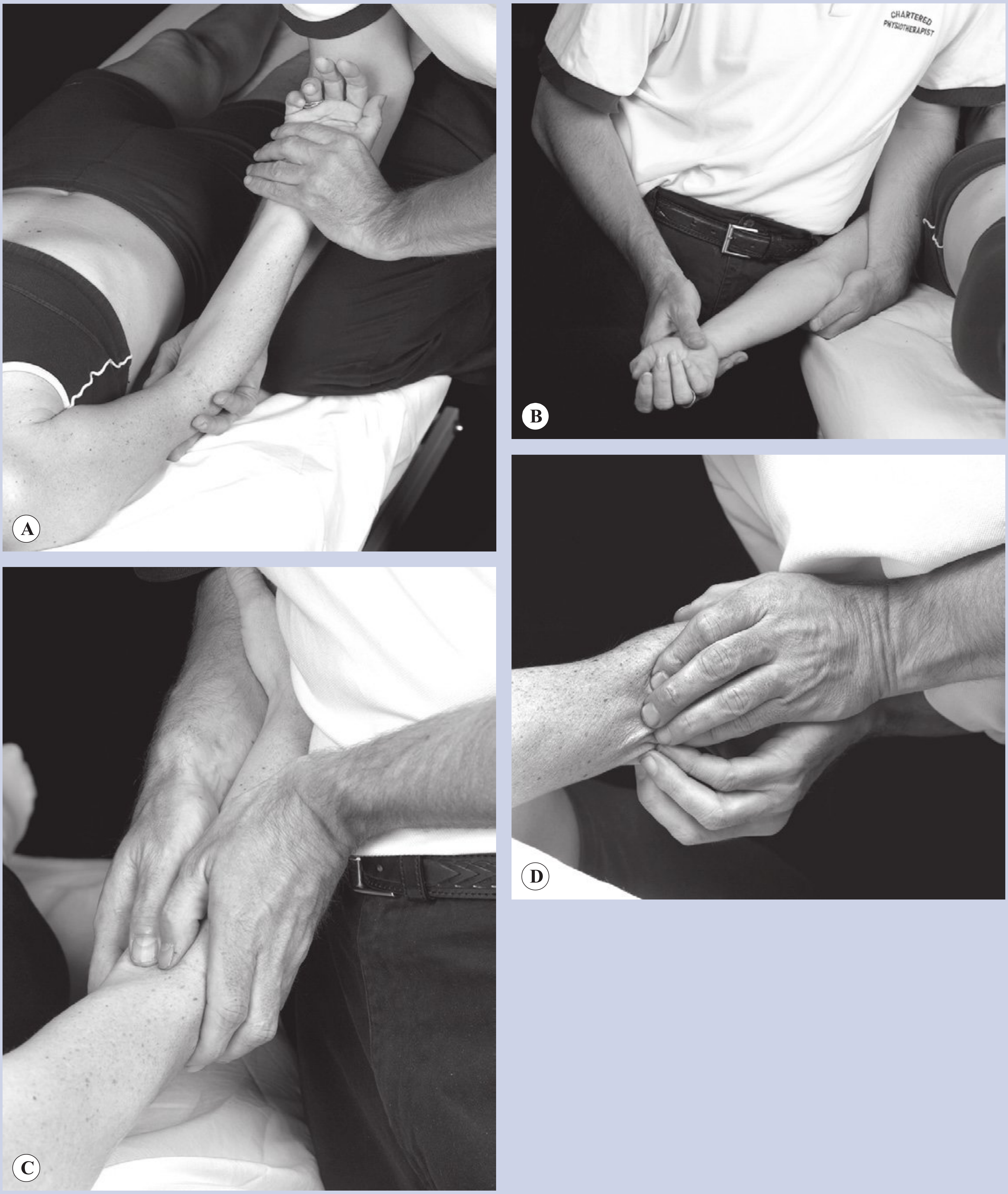

Figure 5.35 • Elbow joint: A extension, grade II; B, C extension grade III/IV; D palpation in olecranon fossa in extension.

Figure 5.35 • cont'd E, F further examination of the olecranon.

Application of forces by therapist (method)

- The oscillatory movement is performed entirely by the therapist's right arm while the therapist's left hand acts as a comfortable support around the patient's elbow.
- The grasp of the patient's right wrist is such that relaxation in this area and throughout the arm is encouraged.
- The amplitude of movement varies but is usually approximately 20–30° and is performed slowly and smoothly.

Uses

- Clinical groups 1 and 3b.
- Recent injury or acute episode of OA or RA.
- Very painful elbow conditions where the radiohumeral or humeroulnar joint is involved.

Grade III (IV)

- *Patient starting position*: Supine lying with the arm abducted approximately 15° so that the wrist is clear of the edge of the couch.
- *Therapist starting position*: Standing by the patient's right shoulder facing the patient's feet.

Localization of forces (position of therapist's hands)

- The left hand supports under the patient's elbow from the medial side.
- The left forearm holds the patient's shoulder down.
- The right hand grasps the patient's partially supinated wrist laterally.
- The thenar eminence and thumb point distally across the front of the patient's wrist.

- The fingers hold across the back of the patient's wrist and hand.

Application of forces by therapist (method)

- The oscillatory movement is performed entirely by the therapist's right arm. The patient's right hand is stabilized by the grasp of the wrist.
- The amplitude of the elbow movement is approximately 20–30° (grade III).
- For through-range pain the movement is performed slowly and smoothly.
- For chronic end-of-range pain and stiffness the movement is performed as a staccato flicking movement.

Variations in the application of forces: grade III (IV)

- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Localization of forces (position of therapist's hands)

- The patient's right arm is lifted first so that it can be held against the therapist's right side.
- Both hands hold around the elbow.
- The thumbs are placed anteriorly to the joint and the fingers of both hands overlap posteriorly.

Application of forces by therapist (method)

- Feel for the soft tissue movement between the olecranon and the margins of the olecranon fossa during extension. This soft tissue palpation should be compared with the normal elbow.
- Normally the fingertips should easily fit into the space between the process and the fossa margins. The feeling should be that of clean bony margins.
- Palpation of these margins can also be carried out with the patient prone, lying with the upper arm supported on the couch and the hand and forearm hanging down to the floor.
- Thumb pressure or the heel of the hand can then be applied to the olecranon medially, laterally, caudally and with compression (Fig. 5.35 E and F).

Uses grade III (IV)

- Limitation of elbow extension due to injury, resolving episodes of OA or RA or fracture involving stiff and stiff/painful humeroulnar or radiohumeral joints.
- Patients with elbow disorders in clinical groups 2 and 3b.
- The alternative method is best used for the last 30° of extension when the patient needs to relax more.

Flexion (Fig. 5.36)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F.
- Patient starting position: Supine, lying in the middle of the couch.

Grade II

- *Therapist starting position*: Standing by the patient's right shoulder facing the patient's feet.

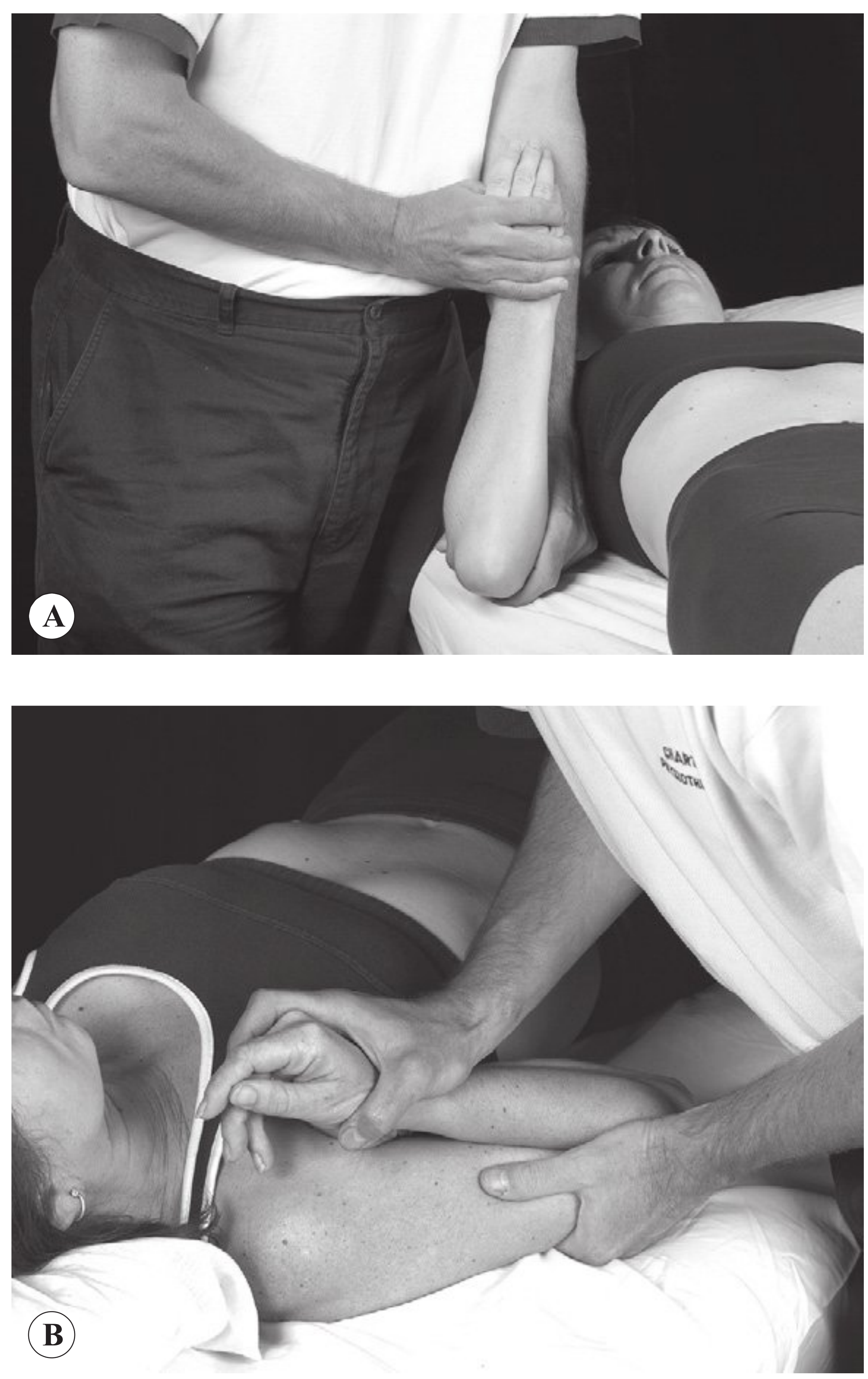

Figure 5.36 • Elbow joint: A flexion grade II; B flexion grades III and IV.

Localization of forces (position of therapist's hands)

- The left forearm crosses the patient's right upper arm so that the left hand can support under the patient's elbow from the medial side.
- The right hand grasps the patient's partially supinated wrist from the lateral side.
- The f ngers lie across the back of the patient's hand.
- The thumb lies between the patient's thumb and index f nger into the palm.
- The stop is provided by the left forearm in contact with the patient's right wrist from in front as the elbow is flexed to the required degree.

Application of forces by therapist (method)

- The oscillatory movement, performed by the therapist's right arm, is taken back and forth through 20–30° slowly and smoothly up to the stop provided by the left forearm.
- As the range improves the forearm can be lowered.

Grade III and IV (almost full range)

- *Therapist starting position*: Standing by the patient's right side distal to the elbow, facing the patient's head.

Localization of forces (position of therapist's hands)

- The left hand supports the patient's right upper arm just above the elbow.
- The right hand holds the back of the patient's right hand.
- The thumb of the right hand passes through the patient's f rst interosseous space.
- The medial three f ngers spread medially around the patient's f fth metacarpal.
- The index f nger extends distally along the back of the hand.
- The patient's partially supinated elbow is flexed.

Application of forces by therapist (method)

- The oscillatory movement is produced entirely by moving the patient's right arm while the therapist's left hand acts as a support under the elbow.
- Grade III movements are performed as large amplitude movements of 10–30° into stiffness.
- Grade IV movements are performed as small amplitude movements of 3–4° into stiffness.

Flexion with longitudinal movement caudad (Fig. 5.37)

- *Direction*: Elbow flexion combined with a longitudinal movement caudad.
- *Symbol*: F/↔ caud.
- *Patient starting position*: Supine, lying in the middle of the couch.
- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Localization of forces (position of therapist's hands)

- The right hand flexes the patient's elbow to 90°.
- The right hand grasps round the medial aspect of the patient's supinated wrist.
- The f ngers spread across the front of the wrist.

Figure 5.37 • Elbow joint: flexion with longitudinal movement caudad.

- The thumb is placed across the back of the wrist.
- The supinated left forearm just proximal to the wrist is placed in the 'crook' of the patient's elbow.
- The flexion of the patient's elbow is then continued until the left wrist is squeezed frmly between the patient's forearm and upper arm.

Application of forces by therapist (method)

- The small oscillatory movements are produced by the therapist's right arm.
- Care is needed to maintain the therapist's wedged wrist in a constant proximity to the patient's elbow because the tendency will be for it to be squeezed out.
- A wrong degree of supination forming the wedge will make the position uncomfortable for the patient.

Uses (all flexion techniques)

- Clinical groups 1, 2, 3a and 3b adapted to the desired effect.
- Pain and/or stiffness following injury or fracture affecting the humeroulnar and radiohumeral joints in particular.
- Flexion with longitudinal caudad may be of value for disorders where symptoms are minor and not obviously detected on routine testing.

Longitudinal movement caudad (elbow in 90° flexion) (Fig. 5.38)

- *Direction*: Longitudinal movement caudad in 90° of elbow flexion, that is in line with the humerus.
- *Symbol*: ↔ caud.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° or to the limit of the available range.
- *Therapist starting position*: Standing by the patient's right thigh facing the patient's head.

Localization of forces (position of therapist's hands)

- The right hand grasps the proximal anterior aspect of the patient's supinated right forearm.
- The palm of the left hand fxes the humerus to the table, close to the elbow joint.

Figure 5.38 • Elbow joint: longitudinal movement caudad (90° flexion).

- The posterior aspect of the lower forearm rests on the therapist's right shoulder.

Application of forces by therapist (method)

- The soft tissue slack around the humerus and forearm must be taken up before alternating pressures are applied against the forearm to produce the distraction movement.
- The movement can be combined with an increase in elbow flexion.
- The left hand can be positioned so as to move: (1) both the radius and ulna; (2) the radius alone; (3) the ulna alone.

Uses

- When symptoms are minimal (clinical groups 2, 3b).
- Stiffness and pain of this accessory movement at the limit of or in flexion.

Note: it is also possible to perform a longitudinal caudad movement on the ulna and radius using a manual therapy belt (Fig. 5.39). In this case the humerus is fxed by the therapist's left hand, while the mobilizing force is created by the therapist drawing the pelvis posteriorly.

Supination (Figs 5.40 and 5.41)

- *Direction*: Supination of the forearm and elbow.
- *Symbol*: Sup.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90°.

Figure 5.39 • Longitudinal caudad radius and ulna using belt.

- *Therapist starting position*: Standing by the patient's right side beyond the flexed elbow, facing the patient's head.

Grades III and IV

Localization of forces (position of therapist's hands)

- The left hand supports under the patient's elbow.
- The right hand grasps the patient's supinated wrist from the medial side.
- The fngers spread across the front of the wrist and carpus.
- The thumb holds across the back of the wrist and carpus.

Application of forces by therapist (method)

Grades III and IV

- In addition to the above, the patient's elbow must be supported medially by the therapist to prevent any glenohumeral adduction.

Grade IV−

- *Therapist starting position*: Standing by the patient's flexed right elbow.

Localization of forces (position of therapist's hands)

- The left and right hands hold the patient's fully supinated radius and ulna respectively; the hold is far enough distally to stabilize the hand.
- The left forearm is fully supinated.
- The lateral surface of the distal phalanx of the index fnger holds the distal end of the radius posteriorly.
- The pad of the thumb holds anteriorly.
- The right hand holds the distal end of the ulna.
- The thumb and thenar eminence point distally over the posterior surface of the ulna.
- The fngers hold the ulna anteriorly.
- The forearms are directed opposite each other at right angles to the coronal plane of the patient's fully supinated wrist.

Application of forces by therapist (method)

- The therapist's forearms are directed in the same line and the movement is produced as the patient's forearm is supinated a further 2–3° by a rocking action of the therapist's pelvis and trunk through the hands to the radius and ulna and then released (IV+ to IV− then IV− to IV+).
- A small amplitude of movement is therefore used.
- If the elbow supination range is limited, the therapist's body is turned to the right an appropriate amount so that the forearm direction is changed.

Uses

- Mainly for a painful or stiff superior radioulnar joint or stiffness of the olecranon which swings at the extreme of supination.

Pronation (Figs 5.42 and 5.43)

- *Direction*: Pronation of the forearm and elbow.
- *Symbol*: Pron.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90°.

Grades II, III and IV

- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Localization of forces (position of therapist's hands)

- The right hand supports under the patient's flexed right elbow so that the fngers can reach the lateral surface.

Figure 5.40 • Superior radioulnar joint: supination grades I–IV.

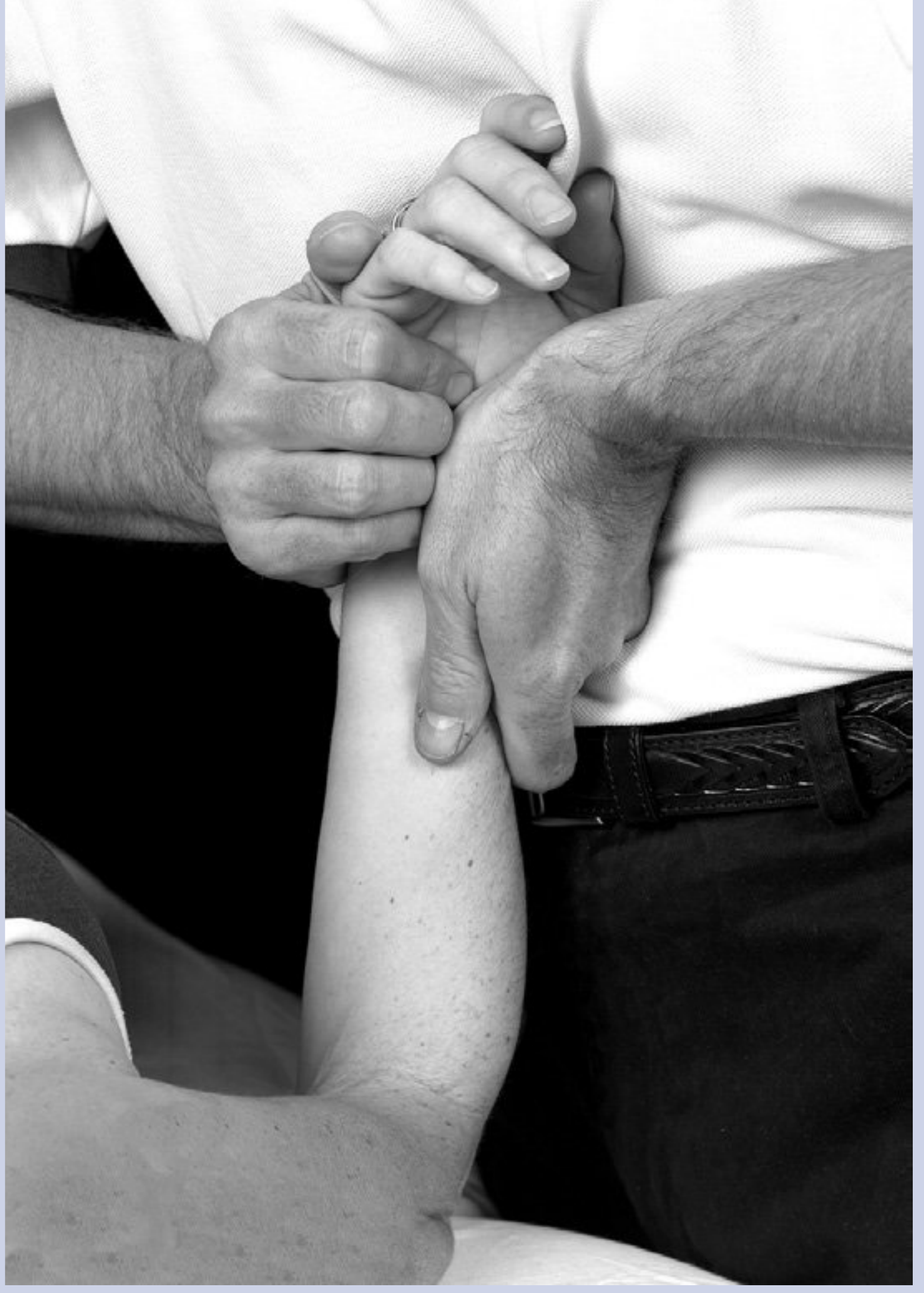

Figure 5.41 • Superior radioulnar joint: supination grade IV+.

Figure 5.42 • Superior radioulnar joint: pronation.

Figure 5.43 • Superior radioulnar joint: pronation, grade IV+.

- The left hand grasps the pronated forearm distally.
- The f ngers of the left hand extend across the dorsum of the wrist and hand to reach the carpus.
- The thumb extends around the anterior surface of the wrist and hand so that the wrist is fully stabilized.
- The rotary movement is performed by slight flexion of the therapist's glenohumeral joint combined with left shoulder and elbow extension, thus assisting the forward movement of the therapist's arm.
- This action is combined with full flexion of the therapist's wrist and f ngers to produce pronation.
- The therapist's right hand stabilizes the patient's upper arm preventing abduction of the shoulder.

Grade IV−

- *Therapist starting position*: Standing by the patient's elbow, facing across the body, the patient's elbow being flexed to 90° and pronated.

Localization of forces (position of therapist's hands)

- The left and right hands grasp the distal ends of the radius and ulna, respectively.
- The thenar eminence of the left hand is placed against the dorsal surface of the radius.
- The thumb of the left hand extends distally across the back of the patient's wrist.
- The f ngers grasp anteriorly around the radius.
- The right hand, fully supinated, grasps the distal end of the ulna.
- The heel of the right hand and thumb point proximally against the anterior surface of the ulna.
- The f ngers grasp around the ulna to reach the posterior surface.
- The forearms are directed opposite each other.

Application of forces by therapist (method)

- The therapist's forearms are directed in the same line and the movement is produced as the patient's forearm is pronated a further 2–3° by a rocking action of the therapist's pelvis and trunk through the hands to the radius and ulna and then released (IV+ to IV−, IV− to IV+).
- A small amplitude movement is therefore used.
- If the elbow pronation range is limited, the therapist's body is turned to the left an appropriate amount so that the forearm direction is changed.

Uses

- Mainly for painful or stiff superior radioulnar joint or stiffness of the olecranon as it swings at the extreme of pronation.

Anteroposterior movement of the head of the radius (Fig. 5.44)

- *Direction*: Anteroposterior movement of the head of the radius in relation to the trochlea of the humerus and the ulna.
- *Symbol*: ↕
- *Patient starting position*: Supine, lying in the middle of the couch.
- *Therapist starting position*: Standing by the patient's right side beyond the slightly flexed right elbow, facing the patient's head.

In supination

Localization of forces (position of therapist's hands)

- The therapist's right side supports the back of the patient's supinated forearm.
- The pads of the thumbs are placed over the anterior surface of the head of the radius.
- The f ngers of the left and right hands spread over the lateral and medial surfaces of the upper end of the patient's forearm.

Application of forces by therapist (method)

- The therapist gradually applies pressure with the thumbs so that they sink into the relaxed muscle tissue until they contact the head of the radius.
- The oscillatory movement is produced by the therapist's body and arms acting through the thumbs, which act like springs.
- The movement must not be produced by the therapist's thumb flexors as this will be uncomfortable for the patient and the therapist will lose all feel to the movement.

In pronation

Localization of forces (position of therapist's hands)

- The right hand holds the patient's pronated left wrist around its lateral border.
- The thumb of the right hand crosses the back of the patient's wrist.
- The fngers cross in front of the patient's wrist.
- The patient's forearm is held in pronation as the anteroposterior movement tends to produce supination.
- The therapist's side supports the patient's forearm.
- The pad of the left thumb is placed against the head of the radius anteriorly.
- The fngers of the left hand spread around the lateral surface of the patient's forearm.

Application of forces by therapist (method)

- The oscillatory movement is produced by the therapist's left arm acting through the stable left thumb while the pronation of the patient's forearm is maintained by the grip of the therapist's right hand.

Uses

- Lateral epicondylalgia where joint signs are evident.
- Painful loss of range of elbow flexion, extension, pronation and supination due to acute injury or mechanically generated inflammation.
- Through range mobilization of pain and stiffness in the anteroposterior direction.
- Minor symptoms which can be directly reproduced in this direction.
- Combined with the posteroanterior direction.
- Most relevant for use in disorders of the radiohumeral and superior radioulnar joints.

Posteroanterior movement of the head of the radius (Fig. 5.45)

- *Direction*: Posteroanterior movement of the head of the radius in relation to the trochlea of the humerus and the ulna.
- *Symbol*: ↧
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed at 30° and either fully supinated or fully pronated.
- *Therapist starting position*: Standing by the patient's right side distal to the slightly flexed elbow, facing the patient's head.

In supination

Localization of forces (position of therapist's hands)

- The right hand holds the patient's supinated right wrist from the medial side.
- The right thumb is placed across the front of the patient's wrist.
- The fngers spread across the back of the wrist.
- The pad of the left thumb, pointing distally, is placed against the dorsal surface of the head of the radius.
- The fngers of the left hand are placed against the front of the distal end of the patient's upper arm to provide counterpressure for the movement.
- The patient's wrist is stabilized in supination as the movement tends to produce pronation.

Application of forces by therapist (method)

- The movement is produced by small adduction movements of the therapist's left shoulder combined with slight forearm supination (therapist's) to exert pressure against the head of the radius with the left thumb.
- The oscillatory movement should not be produced by the therapist's thumb flexors as the feeling of movement will be lost and the pressure will be uncomfortable to the patient and the operator.

In pronation

- The same *localization of forces* and *application of forces* are applied with the exception that the patient's forearm and wrist are held in pronation.

Uses

- As a grade III or IV for osteoarthritis (non-severe or irritable) causing stiffness and pain or stiffness in disordered radiohumeral or superior radioulnar joints.
- Where painful joint signs are causing pain inhibition of the wrist and forearm extensor muscles.

- Minor symptoms which can be directly reproduced in this movement direction.
- Combined with the anteroposterior direction.
- Most relevant for use in the radiohumeral and superior radioulnar joints.

Longitudinal movement caudad (radioulnar) (Fig. 5.46)

- *Direction*: Longitudinal movement caudad of the radius in relation to the humerus and ulna in the line of the forearm (in any position of elbow flexion, extension, pronation, supination; examine in the mid-position of all these movements initially for best effects).
- *Symbol*: ↔ caud.
- *Patient starting position*: Supine lying in the middle of the couch with the elbow mid-way between flexion, extension, pronation and supination.
- *Therapist starting position*: Standing by zthe patient's right side just beyond the elbow.

Localization of forces (position of therapist's hands)

- The therapist's right side has the patient's right forearm resting against it.
- The left hand holds across the front of the patient's upper arm proximal to the elbow.
- The fngers of the left hand spread laterally.
- The thumb of the left hand is placed medially.
- The web of the frst interosseous space is the main point of contact with the patient's upper arm.
- The right hand grasps the anterior surface of the patient's mid-supinated carpus.
- The thumb of the right hand grasps around the radial surface proximal to the base of the ffth metacarpal.
- The middle fnger and thumb reach as far as possible around the posterior surface of the carpus.
- The right forearm must be brought into the same line as the patient's forearm.

Application of forces by therapist (method)

- When this technique is used in treatment as a grade IV the slack of the soft tissues must be taken up frst.
- As the therapist pulls with the right hand the therapist's left hand sinks into the patient's flexor muscle tissue to hold the upper arm frmly.
- Slack must be taken up at the wrist.
- Small oscillatory movements can be performed by a pulling action of the therapist's right arm counteracted by a stabilizing pressure through the therapist's left hand.
- The movement can be enhanced by adding ulnar deviation in rhythm with the pulling action.

Variations in the application of forces

With adjustment of the right hand position, the longitudinal caudad movement can also be produced at:

1. Both the radius and the ulna at the same time;
2. The ulna alone by grasping around the ulna with the right hand and combining the pull on the ulna with a radial deviation of the patient's wrist to enhance the longitudinal movement; and
3. The radius alone as described above.

Uses

- When this movement direction is most painful and restricted.
- For very painful intra-articular radiohumeral or humeroulnar disorders where this movement affords relief of pain.
- To complement pain-free movement of flexion, extension, pronation or supination at the elbow.
- As an accessory movement grade IV at the limit of stiff painless pronation or supination (stiff superior radioulnar joint).
- As a part of joint differentiation testing at the elbow.

Mobilization with movement

It is important to re-emphasize that MWM are pain-free accessory movements (glides) combined with the most comparable activity or movement (Mulligan 2010). The glide component is always performed parallel to the treatment plane of the joint, which is a line drawn across the concave joint surface. If the technique is successful, the patient will be able to achieve a substantial improvement in the

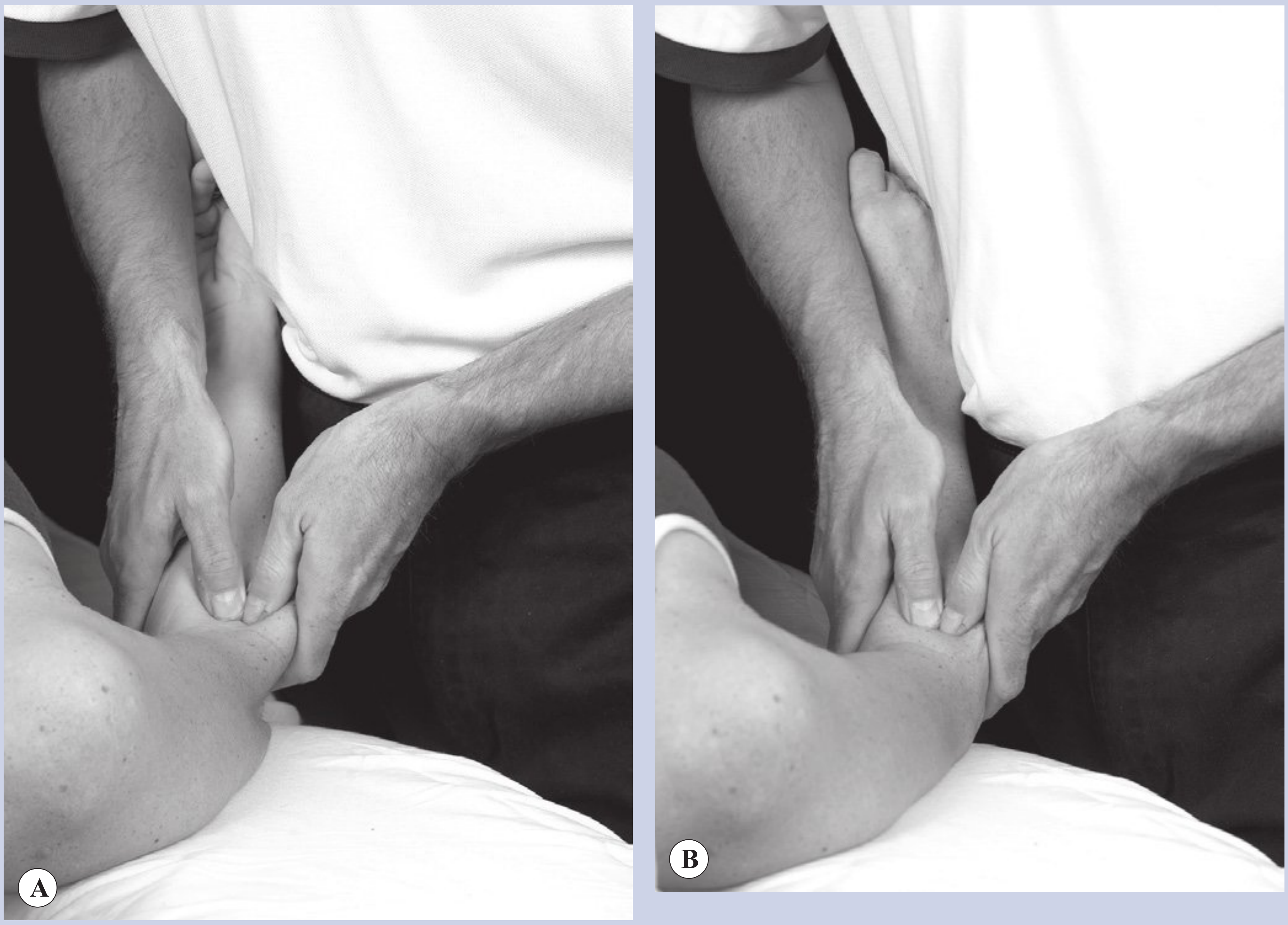

Figure 5.44 • Superior radioulnar joint: A anteroposterior movement in supination; B anteroposterior movement in pronation.

Figure 5.45 • Superior radioulnar joint: posteroanterior movement in supination.

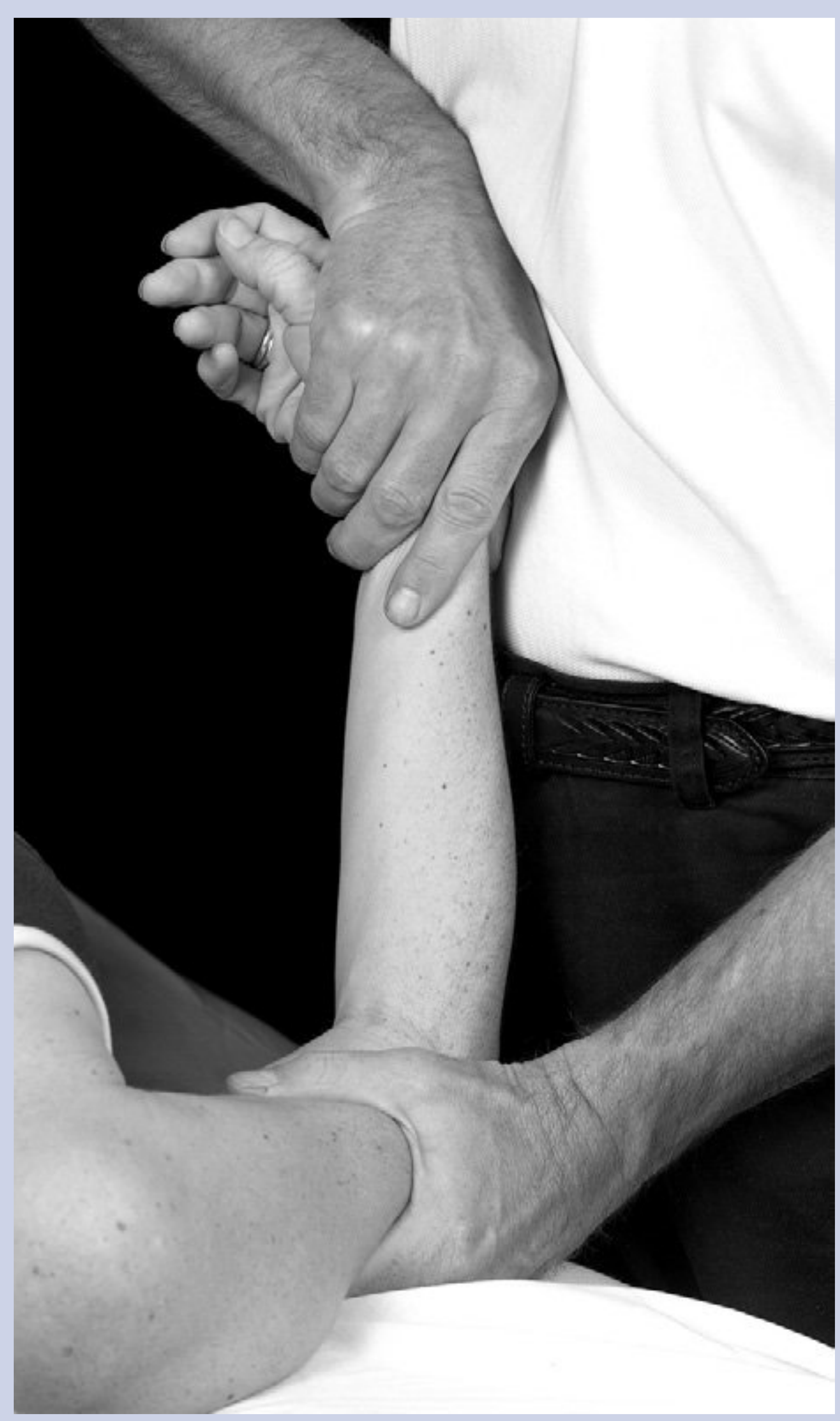

Figure 5.46 • Superior radioulnar joint: longitudinal movement caudad.

comparable activity or movement without pain, while the glide is maintained (Vicenzino et al. 2011). The amount of gliding force will depend on the successful outcome of the technique. If the activity or range is improved, the technique is repeated six to 10 times before reassessment without the glide component. If improvement in the comparable sign is maintained the technique could be used in management. Three to five sets would be undertaken. Home exercise should also be prescribed, mimicking the clinic technique as closely as possible, to aid patient progress. The technique would be progressed to achieve maximum range with overpressure. These principles have been reviewed (Hing et al. 2008) and apply for all the following techniques.

Elbow extension with lateral glide MWM – assessment (Fig. 5.47)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E MWM lat glide.
- *Patient starting position*: Supine, lying to the right side of the couch.
- *Therapist starting position*: Standing by the patient's right side, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned at the point of extension limitation prior to the onset of pain.
- The left hand contacts the extreme distal lateral aspect of the upper arm to support and stabilize the humerus such that the shoulder is fixed in lateral rotation.
- The right hand contacts the extreme proximal medial aspect of the forearm.
- The therapist's forearms are positioned perpendicular to the patient's upper limb.

Application of forces by therapist (method)

- The right hand glides the proximal forearm in a lateral direction.
- The left hand applies a stabilizing counterforce in a medial direction on the distal humerus.
- While maintaining the lateral glide, the patient actively extends the elbow.

Uses

- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow extension with lateral glide MWM – belt (Fig. 5.48)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E MWM belt lat glide.
- *Patient starting position*: Supine, lying to the right side of the couch.
- *Therapist starting position*: Standing by the patient's right elbow, facing across the patient.

Localization of forces (position of therapist's hand and manual therapy belt)

- The elbow is positioned at the point of extension limitation prior to the onset of pain.
- The left hand contacts the extreme distal lateral aspect of the humerus to support and stabilize the upper arm in lateral rotation.
- The right hand grips the lower forearm to control the movement into extension.
- The manual therapy belt is looped around the therapist's pelvis and the proximal end of the patient's right forearm.
- The manual therapy belt is horizontal at all times.

Application of forces by therapist (method)

- The therapist applies a lateral gliding force on the proximal forearm through the belt.
- The left hand stabilizes the distal humerus.
- While the glide is maintained, the patient actively extends the elbow.
- The therapist moves his pelvis to the right to account for movement of the patient's forearm during extension.

Uses

- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow extension with medial glide MWM – assessment (Fig. 5.49)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E MWM med glide.

- *Patient starting position*: Supine, lying to the right side of the couch.
- *Therapist starting position*: Standing by the patient's right side, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned short of extension limitation or pain.
- The right hand contacts the extreme distal lateral aspect of the humerus to support and stabilize the upper arm such that the shoulder is fxed in lateral rotation.
- The left hand contacts the proximal aspect of the forearm on the lateral side.
- The therapist's forearms are positioned perpendicular to the patient's upper limb.

Application of forces by therapist (method)

- The left hand glides the proximal forearm in a medial direction, parallel to the elbow joint line.
- The right hand applies a stabilizing counterforce in a lateral direction on the distal humerus.
- While maintaining the medial glide, the patient actively extends the elbow.

Uses

- Usually indicated when a lateral glide MWM is not effective.
- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow extension with medial glide MWM – belt (Fig. 5.50)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E MWM belt med glide
- *Patient starting position*: Supine, lying to the right side of the couch, shoulder abducted to 90° with neutral rotation.
- *Therapist starting position*: Standing on the medial aspect of the patient's right elbow, facing perpendicular to the arm.

Localization of forces (position of therapist's hands and belt)

- The elbow is positioned at the point of extension limitation prior to pain onset.
- The right hand contacts the extreme distal medial aspect of the humerus to support and stabilize the humerus and prevent shoulder movement.
- The left hand grips the lower forearm to control the movement into elbow extension.
- The manual therapy belt is looped around the therapist's pelvis and extreme proximal end of the patient's forearm.
- The manual therapy belt is horizontal.

Application of forces by therapist (method)

- The therapist applies a medial gliding force on the proximal forearm through the belt.
- The right hand stabilizes the distal humerus.
- While the glide is maintained, the patient actively extends the elbow.
- The therapist moves his body to account for movement of the patient's forearm.

Uses

- Usually indicated when a lateral glide MWM is not effective.
- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow flexion with lateral glide MWM – assessment (Fig. 5.51)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F MWM lat glide.
- *Patient starting position*: Supine, lying to the right side of the couch.
- *Therapist starting position*: Standing by the patient's right side, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned at the point of flexion limitation prior to the onset of pain.
- The left hand contacts the extreme distal lateral aspect of the upper arm to support and stabilize

Figure 5.47 • Elbow extension with lateral glide MWM.

Figure 5.48 • Elbow extension with lateral glide MWM.

Figure 5.49 • Elbow extension with medial glide MWM.

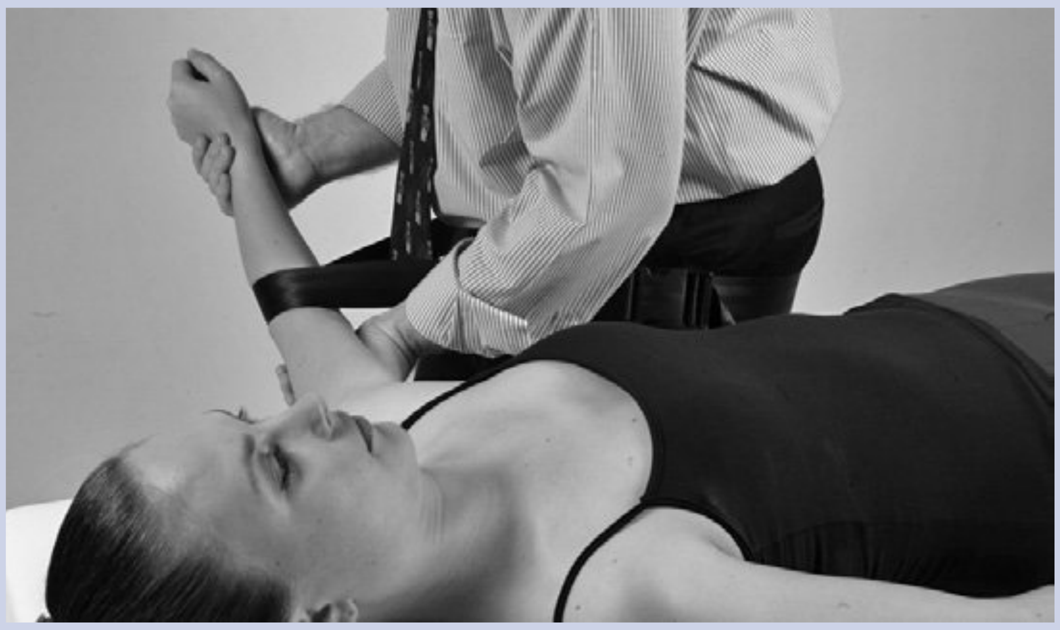

Figure 5.50 • Elbow extension with medial glide MWM.

the humerus such that the shoulder is fxed in lateral rotation.

- The right hand contacts the extreme proximal medial aspect of the forearm.
- The therapist's forearms are positioned perpendicular to the patient's upper limb.

Application of forces by therapist (method)

- The right hand glides the proximal forearm in a lateral direction.
- The left hand applies a stabilizing counterforce in a medial direction on the distal humerus.
- While maintaining the lateral glide, the patient actively flexes the elbow.

Uses

- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow flexion with lateral glide MWM – belt (Fig. 5.52)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F MWM belt lat glide.
- *Patient starting position*: Supine, lying to the right side of the couch.

- *Therapist starting position*: Standing by the patient's right elbow, facing across the patient.

Localization of forces (position of therapist's hand and manual therapy belt)

- The elbow is positioned at the point of flexion limitation prior to the onset of pain.
- The left hand contacts the extreme distal lateral aspect of the humerus to support and stabilize the upper arm in lateral rotation.
- The right hand grips the lower forearm to control the movement into flexion.
- The manual therapy belt is looped around the therapist's pelvis and the proximal end of the patient's right forearm.
- The manual therapy belt is horizontal at all times.

Application of forces by therapist (method)

- The therapist applies a lateral gliding force on the proximal forearm through the belt.
- The left hand stabilizes the distal humerus.
- While the glide is maintained, the patient actively flexes the elbow.
- The therapist subtly moves his pelvis to the left to account for movement of the patient's forearm during flexion.

Uses

- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow flexion with medial glide MWM – assessment (Fig. 5.53)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F MWM med glide.
- *Patient starting position*: Supine, lying to the right side of the couch.
- *Therapist starting position*: Standing by the patient's right side, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned prior to the point of flexion limitation or prior to the onset of pain.
- The right hand contacts the extreme distal lateral aspect of the humerus to support and stabilize the upper arm such that the shoulder is fixed in lateral rotation.
- The left hand contacts the extreme proximal lateral aspect of the forearm.
- The therapist's forearms are positioned perpendicular to the patient's upper limb.

Uses

- Usually indicated when a lateral glide MWM is not effective.
- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow flexion with medial glide MWM – belt (Fig. 5.54)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F MWM belt med glide
- *Patient starting position*: Supine, lying to the right side of the couch, shoulder abducted to 90° with neutral rotation.
- *Therapist starting position*: Standing on the medial aspect of the patient's right elbow, facing perpendicular to the arm.

Localization of forces (position of therapist's hands and belt)

- The elbow is positioned at the point of flexion limitation prior to pain onset.
- The left hand contacts the extreme distal medial aspect of the humerus to support and stabilize the upper arm and prevent shoulder movement.
- The right hand grips the lower forearm to control the forearm movement during elbow flexion.
- The manual therapy belt is looped around the therapist's pelvis and extreme proximal end of the patient's forearm.
- The manual therapy belt is horizontal at all times.

Application of forces by therapist (method)

- The therapist applies a medial gliding force on the proximal forearm through the belt.

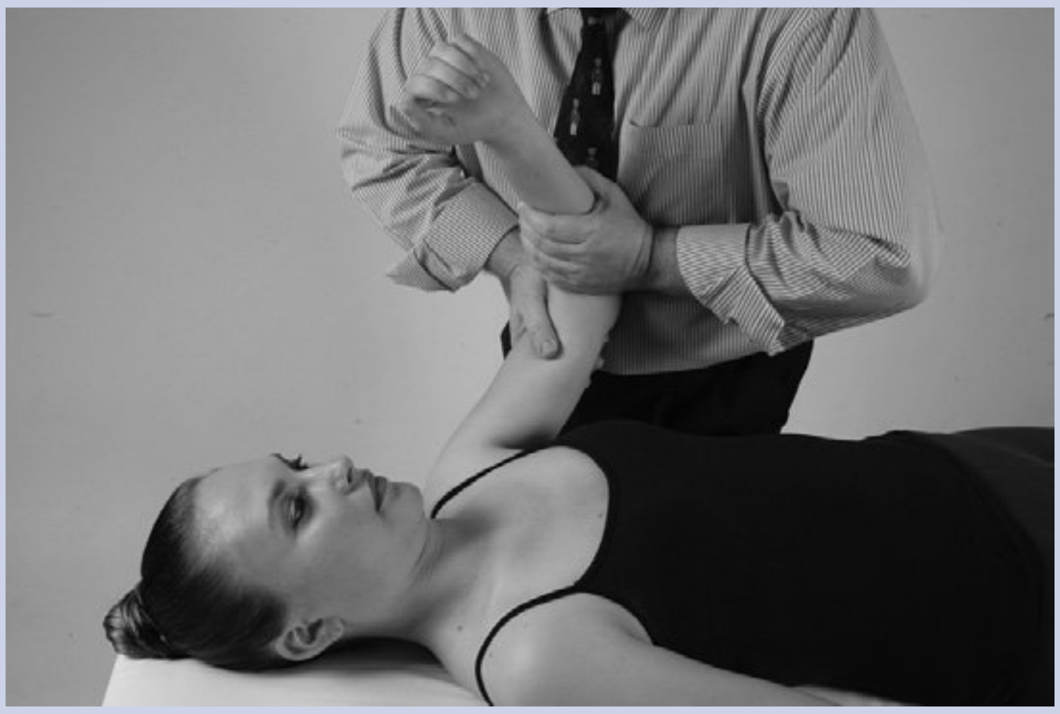

Figure 5.51 • elbow flexion with lateral glide mwm.

Figure 5.52 • elbow flexion with lateral glide mwm.

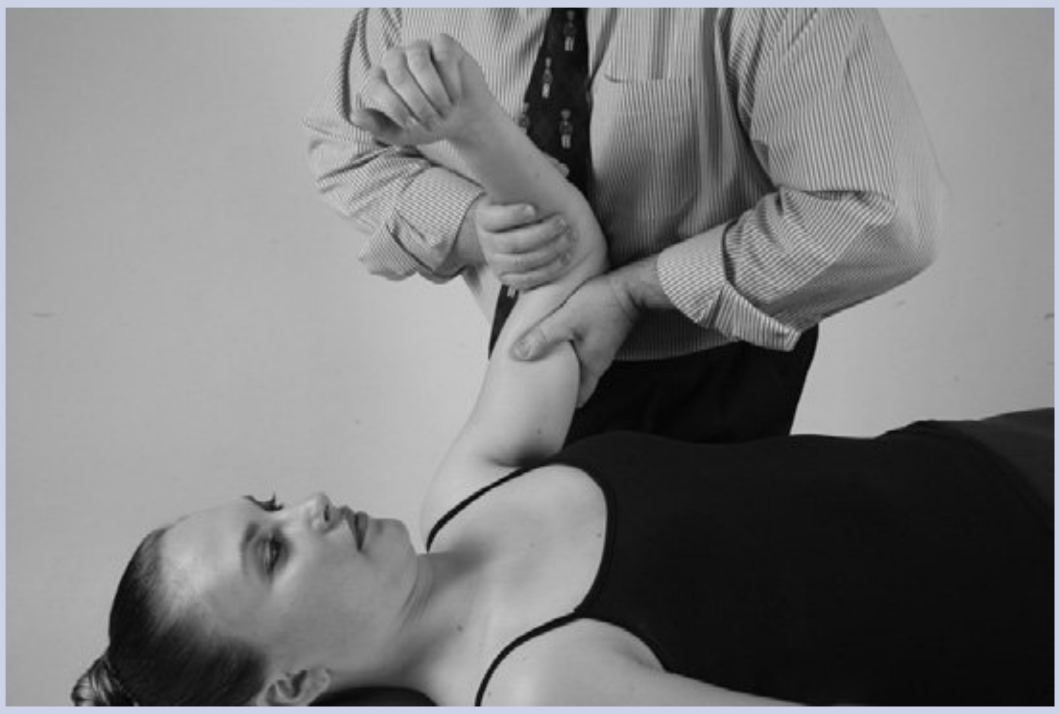

Figure 5.53 • Elbow flexion with medial glide MWM.

Figure 5.54 • Elbow flexion with medial glide MWM.

- The left hand stabilizes the distal humerus.
- While the glide is maintained, the patient actively flexes the elbow.
- The therapist subtly moves his pelvis to the right, to account for movement of the patient's forearm during flexion.

Uses

- Usually indicated when a lateral glide MWM is not effective.
- As an assessment.
- Management of clinical groups 1, 2, 3a and 3b.
- Recent or chronic injury or episode of OA.
- Very painful elbow conditions.

Elbow extension with ulnar lateral tilt MWM (Fig. 5.55)

- *Direction*: Elbow extension movement.
- *Symbol*: Elbow E MWM ulnar lat tilt.

- *Patient starting position*: Supine, lying to the right side of the couch, arm by the side.
- *Therapist starting position*: Standing by the patient's right side, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned short of extension limitation or pain.
- The thenar eminence of the right hand contacts the medial border of the ulnar.
- The left hand contacts the distal aspect of the humerus on the lateral side.
- The therapist's hands 'cup' posteriorly the patient's forearm and humerus.

Application of forces by therapist (method)

- The right hand tilts the ulnar in a lateral direction, rotating the ulnar along its long axis, through a supination movement of the therapist's right forearm.
- The left hand applies a stabilizing counterforce in a lateral direction on the distal humerus.
- While maintaining the lateral tilt, the patient actively extends the elbow.

Uses

- As an assessment.
- Limitation of elbow extension, particularly associated with throwing action.

Elbow extension with ulnar medial tilt MWM (Fig. 5.56)

- *Direction*: Elbow extension movement.
- *Symbol*: elbow E MWM ulnar med tilt.
- This technique is similar to the previous technique, with the exception that the therapist's left hand tilts the ulnar medially, via contact on the lateral border of the ulnar. The therapist's right hand now stabilizes the lateral aspect of the humerus.

Elbow flexion with longitudinal caudad glide MWM (Fig. 5.57)

- *Direction*: Elbow flexion movement.
- *Symbol*: Elbow F MWM ulnar ↔ caud.
- *Patient starting position*: Supine, lying to the right side of the couch, arm by the side. Shoulder in 90° flexion and lateral rotation.
- *Therapist starting position*: Standing lateral to the patient's right shoulder, facing across the patient.

Localization of forces (position of therapist's hands)

- The elbow is positioned short of flexion limitation or pain.
- The therapist's right 'cupped' palm (between thenar and hypothenar eminences) contacts the proximal aspect of the patient's olecranon, taking up the soft tissue slack to ensure a frm contact.
- The left hand contacts the anterior distal anterior aspect of the humerus.
- The therapist's forearms are positioned such that they are parallel to each other, with the therapist's right forearm aligned with the patient's right forearm.

Application of forces by therapist (method)

- The right hand glides the olecranon in longitudinal caudad direction.
- The left hand applies a stabilizing counterforce on the distal anterior humerus, to stabilize the upper arm.
- While maintaining the glide, the patient actively flexes the elbow.

Uses

- As an assessment.
- Limitation of elbow flexion.

Elbow pronation or supination with ↓ or ↑ radius MWM (Fig. 5.58)

- *Symbol*: Elbow Sup. MWM ↓ radius; elbow Sup. MWM ↑ radius; elbow Pro. MWM ↓ radius; elbow Pro. MWM ↑ radius.
- *Patient starting position*: Supine, lying to the right side of the couch, elbow flexed to 90°.
- *Therapist starting position*: Standing by the patient's right side, facing across the patient.

Localization of forces (position of therapist's hands)

- The elbow is positioned short of pronation or supination limitation or pain.
- The thumbs of both hands (one reinforcing on top of the other) contact the anterior or posterior aspect of the proximal aspect of the radius.

Application of forces by therapist (method)

- With both thumbs the therapist applies either a PA or AP glide on the radius.
- The fingers and palms of the therapist's hands provide general stability to the proximal forearm and elbow.

Uses

- Limitation of forearm pronation or supination.

Techniques for lateral epicondylalgia

The following techniques are described for a patient with lateral epicondylalgia, where the pain‑provoking

Figure 5.55 • Elbow extension with ulnar lateral tilt MWM.

Figure 5.56 • Elbow extension with ulnar medial tilt MWM.

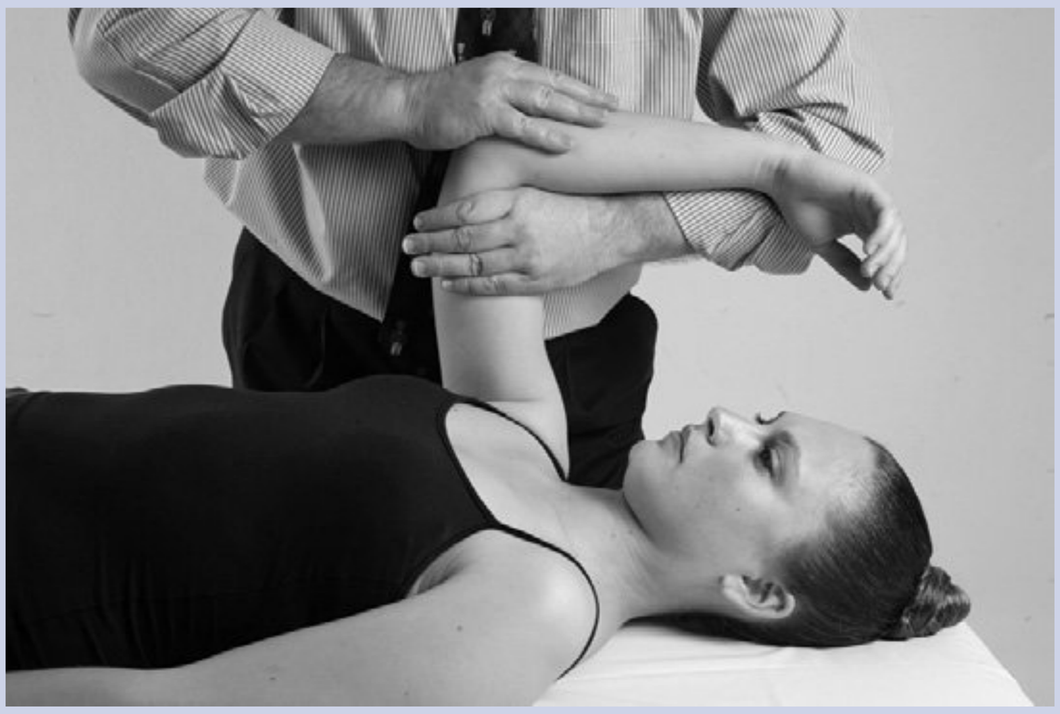

Figure 5.57 • Elbow flexion with longitudinal caudad glide MWM.

Figure 5.58 • Elbow pronation or supination with ↓ or ↑ radius MWM.

activity is making the fist (gripping). The same technique could be applied where isometric finger and/or wrist extension is provocative.

Gripping with lateral glide MWM (Fig. 5.59)

- *Symbol*: Lat glide grip MWM.
- *Patient starting position*: Supine, lying to the right side of the couch, arm by the side, elbow extension and forearm pronation.
- *Therapist starting position*: Standing by the patient's right side, lateral to the elbow, facing towards the patient's head.

Localization of forces (position of therapist's hands)

- The elbow is positioned in full pronation and extension.
- The left hand contacts the extreme distal lateral aspect of the upper arm to support and stabilize the humerus such that the shoulder is fixed in lateral rotation.
- The right hand contacts the extreme proximal medial aspect of the forearm.
- The therapist's forearms are positioned perpendicular to the patient's upper limb.

Application of forces by therapist (method)

- The right hand glides the proximal forearm in a lateral direction.
- The left hand applies a stabilizing counterforce in a medial direction on the distal humerus.
- While maintaining the lateral glide, the patient grips to make a fist.

Uses

- As an assessment.
- To eliminate pain associated with gripping to make a fist and wrist or finger isometric extension.

Variations on this technique include the use of a manual therapy belt to apply the lateral glide force, rather than the therapist's hands (Fig. 5.60). In some patients it is necessary to adjust the angle of the gliding force, as the glide that achieves the pain-free activity is not always in a purely lateral direction. At least 66% of maximum glide force is required to achieve optimum improvement (McLean et al. 2002).

The patient can be instructed to carry out a lateral glide at the elbow, while making a fist, as a home exercise. This will greatly enhance recovery.

Taping is a useful adjunct treatment when the aforementioned technique has been found to be effective. Two strips of 38 mm non-stretch sports tape are applied from the medial aspect of the forearm, spiralling proximally across the anterior aspect of the elbow, to finish on the posterior aspect of the humerus on the lateral side (Fig. 5.61). Both strips overlay each other. To achieve some degree of tension the tape should be applied with the elbow slightly flexed and maximally supinated. If tape is applied under tension, then when the elbow is in an extended/pronated position, further tension will be generated, which should produce a degree of lateral force.

The patient's symptoms should be assessed before and after the tape is applied. A significant improvement in the pain-free grip force indicates

Figure 5.59 • Gripping with lateral glide MWM.

Figure 5.60 • Gripping with lateral glide MWM.

a positive outcome. In that case the tape is usually worn for 48 hours before removal, skin inspection, and reapplication if necessary. Prior to the frst application, it is important to assess for any contraindications (skin allergy, open wounds, infection, etc.), and to warn the patient about occurrence of potential side effects, which requires the immediate careful removal of tape to prevent skin breakdown.

Gripping with ↓ radius MWM (Fig. 5.62)

- *Symbol*: ↓ radius grip MWM.
- *Patient starting position*: Supine, lying to the right side of the couch, arm by the side, elbow extension and forearm pronation.
- *Therapist starting position*: Standing by the patient's right side, lateral to the elbow, facing across the patient.

Localization of forces (position of therapist's hands)

- The elbow is positioned in full pronation and extension.
- The thumbs of both hands (one reinforcing on top of the other) contact the posterior aspect of the proximal aspect of the radius.

Figure 5.61 • Tennis elbow tape lateral glide.

Application of forces by therapist (method)

- With both thumbs the therapist applies either a posteroanterior glide on the radius.
- The fngers and palms of the therapist's hands provide general stability to the proximal forearm and elbow.

Uses

- As an assessment.
- To eliminate pain associated with gripping to make a fst and wrist or fnger isometric extension.

The patient can be instructed to carry out a posteroanterior glide of the radius, while making a fst, as a home exercise. This will greatly enhance recovery.

Taping can mimic a posteroanterior glide of the radius (Fig. 5.63). Apply two short strips of 38 mm non-stretch sports tape from the posterior aspect of the head of the radius, wrapping around the forearm to end on the medial aspect of the forearm.

Figure 5.62 • Gripping with ↓ radius MWM.

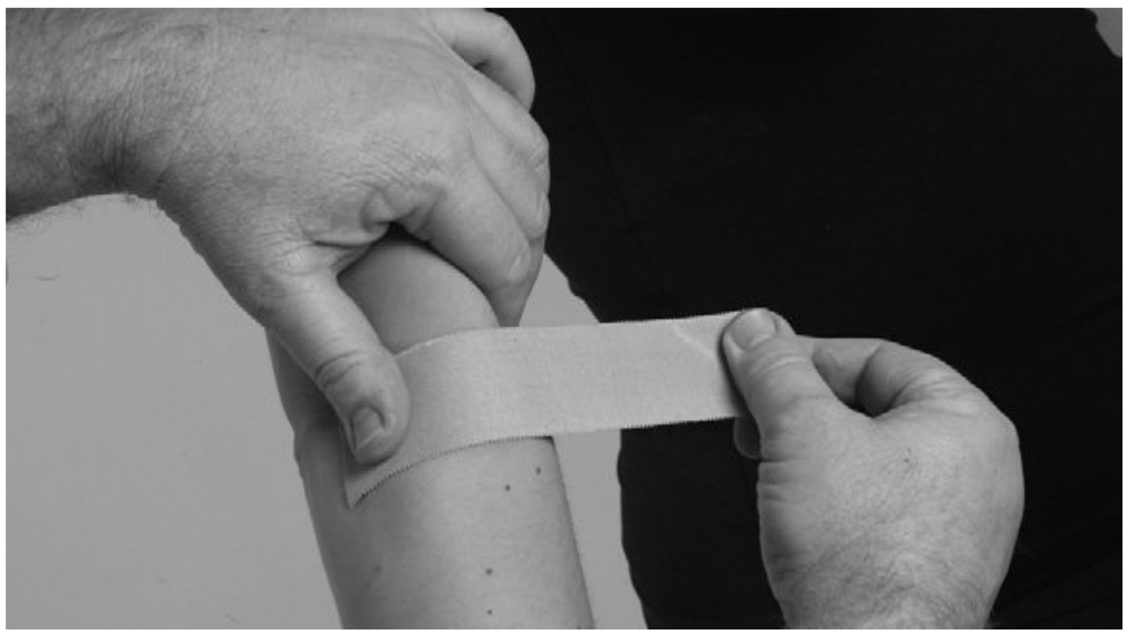

Figure 5.63 • Tape for PA radius.

Lay the tape under tension, pulling the tape in an anterior direction, while at the same time applying a posteroanterior gliding force on the head of the radius.

Neurodynamic techniques

Treatment for elbow disorders, where peripheral nerve sensitization can be identified as the pain source, should consist of gentle manual therapy in which the structures surrounding the involved neural tissue are gently mobilized. The cervical lateral glide is the technique of choice for patients with peripheral nerve sensitization involving the upper limb (Hall & Elvey 2011).

Cervical lateral glide technique (Fig. 5.64)

- *Direction*: Cervical lateral glide.
- *Symbol*: Cx lat glide.
- *Patient starting position*: Supine, lying in the centre of the couch, with the top of the head level with the end of the couch. Both hands resting on the abdomen.
- *Therapist starting position*: Standing at the patient's head, the therapist rests their abdomen against the top of the patient's head.

Localization of forces (position of therapist's hands)

- The cervical spine is positioned in neutral, with the individual sensitized peripheral nerve trunk positioned out of provocation (hands resting on the abdomen, with the elbows flexed to 90°).
- The left hand contacts the posterior aspect of the cervical spine, with the fingers and thumb wrapping around each side of the neck. The index finger should be immediately proximal to the most sensitized cervical segment.
- The right hand contacts the superior surface of the patient's right acromion to stabilize the scapula and prevent elevation.

Application of forces by therapist (method)

- The left hand translates the head and cervical spine in a contralateral direction, returning to neutral position, oscillating between each end point.

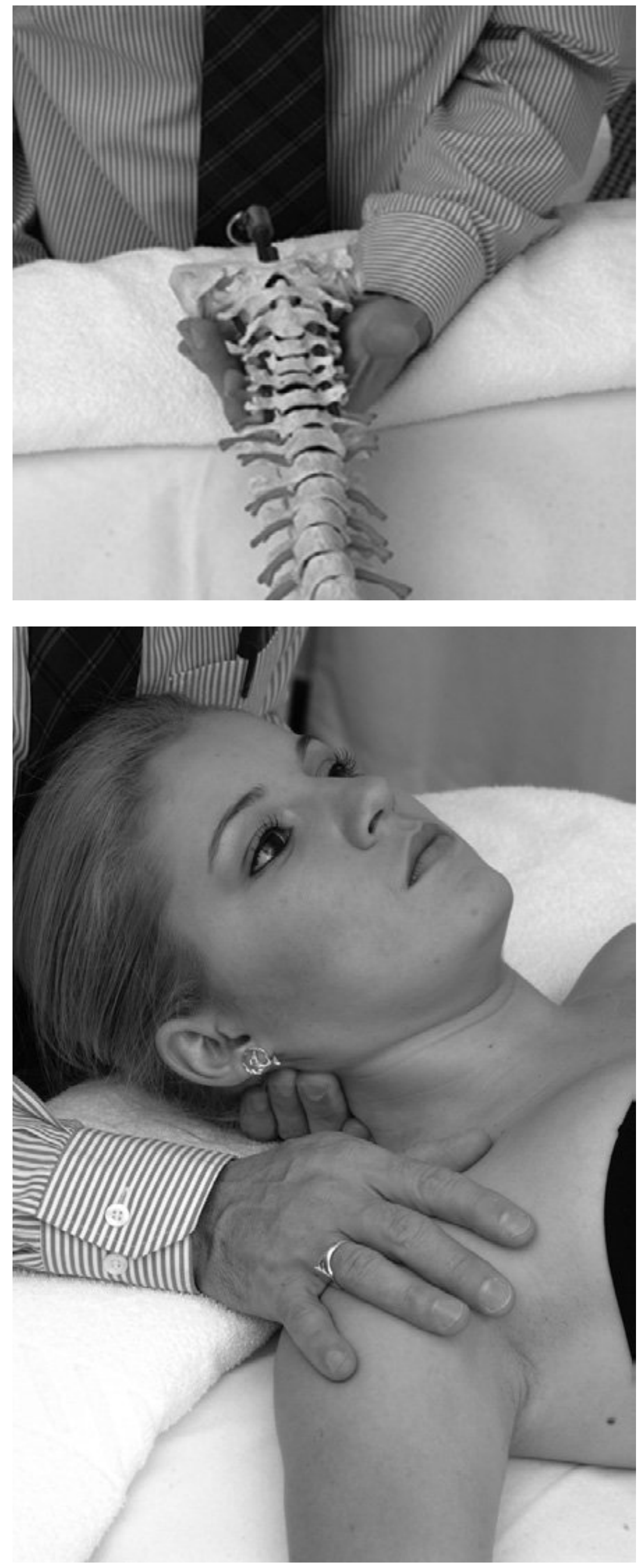

Figure 5.64 • Cervical lateral glide.

- The patient's arm is positioned, during follow-on treatment sessions, in progressively greater degrees of neural tissue provocation as mechanosensitivity diminishes.

Uses

- When pain predominates from peripheral nerve sensitization involving the median, radial, or ulnar nerve trunk around the elbow.

Scaphoid IV and V (Fig. 5.65)

- *Direction*: Wrist extension movement.
- *Symbol*: PA scaphoid IV and V.

Figure 5.65 • Scaphoid high velocity thrust.

- *Patient starting position*: Supine, lying with the shoulder in abduction, elbow in extension, forearm pronation.
- *Therapist starting position*: Standing by the patient's right side just beyond the elbow, facing the patient's head.

Localization of forces (position of therapist's hands)

- The therapist holds the patient's right hand.
- The thumbs of each hand overlay each other, contacting the dorsal aspect of the scaphoid.
- The index fngers of each hand overlay each other, contacting the ventral aspect of the scaphoid.
- The remaining fngers support the hand and control the movement of the wrist.

Application of forces by therapist (method)

- The therapist flexes the patient's elbow and wrist simultaneously, followed by extension of the wrist and elbow. When this technique is used in treatment as a grade IV the slack of the soft tissues must be taken up frst.
- As the therapist extends the wrist, the thumbs apply frm ventrally directed pressure to the scaphoid.
- Small oscillatory movements can be performed through range of wrist extension.
- A high velocity thrust (grade V) can be applied by a quick flick of the patient's wrist into extension combined with rapid, small amplitude, posteroanterior pressure on the scaphoid.

Variations in the application of forces

Gentle traction can be employed during the application of force against the scaphoid to separate the carpal articular surfaces.

Uses

- Elbow lateral epicondylalgia.
- When wrist extension is most painful and restricted.
- For localized pain and restriction of movement of the radioscaphoid articulations.

Elbow disorders and their clinical profiles

Introduction

The most common types of elbow neuromusculoskeletal disorder fall into the following broad categories:

- *Trauma* – particularly fractures of the head of radius and olecranon, subluxation of the head of radius, and apophyseal separation in children.
- *Overuse strain* – especially medial and lateral epicondylalgia (Table 5.2) and valgus extension overload from throwing or racket use (Ellenbecker et al. 2010a).
- Peripheral *nerve sensitization* – especially the ulnar and radial nerves.
- *Peripheral nerve compression (CN)* – especially the ulnar nerve in the cubital tunnel.
- *Osteoarthritis* (mechanical, degenerative, traumatic or systemic) which may include impairment due to loose bodies.
- *Rheumatoid arthritis.*
- *Osteochondrosis* – Panner's disease (medial epicondyle apophysitis) is the most common cause of elbow pain in children under 10 years (Atanda et al. 2011).
- Less common conditions include osteochondritis dissecans, olecranon bursitis and myositis ossifcans.

Maitland (2001) has categorized elbow disorders by their common clinical characteristics. The purpose of this is to help establish the role which mobilization/

Table 5.2 Clinical profile: lateral epicondylalgia

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Predominantly multidimensional involving three interrelated components. These are: (1) extensor tendon pathology, (2) changes in the pain system, and (3) motor system impairments (Coombes et al. 2009). Most commonly pain on the lateral side of the elbow occurs with gripping, forearm pronation and wrist/finger extension activities
Body chart features	Lateral elbow pain Joint: deep aching pain within the joint; feeling of stiffness Radial nerve: Proximal/distal spread of pain; lines of pain; accompanying sensitivity to touch (allodynia, hyperalgesia). Pain, dysaesthesia, occasional paraesthesia in the distribution of the sensory branch of the radial nerve Muscle/tendon: superficial pain local to the common extensor origin; sore, bruised feeling; feeling of weakness in the arm and tiredness of the forearm muscles Other sources: heaviness of the whole arm, diffuse pain; dysaesthesia; the characteristic dermatomal distribution of nerve root pain in cervical radiculopathy
Activity limitations/ 24-hour	Reduced grip strength often accompanied by pain. Pain and weakness behaviour of symptoms reproduced during activities involving gripping or lifting items with elbow extended Joint disorders accompanied by stiffness and limitation by pain during activities which involve elbow extension, pronation or supination depending on the predominant joint involved, such as reaching and lifting a heavy saucepan, or opening a stiff door. Morning stiffness is common in arthritic joints or inflammatory arthropathies Disorders with radial nerve involvement will be affected by activities which enhance the mechanosensitivity of the affected nerve, including activities which lengthen sensitized neural tissue such as keyboard use, carrying shopping bags, muscle stretching Muscle/tendon disorders will show up as pain or pain inhibition during gripping activities. However, gripping is also known to cause compression of the radial nerve in the supinator tunnel, and strain painful joints. Isolated referred pain from the cervical spine is generally unaffected by activities which would usually stress the tissues around the elbow
Present/past history	Although commonly called tennis elbow, this condition affects more industrial workers than sportsmen (Van Hofwegen et al. 2010). Occupations/activities involving non-neutral postures of hands and arms, use of heavy handheld tools, and high physical strain are particularly at risk (Haahr & Andersen 2003). The condition is prone to recurrent bouts and is characterized by a protracted history
Special questions	MRI should be considered to exclude other conditions such as osteochondral lesions, non-displaced epiphyseal fractures and other underlying bone problems (Van Hofwegen et al. 2010). If these are not suspected no further screening is recommended
Source/ mechanisms of symptom production	Primarily degenerative tendinopathy, chemical/mechanical nociception, or peripheral neurogenic pain from nerve sensitization or, very rarely, true radial nerve entrapment. Consider also cervical nerve root pain
Cause of the source	Consideration should be given to the cervical spine (Berglund et al. 2008, Cleland et al. 2004), neural tissue involvement (Berglund et al. 2008, Buzzi & Moskowitz 2005, Waugh et al. 2004, Yaxley & Jull 1993) and poor dynamic control (Bisset et al. 2006b, Ellenbecker et al. 2010b)
Contributing factors	Occupation; pre-existing degenerative changes in tendon connective tissue; central sensitization of nociceptive tissue
Observations	Swelling or prominence of the lateral epicondyle; overactivity of ECRB (elbow flexed); muscle atrophy is more likely to be related to disuse rather than the rare event of true posterior interosseous nerve compression (Rosenbaum 1999)

Table 5.2 Clinical profile: lateral epicondylalgia—cont'd

Examination	Clinical evidence/'brick wall' thinking
Functional demonstration	Grip strength test with elbow in extension and pronation; minor restriction of joint movements (flexion, extension, pronation, supination); active neurodynamic screening tests for the radial nerve involvement may be helpful (Hall & Elvey 2011)
If necessary tests	Lower cervical quadrant for reproduction of symptoms consistent with cervical nerve root compression (in the absence of arm pain reproduction, consider combining with axial compression); flick at the end of elbow flexion, extension, pronation, supination as overpressure if movements previously symptom free
Other structures in plan	Screening tests for shoulder, wrist and hand, thoracic spine
Isometric/muscle length tests	Pain and weakness with grip strength tests, wrist extension, and finger extension; alignment faults in gripping with increased wrist flexion (Bisset et al. 2006b); pain-free grip force is a more valid measure of outcome (Stratford et al. 1995)
Neurological examination	Sensory loss and motor loss in peripheral nerve distribution if nerve entrapment at the elbow; reflex, dermatome or myotome changes if nerve root lesion
Neurodynamic testing	Pain reproduction, altered range, and increased resistance to movement on radial nerve neurodynamic testing
Passive movement	Spongy thickening and swelling in the olecranon fossa may be palpable and cause lateral elbow pain
Palpation findings	Soft tissue changes evident over the joint line of the radiohumeral joint if there is joint involvement. Tenderness and swelling of the common extensor origin may be palpable, and gentle pressure on the radial nerve may reveal abnormal sensitivity to touch (Berglund et al. 2008)
Accessory/ physiological	Minor signs. Reproduction of symptoms and joint signs with combined movements,extension/adduction, extension/abduction, flexion/adduction, flexion/abduction, extremes of pronation and supination, and anteroposterior/posteroanterior pressure on the head of the radius
Mobilization/ manipulation	Usually fit into the category of chronic minor symptoms in which case the preferred techniques will be MWM. Lateral glide of the elbow or posteroanterior glide of the head of the radius with grip should be trialled. In addition elbow extension/adduction grade IV to IV[+] and accessory movements at the limit of range, usually anteroposterior/posteroanterior on the head of the radius in pronation may also be helpful. The desired effects of such techniques are pain relief and restoration of ideal function. Associated techniques to consider are cervical mobilization (lateral glide), and neurodynamic 'sliders' in the presence of significant peripheral sensitization of the radial nerve. Recently elbow manipulation and Cyriax transverse friction have not been found to be effective (Stasinopoulos & Johnson 2004, Stasinopoulos & Stasinopoulos 2006). Consider manipulation of the wrist
Other management strategies	Short-term benefit of cortisone injection, reversed at mid- and long-term (Coombes et al. 2010); therapeutic exercise programme effective but usually given in combination with manual therapy (Coombes et al. 2009, Bisset et al. 2005), sports taping (Vicenzino et al. 2003)
Prognosis/ natural history	Prognostic factors predicting recovery have been identified. These include work-related disease, length of history of the disease, ergonomic risk exposure, job stress, level of job support, and pain-coping style (Feuerstein et al. 2000). Another report suggested that the psychological status of the patient is important (Alizadehkhaiyat et al. 2007a). The presence of neural symptoms in the arm, and cervical joint signs, has been associated with poor short-term outcome (Waugh et al. 2004)
Evidence base	A multimodal approach has been proposed to manage lateral epicondylalgia due to the complexity of this condition's pathophysiology and the heterogeneity of clinical presentation (Coombes et al. 2009). Furthermore, evidence suggests a multimodal approach is more effective than local treatment alone (Cleland et al. 2004)

manipulation can play in such disorders. The main characteristics to consider are:

- Lateral epicondylalgia
- Joint stiffness
- Chronic minor joint pain.

Lateral epicondylalgia

Pain over the lateral epicondyle associated with wrist and hand activity is commonly known as tennis elbow, but the correct term is lateral epicondylalgia. This disorder is common in both men and women between the age of 35 and 54 and particularly affects the dominant arm in racquet sports and manual occupations (Shiri et al. 2006). Despite the relatively simple clinical picture, the underlying pathophysiological mechanisms are complex (Vicenzino 2003) and can be conceptualized as encompassing three interrelated components (Coombes et al. 2009). These are: (1) extensor tendon pathology, (2) changes in the pain system, and (3) motor system impairments. Pathology of the tendon may be the result of overuse, underuse, or tensile, compressive or shear forces, which leave the tendon in a debilitated state (Coombes et al. 2009).

Despite the complexity, the potential for locally applied manual therapy to help relieve pain and restore function has been demonstrated in a number of trials (Amro et al. 2010, Bisset et al. 2006a, Drechsler et al. 1997, Kochar & Dogra 2002). Careful examination of the elbow will frequently reveal a variety of joint signs potentially contributing to the generation of the patient's symptoms. Box 5.5 highlights some of the variations in potential diagnosis in lateral epicondylalgia and the primacy of selecting treatment techniques based on the clinical information as it emerges.

When minor joint signs are present they can be used as the passive movement treatment techniques. In particular MWM consisting of a posteroanterior glide on the head of radius (Fig. 5.62), or lateral glide of the elbow (Fig. 5.60), combined with gripping has been shown to be an effective treatment technique (Bisset et al. 2006a). Taping (Figs 5.61 and 5.63) may provide long-term pain relief and encourage return to more normal activity. Combined with this should be exercise to stimulate tendon remodelling, produce muscular adaptive responses and improved dynamic control of the whole upper limb kinetic chain. In addition, treatment should be directed to mobilize the spine and desensitize the radial nerve, if found to be involved in the disorder. A multifaceted manual therapy treatment approach, such as that presented here, has been shown to be more effective than localized treatment to the elbow alone (Cleland et al. 2004).

Box 5.5

Lateral epicondylalgia: varied presentations

Clinical presentation

1. Localized lateral elbow pain with lifting saucepan. Came on after lifting heavy pot
   - Cervical spine, thoracic spine □ □
   - Shoulder □ □, elbow E/Ab □ slight pain
   - Isometric wrist extension pain □ ++
   - MWM – ↓ on radial head relieves pain on wrist extension

   Probable localized elbow problem
2. Whole arm aches, especially around the lateral elbow and into the forearm. Occasional thumb pins and needles. Some neck stiffness. Arm aches with sitting.
   - Elbow □ □, isometrics □ □
   - Cervical rotation to the side of the arm – reduced ROM by a few degrees
   - Spurling's test positive for arm pain
   - Neurodynamic tests provoke arm paraesthesia only
   - ↓ C6/7, locally sore and stiff

   Probable cervical nerve root involvement – CN
3. Lateral epicondyle pain radiates proximally with reaching movement. Aches at the end of the day with use
   - Elbow – E/Ad pain □++
   - Elbow – extension/pronation pain, worse in shoulder abduction/cervical lateral flexion □
   - Radial nerve neurodynamic test positive for arm pain and reduced ROM
   - Radial nerve hyperalgesic proximal and distal to elbow
   - C4–5 stiff, sore locally
   - Neurological examination normal

   Probable PNS

Joint stiffness

It is clear that judicious, thoughtful and controlled stretching of the elbow (grades III and IV) is unlikely to cause trauma and myositis ossificans.

If a patient has a stiff and painful elbow (clinical groups 3a and 3b), mobilization techniques should be directed towards influencing the movement-related pain first until a clear picture of the irritability and behaviour of the pain emerges. Once this is known, treatment can be directed towards stretching the elbow in any direction, provided progression of the strength of the technique used does not unfavourably alter the pattern of pain. In such cases the stretching technique will be completely safe.

The stretching techniques for a stiff elbow should consist of:

1. physiological movement grade IV or IV+ provided pain is minimal;
2. accessory movements grade IV or IV− with the joint supported at the limit of the physiological range;
3. interspersing between physiological IV and accessory IV at the limit of range;
4. grade III+ through as large a range as possible to minimize the effects of treatment soreness.

Chronic minor joint pain

When a patient's elbow symptoms are comparatively minor, or are longstanding but still having an effect on the patient's daily life, there are certain passive examination tests, which must be assessed (Box 5.6).

In examination and then treatment, accessory movements at the limit of the various ranges of movement may help to determine which of the three elbow joints is primarily at fault. Extension/abduction and extension/adduction may well provide the most comparable joint signs in such cases; accessory movements at limit and E/Ab and E/Ad are therefore most commonly used in treatment.

The elbow joint can easily be over-treated, whether pain or stiffness is the prime consideration. If a technique such as extension is being used it is vital that the patient's arm is completely relaxed during the treatment and the technique should be completely free of even the most minor feeling of discomfort (III−) (Fig. 5.35A).

If the patient's symptoms are comparatively mild and extension is being used, a gentle grade IV can be considered as a relevant treatment technique, applied more slowly than usual so as to provoke only a minimal amount of pain. This will ensure that the patient's pain is not exacerbated.

Box 5.6

Important passive movement tests for elbow symptoms

- Supine: flexion and extension, plus abduction and adduction
- Supination and pronation plus ↕ and ↕ plus compression
- Longitudinal caudad (humeral line) in 90° elbow flexion
- Olecranon movements
- Functional test, grip (small and large) in F, E, Sup, Pron
- Isometric and muscle length tests

Test movements begin as IV− with observation for pain response. If pain free, adequate overpressure is applied until pain is provoked or the movement is judged 'clear'.

When a positive pain response is provoked, that test movement may need to be differentiated to determine the specific joint at fault, and/or other movements may need to be tested so as to either exclude or incriminate other joints as contributing to the symptoms.

If all test movements appear 'clear' at first examination, they should be repeated more strongly.

Box 5.7

Proving that the elbow joints are, in fact, unaffected

- Supine: extension/abduction. Extension/adduction and 'scouring'
- Supination and pronation with IV+ OP
- Olecranon tests

Proving the elbow unaffected

The elbow joints can be screened thoroughly to prove that they are unaffected in disorders of the upper limb where the elbow could be a source, or cause of the source, of the patient's symptoms (Box 5.7). These three passive movements should be performed as grade IV− movements.

Composite elbow

Box 5.1 lists the test movements that need to be performed if it is not clear which of the three elbow joints is responsible for the patient's symptoms. Further differentiation of the test movements should reveal which joint is the source. For example, supination at its limit may be painful. This could be due to torsion of the humeroulnar joint or spin of the head of the radius against the ulna and sliding of the head of the radius under the capitulum. Supination can then be performed in ways that will establish which joint is causing the patient's pain.

Case study 5.1

A clinical example of recording – the elbow region

Mr K is a 25-year-old motor mechanic who enjoys surfing two to three times per week.

Kind of disorder

Elbow pain with elbow extension and supination.

Body chart

Areas of symptoms are as outlined in Figure 5.66.

Activity limitations/24-hour behaviour of symptoms

**□ push-ups at gym – immediate pain – eases in a few minutes

□ using a screwdriver with elbow extended – onset in 10 seconds – aches for one minute

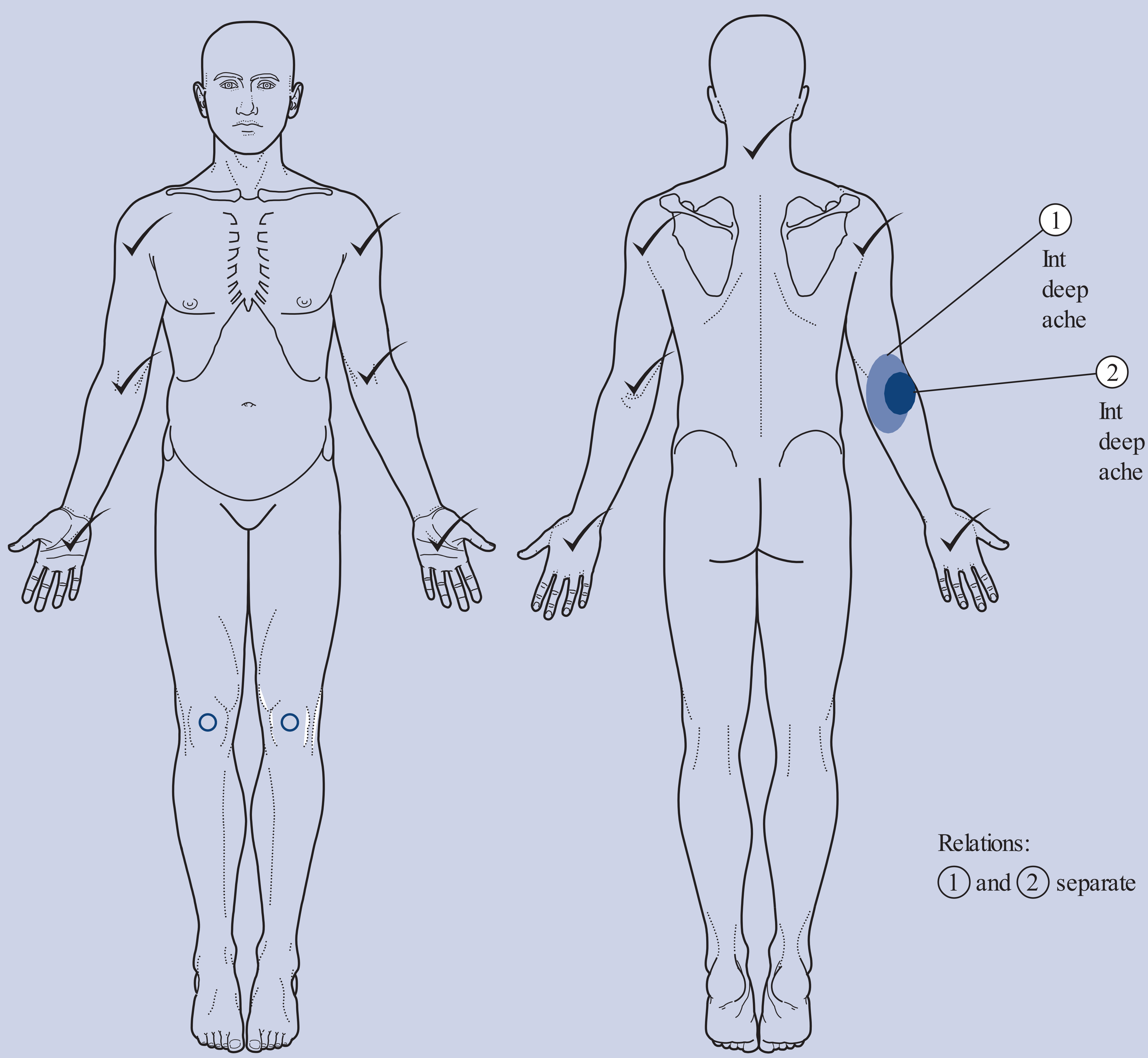

Figure 5.66 • Body chart of Mr K.

Case study 5.1—cont'd

Sleep

Works as a small motor mechanic repairing motors – □ ⁻ EOD

Past/present history

- □ commenced after a fall onto a sandbar while surfing 12 weeks ago. Fell onto outstretched arm – no hyperextension.
- Experienced immediate pain, although was able to keep surfing for another 30 minutes.
- No previous history of □. Very sore next morning. Since then, had fuctuating symptoms though currently about the same.
- □ commenced a week later and has remained about the same since.
- Consulted medical practitioner four weeks ago, who prescribed analgesics as required and X-rays.
- He has had no treatment for the problem at this stage.
- No relevant previous history of upper limb injury or problems.

Special questions

General health – NAD

X-rays four weeks ago – NAD

Medication – analgesia as required

Hypothesis

- Elbow sprain due to fall on outstretched arm.
- The history suggests probable residual dysfunction of the humeroulnar joint and the radiohumeral joint and the superior radioulnar joint.
- The severity and irritability are low, suggesting that the examination and treatment can be to the limit of the movement directions.

Physical examination

Observation: holds the elbow in slightly increased fexion compared to the left side.

Present pain: nil.

Functional demonstration and differentiation:

- Quick test:

  Elbow movements

  Extension elbow pain □ and restriction

  Flexion □□

  Pronation □□

  Supination: EOR pain □ and restriction

  Shoulder movements

  Elevation through fexion □□

  Abduction □□

  Hand behind back □□

  Cervical Spine

  Quadrant □□

  Wrist

  Flexion □□, extension □□, ulnar deviation □□, radial deviation □□

- Active movements:

  Elbow extension: P1 5° fexion P2R2 with OP

  Elbow fexion: □□

  Forearm supination: P1 75°P2 OP □

  Forearm pronation: □□

- Palpation (elbow):

  Tender proximal to olecranon

  Tender over radiohumeral joint line

- Isometric tests: □□ (Muscle length not tested)
- Neurodynamic active screening tests: radial □□, median, □□, ulna □□
- Neurological examination: □□□
- Passive movements (joints):

  Extension R1 10° fexion P1 5° fexion P2R2 OP 0° fexion (□)

  Supination: R1 70° P1 80° R2P2 OP 90° □

  ↕ head of radius □++

- Assessment using MWM for extension:

  Medial and lateral glide – no change to elbow extension

  Apply lateral tilt on olecranon – pain free

  Sustain lateral tilt on olecranon with active elbow extension – pain-free movement into extension and able to extend to end-range active extension 0°

  MWM repeated × 10

  Post-technique active extension full end range pain only with OP □

  Supination unchanged

Plan for treatment 1

Treat elbow extension initially using MWM. Evaluate infuence on supination and progress subsequent treatment according to response to MWM.

Rx1

Treatment

Elbow extension MWM with lateral tilt – two sets of 10 repetitions.

After treatment

Active extension P1R2 with OP only. Supination unchanged.

Rx2a

Assessment

C/O− elbow pain □ improved 40%, □ unchanged

Elbow extension pain on OP □. Supination unchanged

Case study 5.1—cont'd

Treatment 2a

MWM elbow extension with lateral tilt – three sets of 10 repetitions.

Post-treatment

Active extension □□

Supination unchanged. ↕ head of radius □++

Treatment 2b

3 × ↕ head of radius grade III−

Post-treatment 2b

Active extension □□

Supination P1 85° P2 OP

↕ head of radius □

Rx3

Assessment

C/O− elbow pain □ improved 80%, □ improved 30%

Elbow extension pain on OP □

Supination P1 85° P2 OP

↕ head of radius □+

Treatment

MWM elbow extension with lateral tilt – three sets of 10 repetitions with OP

3 × ↕ head of radius grade III

Home exercise MWM using elbow extension with ulnar lateral tilt – three sets of 10 per day

Post treatment

Active extension □□

Supination P1 OP

↕ head of radius □

Rx4

Assessment

C/O elbow pain □ improved 100%, □ improved 80%

Elbow extension □□

Supination P1 OP

↕ head of radius □

Treatment

5 × ↕ head of radius grade III+

Post-treatment

Elbow extension □□

Supination □□

↕ head of radius □

Rx5

Assessment

C/− elbow pain □ improved 100%, □ improved 100%

Elbow extension □□

Supination □□

Advice given to maintain improvement by non-specific ROM exercises for extension and supination.

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6

Management of wrist and hand disorders

Pierre Jeangros

CHAPTER CONTENTS

Key words

Inferior radioulnar joint, radiocarpal, midcarpal, intercarpal, carpometacarpal, intermetacarpal, metacarpophalangeal, interphalangeal

Introduction

The bio-psychosocial role of the hand is greater than that of any other part of the body. Hofer (2009) has long recognized the role of the tactile kinaesthetic system (touch or feeling) in the development of mankind. The hand and the brain act as a functional unit. The hand occupies a central place and is highly represented within the sensory homunculus. The hand within the sensory homunculus plays an important role in maintaining internal homeostasis and balance relative to the socioemotional environment and functioning.

The development of mankind has been characterized by an interaction between man, as an individual, and his environment and an unlimited range of activities. The hand tells us about centuries of evolving sensations and functional applications of many different kinds.

Several professions are totally dependent on perfect function of the hand, including the requirement for great adaptability which, along with a great capacity for differentiation of a vast range of functions, is a development acquired over many years. All those qualities are found not only among artists (musicians, jewellers, etc.), but also in a range of professions including carpenters, watchmakers and surgeons. The hand is more than a tool – it is a means of expression and non-verbal communication. It is a means of being able to carry out work, which, in effect, represents the essence of life and which defines a person's existence.

Manual therapists, too, are clearly a professional group whereby if they experience a small loss of function of the hand, there will be major consequences in terms of participation (job and hobbies) and quality of life (feeling of fulfilment). The effect of the smallest derangement or disease on functioning and disability is crucial. The International Classification of Functioning, Disability and Health (ICF) (WHO 2001) provides an ideal framework for identifying the impact of hand disorders on functioning, participation and social and environmental factors in an individual's life.

The consequences for the manual therapist of working within such a framework of clinical practice is that it forces the clinician to consider not only the input pain mechanism of nociception and peripheral neurogenic pain, but also the associated and consequential processing of the individual's experience and how this impacts on their ability to lead a fulfilling life.

Where processing of the pain experience is concerned, chronicity will be a major factor resulting in sensitization of the central nervous system (CNS).

This, in turn, adds to the factors perpetuating and contributing to the incidence and prevalence of hand disorders in populations. Understanding pain mechanisms and how they affect the patient experiences and responses will, therefore, play an important role in the management of hand disorders.

Moseley et al. (2008) suggest that chronic pain may lead to reduced tactile acuity and that a clear relationship exists between pain intensity, tactile acuity and cortical reorganization. Their research shows that when pain resolves, tactile function improves and cortical organization normalizes. This demonstrates yet again the close relationship between hand and brain.

If, in relation to pain mechanisms, the primary problem is one of nociception causing a localized pain experience, the aim of manual therapists is to reduce, relieve and put an end to it. If chronic central sensitization is driving symptoms in the hand, the aim of management is to try to allow the patient to cope with it, to accept it and to perform adapted functional exercises including automobilization.

The hand needs to be examined very specifically and in detail with an attention to differentiation testing wherever possible. Hand function is complex and fine-tuned with a multitude of adaptive capabilities which, for example, have to be able to enhance subtle and profound feelings for playing a melody on a piano, allow a capacity to build and move the same piano and even enable the chopping down of the tree which will eventually become the said piano.

The examiner will have to show a lot of creativity, flexibility of mind and imagination to reproduce the multitude of possible functions and they must have a deep commitment to review and analysing the great subtlety, fineness and vigour of hand function.

The complex and detailed role of the wrist and hand in both prehensile and non-prehensile functions and the fineness of this organ's sensory and motor representation warrant attention to detail in the clinical study of the relationships between the joints, muscles and nerves of the wrist and hand.

Mobilization/manipulation has a place in the management of neuromusculoskeletal disorders of the wrist and hand alongside many other rehabilitation strategies. This chapter offers the clinician an opportunity to examine and physically treat the articular impairments of wrist and hand disorders and, at the same time, to recognize the influence of the neural, musculotendinous, fascial and vascular systems upon such disorders. The aim of the manipulative physiotherapist, therefore, is to contribute to the physical, psychosocial and socioeconomic rehabilitation of the patient with wrist and hand impairments.

To achieve the desired effects of intervention, the examination of the wrist and hand for the manipulative physiotherapist will have to take into consideration the points outlined below.

Origin of the symptoms

The therapist needs to determine whether the symptoms are due to impairment of the structures in the hand or are being referred or generated from more remote sources.

By using larger than normal body charts for the wrist and hand, the precise area of the patient's symptoms can be documented. In such cases a clear relationship between the patient's pain (symptom) and a known anatomical structure (joint, nerve, muscle/tendon) may become evident. The description of paraesthesia may reveal, for example, that it is in the cutaneous distribution of the median nerve, and therefore carpal tunnel syndrome may be a more favoured hypothesis than a C5 or C6 nerve root lesion.

Finding consistency in functional demonstrations

There are an infinite variety of positions in which the wrist and hand can function. This makes consistency in the repeated measurement of functional demonstrations challenging. It is therefore essential to use functional demonstrations to identify the movement directions which make up the impairment. In this way a relevant and detailed model of establishing articular movement impairment can be developed.

For example, a patient may complain of wrist pain upon opening a jam jar. On analysis of the functional movement concerned it can be established that pronation of the wrist and hand is the painful movement. Through differentiation of this painful movement, it will be possible to establish whether the inferior radioulnar joint, radiocarpal, intercarpal or metacarpophalangeal joint is the source of the pain. If the radiocarpal joint is the source, further differentiation will establish whether it is movement between the scaphoid, lunate or triquetral bones and the radius or radius fibrocartilaginous disc which is painful. In this way a specifically directed mobilization technique is more likely to influence the joint signs. But it could also be observed that this local pain on the wrist in pronation is increased when the elbow is in extension. Further differentiation using the scapular/thoracic depression or contra-lateral cervical lateral flexion will help to find a peripheral neurogenic participation and will determine if treatment should be applied in the hand or in the cervical spine or whether the therapist should look for other adverse mechanical interface on the course of the nerve.

Another example could be a patient's activity limitations of non-prehensile function, being unable to fully extend the hand (e.g. when waving). Pain and stiffness across the back of the wrist would suggest a local impairment. Firstly, differentiation would allow the therapist to differentiate between muscular or tendinous, neural and articular origins of the symptoms. Secondly, differentiation would also indicate which further tests are required to determine whether the origin is radiocarpal, intercarpal or carpometacarpal.

Defning the dominant pain mechanism

Reflecting the history of manual therapy in the last decades, the last two points concerning the origin of the symptoms have been purely tissue related. With hand disorders, it is postulated epidemiologically that pain is the number one reason for consulting a health care practitioner. However, as outlined in the introduction to this chapter, it is evident that pain perception should be considered within a more biopsychosocial context. An increased mechanosensitivity, due to mechanical and/or chemical processes, may also influence joints and soft tissue pathologies of the hand.

The clinical reasoning process should integrate the different pain mechanisms, which are always present in different combinations and are constantly evolving, dynamically changing and switching in importance:

A painful and debilitating musculoskeletal condition is mostly a combination of three mechanisms: input, output and processing.

Input

1. *Nociceptive pain*: recent onset symptoms which correspond to a traumatic or injurious event, normally accompanied by the cardinal symptoms of inflammation, such as swelling, heat, redness and signs of sympathetic activity (e.g. sweating), which brings us immediately to the next category – output (see below).
2. *Peripheral neurogenic mechanisms*: not only paraesthesia or atrophy suggest a pathological process in the nerve, but also factors of a vascular, mechanical (stretching, compression) or systemic nature. All will increase the chemical or mechanical sensitivity of the nerve and implicate it as the source of pain or movement dysfunction. The hypothesis of double crush, as described by Upton & McComas (1973) (of 115 patients with carpal tunnel syndrome, 81 had a cervical origin), is particularly relevant for the upper extremity with canal syndrome or entrapment neuropathy. Mumenthaler (1979) found that of 4958 carpal tunnel operations 9% of patients had a painful shoulder and Narakas (1990) found that of 1916 carpal tunnel operations 26% had a painful shoulder.

Output

Sympathetic involvement is obvious in complex regional pain syndrome (CRPS) patients (sensory, motor and vegetative dysfunctions). It is sometimes a bit more tricky to find its continuous involvement in generating and maintaining all kind of pain, in particular sympathetically maintained pain (SMP). Swelling, altered blood flow, sweating and trophic changes in the skin or nails are the usual signs confirming neurovegetative participation.

The T4 syndrome described by Maitland et al. (2001) is another frequent situation involving symptoms of autonomic origin, distributed in the whole hand or arm, outside the dermatomes but in the sudotomes (Jeangros 2011).

Processing

Central sensitization processing occurs in chronic peripheral neuropathies, high input of action potential or injuries to other structures. As already mentioned, it also depends on the condition of the sensitivity of the CNS, which is altered by affective and cognitive dimension (Gifford 1998).

Deciding the normal range or ideal range for wrist and hand movement (Fig. 6.1)

Kapandji (1982) has suggested that the following ranges of movement are considered as normal average values for the wrist and hand:

- Wrist flexion and extension 85° each (movement taking place primarily at the radiocarpal and midcarpal articulations)
- Wrist radial deviation 15°, wrist ulnar deviation 45° (movement taking place primarily at the radiocarpal joint with accompanying movement at the radioulnar, intercarpal and carpometacarpal joints)
- Wrist pronation 85°, supination 90° (movement taking place primarily at the inferior and superior radioulnar joints, accompanied by rotation at the radiocarpal, midcarpal and carpometacarpal joints).

The carpal bones can be described in terms of their rows for examination, differentiation and localization of treatment (Fig. 6.2): the proximal row of carpal bones consists of the scaphoid, lunate, triquetrum and pisiform; the distal row of carpal bones consists of the trapezium, trapezoid, capitate and hamate. These rows therefore are components of the radiocarpal, midcarpal and carpometacarpal joints.

The carpal bones can also be described in terms of pillars (Fig. 6.3): the lateral pillar consists of the

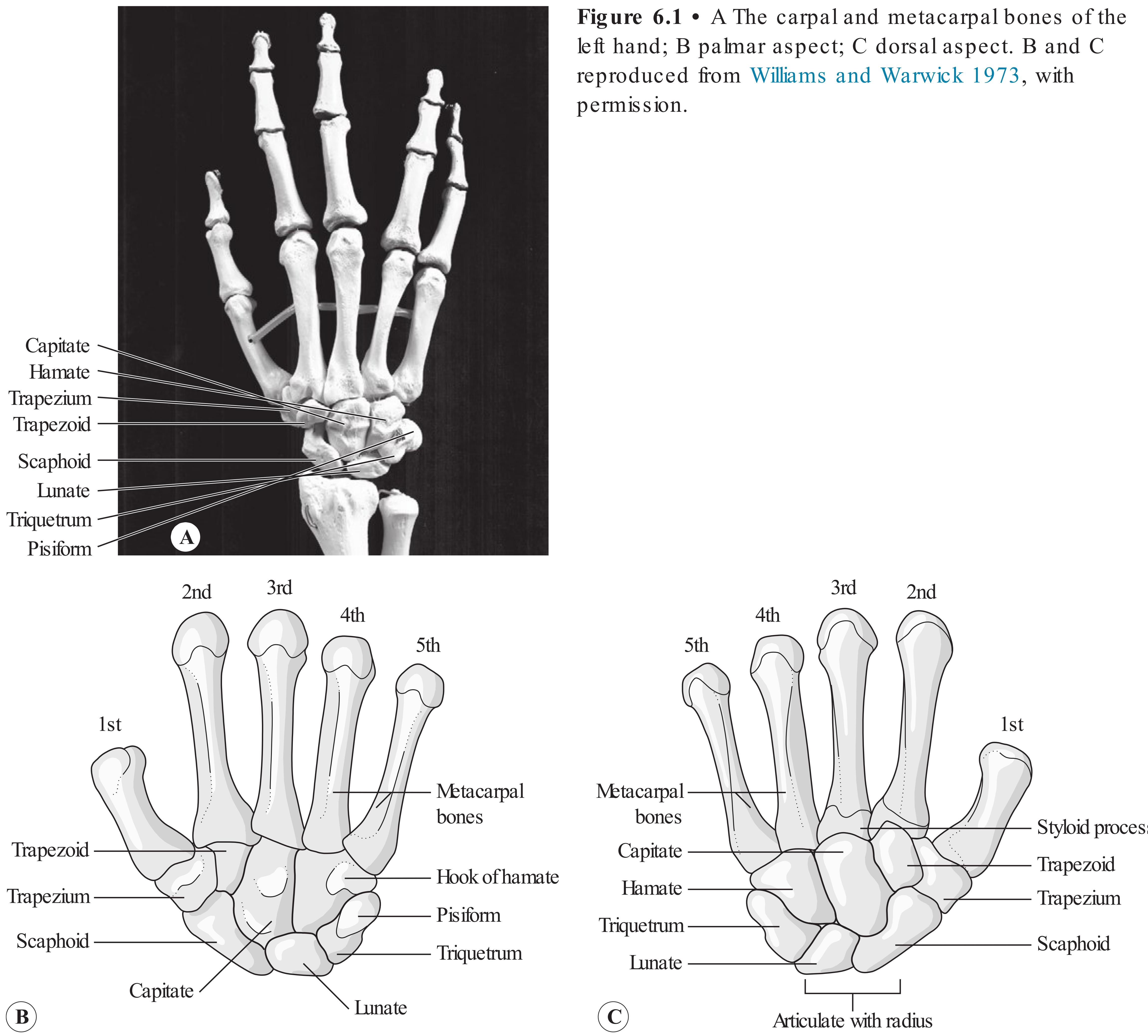

Figure 6.1 • A The carpal and metacarpal bones of the left hand; B palmar aspect; C dorsal aspect. B and C reproduced from Williams and Warwick 1973, with permission.

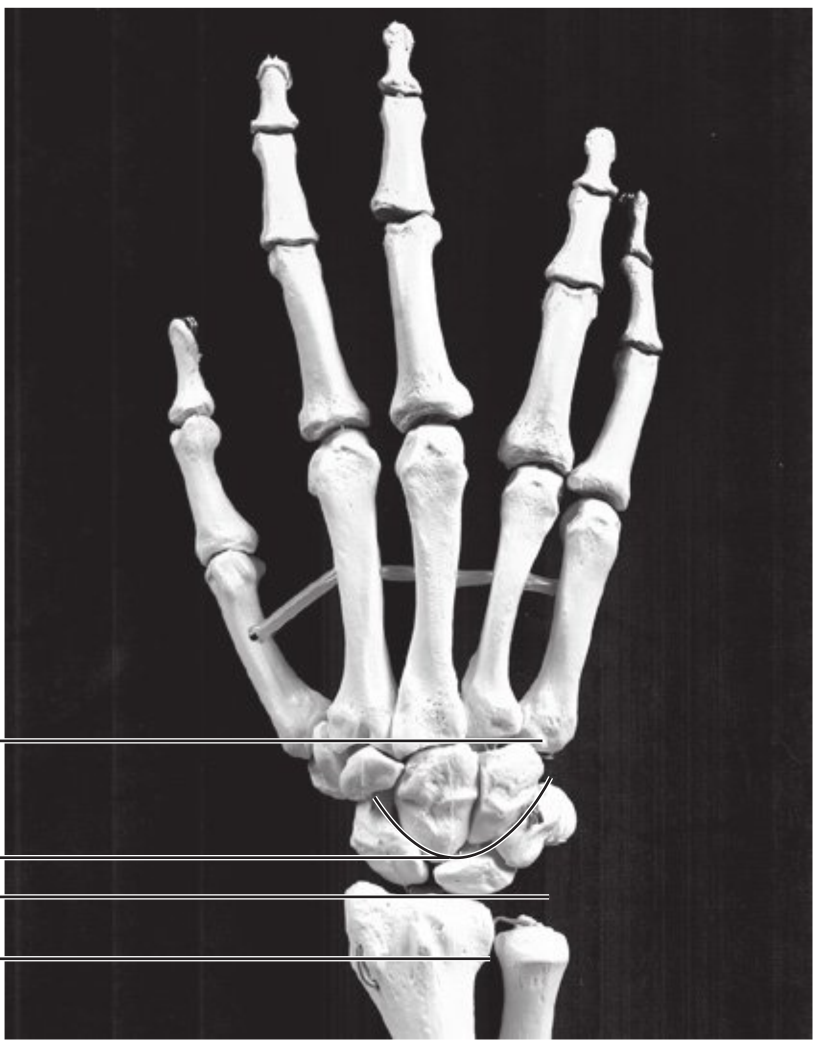

Figure 6.2 • Rows of carpal bones.

scaphoid and trapezium or trapezoid, the central pillar consists of the lunate and capitate and the medial pillar consists of the triquetrum, pisiform and hamate. The value of this is that, ideally, the mobility within the central pillar should be greater than the medial and lateral pillars when individual carpal mobility is tested (Kapandji 1982).

The intercarpal joints and intermetacarpal joints also exhibit a degree of hollowing and flattening which, in this text, is described as horizontal flexion and extension.

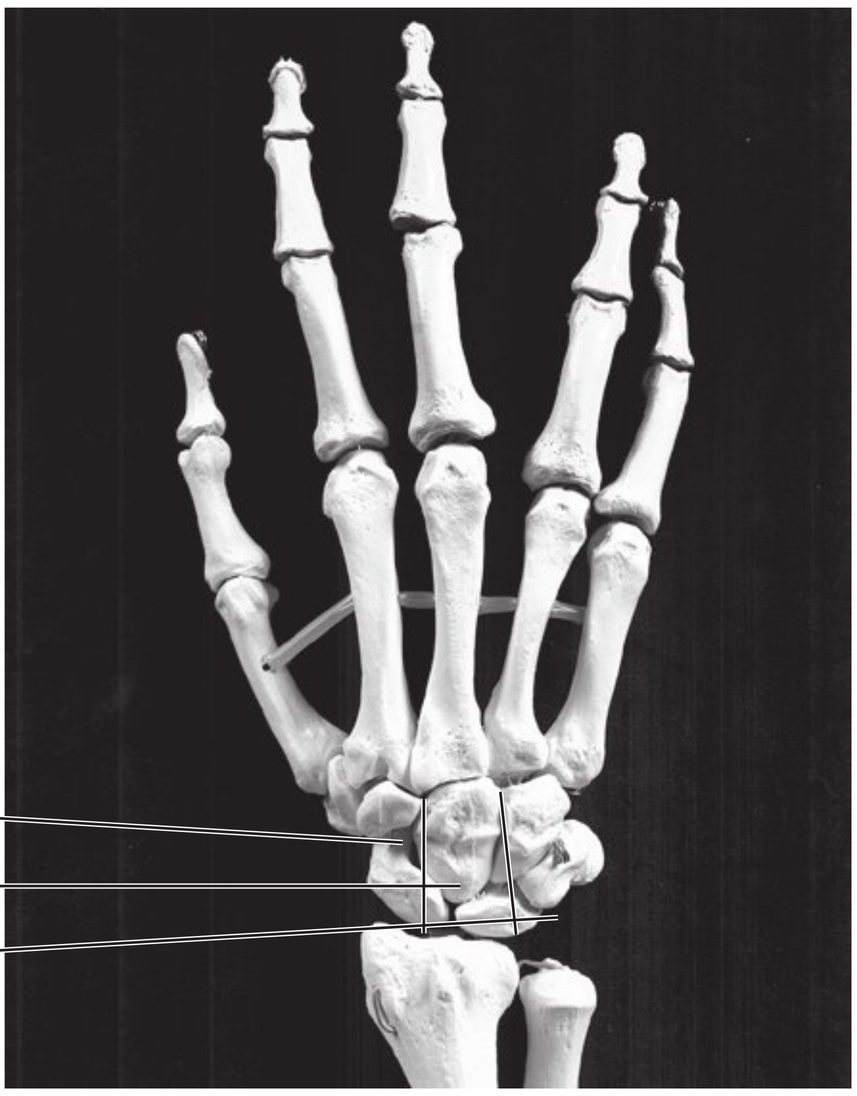

Figure 6.3 • Pillars of carpal bones.

The metacarpophalangeal (MCP) joints can flex on average to 90° (similar to the interphalangeal (IP) joints) and can be passively rotated by 60°. The sequence for examination and treatment of the MCP and IP joints is described in detail on pages 363–369.

A good working knowledge of surface anatomy (Hoppenfeld 1976, Kesson & Atkins 1998) will enhance the clinician's accuracy in localization and application of forces during movement analysis of the wrist and hand.

Subjective examination (C/O)

Procedural and interactive reasoning allow the therapist to build hypotheses to identify the problem. Information from the subjective examination of the patient with wrist and hand symptoms will help to establish the kind of disorder being presented, the source and dominating pain mechanism of the patient's symptoms and the degree to which daily activity is limited by the severity, irritability and nature of the disorder. Information about the history of the symptoms will help to establish the nature of the onset, the directions and degree of injuring forces and the present stage of the disorder's natural history. Special questions will establish any precautions and contraindications to treatment and whether there are any intrinsic or extrinsic predisposing factors or barriers to an ideal rate of recovery.

Kind of disorder: establishing the patient's main problem(s)

- A good working knowledge of surface anatomy of the wrist and hand will help to team up the patient's wrist and hand symptoms with a recognizable joint, peripheral nerve or muscle.
- Activity limitations which include the prehensile or non-prehensile functions of the wrist and hand will strengthen the hypotheses suggesting a local disorder.
- A strong relationship between the symptoms and mechanical trauma or stress to the wrist and hand is what the clinician should expect. Essentially, the patient would be expected to complain of pain, stiffness, swelling, loss of function, loss of feeling and weakness of the wrist and hand.

Areas of symptoms

As discussed earlier in this chapter, a large or 'real size' wrist and hand chart should be used so that the precise area of the patient's symptoms can be represented more accurately (Fig. 6.4). In this way the area which the patient describes as being painful is often diagnostic in itself. A band of pain across the wrist is common in radiocarpal joint disorders; inferior radioulnar joint pain is usually felt locally and deep. Any referred pain is usually felt to spread from the joint towards the elbow. Pain arising from any of the intercarpal joints is always felt locally, although it may radiate out from a central point of the disordered joint. Pain from the intermetacarpal joints will be felt locally at their bases and over the joint. Pain and swelling over the abductor pollicis longus or extensor pollicis brevis tendons indicates a diagnosis of de Quervain's tenosynovitis. Paraesthesia of the thumb, index, ring and half the middle finger is a common presentation in carpal tunnel syndrome (Figs 6.5 and 6.6).

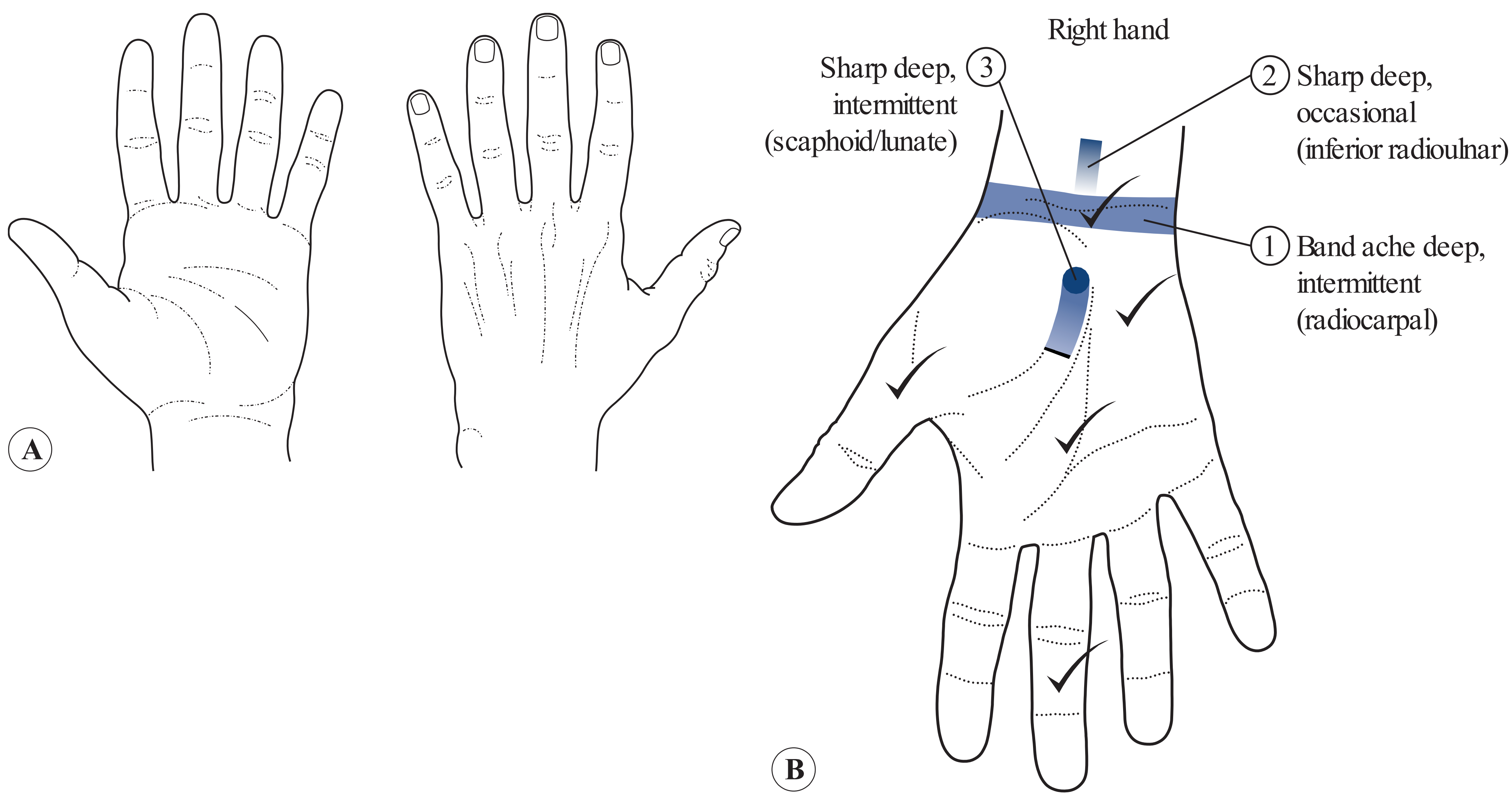

Figure 6.4 • A Hand symptoms-body chart. B Right hand: areas of symptoms.

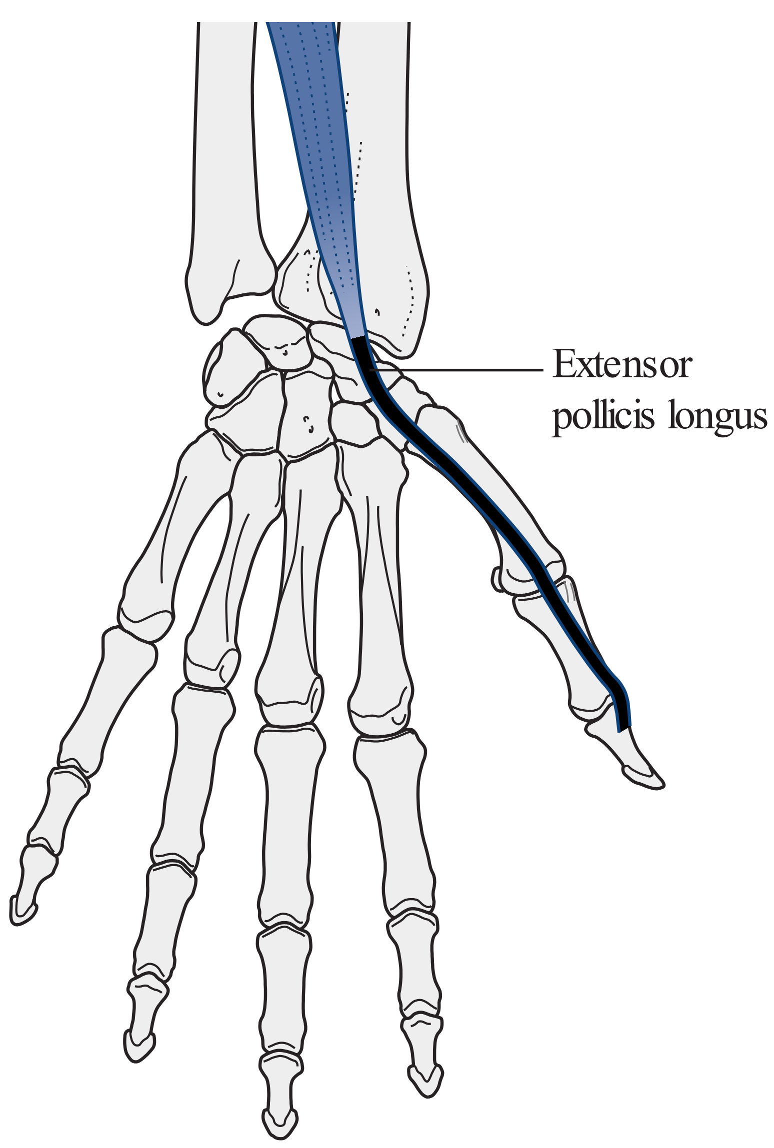

Figure 6.5 • Extensor pollicis longus.

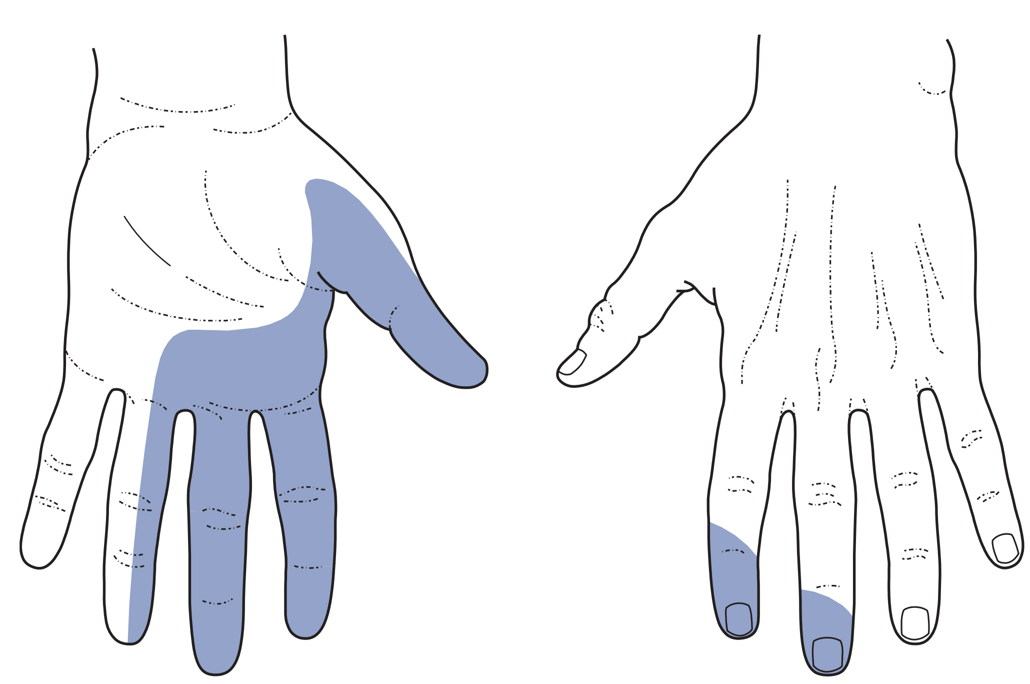

Figure 6.6 • Cutaneous supply of the median nerve in the hand.

A large diffusion of symptoms in the whole hand, occasionally accompanied by heaviness and tiredness of the whole hand, forearm, or whole arm, may lead to suspect a TOS (thoracic outlet syndrome) or a T4 syndrome (Maitland et al. 2001, Jeangros, 2011) with the output as the dominant pain mechanism.

Behaviour of symptoms

If activities increasing the symptoms are numerous and easy to find, it is helpful to establish the common characteristics of the mechanical disorders, which also confirm a dominant input mechanism of pain and support our hypotheses about the treatment and prognosis.

If the wrist and hand are the source of the patient's symptoms, hand functions will be compromised or restricted by pain, stiffness, protective spasm or other associated signs such as weakness, pain inhibition or loss of feeling.

Prehensile functions which may be compromised include forearm twisting (pronation, supination), wrist flexion, extension, ulnar and radial deviation, the function of opposition and manipulative or gripping activities; non-prehensile functions which may be compromised include pushing, pulling or weight-bearing activities.

The stage of the disorder and the severity and irritability of the symptoms will determine the degree of impairment experienced by the patient. For example, a patient who has a one-week history of a badly sprained wrist will use the hand less than someone with stiffness 12 weeks after a Colles' fracture.

As already seen in the introduction, the loss of hand function may also impact on the cognitive and emotional dimensions of the patient's experience of impairment. As an important sensory and communication organ, the impaired hand will affect many aspects of the patient's daily life.

Night-time is usually a time of relief from mechanical nociceptive symptoms. However, patients with peripheral neurogenic mechanisms often suffer more from their symptoms at night. With osteoarthritic or degenerative disorders, morning stiffness would be expected, as would morning soreness with inflammatory components.

History (present and past)

Information from the recent and past history of the patient symptoms will provide valuable evidence about the sensitized status of the central nervous system on the one hand, and the bio-psychosocial impact of this sensitization on the other. Such information helps to support the clinical diagnosis and prognosis

Often, the history of the patient's symptoms will correspond to the different recognizable patterns as described by Corrigan & Maitland (1983):

- Spontanous insidious onset corresponds mostly to degenerative rheumathological disease such as arthritis or tendinopathy through overuse or repeated friction
- Peripheral neurogenic mechanisms may also be considered, but are more difficult to detect, especially if they are not accompanied by paraesthesia or atrophy
- Traumatic events, fractures (Colles' fracture, scaphoid necrosis, etc.), intra- and periarticular, soft tissue (tendon, ligament, etc.) injuries should be considered.

Medical screening questions

The main area of concern with wrist and hand symptoms is whether any neurological compromise is taking place or could be effected by physical examination and treatment. Vascular or metabolic disorders may also present with symptoms in the hands.

Special attention should be paid to scaphoid necrosis, particularly in the absence of X-rays.

Planning the physical examination (P/E)

When planning the physical examination, the therapist must first determine which structure should be examined on day one. With a hypothesis of peripheral neurogenic mechanisms, the cervical spine may be included in the examination and treatment on day one. In such cases, it is important to examine the neurological conduction status of the limb (sensation, reflexes and motor power), something which is not always necessary as part of the physical examination of the wrist and hand. Before examining the cervical spine, it is useful to see an active movement of the hand or to look at a functional demonstration involving the hand. The reassessment of the hand movement reproducing the symptoms, or being a comparable sign, could then show the influence of the treatment of the spine on the hand.

If the hypothesis is suggestive of a nociceptive origin of pain, the focus will be directed onto the structure that is most affected, local or remote: joint, tendons, muscles or ligaments.

With a hypothesis of output pain mechanisms, it may be necessary to decide to treat the thoracic spine at the first treatment, either by mobilization or manipulation with the aim of calming down the sensitivity of the sympathetic trunk. This treatment could also be performed in a sympathetic slump position (Jeangros 2011).

A decision should be made whether to respect irritability or whether it will be difficult to find the symptoms and therefore if the hand should be treated gently or with vigour. In some instances, such as in cases of rheumatoid arthritis, more forceful mobilization is contraindicated. In such cases management should be directed towards ergonomic issues, exercise and automobilization and stabilization strategies.

Physical examination (P/E) (Boxes 6.1-6.9)

Observation

- The observation begins when the patient enters the room and shakes hands. At this point the therapist is already evaluating the patient's willingness to move and use the hand. The

Box 6.1

Wrist and hand complex

A. Move to *pain* or move to *limit*

B. Chronic – minor wrist or hand symptoms

Mandatory passive movement test, when chronic symptoms occupy any part of the area from the lower third of the radius and ulna to the mid-metacarpals (thumb excluded).

Supine:

- Flexion and extension
- Supination and pronation (through metacarpals)
- Radial and ulnar deviation
- AP/PA movement
- HF and HE
- Longitudinal caudad and cephalad

Test movements begin as IV– with observation for pain response. If pain free, adequate overpressure is applied until pain is provoked or the movement is judged 'clear'.

When a positive pain response is provoked, that test movement may need to be differentiated to determine the specifc joint at fault, and/or other movements may need to be tested so as to either exclude or incriminate other joints as contributing to the symptoms.

If all test movements appear 'clear' at frst examination, they should be repeated more strongly. If still 'clear', they may prove positive when repeated at the next consultation.

C. Proving the wrist or hand is unaffected

- F and E (fngers to wrist)
- Supination and pronation
- Wrist deviations
- ←•→ ceph, caud

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Box 6.2

Physical examination of the inferior radioulnar joint

The routine examination of this joint must also include examination of the wrist, as supination and pronation also occur as accessory movements of the wrist joint.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

- Wrist Ab, Ad (F and E)
- Supination, pronation
- Note range, pain

Box 6.2—cont'd

Isometric tests

Other structures in 'plan'

- Thoracic outlet
- Entrapment neuropathy
- Tendon sheaths

Passive movements

Physiological movements

Routinely

- Sup and Pron

Note range, pain, resistance, spasm and behaviour

Accessory movements

As applicable

1. ↑, ↓
   a. in neutral (also ↕)
   b. at limit of pronation
   c. at limit of supination
2. Sup or Pron with compression
3. Sup and Pron differentiating for wrist
   Note range, pain, resistance, spasm and behaviour
4. Slump test
5. Differentiation tests
6. ULNT

Palpation

+ When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 6.3

Physical examination of the wrist joint

The routine examination of this joint must include the inferior radioulnar joint and intercarpal joints.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

- F, E, Ab, Ad, Sup, Pron
- Note range, pain (repeated and rapid)
- Clenching fst

Isometric tests

Other structures in 'plan'

As applicable

- Full active resisted movement through range for 'sheaths'
- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

- F, E, radial and ulnar deviation, Sup and Pron
- Note range, pain, resistance, spasm and behaviour. All without and with compression as applicable

Accessory movements

Routinely: ↕ ↑, → ←, ↔ ceph and caud

As applicable

1. F and E differentiating
2. Sup and Pron differentiating
3. Meniscus
4. Pisiform
5. Wrist ↑, ↓, → ← in supination, neutral and pronation and in varying positions of flexion and extension
6. Slump test
7. Differentiation tests
8. ULNT

Palpation

- Include tendon sheaths and 'anatomical snuff box' as applicable
- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 6.4

Physical examination of the intercarpal joints

The routine examination of these joints must also include examination of the wrist joint, carpometacarpal (C/MC) joints and pisiform movements.**

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Isometric tests

Other structures in 'plan'

- Add full active resisted movement through range for 'sheaths'
- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

1. Wrist F, E, Ab, Ad, Sup, Pron
2. Midcarpal F and E
3. Differentiating F and E
4. Individual carpometacarpal (C/MC) F and E

Note range, pain, resistance, spasm and behaviour

Accessory movements

Routinely

1. ↓ and ↑ (varying angles and points of contact). ↕ (i.e. gliding of each carpal bone on adjacent carpal bone)
2. HF and HE of carpus
3. **Pisiform, without compression and with compression, → ← ↔, ceph and caud, distraction
4. C/MC joints
   a. ↓ and ↑ (varying angles and points of contact) ↕
   b. → ← of metacarpals on carpus, with and without abduction and adduction
   c. ↺ and ↻ metacarpals

   Note range, pain, resistance, spasm and behaviour
5. Slump tests
6. Differentiation tests
7. ULNT

Palpation

- Include tendon sheaths
- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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therapist will also become aware of the strength of the patient's grip.

- Inspection of the cardinal signs – colour changes of the skin, inflammation, deformity, trophic changes (skin, nails, hair), other circulatory changes, as well as general dexterity.

Functional demonstration

- Let the patient demonstrate the activity reproducing their pain or producing a degree of discomfort which is considered as abnormal, limited or impairing.
- Look for alignment faults with grip, including the ability to fully oppose the thumb and the range of finger flexion.
- Look for gripping with the wrist in flexion or gripping with the wrist deviating (usually radial because of overpull of extensor carpi radialis brevis).
- Analyze and record the ranges of movement, the symptom response and the quality of movement.
- Pain increased by weight-bearing activities could confirm a more intra-articular participation.
- For pain arising from the inferior radioulnar joint the functional demonstration may involve the action of turning on a tap. The point at which the pain comes on with supination is determined and in this position the ulna can be moved further into the range to determine any increase in pain.

Active movements of whole hand

- Active movements of the whole hand with grade III+ overpressure if necessary, recording

Box 6.5

Physical examination of the carpometacarpal joints

The routine examination of these joints must include examination of intercarpal joints and proximal and distal intermetacarpal joints and spaces.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Isometric tests

Other structures in 'plan'

- Full range active or resisted wrist and finger F for sheaths
- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

1. Individual C/MC F and E
2. HF and HE of carpus } and differentiating
3. HF and HE of metacarpals } and differentiating

Note range, pain, resistance, spasm and behaviour

Accessory movements

Routinely

1. ↓ and ↑ (varying angles, medial, lateral, ceph, caud), ↕
2. →•→ and ←•←
3. Abduction and adduction
4. Combining (2) with (3)
5. ⟲ and ⟳ of metacarpals

All with and without compression

Note range, pain, resistance, spasm and behaviour

As applicable

1. Slump test
2. Differentiation tests
3. ULNT

Palpation

Include tendon sheaths

+ When 'comparable signs' ill-defined, reassess 'injuring movement'

Check case records etc.

Highlight main findings with asterisks

Instructions to patient

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Box 6.6

Physical examination of intermetacarpal movement

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Isometric tests

Other structures in 'plan'

- Full active resisted movement through range for 'sheaths'
- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

- HF and HE of metacarpals (on bases and heads)

Note range, pain, resistance, spasm and behaviour

As applicable

1. Slump tests
2. Differentiation tests
3. ULNT

Box 6.6—cont'd

Accessory movements

Routinely

1. ↓ and ↑ of each metacarpal in relation to its neighbour (bases and heads)
2. Individual HF or HE (bases and heads)

Note range, resistance, pain, spasm and behaviour

Palpation

- Include tendon sheaths
- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 6.7

Physical examination of the metacarpophalangeal and interphalangeal joints

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

Routinely

- F, E, spreading; fst or grip

  Note range and pain, repeated and rapid

Isometric tests

Other structures in 'plan'

As applicable

- Full active resisted movements through range for 'sheaths'
- Joint restriction, c.f. muscle or tendon restriction
- Thoracic outlet
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

- F, E

Note range, pain, resistance, spasm and behaviour

As applicable

- Joint restriction, c.f. muscle or tendon restriction

Accessory movements

Routinely

1. ↔ ceph and caud, Ab, Ad, →, ←, ↑, ↓, ↺, ↻
2. The above in different positions of other physiological ranges

As applicable

1. Same movements under compression
2. Ab, with → and ←
3. Ad, with → and ←
4. Slump tests
5. Differentiation tests
6. ULNT

Palpation

- Include tendon sheaths
- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 6.8

Physical examination of the carpometacarpal joint of thumb

The routine examination of this joint must include the adjacent intercarpal joints and wrist.

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

- Add active movements of thumb including gripping and fst

Isometric tests

Other structures in 'plan'

- Full active resisted movements through range for 'sheaths'
- Joint restriction, c.f. muscle or tendon restriction
- Entrapment neuropathy

Passive movements

Physiological movements

Routinely

1. Thumb F, E, Ab, Ad
2. Differentiating F, E, Ab, Ad Rotn and opposition
3. HF and HE of carpus

Note range, pain, resistance, spasm and behaviour

Accessory movements

Routinely

1. ↓ and ↑ of frst metacarpal on trapezium
2. → and ← against metacarpal on carpus, with and without abduction and adduction, with and without compression
3. ↺ and ↻ and of metacarpal, with and without compression
4. ↕ adjacent intercarpal and 1st C/MC joint

Note range, pain, resistance, spasm and behaviour

As applicable

1. Intercarpal tests
2. C/MC ↓ with E
3. Slump tests
4. Differentiation tests
5. ULNT

Palpation

- Include tendon sheaths
- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.

Highlight main fndings with asterisks

Instructions to patient

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Box 6.9

Physical examination of the composite wrist or hand

Observation

*Functional demonstration/tests

- *Their* demonstration of *their* functional movements affected by *their* disorder
- Differentiation of their demonstrated functional movement(s)

Brief appraisal

Active movements (move to pain or move to limit)

- Clench fst and test grip
- F, E, Ab and Ad of wrist
- Sup and Pron

Isometric tests

Other structures in 'plan'

Passive movements

As required

Whole hand

1. F and E
2. Radial and ulnar deviation
3. Sup and Pron
4. ↔ ceph and caud
5. HF and HE
6. Pisiform
7. ↓ ↑, →, ← in different positions of wrist Sup, Pron, F and E

Box 6.9—cont'd

8. Sheaths
9. Tendon length and function
10. Meniscus

Differentiating as required

1. F and E
   a. radiocarpal
   b. midcarpal
   c. carpometacarpal
2. Radial and ulnar deviation
   a. radiocarpal
   b. midcarpal
   c. carpometacarpal
3. Supination and pronation
   a. radiocarpal
   b. inferior R/U joint
4. ←•→ caud and ceph
   a. radiocarpal
   b. intercarpal
   c. carpometacarpal
5. HF and HE
   a. intercarpal
   b. carpometacarpal
   c. intermetacarpal

Other test movements

1. ↓, ↘, ↙, ↑, ↗, ↖, ↕ (from inferior R/U to heads of metacarpals)
2. Slump tests
3. ULNT

Palpation

- + When 'comparable signs' ill-defned, reassess 'injuring movement'

Check case records etc.
Highlight main fndings with asterisks
Instructions to patient

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range, symptom response and quality of movement (palmar flexion 85°, dorsal extension 85°, ulnar adduction 45°, radial abduction 15°) and brief appraisal tests should also include, pronation, supination, horizontal flexion and horizontal extension.

If necessary tests

Isometric tests (grip strength test)

- Indication for using these 'if necessary tests' would be, on the one hand, to recognize the typical pattern (for example, pain after repeated movement and stiffness after rest) or localization of a muscle or tendon (knowing that most of the strains occur at the musculotendinous junction).
- On the other hand, as it is nearly impossible to mobilize a joint of the wrist without having the fingers of the therapist affecting a tendon, it seems important to differentiate first if the pain is coming from a tendon or another structure.
- Other indications for using isometric tests would be a diagnosis of de Quervain's disease, Dupuytren's contracture, a past history of overuse (secretary with mouse), a recent overstretching, a traumatic event or a muscle strain confirmed by an MRI or not.
- Finkelstein's test is, for example, used when considering dysfunction of the abductor pollicis longus and the extensor pollicis brevis suggesting a de Quervain tendinopathy: flexion (and adduction) of the thumb combined with a strong ulnar deviation. This test is very similar to the neurodynamic test ULNT 2b (Butler 1991) for testing the radial nerve, and will need further differentiation with elbow extension, scapular elevation or lateral flexion of the cervical spine. Symptoms are seldom related to a single structure.
- Most of the muscles and tendons in the hand cross more than one or two joints and perform eccentric contraction. This means the hand contains a greater proportion of mobilizing rather than stabilizing muscles.
- Isometric tests are first performed in neutral and then in the functional position. The localization of symptoms and direct palpation (or deep friction) can help to differentiate beween muscles and tendons.
- Tendons are tested by full stretching, maximal elongation. Further differentiation between the tendon and the sheath of the tendon

(tenosynovitis) can be made by compressing the tendon at the painful spot and letting the tendon move through range.

- The grip strength test can be used for re-evaluation, but is not pathognomonic.

Neurological examination

If symptoms follow a dermatomal distribution (Fig. 6.7) or if there is a history of cervical spine involvement then a thorough neurological examination of the upper extremity is necessary. In this case, a peripheral neurological examination of the sensitivity (light touch and pinprick, reflexes and motor power will be assessed) (Fig. 6.8).

Neurodynamic tests

Neurodynamic tests are obligatory where there is a need to differentiate between structures causing symptoms in the upper extremity. The distribution of symptoms will determine whether there is a need to use the ULNT1 (median bias), ULNT 2b (radial bias) or ULNT 3 (ulnar bias) (Butler 1991).

In supine lying

Inspection and palpation

- Identification of surface anatomy landmarks (Hoppenfeld 1976).
- Identification of signs of movement impairment (temperature changes, excessive sweating, soft tissue changes including swelling and soft tissue thickening, bony abnormalities such as exostosis).
- Palpation of the median, ulnar and radial nerves around the wrist and hand for mechanosensitivity, symptom reproduction and signs of swelling or thickening (Fig. 6.9).
- Palpate tendons and tendon sheaths where tenosynovitis may be evident (abductor pollicis longus and extensor pollicis brevis in particular).
- Brachial and radial pulses to check for circulatory viability.

Differentiation of movements reproducing pain

- Pronation and supination: differentiate between inferior radioulnar, radiocarpal, midcarpal and carpometacarpal (Figs 6.10–6.15).
- Flexion and extension: differentiate radiocarpal and midcarpal (see Figs 6.23–6.28).
- Radial and ulnar deviation: differentiate inferior radioulnar, radiocarpal and midcarpal (see Figs 6.29–6.32).
- Horizontal flexion and extension: differentiate between proximal and distal carpal rows and intermetacarpal joints (see Figs 6.37–6.38).

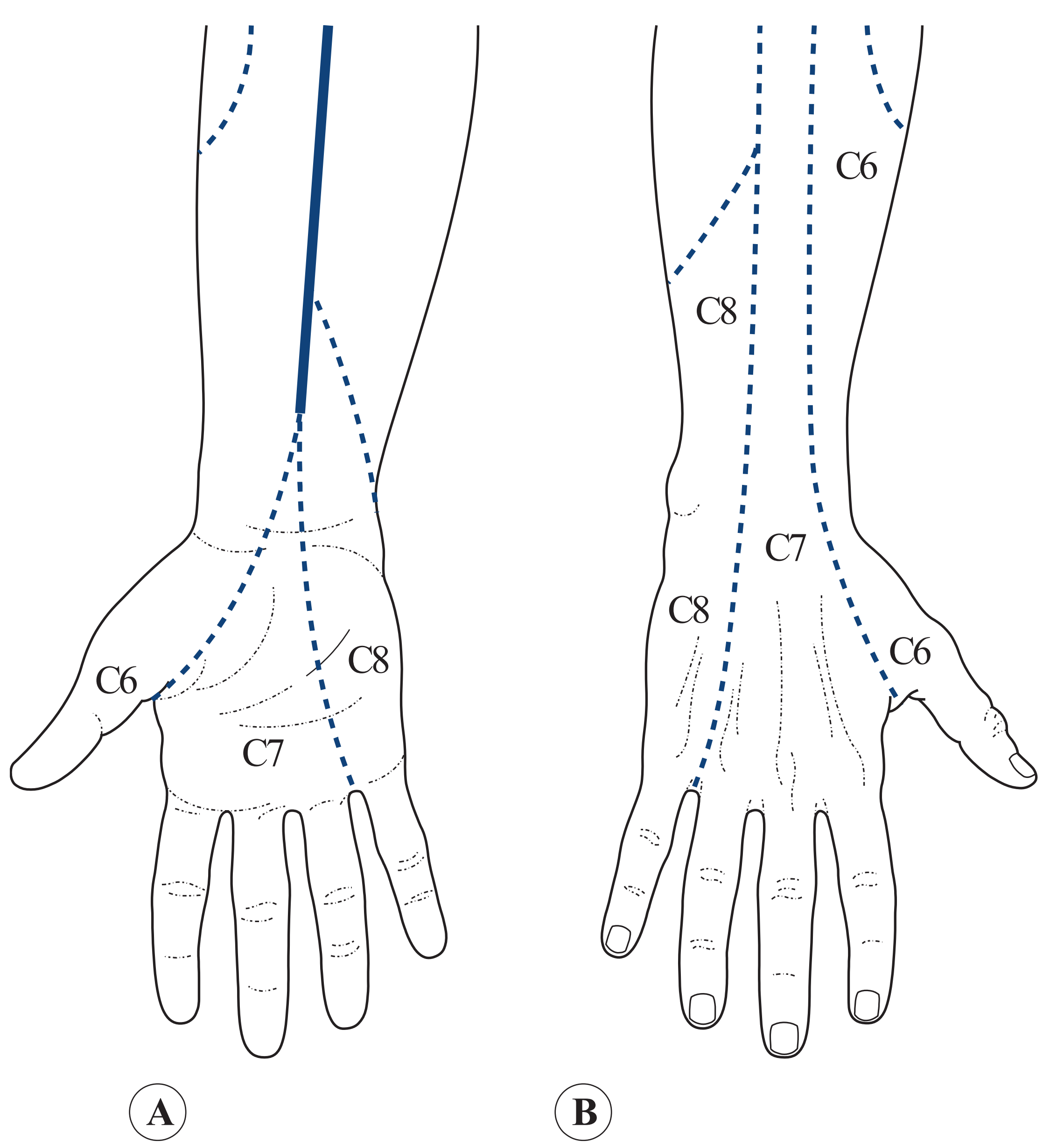

Figure 6.7 • Dermatomes. Reproduced from Williams and Warwick 1973, with permission.

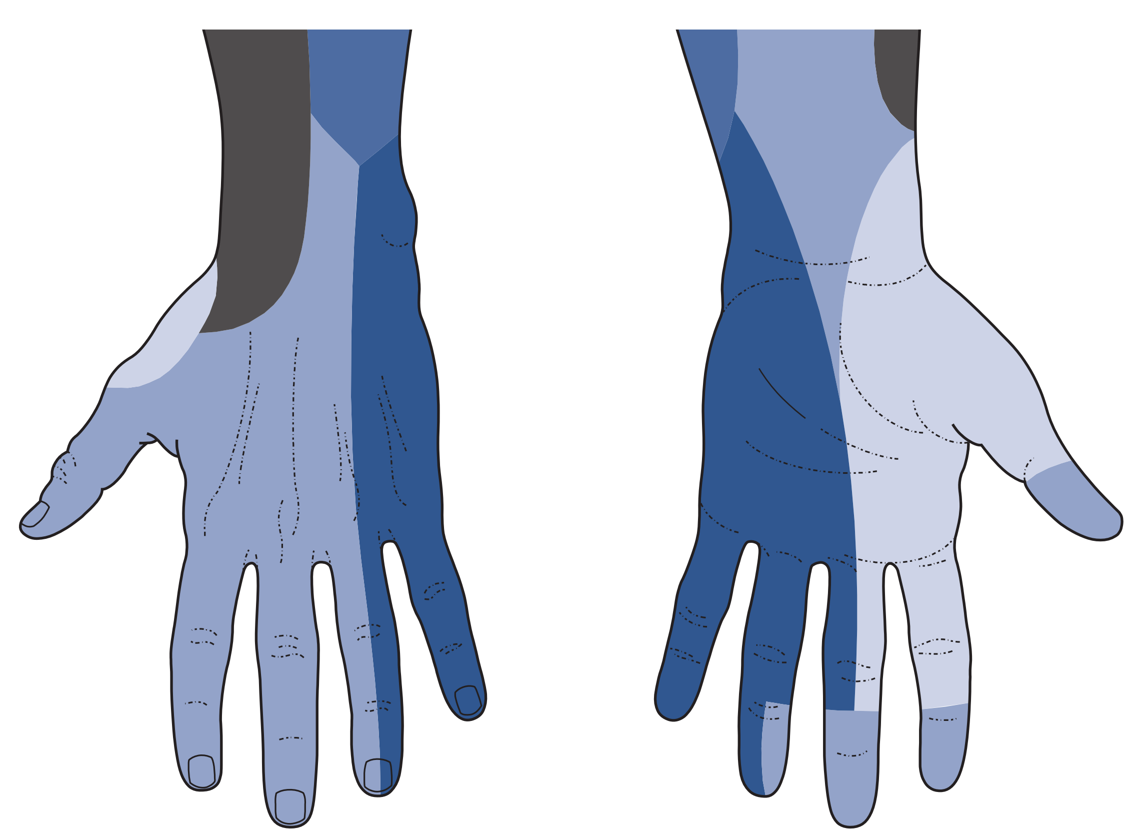

Figure 6.8 • Cutanous peripheral nerve supply. After Putz and Pabst 2006.

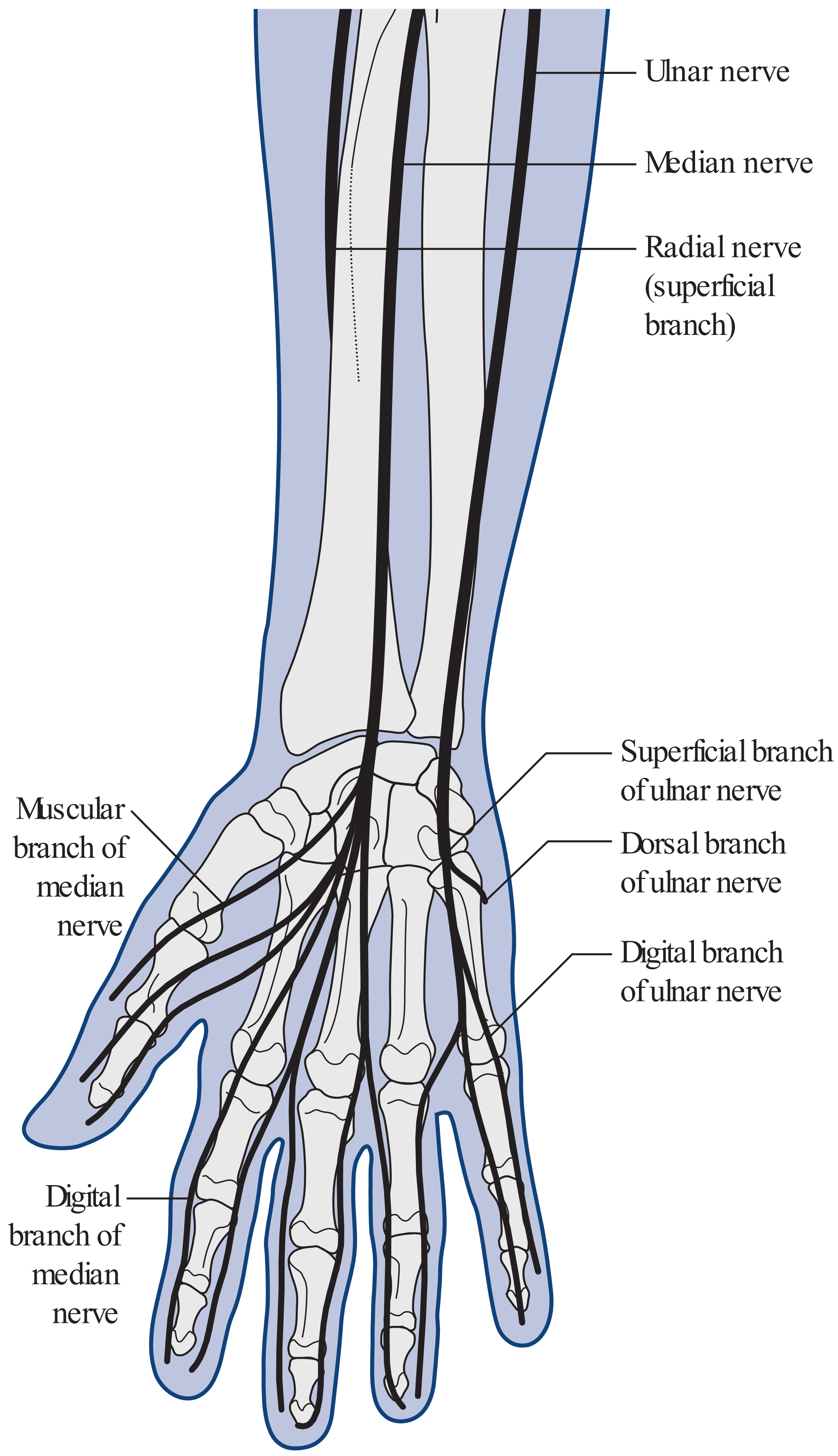

Figure 6.9 • Superficial nerves.

Passive movements wrist and hand – examination and treatment techniques

Whole hand movements, differentiating rows:

- Inferior radioulnar joint: pronation, supination, anteroposterior or posteroanterior movement, longitudinal movement cephalad and caudad, compression, movements under compression.
- Radiocarpal joint: flexion, extension, radial deviation, ulnar deviation, medial rotation, lateral rotation, anteroposterior/posteroanterior movements, transverse movement medially, transverse movement laterally, horizontal flexion, horizontal extension, compression, distraction, movements under compression/ distraction.
- Midcarpal joint: flexion, extension, horizontal flexion, horizontal extension.
- Intercarpal movements: anteroposterior/ posteroanterior movements of individual bones or over the joint line, with inclinations.
- Intermetacarpal joints: anteroposterior or posteroanterior movements, horizontal flexion, horizontal extension.
- Carpometacarpal, metacarpophalangeal, interphalangeal joints: flexion, extension, abduction, adduction, medial rotation, lateral rotation, anteroposterior or posteroanterior, transverse medial, transverse lateral, compression, distraction, movements under compression or distraction.

Differentiation of radial and ulnar deviation

- Ulnar – see Figures 6.29 and 6.30.
- Radial – see Figures 6.31 and 6.32.
- Longitudinal caudad/cephalad of the inferior radioulnar joint – see Figures 5.46 and 6.22.
- Localization of forces to radiocarpal, midcarpal and carpometacarpal – see Figures 6.30 and 6.32.

Differentiation of horizontal flexion and extension

- Intercarpal – see Figures 6.37 and 6.38.
- Intermetacarpal – see Figure 6.46.

Supination (Figs 6.16 and 6.17)

Method

This technique is identical to that described in Chapter 5, see Figures 5.40 and 5.41.

Pronation (Figs 6.18 and 6.19)

Method

This technique is identical to that described in Chapter 5, see Figures 5.42 and 5.43.

Inferior radioulnar joint posteroanterior and anteroposterior movements (Fig. 6.20)

- *Direction*: The posteroanterior (PA) and anteroposterior (AP) movements are referred to

Figure 6.10 • Whole hand supination.

Figure 6.11 • Inferior radioulnar and radiocarpal supination.

Figure 6.12 • Release radiocarpal supination.

Figure 6.13 • Release radioulnar supination.

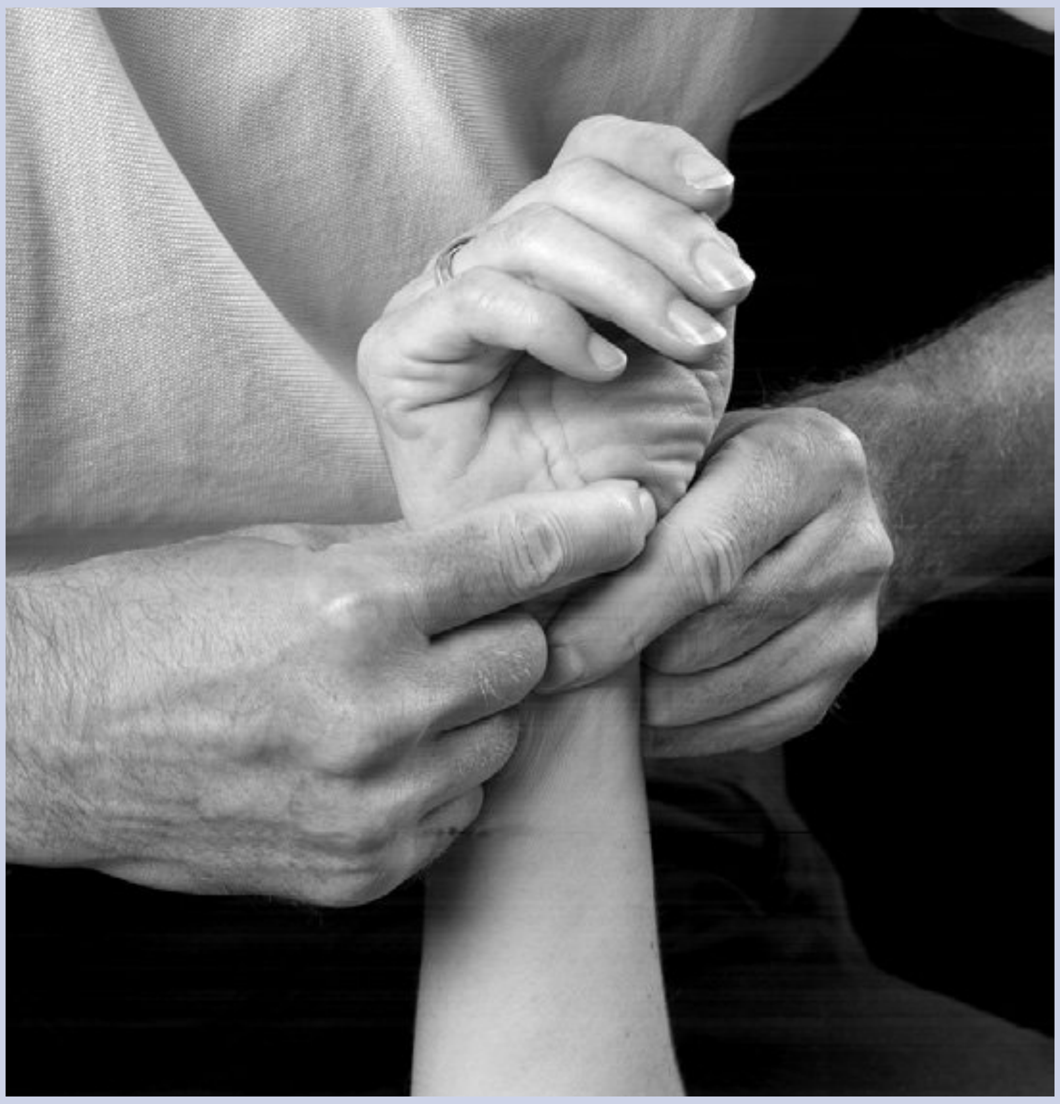

Figure 6.14 • Increase radiocarpal supination.

Figure 6.15 • Increase radioulnar supination.

as movements of the *ulna on the radius* because it is easier to stabilize the comparatively large distal end of the radius and produce the movement by pushing the distal end of the ulna.

- *Symbols*: ↓, ↑
- *Patient starting position*: Supine in the middle of the couch with the elbow flexed to 90°. The

Figure 6.16 • Inferior radioulnar joint: supination grades I–IV.

Figure 6.17 • Inferior radioulnar joint: supination grade IV+.

Figure 6.18 • Inferior radioulnar joint: pronation.

AP and PA movements are of the largest amplitude possible with the inferior radioulnar joint positioned midway between pronation and supination. The movements can be produced in any position of pronation and supination.

- *Therapist starting position*: Standing by the patient's right side just beyond the flexed elbow, facing the patient's left shoulder.
- Localization of forces (position of therapist's hands).
- The thumb and index finger of both hands hold the patient's forearm midway between pronation and supination.
- The thumb of the left hand posteriorly and the flexed index finger anteriorly hold onto the distal end of the radius.
- The remaining fingers flex to add lateral support to the index finger which makes the main point of contact.
- The right hand holds the distal end of the ulna with an identical grip.

Figure 6.19 • Inferior radioulnar joint: pronation, grade IV+.

Application of forces by therapist (method)

- A PA movement of the ulna on the radius is produced by pressure against the posterior surface of the ulna with the therapist's right thumb and an equal and opposite pressure against the anterior surface of the radius with the left index finger.
- An AP movement of the ulna on the radius would be produced by an opposite action.

Figure 6.20 • Inferior radioulnar joint: posteroanterior and anteroposterior movements.

Variations in the application of forces

- For stronger movement stretching at the limit of supination or pronation the therapist should grasp the radius and ulna more firmly between the thenar eminences rather than just using the thumbs and index fingers. In this way the PA and AP stretching can be performed more strongly at the limit of supination or pronation by a pushing and pulling action of the arms.

Uses

- Mainly clinical groups 2 and 3b.
- Patients with stiffness or pain and stiffness with pronation or supination.
- Postfracture or postimmobilization pain and stiffness in pronation or supination.

Inferior radioulnar compression (Fig. 6.21)

- *Direction*: Compression of the radius and ulna towards each other at the inferior radioulnar joint.
- *Symbol*: >•<
- *Patient starting position*: Supine in the middle of the couch with the elbow flexed to 90° and the forearm in the mid-pronation or mid-supination position.
- *Therapist starting position*: Kneeling by the patient's right side beyond the flexed elbow.

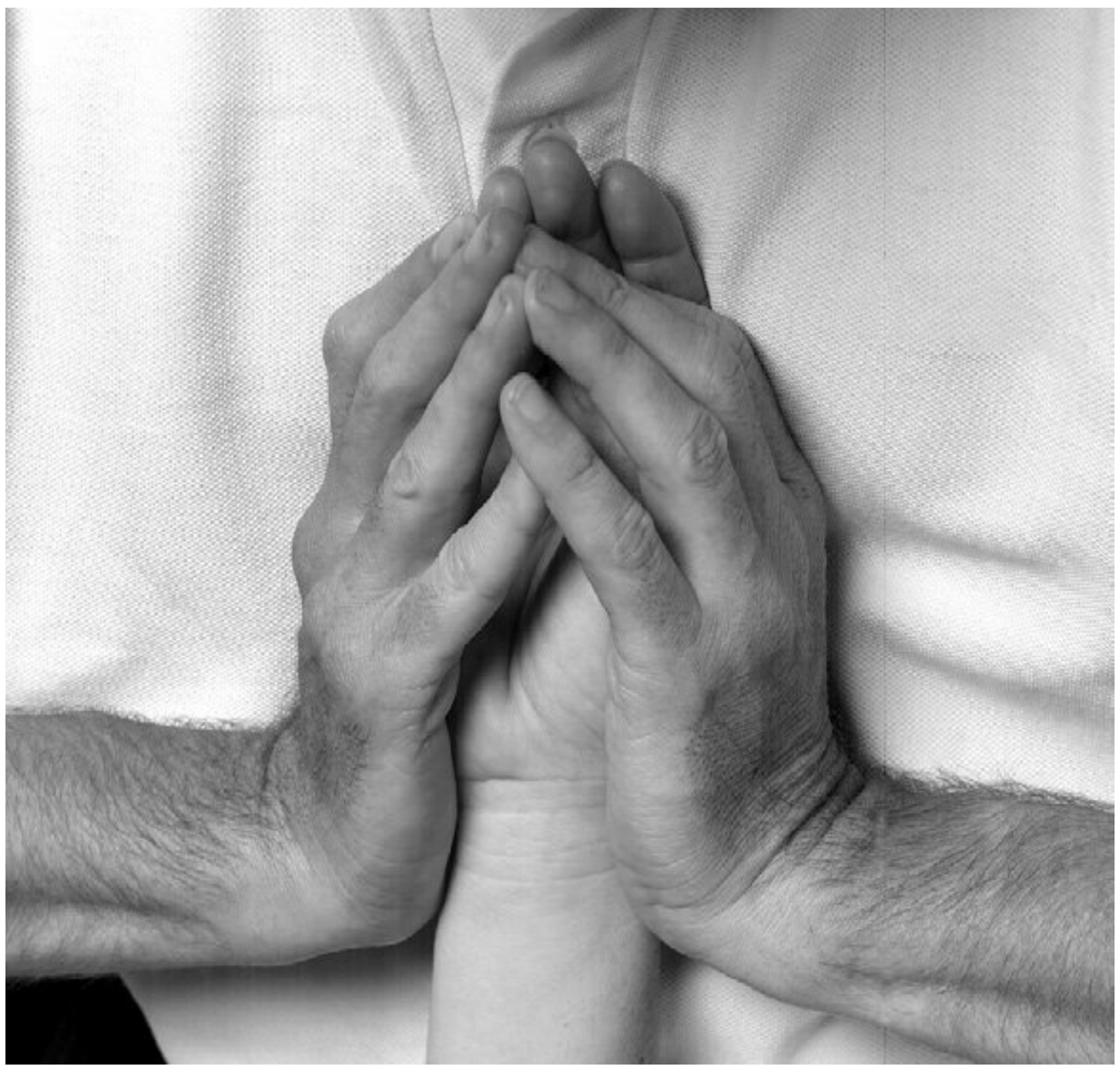

Figure 6.21 • Inferior radioulnar joint: compression.

Localization of forces (position of therapist's hands)

- Both hands grasp the patient's right hand.
- The thumbs and thenar eminences, pointing towards the patient's fingers, cover the posterior surface of the patient's wrist meeting in the midline.
- The fingers reach around to meet anteriorly in the midline.
- The heel of the left hand cups around the lateral surface of the distal end of the patient's radius.
- The heel of the right hand cups around the distal end of the patient's ulna.
- Both arms are directed opposite to each other at right angles to the patient's forearm.

Application of forces by therapist (method)

- Firstly, supination and pronation are produced by a twisting in opposite directions of the heels of the therapist's cupped hands, pivoting around stationary fingers and thumbs.
- Pronation of the patient's forearm is produced by pronation of the therapist's left forearm and supination of the right forearm so that the heels of the therapist's hands move away from each other.
- Supination is produced by supination of the therapist's left forearm combined with pronation of the right.
- A back-and-forth rocking movement between supination and pronation is continued while compression is maintained between the therapist's two arms.

Variations in the application of forces

- As a brief appraisal test for the joint, the radius can be compressed strongly against the ulna at the same time as rocking the radius and ulna back and forth against each other.
- The same grip can be used to distract or separate the distal ends of the radius and ulna.

Uses

- When pain in the inferior radioulnar joint is aggravated by gripping activities.
- When pain is provoked on squeezing the radius and ulna firmly together at the inferior radioulnar joint.

Inferior radioulnar joint longitudinal movement caudad/cephalad

Method

This technique is identical to that described for Figure 5.46 (caudad) and Figure 6.22 (cephalad).

Variations in the application of forces

These longitudinal movements are described as being longitudinal movement of the radius on the ulna. The reasons for presenting the movement as being that of the radius on the ulna are:

- The ulna is relatively more stable at the elbow
- One of the best ways of producing this movement is to carry out ulnar deviation of the hand, which pulls the radius in a caudad direction.

Cephalad longitudinal movement of the radius on the ulna is produced by radial deviation of the wrist.

Longitudinal movement cephalad

- Emphasis is placed on the exact position of the patient's hand and the direction of the pressure applied by the therapist's hand.

Figure 6.22 • Superior radioulnar joint: longitudinal movement cephalad.

- The patient's hand must be tilted towards radial deviation (abduction) and the therapist should apply contact mainly through the base of the patient's thenar eminence so that the pressure is in a straight line with the shaft of the radius.
- *During radial deviation of the patient's hand there is a cephalad longitudinal movement of the radius in relation to the ulna.*

Longitudinal movement caudad

- The therapist must grasp around the patient's hand immediately adjacent to the base of the first metacarpal and the pisiform.
- During the movement longitudinally the patient's wrist should be deviated towards the ulnar side (adduction).
- *During ulnar deviation of the patient's wrist there is a caudad longitudinal movement of the radius in relation to the ulna.*

Uses

- Limited or painful radial and ulnar deviation of the wrist and hand.
- Painful restricted longitudinal movement of the radius on the ulna at the inferior radioulnar joint.

Wrist flexion (general) (Fig. 6.23)

- *Direction*: General flexion of the wrist and hand.
- *Symbol*: F.
- *Patient starting position*: Supine in the middle of the plinth with the elbow flexed to 90° and midway between pronation and supination.
- *Therapist starting position*: Standing by the patient's right side beyond the flexed elbow.

Localization of forces (position of therapist's hands)

- The right hand grasps around the medial border of the patient's right hand.
- The thumb is placed against the dorsum of the patient's metacarpals.
- The fingers are placed in the palm of the patient's hand.
- The left hand stabilizes the patient's forearm midway between supination and pronation immediately proximal to the carpus.

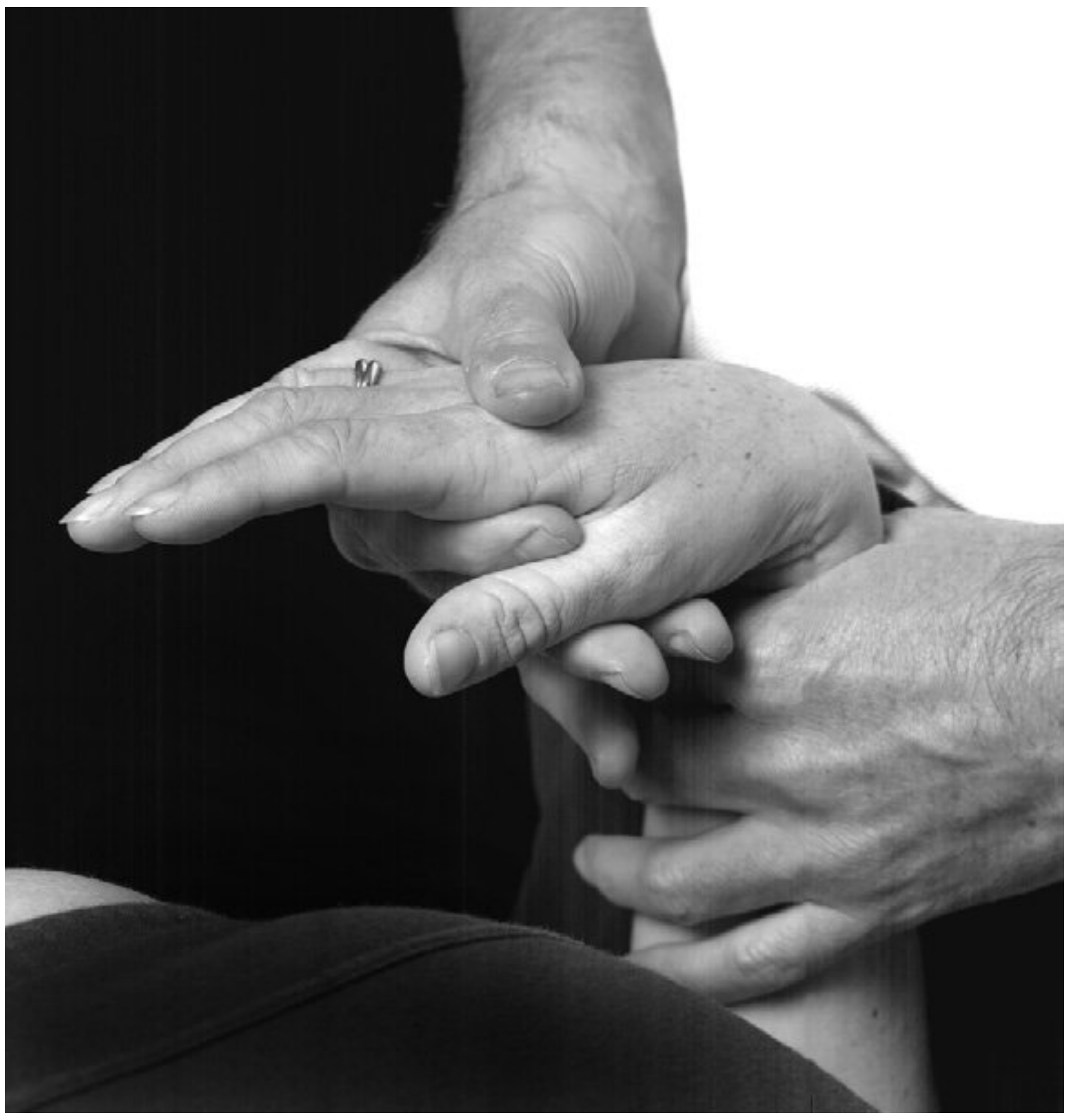

Figure 6.23 • Wrist flexion (general).

Figure 6.24 • Radiocarpal flexion.

Application of forces by therapist (method)

- Starting midway between flexion and extension the therapist's thumb flexes the patient's wrist and hand to the limit of its range; the therapist's fingers then return the patient's wrist to its starting position.
- The therapist's index finger is positioned near to the patient's metacarpophalangeal joints so as to control the return movement.

Uses

- As examination of wrist flexion with the addition of overpressure if necessary.
- As a general mobilization of wrist and hand flexion.
- Recovery of flexion after a Colles' fracture.
- As a through-range mobilization for patients with osteoarthritis of the wrist.
- As a neurodynamic mobilization technique in the ULNPT 2b position (radial nerve entrapment).

Radiocarpal **flexion** (Fig. 6.24)

- *Direction*: Flexion localized to the radiocarpal joint only.
- *Symbol*: Radiocarpal F.
- *Patient starting position*: Supine, lying in the middle of the couch, forearm and wrist supinated.
- *Therapist starting position*: Standing by the patient's right hip facing the right shoulder.

Localization of forces (position of therapist's hands)

- Both the therapist's hands hold the patient's supinated and extended arm at the wrist.
- Both thumbs point proximally on the anterior surface of the proximal row of the carpal bones.
- The fingers are placed across the back of the carpus.
- The flexed index fingers form the main point of contact against the proximal row of the carpal bones posteriorly.
- The index fingers and thumbs grasp immediately opposite each other mainly around the scaphoid and lunate but also including the triquetrum.
- The thumbs make contact through the base of their terminal phalanges rather than their tips.

Application of forces by therapist (method)

- From a position midway between flexion and extension, the patient's wrist is moved downwards towards the floor while the carpus, held firmly between the therapist's index fingers and thumbs, is flexed on the radius and ulna. While performing this movement the carpus must be held firmly.

Variations in the application of forces

- The point of contact of the thumbs can be adjusted to influence movement more at the scaphoid, lunate or triquetrum.
- The flexion can also be repeated in varying positions of radial or ulnar deviation.

Uses

- As a localized mobilization of the radiocarpal joint.
- To mobilize the radiocarpal joint after scaphoid fracture.
- Combined with horizontal extension to assist in the rehabilitation of patients with carpal tunnel syndrome.
- As part of the process of differentiating wrist pain coming from the radiocarpal or midcarpal joints.

Midcarpal flexion (Fig. 6.25)

- *Direction*: Flexion localized to the midcarpal joint, i.e. between the proximal and distal rows of the carpal bones.
- *Symbol*: Midcarpal F.
- *Patient starting position*: Supine in the middle of the couch with the arm and wrist supinated.
- *Therapist starting position*: Standing by the patient's right side facing the right shoulder.

Localization of forces (position of therapist's hands)

- The tips of both thumbs are placed over the anterior surface of the *distal* carpal row (i.e. the trapezium, trapezoid, capitate and hamate).
- The index fingers, pointing towards each other and reinforced by the middle fingers overlie the posterior surface of the *proximal* carpal bones (i.e. scaphoid, lunate, triquetrum and pisiform).

Figure 6.25 • Midcarpal flexion.

Application of forces by therapist (method)

- Flexion at the midcarpal joint is produced by a tilting action of flexion of the patient's hand pivoting through the thumb tips which apply pressure to the proximal carpal row anteriorly.
- Counterpressure is applied to the proximal carpal row posteriorly by the index fingers.
- If performed correctly there should be no radiocarpal or carpometacarpal movement.

Summary

- Thumbs against the distal row anteriorly.
- Index fingers against the proximal row posteriorly.

Uses

- Localization of flexion to the midcarpal joint.
- Differentiation of pain originating from the radiocarpal or midcarpal joints.

Wrist extension (general) (Fig. 6.26)

- *Direction*: General extension of the wrist and hand.
- *Symbol*: E.
- *Patient starting position*: Supine in the middle of the couch with the elbow flexed to 90° and midway between pronation and supination.
- *Therapist starting position*: Standing by the patient's right side beyond the flexed elbow.

Localization of forces (position of therapist's hands)

- The right hand grasps around the medial border of the patient's right wrist.
- The thumb is placed against the dorsum of the patient's metacarpals.
- The fingers are placed in the palm of the patient's hand.
- The left hand stabilizes the patient's forearm midway between supination and pronation immediately proximal to the carpus.

Application of forces by therapist (method)

- Starting midway between flexion and extension the therapist's fingers extend the patient's wrist and hand to the limit of its range; the therapist's thumb then returns the patient's wrist to its starting position.

Uses

- As examination of wrist extension with the addition of overpressure (up to III+) if necessary.
- As a general mobilization of wrist and hand extension.
- Recovery of extension after fracture immobilization or injury.
- As a through-range mobilization for patients with osteoarthritis of the wrist.
- As part of a neurodynamic mobilization technique in the ULNPT 1 position (carpal tunnel syndrome).

Radiocarpal extension (Fig. 6.27)

- *Direction*: Extension localized to the radiocarpal joint.
- *Symbol*: E.
- *Patient starting position*: Supine, lying in the middle of the couch with the forearm partially pronated.
- *Therapist starting position*: Standing by the patient's right hip facing the right shoulder.

Localization of forces (position of therapist's hands)

- Both the therapist's hands hold the patient's pronated and extended arm at the wrist.
- Both thumbs point proximally on the posterior surface of the proximal row of the carpal bones.
- The fingers are placed across the front of the carpus.

Figure 6.26 • Wrist extension (general).

Figure 6.27 • Radiocarpal extension.

- The flexed index fingers form the main point of contact against the proximal row of the carpal bones anteriorly.
- The index fingers and the thumbs grasp immediately opposite each other, mainly around the scaphoid and lunate but also including the triquetrum.
- The thumbs make contact with the base of their terminal phalanges rather than their tips.

Application of forces by therapist (method)

- The extension movement is produced through a very firm localized grasp with the fingers and thumbs while lowering the wrist towards the floor as the wrist is extended.
- The oscillation is completed by returning the patient's arm to the starting position while at the same time returning the extended radiocarpal joint to its mid-position.

Variations in the application of forces

- The point of contact of the thumbs can be altered to influence movement more at the scaphoid, lunate or triquetrum.
- The extension can be repeated in varying positions of radial and ulnar deviation.

Uses

- As a localized mobilization of the radiocarpal joint.
- To mobilize the radiocarpal joint after fracture of the wrist or injury.
- Combined with horizontal extension to assist in the rehabilitation of patients with carpal tunnel syndrome.
- As part of the process of differentiating wrist pain coming from the radiocarpal or midcarpal joints.

Midcarpal extension (Fig. 6.28)

- *Direction*: Extension localized to the midcarpal joint, i.e. between the proximal and distal rows of the carpal bones.
- *Symbol*: Midcarpal E.
- *Patient starting position*: Supine, lying in the middle of the couch with the arm and wrist pronated.

Figure 6.28 • Midcarpal extension.

- *Therapist starting position*: Standing by the patient's right side facing the right shoulder.

Localization of forces (position of therapist's hands)

- The proximal end of the distal phalanx of each thumb is placed immediately over the distal margin of the proximal row of the carpal bones posteriorly.
- The reinforcing index fingers lie firmly against the anterior surface of the distal row of the carpal bones.

Summary

- Thumbs against the proximal row posteriorly.
- Index fingers against the distal row anteriorly.

Application of forces by therapist (method)

- A tilting action is produced through the index fingers against the distal row of the carpal bones, with the bases of the thumbs preventing movement of the proximal row.

- There should be no extension of the radiocarpal or the carpometacarpal joints.

Uses

- Localization of extension to the midcarpal joint.
- Differentiation of pain originating from the radiocarpal or midcarpal joints.

Wrist ulnar deviation (general and localized) (Figs 6.29 and 6.30)

- *Direction*: Ulnar deviation of the wrist and hand.
- *Symbol*: Ulnar deviation – general and localized.
- *Patient starting position*: Supine in the middle of the couch with the elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's right side facing the patient's feet.

Localization of forces (position of therapist's hands)

- The right hand grasps the patient's forearm distally.
- The index finger of the right hand stabilizes around the styloid process of the ulna.
- The left hand grasps the anterior and posterior surface of the metacarpals.
- The fingers of the right hand reach around the ulnar border of the patient's hand.
- The thumb of the left hand holds through the patient's first interosseous space.

Application of forces by therapist (method)

- The oscillatory movement performed in any part of the range is produced by a supination action of the therapist's right forearm, and a pronation action returning the wrist and hand to its starting position.

Variations in the application of forces (for the purpose of differentiating the source of wrist pain)

Localization to the radiocarpal joint

- The tips of the thumb and index finger of the left hand stabilize the distal ends of the ulna and the radius medially and laterally in a pinch grip.

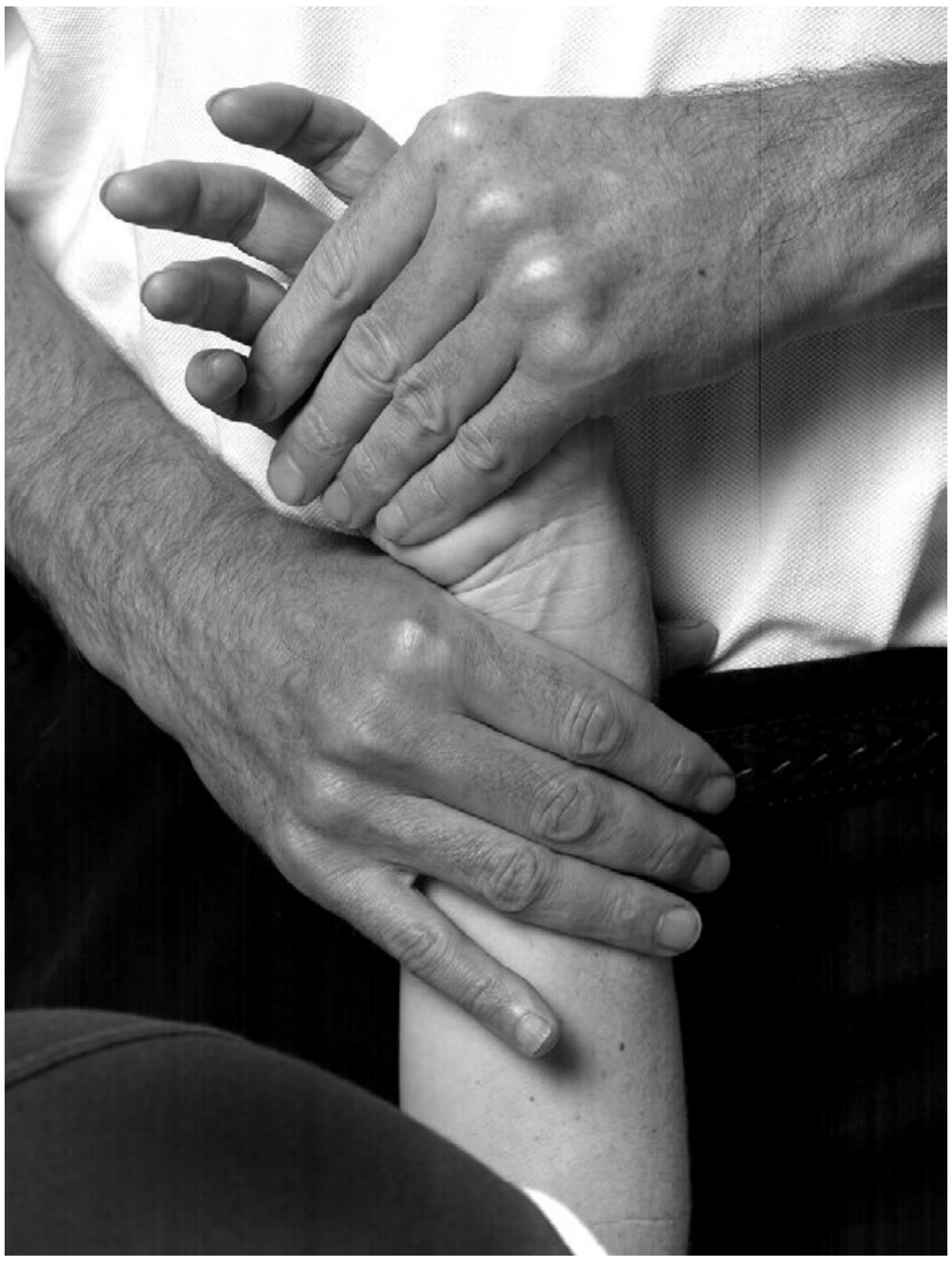

Figure 6.29 • Wrist ulnar deviation (general).

Figure 6.30 • Wrist ulnar deviation (local).

- The tips of the thumb and index finger of the right hand hold the proximal row of the carpal bones from medially and laterally in a pinch grip.
- As the thumb and index finger of the left hand stabilize the ulna and radius, the thumb and index finger of the right hand can tilt the proximal row of the carpal bones into ulnar deviation.

Localization to the midcarpal and carpometacarpal joints

- The same methods of localization of forces and application of forces are adopted. However, for the midcarpal joint the proximal row of the carpal bones is stabilized and the distal row is tilted. For the carpometacarpal joint the distal row is stabilized and the metacarpals are tilted into ulnar deviation.

Uses

- General ulnar deviation of the wrist and hand or localization to the appropriate joint.
- Pain and stiffness with ulnar deviation (mainly clinical groups 2, 3a and 3b).

Wrist radial deviation (general and localized) (Figs 6.31 and 6.32)

- *Direction*: Radial deviation of the wrist and hand.
- *Symbol*: Radial deviation – general and localized.

Localization of forces (position of therapist's hands)

- This is the same as for ulnar deviation with the exception that the therapist's left thumb holds the radial styloid and the right hand grasps the metacarpals.

Application of forces by therapist (method)

- This is the same as for ulnar deviation with the exception that the movement produced by the therapist's forearm is radial deviation.

Variations in the application of forces

- The method of localization of forces and application of forces to the radiocarpal,

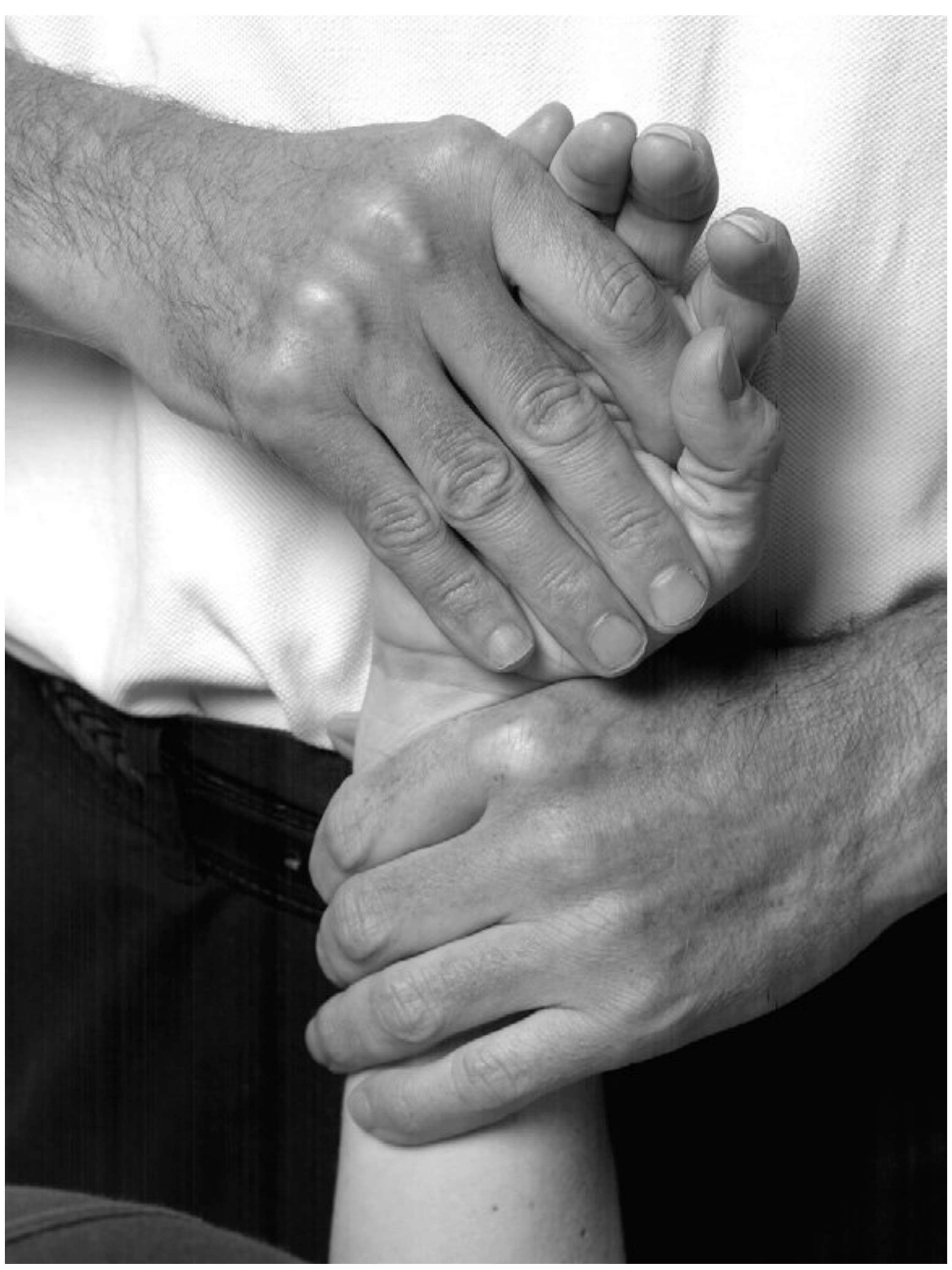

Figure 6.31 • Wrist radial deviation (general).

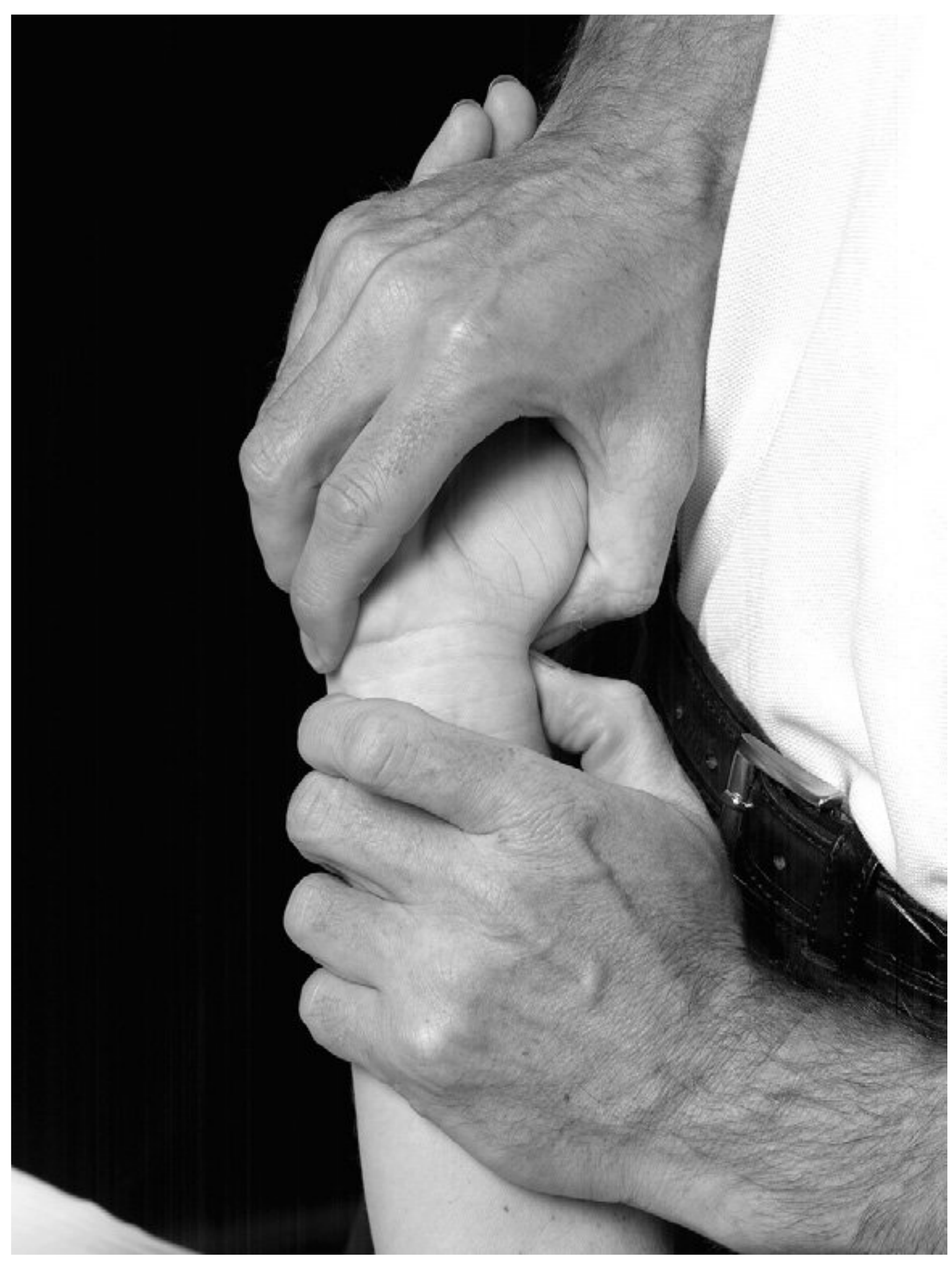

Figure 6.32 • Wrist radial deviation (local).

midcarpal and carpometacarpal joints alone is the same as that described for ulnar deviation with the exception that the joints in question are moved in the direction of radial deviation.

Uses

- These are the same as those described for ulnar deviation.

Radiocarpal posteroanterior movement (Fig. 6.33)

- *Direction*: Movement of the proximal row of the carpal bones on the radius and fibrocartilaginous disc in the posteroanterior direction.
- *Symbol*: ↧
- *Patient starting position*: Supine in the middle of the couch, elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's right hip facing the patient's head.

Figure 6.33 • Radiocarpal posteroanterior movement.

Localization of forces (position of therapist's hands)

- The left hand holds the posterior surface of the patient's hand.
- The right hand holds the anterior surface of the distal forearm.
- The right hand is fully supinated and extended at the wrist.
- The fingers of the right hand point proximally.
- The heel of the right hand is placed level with the distal end of the radius and ulna.
- The fingers of the right hand grasp around the patient's forearm.
- The heel of the left hand should lie *over* the carpus.
- The fingers of the left hand grasp round the patient's thumb.
- The thumb of the left hand grasps around the ulnar border of the patient's hand.
- The therapist should draw the patient's wrist and hand towards their body and crouch, directing both forearms opposite to each other.

Application of forces by therapist (method)

- The oscillation starts from the neutral position of the wrist and hand and is taken to the limit or appropriate point in the range by an equal and opposite movement of the therapist's forearms.
- The patient's hand should be kept straight to prevent flexion and extension of the wrist.

Variations in the application of forces

- The movement can also be performed by using the couch and the left hand to stabilize the radius and ulna while the right hand grasps the back of the patient's carpus and directs the posteroanterior movement through the heel of the therapist's hand towards the floor.

Uses

- As a grade I or II movement for very painful wrists.

- As a grade III or IV movement for a predominantly stiff joint.
- As a screening test in physical examination with the addition of sufficient overpressure (usually III+).

Radiocarpal anteroposterior movement (Fig. 6.34)

- *Direction*: Anterior movement of the carpus in relation to the radius and fibrocartilaginous disc.
- Symbol: ↥
- *Patient starting position*: Supine in the middle of the couch with the elbow flexed and forearm in the mid-pronation or mid-supination position.
- *Therapist starting position*: Standing between the patient's right side and the elbow and facing away from the patient.

Figure 6.34 • Radiocarpal anteroposterior movement.

Localization of forces (position of therapist's hands)

- The right hand grasps the patient's palm from in front.
- The thumb of the right hand holds around the ulnar border of the patient's hand.
- The fingers hold around the radial border.
- The patient's thumb lies between the therapist's ring and middle fingers.
- The heel of the right hand forms the main point of contact against the carpus anteriorly.
- The base of the left thumb is placed opposite the distal border of the radius posteriorly.
- The fingers of the left hand grasp around the radius.
- The therapist should draw the patient's wrist and hand towards their body and crouch, directing both forearms opposite each other.

Application of forces by therapist (method)

- The oscillation starts from the neutral position of the wrist and hand and is taken to the limit or appropriate point in the range by an equal and opposite movement of the therapist's forearms.

Variations in the application of forces

- The movement can also be performed by using the couch and the left hand to stabilize the radius and ulna while the right hand grasps the front of the patient's right hand and directs the anteroposterior movement through the heel of the therapist's hand towards the floor.

Uses

- As a grade I or II movement for very painful wrists.
- As a grade III or IV movement for a predominantly stiff joint.
- As a screening test in physical examination with the addition of sufficient overpressure (usually III+).

Radiocarpal supination (lateral rotation) (Fig. 6.35)

- *Direction*: Supination or lateral rotation of the carpus in relation to the radius and ulna.
- *Symbols*: Sup/↻

Figure 6.35 • Radiocarpal supination (lateral rotation).

- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's flexed right forearm.

Localization of forces (position of therapist's hands)

- The left hand holds the patient's forearm adjacent to the wrist.
- The left thumb hooks around the lateral border of the distal end of the radius, reaching to the posterior surface of the radius.
- The index finger of the left hand makes firm contact against the anterior surface of the distal end of the ulna.
- The right hand holds across the posterior surface of the proximal row of the carpal bones.
- The thumb of the right hand hooks around the scaphoid to hold it firmly anteriorly.
- The index finger of the right hand lies across the proximal row of the carpal bones, making firm contact with the triquetrum.

Application of forces by therapist (method)

- Further supination of the inferior radioulnar joint is prevented by the therapist's left hand.
- Supination or lateral rotation of the radiocarpal joint is produced by the therapist's right arm acting through the right wrist and hand.
- The tip of the therapist's right thumb and the distal end of the proximal phalanx of the index finger are the parts through which all of the pressure is transmitted to the carpus, while the therapist's left thumb and index finger provide counterpressure.

Variations in the application of forces

- The supination or lateral rotation movement can be performed in this manner in any position of forearm supination or pronation.

Uses

- To increase the range of radiocarpal supination (e.g. after a Colles' or scaphoid fracture).

Radiocarpal pronation (medial rotation) (Fig. 6.36)

- *Direction*: Pronation or medial rotation of the carpus in relation to the radius and ulna.
- *Symbol*: Pron/↺
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's right hip facing the patient's shoulder.

Localization of forces (position of therapist's hands)

- The left hand holds the distal end of the patient's forearm.
- The left thumb hooks posteriorly around the ulna.
- The base of the left index finger is placed against the anterior surface of the radius.
- The right hand grasps around the carpus.
- The right thumb hooks around the triquetrum anteriorly.

Figure 6.36 • Radiocarpal pronation (medial rotation).

- The index finger of the right hand presses firmly against the posterior surface of the scaphoid.

Application of forces by therapist (method)

- The movement is produced by the pressure of the therapist's left hand against the patient's carpus while the therapist's right hand stabilizes the patient's forearm by applying an equal and opposite counterpressure.

Variations in the application of forces

- The pronation or medial rotation movement of the radiocarpal joint can be performed in any position of forearm pronation or supination.

Uses

- To increase the range of radiocarpal pronation or medial rotation.

Radiocarpal lateral transverse movement

- *Direction*: Transverse lateral movement of the carpus in relation to the radius and ulna.
- *Symbol*: ⟶•⟶
- *Patient starting position*: Supine, lying on the couch with the right arm abducted so that the wrist lies at the edge of the couch, with the patient's hand beyond it and the thumb pointing towards the floor.
- *Therapist starting position*: Standing beyond the patient's right wrist facing the patient's feet.

Localization of forces (position of therapist's hands)

- The left hand holds firmly around the distal end of the patient's radius and ulna immediately around the styloid processes.
- The knuckles of the left hand, between the patient's distal forearm and the surface of the couch, stabilize the patient's wrist.
- It may also be necessary for the therapist's forearm to rest across the patient's forearm or elbow to stabilize the patient's arm.
- The right hand grasps around the posterior surface of the patient's hand.
- The right thumb and index finger grasp the carpus around the triquetrum and the pisiform adjacent to the ulnar styloid process.

Application of forces by therapist (method)

- The movement of the patient's hand towards the floor is produced through the therapist's left arm and shoulder.
- The therapist's left hand should move as a single unit with the patient's hand.

Variations in the application of forces

The lateral transverse movement can be performed:

1. with the hand in any position of radial or ulnar deviation,
2. with inclinations anteriorly or posteriorly,
3. with the wrist in any position of pronation and supination or
4. with the radiocarpal joint surfaces compressed together or distracted.

   The choice depends on the variation which best reproduces the patient's symptoms or achieves the desired effects.

Uses

- The movement is most effective as an oscillatory grade IV to IV+ or as a large amplitude grade III.

Radiocarpal medial transverse movement

- *Direction*: Transverse movement medially of the carpus in relation to the radius and ulna.
- *Symbol*: ←•—
- *Patient starting position*: Supine, lying in the middle of the couch with the right arm abducted, the patient's wrist lying at the edge of the couch with the hand beyond it and the thumb pointing towards the ceiling.

Localization of forces (position of therapist's hands)

- The left hand holds firmly around the distal end of the patient's radius and ulna immediately around the styloid processes.
- The knuckles of the left hand, between the patient's distal forearm and the surface of the couch, stabilize the patient's wrist.
- It may also be necessary for the therapist's forearm to rest across the patient's forearm or elbow to stabilize the patient's arm.
- The right hand grasps around the posterior surface of the patient's hand.
- The right thumb and index finger grasp the carpus around the triquetrum and the pisiform adjacent to the ulnar styloid process.

Application of forces by therapist (method)

- The movement of the patient's hand towards the floor is produced through the therapist's left arm and shoulder.
- The therapist's left hand should move as a single unit with the patient's hand.

Variations in the application of forces

The lateral transverse movement can be performed:

- With the hand in any position of radial or ulnar deviation
- With inclinations anteriorly or posteriorly
- With the wrist in any position of pronation and supination or
- With the radiocarpal joint surfaces compressed together or distracted.

The choice depends on the variation which best reproduces the patient's symptoms or achieves the desired effects.

Uses

The movement is most effective as an oscillatory grade IV to IV+ or as a large amplitude grade III.

Intercarpal horizontal extension (Fig. 6.37)

- *Direction*: Extension of the carpal bones in a horizontal plane.
- *Symbol*: Intercarpal HE.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm supinated.
- *Therapist starting position*: Standing by the patient's right side beyond the flexed and supinated forearm, facing the patient's head.

Localization of forces (position of therapist's hands)

- The tips of the pads of both thumbs, placed against the centre of the carpus posteriorly, hold the patient's hand from the back.
- The index and middle fingers hold around the pisiform medially and the carpometacarpal joint of the thumb laterally.

Application of forces by therapist (method)

- The oscillatory movement is produced by thumb pressure against the centre of the carpus posteriorly and pulling against the medial and lateral margins of the carpus with the fingers.

Figure 6.37 • Intercarpal horizontal extension.

- The action is produced by extension of the therapist's wrists and facilitated by pushing the patient's hand away with the thumbs.

Variations in the application of forces

- The movement can be localized to the proximal or distal row of the carpal bones using the tips of the thumbs.
- The movement can also be localized to each carpal bone as well as inclining thumb pressure medially, laterally, cephalad, caudad or diagonally).

Uses

- The mobilization of individual carpal bones into horizontal extension.
- Stretching the anterior carpal structures.
- As an interface technique for median nerve entrapment in the carpal tunnel.

Intercarpal horizontal flexion (Fig. 6.38)

- *Direction*: Flexion of the carpal bones in a horizontal plane.
- *Symbol*: Intercarpal HF.
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm supinated.
- *Therapist starting position*: Standing by the patient's right elbow facing across the patient's body.

Localization of forces (position of therapist's hands)

- The right hand grasps the back of the patient's hand with the fingers pointing distally.
- The right hand contacts the medial and lateral margins of the carpus.
- The left thumb tip is placed against the palmar surface of the carpus to apply an anteroposterior pressure to the carpus.
- The forearms are directed opposite each other.

Application of forces by therapist (method)

- The oscillation is produced by opposite pressure through the forearms.

Figure 6.38 • Intercarpal horizontal flexion.

- The right hand produces a cupping action of the patient's hand around the pivot formed by the therapist's left thumb.

Variations in the application of forces

- The left thumb tip and right hand can localize pressure to the carpus as a whole, or to the proximal or distal rows of the carpal bones.
- The left thumb can localize its pressure to the individual carpal bones anteriorly as well as apply pressure inclined medially, laterally, cephalad, caudad or diagonally.

Uses

- Local carpal pain and stiffness (rows or individual bones)
- Recovery of horizontal flexion after fracture or immobilization.
- Intercarpal stiffness as in Sudeck's atrophy.
- As an interface mobilization of the carpal tunnel for median nerve entrapment.

Posteroanterior and anteroposterior intercarpal movements (Figs 6.39 and 6.40)

- *Direction*: Movement of the individual carpal bones in a posteroanterior or an anteroposterior direction in relation the adjacent carpal bone, radius, ulna or adjacent metacarpal.
- *Symbols*: Intercarpal ↓, ↑
- *Patient starting position*: Supine, lying in the middle of the couch with the forearm resting on the couch and pronated (posteroanterior) or supinated (anteroposterior).
- *Therapist starting position*: Standing by the patient's right side beyond the hand, facing the patient's head.

Localization of forces (position of therapist's hands)

Posteroanterior

- The maximum breadth of the thumb tips are placed adjacent to each other on the appropriate carpal bone or intercarpal joint.
- The fingers spread over the adjacent area of the hand for stability.
- The arms and thumbs are positioned in a posteroanterior direction.

Anteroposterior

- The thumbs make contact with the palmar surface of the patient's supinated hand against the appropriate carpal bone or intercarpal joint.
- The fingers spread over adjacent areas of the hand for stability.
- The thumbs and arms are positioned in an anteroposterior direction.

Application of forces by therapist (method)

- The posteroanterior or anteroposterior movement is produced by pressure from the therapist's arms being transmitted through the spring-like action of the thumbs against the appropriate carpal bone or intercarpal joint.

Variations in the application of forces

- The posteroanterior or anteroposterior movement can be included medially, laterally, cephalad, caudad or diagonally.
- A combination of posteroanterior movement of one carpal bone and anteroposterior movement of the adjacent carpal bone can be produced simultaneously by the therapist gripping the individual bones in a pincer grip with the thumbs and index fingers. The opposite movements can then be performed.
- The posteroanterior movement of the individual carpal bones can be emphasized by the therapist's thumbs posteriorly during the horizontal extension movement.
- The anteroposterior movement can be emphasized by the therapist's left thumb

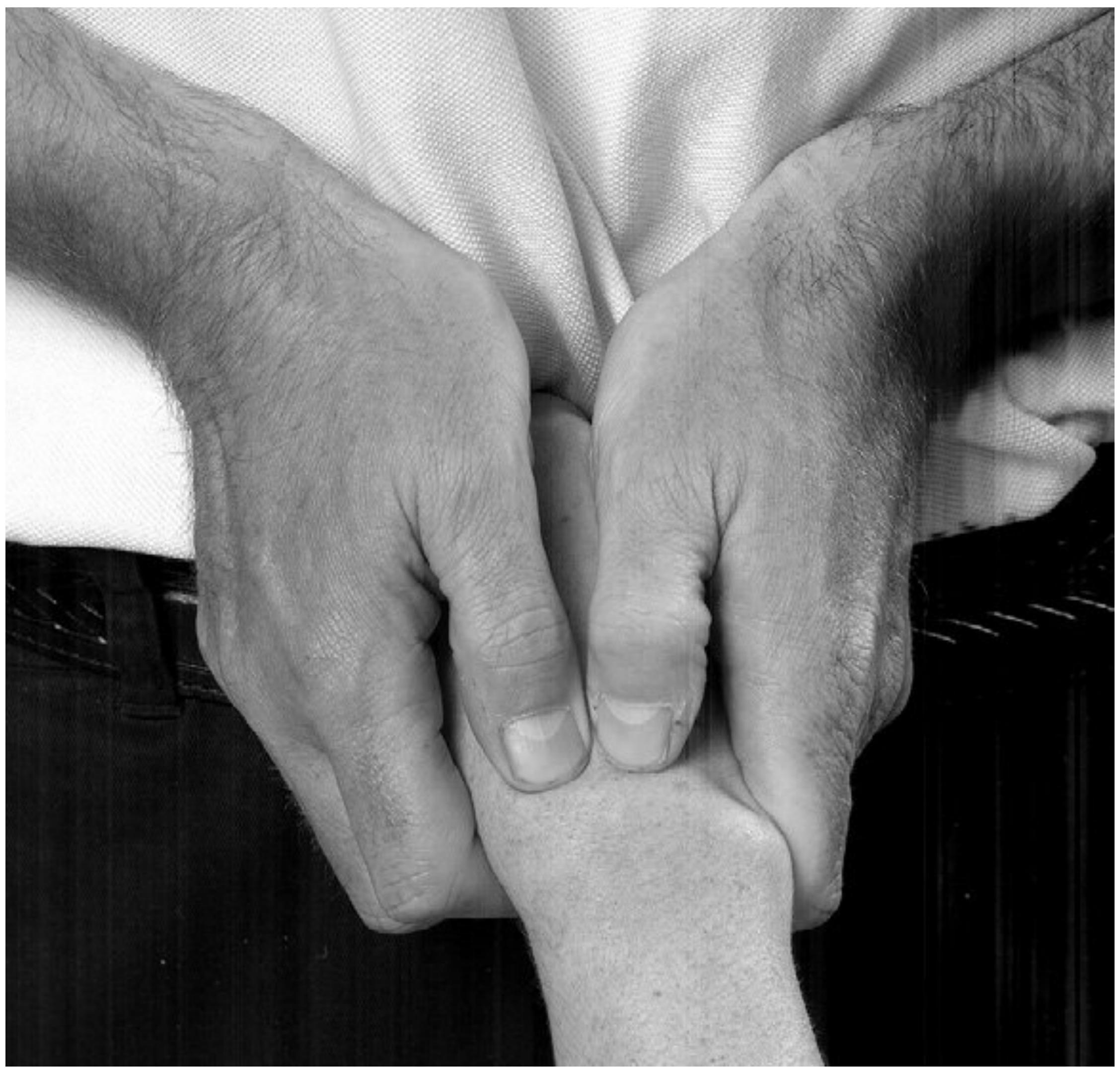

Figure 6.39 • Intercarpal movement posteroanterior.

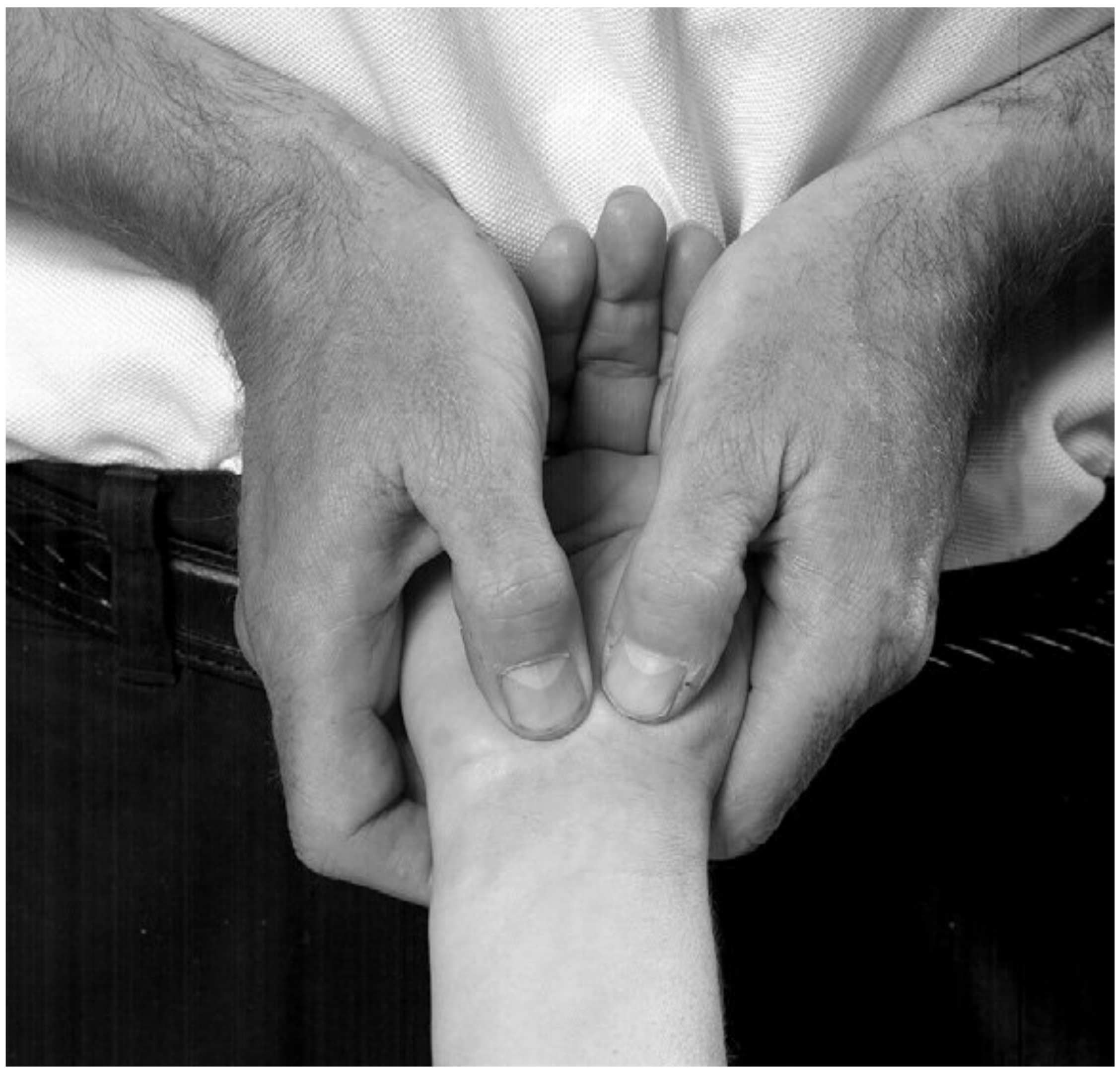

Figure 6.40 • Intercarpal movement anteroposterior.

against the anterior surface of the carpal bones during the movement of horizontal flexion.

Uses

- Very painful intercarpal movement.
- Prevention of stiffness in Sudeck's atrophy.
- Mobilization of the intercarpal joints after injury or immobilization.

Wrist and hand intercarpal longitudinal movement caudad and cephalad (Figs 6.41 and 6.42)

- *Direction*: Longitudinal caudad (distraction) and cephalad (compression) movement of the carpus and hand in relation to the radius and ulna.
- *Symbol*: ↔
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90°, the wrist in its neutral position and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's right side facing the right shoulder.

Localization of forces (position of therapist's hands)

- The left hand holds around the lower end of the patient's humerus from posteriorly.
- The thumb of the left hand is placed laterally for longitudinal cephalad movement and over the patient's biceps for longitudinal caudad movement.
- The fingers of the left hand spread around the lower end of the humerus laterally.

Figure 6.41 • Wrist and hand longitudinal movement cephalad.

Figure 6.42 • Wrist and hand longitudinal movement caudad.

- The right hand adopts the 'shake hands' grip with the thumb and fingers grasping round the patient's metacarpals.
- The index finger of the right hand extends down the patient's forearm to maintain the neutral wrist position.

Application of forces by therapist (method)

- With the grasp round the metacarpals, stability of the upper arm and the patient's wrist in its neutral position, the longitudinal cephalad (compression) movement is produced by directing pressure through the therapist's hand and through the carpus along the line of the radius and ulna.
- The longitudinal movement caudad (distraction) is produced by a pulling action through the patient's metacarpals in line with the radius and ulna.

Variations in the application of forces

- The longitudinal movements can be performed with the wrist in flexion, extension, deviation or rotation.
- The longitudinal movements can be performed in combination with AP and PA of the individual carpal bones.
- An attempt can be made to bias the movement in line with individual carpal pillars and metacarpals (e.g. biased towards the lunate, capitate and third metacarpal).

Uses

- Very painful wrist and hand movements.
- In combination with other movements.

Pisiform movements (Fig. 6.43)

- *Direction*: Movements of the pisiform in a variety of directions in relation to the triquetrum.
- *Symbols*: ↘, ↙, ↖, ↗
- *Patient starting position*: Supine, lying in the middle of the couch with the forearm supinated and the back of the hand resting against the couch or the therapist's body.
- *Therapist starting position*: Standing by the patient's right hip facing across the patient's body.

Localization of forces (position of therapist's hands)

- The therapist's body and one hand maintain stability of the patient's hand and forearm while the thumb pad of the other hand directs pressure against the different surfaces of the pisiform bone.

Application of forces by therapist (method)

- The oscillation is produced by the therapist's thumb, usually as a grade III or IV.

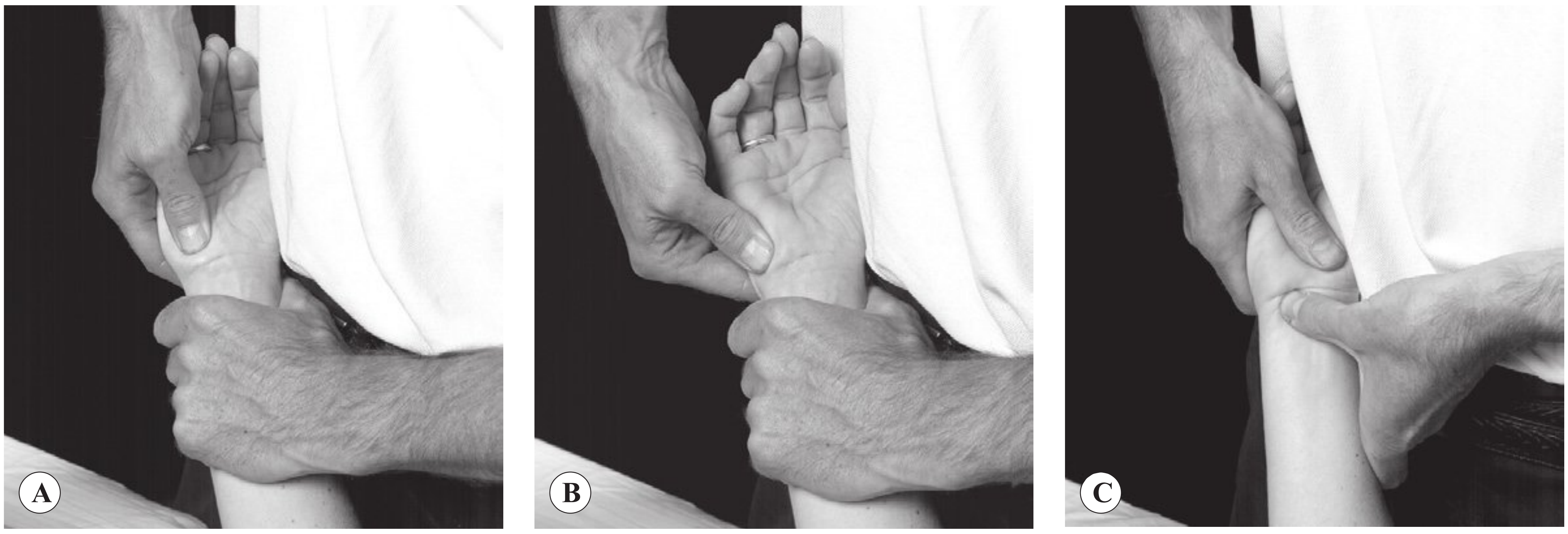

Figure 6.43 • Pisiform movements.

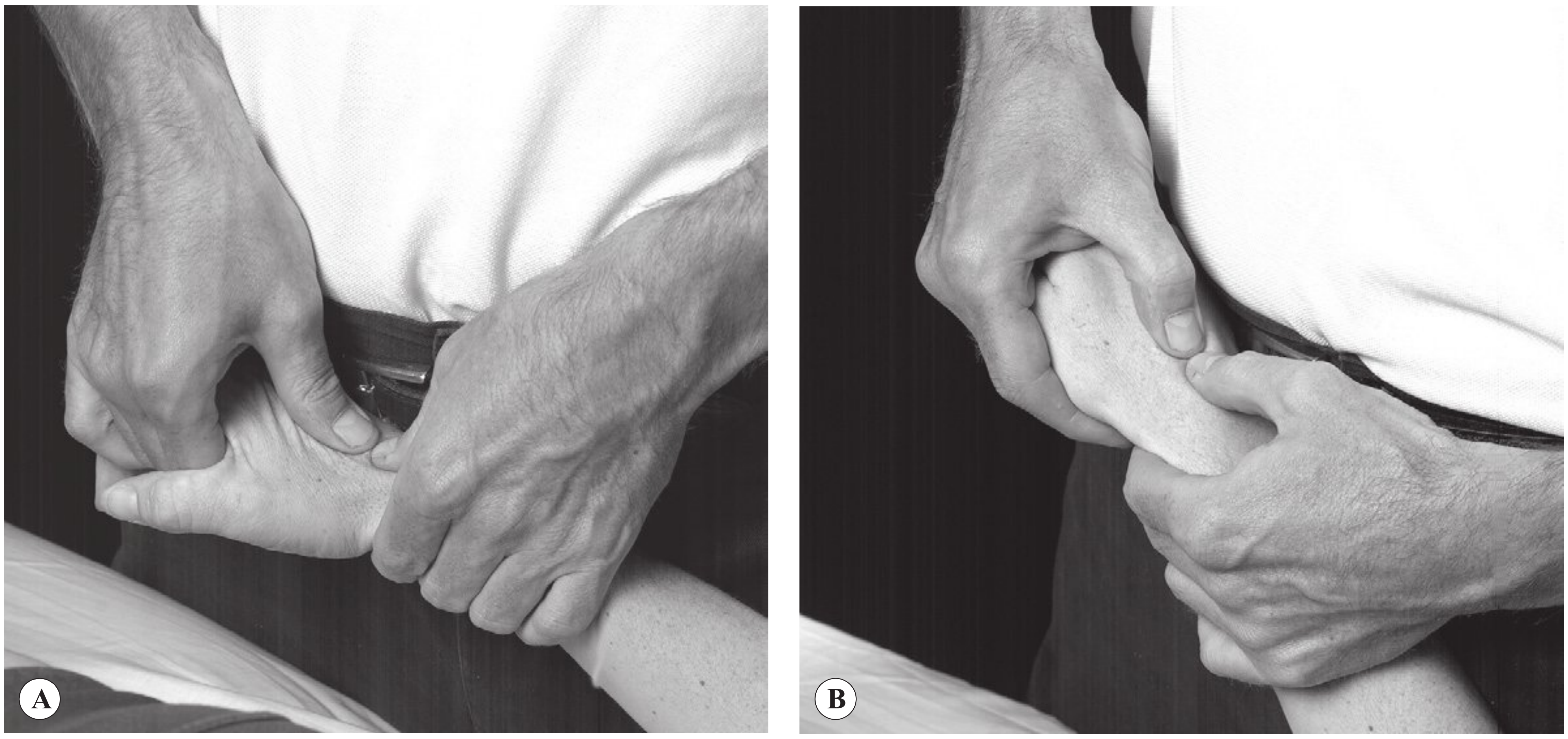

Figure 6.44 • Carpometacarpal extension.

Variations in the application of forces

- Any direction of movement around the 'clock face' of the pisiform bone is possible depending on the limited or painful directions.
- Movements can be performed with the thumb also applying a compression force to the pisiform during its movements.
- By grasping the pisiform between the thumb and index finger laterally it can be lifted away from the triquetrum and therefore moved with the addition of a distraction force.

Uses

- A stiff painful pisiform.
- As an interface technique for ulnar nerve entrapment adjacent to the pisiform or in the wrist.
- After injury or laceration of the flexor carpi ulnaris to restore normal stretch capacities.

Carpometacarpal extension and flexion (Figs 6.44 and 6.45)

- *Direction*: Movement of the metacarpals in an extension and flexion direction in relation to their corresponding carpal bones. The same technique can be used to move the metacarpals in the *anteroposterior and posteroanterior, transverse medial and lateral, medial and lateral rotation, and the longitudinal caudad (distraction) and longitudinal cephalad (compression) directions.*
- *Symbols*: Carpometacarpal E, F.
- *Patient starting position*: Supine, lying in the middle of the couch with the forearm held close to the therapist's body and in pronation *for extension* and supination *for f exion.*

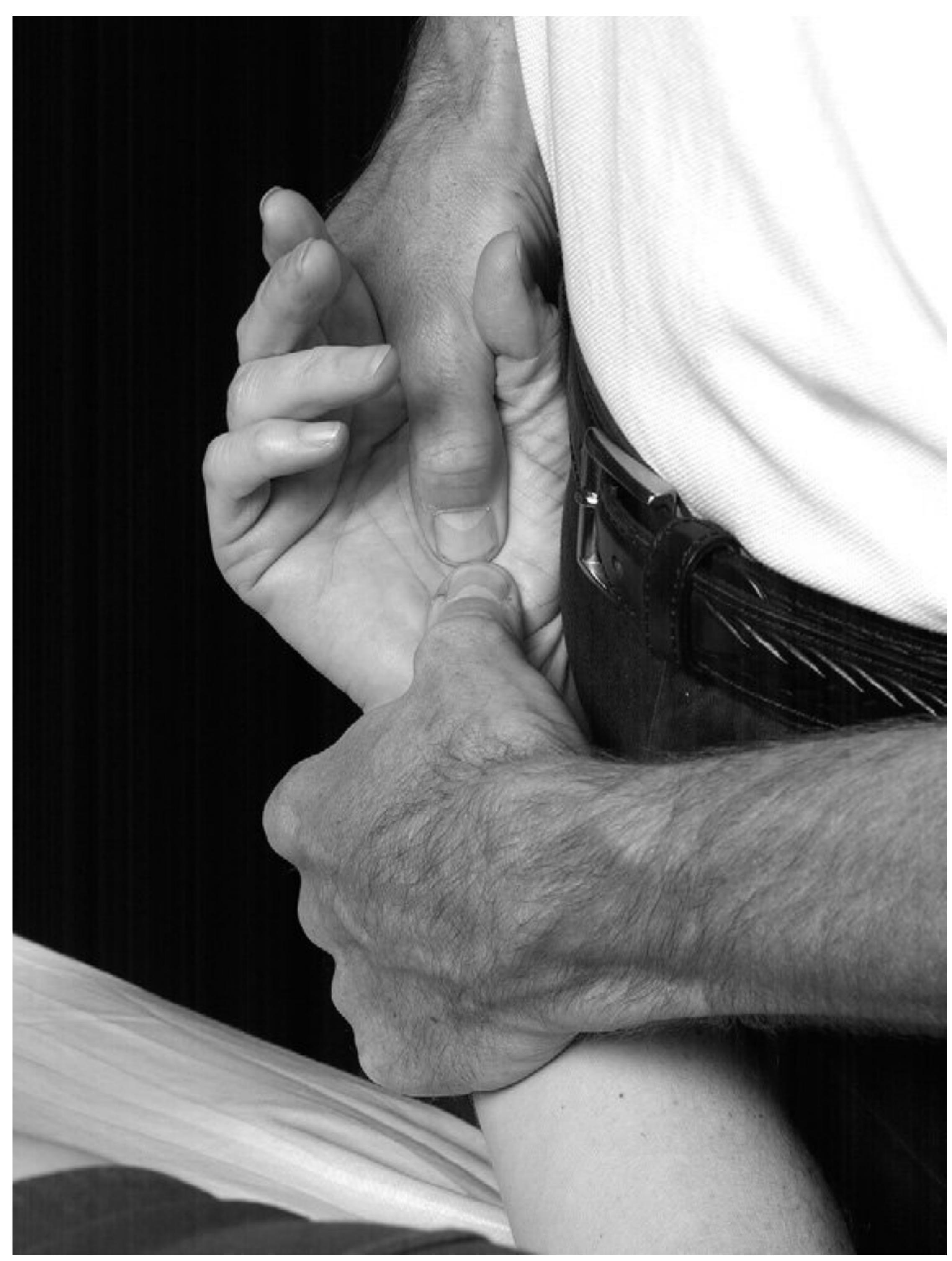

Figure 6.45 • Carpometacarpal flexion.

- *Therapist starting position*: *for extension* – standing by the patient's slightly flexed right forearm facing across the patient's body; *for fexion* – standing by the patient's upper arm facing the patient's feet.

Localization of forces (position of therapist's hands)

For extension (lateral CMC joints)

- The hands hold the patient's partly pronated hand from its lateral side.
- The left hand grasps the relevant carpal bone.
- The right hand grasps the relevant and adjacent metacarpal.
- The right hand grasps through the first interosseous space.
- The tip of the right thumb is placed against the base of the metacarpal posteriorly.

For extension (CMC of the little finger)

- Use the same grip as above except the pad of the thumb is placed over the hamate bone.
- The right hand holds the ulnar border of the patient's right hand in order to grasp the fifth metacarpal.
- The flexed index finger supports the fifth metacarpal distally and anteriorly.
- The thumb of the right hand makes contact with the base posteriorly.

For flexion

- Both hands hold the patient's supinated hand.
- The left hand holds the medial border of the patient's wrist.
- The tip of the left thumb is placed in the palm of the patient's hand over the appropriate carpal bone.

For flexion (for the second CMC joint)

- The right hand holds the second metacarpal through the patient's first interosseous space.
- The tip of the right thumb is placed against the base of the metacarpal anteriorly.
- The flexed index finger of the right hand holds against the distal end of the metacarpal posteriorly.

Application of forces by therapist (method)

For extension

- The use of grades III and IV is most common.
- The movement is produced by the therapist moving the patient's hand away and applying pressure through the thumbs with counterpressure with the fingers to assist the extension.

For flexion

- The therapist produces the movement by pushing the patient's hand away and at the same time the therapist's glenohumeral joints are adducted and the elbows extended to transmit pressure through the thumbs to the palm.
- The movement can be produced either with both thumbs or by stabilizing the carpus with the left hand and flexing the metacarpal with the right.

Variations in the application of forces

- The same grip can be used to perform other movements of the CMC joint such as anteroposterior and posteroanterior accessory movements and compression and distraction.
- A transverse accessory movement can be produced by adjusting the thumb and finger localizations so that movement is produced in the transverse lateral and medial directions.
- Rotation at the joint can be produced by fixing the appropriate carpal bone with one hand and holding onto the appropriate proximal phalanx held in 90° of flexion in the other hand. The appropriate MCP joint is then moved medially and laterally resulting in medial and lateral rotation of the CMC joint.
- Combinations of movements are also possible including, for example, flexion and extension combined with anteroposterior or posteroanterior movements or rotation with compression ordistraction.

Uses

- Mainly grade III and IV movements for stiff orpainful or stiff CMC joints.

Intermetacarpal movements (Fig. 6.46)

- *Direction*: The main movements possible between the metacarpals are general and

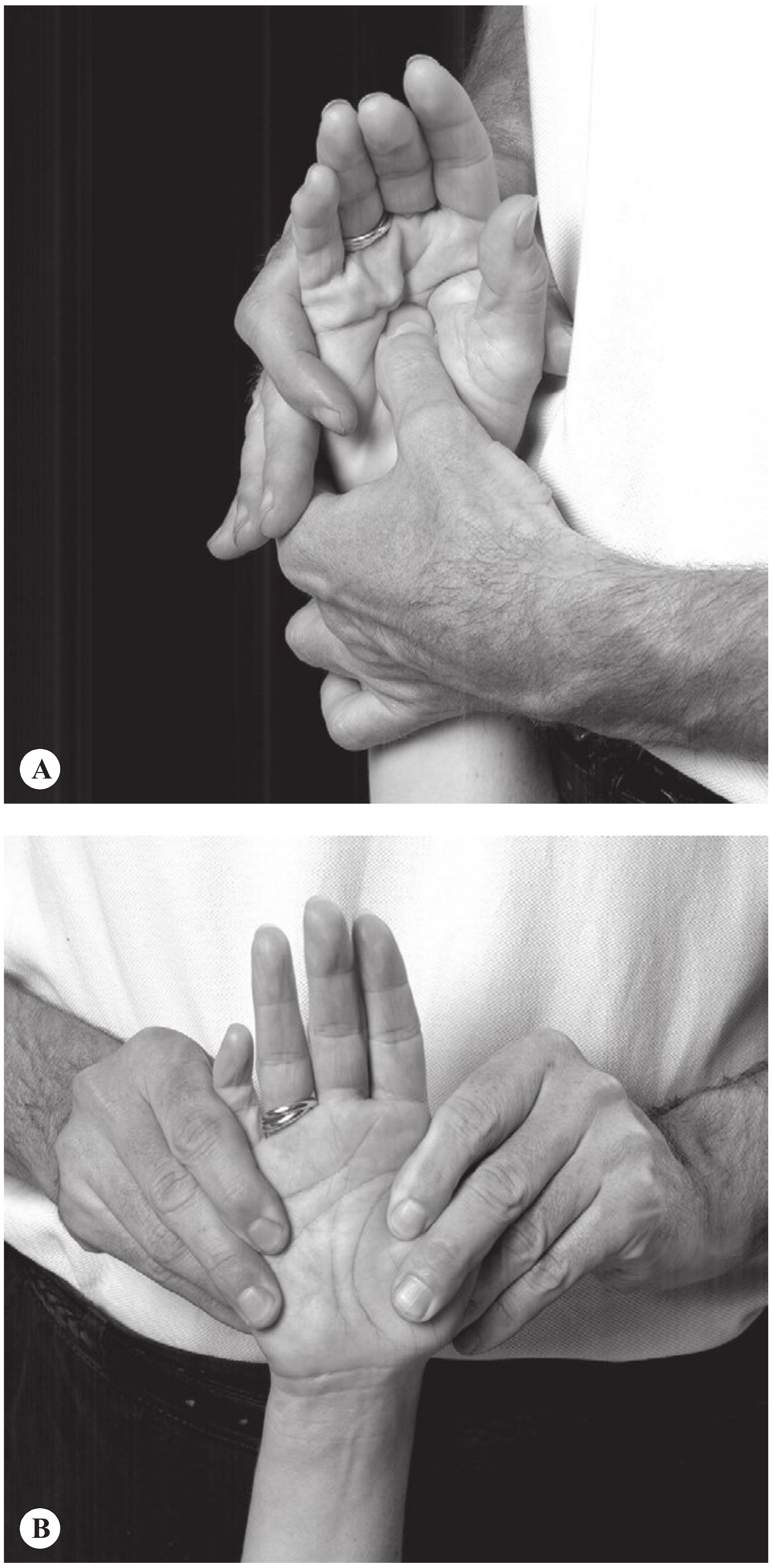

Figure 6.46 • Intermetacarpal movements: A HF; B HE.

localized horizontal flexion, general and localized horizontal extension, anteroposterior and posteroanterior movements, and compression (in a transverse direction).

- *Symbols*: HF, HE ↟, ↡, ≻•≺
- *Patient starting position*: Supine lying with the elbow flexed to 90° and the forearm supinated and held close to the therapist's body.
- *Therapist starting position*: *for HF, AP, PA* – standing facing the back of the patient's flexed and supinated forearm; *for HE, compression (transverse)* – standing beyond the patient's flexed and supinated forearm facing the back of the hand.

Localization of forces (position of therapist's hands)

General horizontal flexion (the whole row of metacarpals)

- The pad of the left thumb is placed in the palm of the patient's hand over the distal end of the third metacarpal.
- The right hand cups across the dorsum of all the metacarpals distally.
- The right thumb presses against the posterior surface of the second metacarpal.
- The fingers of the right hand (particularly the index finger) press against the posterior surface of the fifth metacarpal.
- If the left thumb is placed against the fourth metacarpal this will change the peak of the movement.

Localized horizontal flexion

- Both hands grasp the patient's hand.
- The right thumb holds the patient's fifth metacarpal posteriorly.
- The tips of the right index and middle fingers hold the fifth metacarpal anteriorly.
- The left hand holds the adjacent fourth metacarpal between the pads of the index and middle fingers anteriorly and the pad of the thumb posteriorly.

General horizontal extension

- Both hands hold the patient's hand.
- The pads of the thumbs are placed against the distal end of the posterior surface of the third metacarpal.
- The fingers hold round the medial and lateral margins of the patient's hand to reach to the anterior surface of the second and fifth metacarpals distally.

Localized horizontal extension

- The same localization of forces described for localized horizontal flexion apply.

Posteroanterior or anteroposterior

- The same localization of forces described for localized horizontal flexion apply.

Compression (transverse)

- The 'shake hands' grip is adopted (i.e. right hand to right hand).

- One hand grips around the heads of the metacarpals with one hand.
- The other hand stabilizes the heads of the metacarpals in a straight line from the radial to the ulnar sides.

Application of forces by therapist (method)

General horizontal flexion

- Small or large amplitude movements are produced by the therapist's hands moving in opposite directions.

Localized horizontal flexion

- While the therapist's left hand stabilizes the fourth metacarpal, the therapist's right hand moves the fifth metacarpal in a circular direction.
- When the second metacarpal is to be mobilized on the third, the therapist's left hand performs the movement, whereas when the fourth and fifth metacarpals are to be mobilized the therapist's left hand holds the fourth metacarpal while the right hand moves the fifth metacarpal around the fourth.
- If the third metacarpal is to be mobilized on the fourth the therapist's left hand performs the movement and the right hand acts as the stabilizing force.
- When the fourth metacarpal is to be mobilized on the third, the reverse is the case.

General horizontal extension

- The extension movement is performed by a pulling action with the fingers of both hands pivoting the patient's metacarpals around the thumbs on the third metacarpal while at the same time pushing the patient's hand away (as a grade III large amplitude).

Localized horizontal extension

- The same application of forces described for localized horizontal flexion apply except that the movement is one of pivoting towards extension around stabilized adjacent metacarpals.

Posteroanterior or anteroposterior movements

- The same application of forces described for localized horizontal flexion apply except that the metacarpals are moved so as to traverse parallel lines in opposite directions (i.e. one metacarpal is moved anteroposteriorly or posteroanteriorly in relation to the stabilized neighbouring metacarpal).

Compression (transverse)

- The movement is produced by the therapist alternately squeezing and relaxing the gaps around the patient's metacarpal heads.

Uses

- Movements do not usually become disturbed unless caused by trauma.

Metacarpophalangeal and interphalangeal joint flexion and extension (described for MCP joints) (Figs 6.47 and 6.48)

- *Direction*: Flexion and extension of the proximal phalanx in relation to the metacarpal, or of the interphalangeal, joints.
- *Symbols*: MCP, IP F, E.
- *Patient starting position*: Supine, lying with the elbow flexed and forearm supinated.
- *Therapist starting position*: Standing by the patient's side facing across the body at the level of the patient's flexed elbow.

Localization of forces (position of therapist's hands) (for the index finger)

- The right hand holds the proximal phalanx of the patient's index finger between the thumb

Figure 6.47 • Metacarpophalangeal and interphalangeal joint: flexion.

Figure 6.48 • Metacarpophalangeal and interphalangeal joint: extension.

and the index finger, both of which are directed proximally.

- The left hand stabilizes the patient's hand, particularly around the second metacarpal between the thumb and index finger.

Application of forces by therapist (method)

Flexion

- The joint is flexed comfortably, at the limit of the range if necessary (e.g. a small amplitude grade IV is performed by the therapist's right hand while the metacarpals are stabilized with the left hand).

Extension

- Extension is produced by the combined action of extending the proximal phalanx on the metacarpal and the metacarpal on the phalanx.
- Alternatively, the movement can be produced by stabilizing the metacarpal and moving the proximal phalanx into extension.
- Small or large amplitudes can be used.

Variations in the application of forces

- The flexion and extension can be combined with anteroposterior or posteroanterior movements at their limit, or with compression or distraction.

Uses

- Stiff fingers.

Metacarpophalangeal and interphalangeal joint abduction and adduction (described for MCP joint) (Figs 6.49 and 6.50)

- *Direction*: Abduction and adduction of the proximal phalanx in relation to the adjacent metacarpal or at the interphalangeal joint.
- *Symbols*: MCP, IP Ab, Ad.

Figure 6.49 • Metacarpophalangeal and interphalangeal joint: abduction.

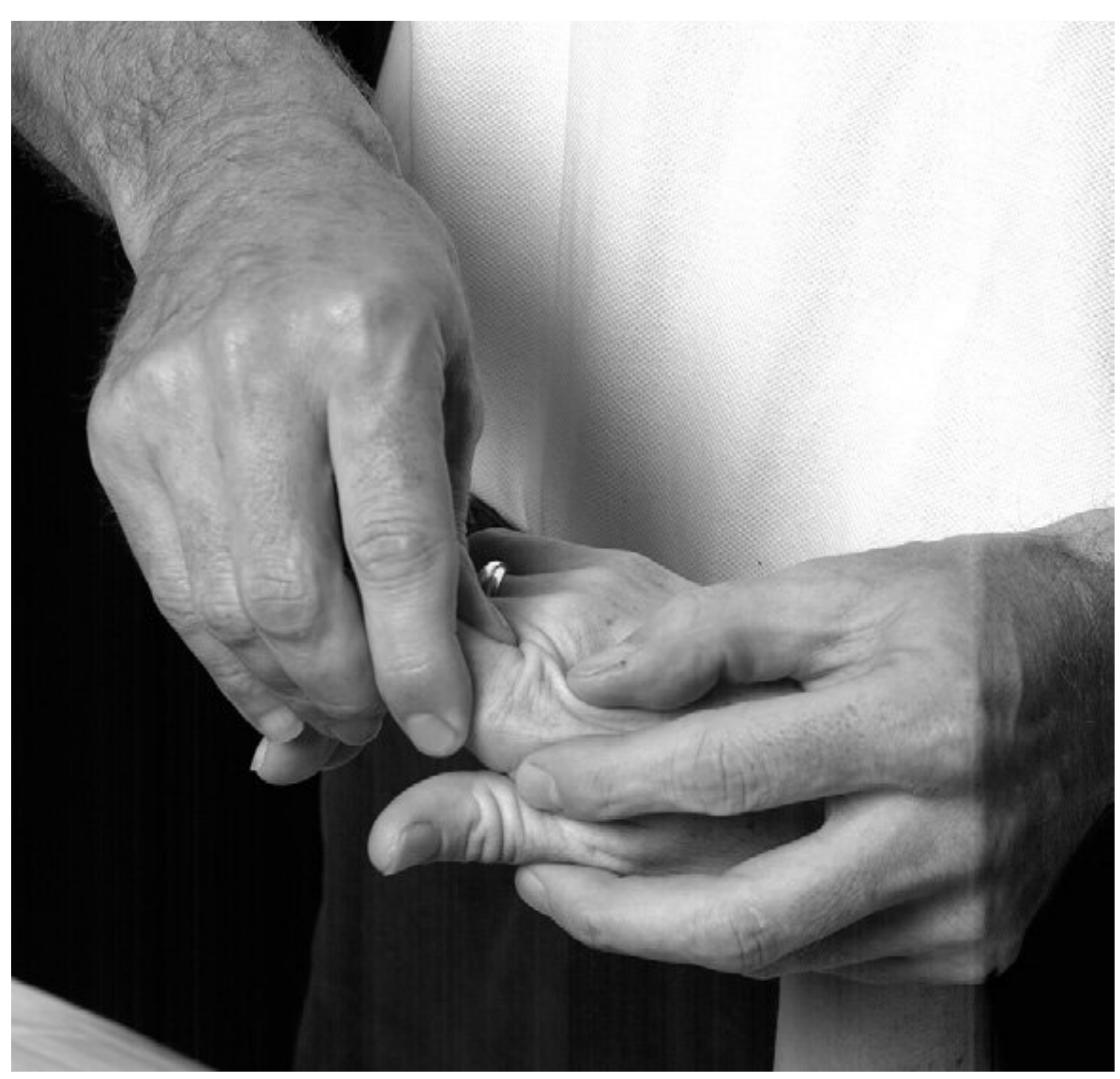

Figure 6.50 • Metacarpophalangeal and interphalangeal joint: adduction.

- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed and pronated for adduction and supinated for abduction.
- *Therapist starting position*: Standing by the patient's side at the level of the elbow facing across the patient's body.

Localization of forces (position of therapist's hands) (for the index finger)

Abduction

- The left hand holds the posterior surface of the patient's right hand.
- The right hand holds the patient's index finger.
- The left hand holds the posterior surface of the patient's hand from the radial side.
- The left thumb, pointing distally, is placed against the lateral surface of the second metacarpal distally.
- The fingers of the left hand grasp the ulnar border of the patient's hand.
- The pad of the right thumb, pointing proximally, stretches along the lateral surface of the proximal phalanx to its base.

Adduction

- The left hand holds the posterior surface of the patient's hand around its radial border.
- The left thumb wedges into the second interosseous space as much as possible.
- The fingers of the left hand reach around the patient's thumb and through the first interosseous space to stabilize the patient's hand.
- The right hand grasps the patient's index finger.
- The pad of the right thumb, pointing proximally, holds against the medial surface of the proximal phalanx.

Application of forces by therapist (method)

Abduction

- The oscillatory movement is produced by movement of the therapist's two hands combining abduction with pushing the patient's hand away.
- Small or large amplitude movements can be performed in any part of the range.
- Adduction
- The oscillatory movement is produced by the therapist's arms acting through both hands while pushing the patient's hand away.

Variations in the application of forces

The abduction or adduction movements can be combined with:

- Compression or distraction
- A transverse glide
- Inclinations anteriorly or posteriorly.

Uses

- Stiff fingers.
- Restoration of movement after collateral ligament injury.

Metacarpophalangeal and interphalangeal joint medial and lateral rotation (described for MCP joints) (Figs 6.51 and 6.52)

- *Direction*: Medial rotation or lateral rotation of the phalanges in relation to stabilized metacarpals or at interphalangeal joints.
- *Symbols*: MCP, IP ↺, ↻
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed and the forearm in its mid-pronation or mid-supination position.

Figure 6.51 • Metacarpophalangeal and interphalangeal joint: medial rotation.

Figure 6.52 • Metacarpophalangeal and interphalangeal joint: lateral rotation.

- *Therapist starting position*: Standing by the patient's side, level with the flexed elbow and facing across the patient's body.

Localization of forces (position of therapist's hands) (for the index finger)

Medial rotation

- The left hand stabilizes the second metacarpal by holding it firmly between the fingers anteriorly and the thumb posteriorly.
- The right hand holds the slightly flexed index finger in 10° of MCP flexion and 80° of proximal IP flexion. (The maximum range of medial rotation is obtained when the MCP is positioned in a few degrees of flexion as this is the joint's mid flexion/extension position. However, the degree of flexion or extension used in treatment will be determined by the presenting pain and stiffness.)
- The tip of the right thumb is placed against the medial aspect of the proximal IP joint.
- The tips of the right index and middle fingers are placed against the lateral surface of the patient's middle and distal phalanges.

Lateral rotation

- The left hand holds across the posterior surface of the patient's hand.
- The fingers of the left hand are threaded around the lateral border of the hand.
- The index finger passes through the first interosseous space to reach the palm of the patient's hand.
- The remaining fingers grasp around the thenar eminence.
- The right hand holds the patient's flexed finger.
- The right thumb is placed against the lateral surface of the proximal IP joint.
- The index finger of the right hand is placed against the medial surface of the distal IP joint.

Application of forces by therapist (method)

Medial rotation

- The movement is produced entirely by the therapist's right hand while the left hand stabilizes the patient's hand.
- The therapist pivots the distal phalanx around the therapist's thumb tip causing the patient's proximal phalanx to medially rotate.

Lateral rotation

- The therapist produces the rotation by movement of the left hand and forearm while the therapist's right hand stabilizes the patient's hand.

Variations in the application of forces

- The rotation can be performed with compression or distraction or in any position of flexion, extension, abduction or adduction.

Uses

- Stiff fingers.
- With compression in minor symptoms produced by osteoarthritis.

Metacarpophalangeal and interphalangeal joint longitudinal movement caudad (distraction) and cephalad (compression) – described for the MCP joint (Figs 6.53 and 6.54)

- *Direction*: Longitudinal movement caudad (distraction) and cephalad (compression) of the proximal phalanx in relation to the adjacent metacarpal or at the IP joint.
- *Symbols*: MCP, IP ←•→, >•<
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.

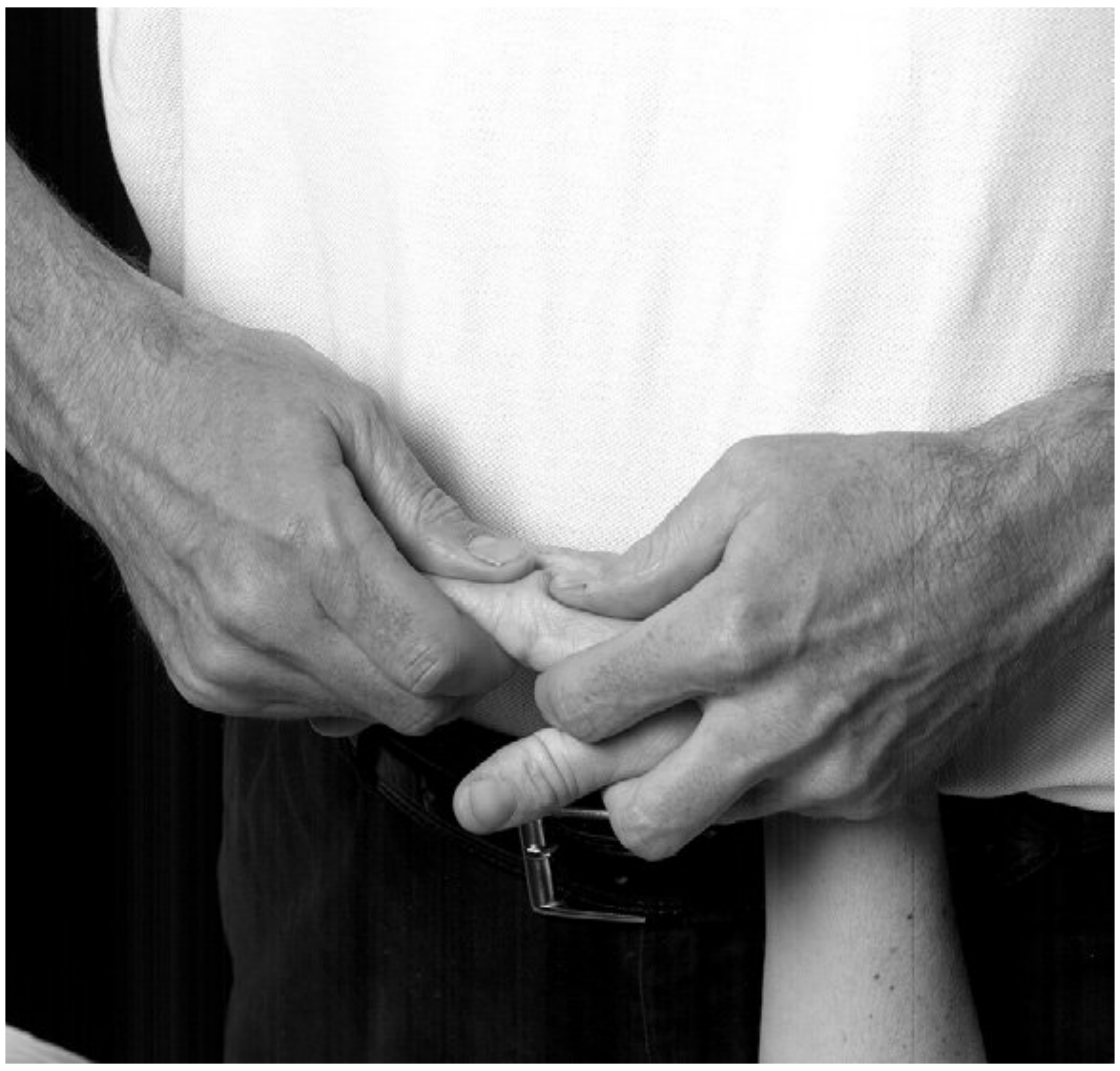

Figure 6.53 • Metacarpophalangeal and interphalangeal joint: longitudinal movement caudad (distraction).

- *Therapist starting position*: Standing by the patient's right side, level with the forearm and hand, facing across the patient's body.

Localization of forces (position of therapist's hands) (for the index finger)

Longitudinal caudad

- The left hand grasps firmly around the lateral border of the patient's right hand.

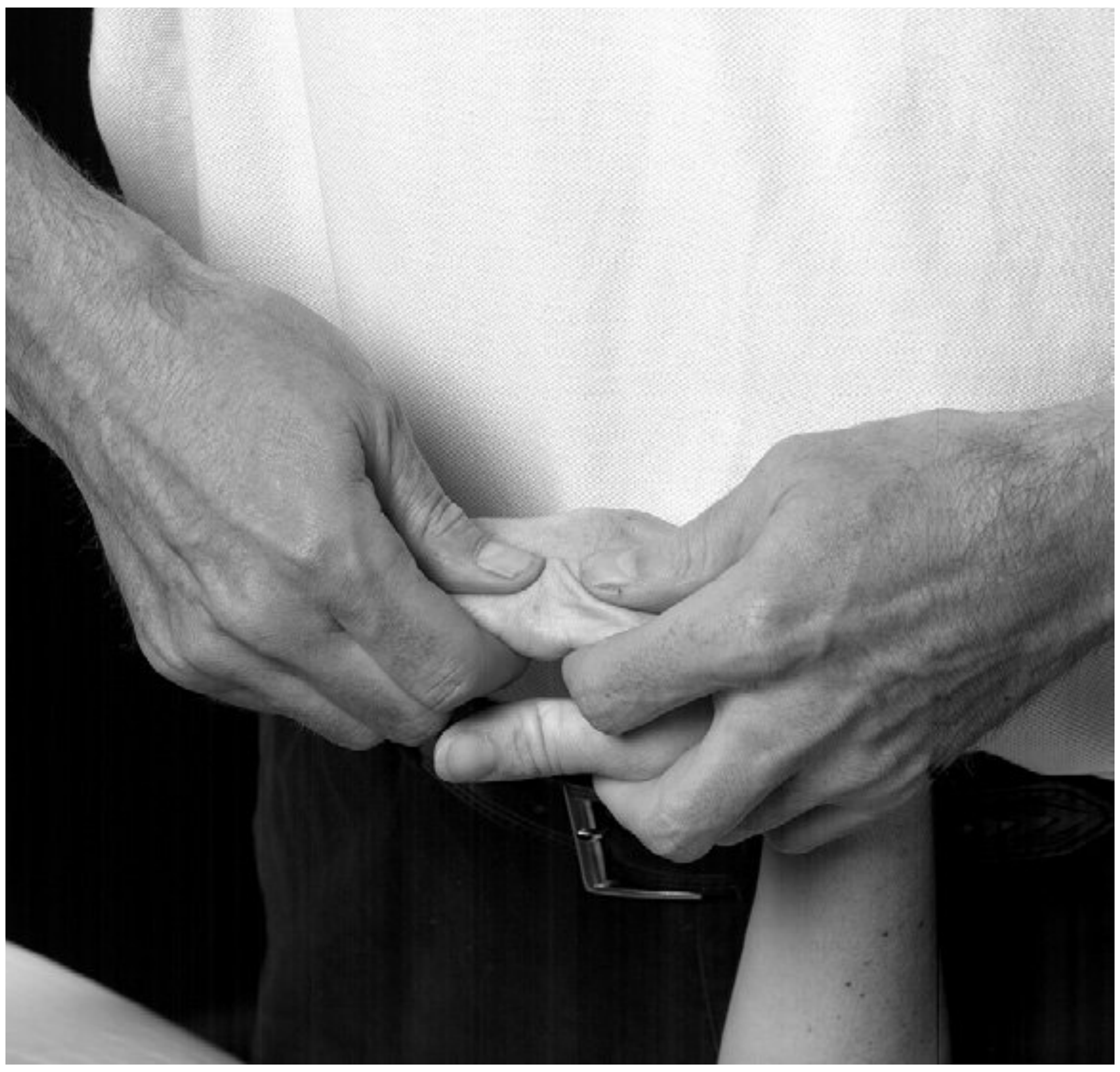

Figure 6.54 • Metacarpophalangeal and interphalangeal joint: longitudinal movement cephalad (compression).

- The right hand holds the patient's index finger.
- The left hand holds the second metacarpal between the flexed index finger and thumb.
- The proximal IP joint of the left index finger holds the anterior surface of the distal end of the metacarpal.
- The left thumb holds firmly against the shaft of the metacarpal posteriorly.
- The right hand grasps the patient's index finger in a similar fashion, i.e. the fully flexed index finger holds the patient's proximal phalanx anteriorly and the thumb grasps along the shaft of the same phalanx.
- The patient's MCP joint is then positioned midway between its other ranges to permit maximum caudad movement.
- Longitudinal cephalad
- The same localization of forces as for longitudinal caudad is applied except the fingers and palm hold the whole of the patient's index finger, which should be slightly flexed at each IP joint.

Application of forces by therapist (method)

Longitudinal caudad

- The movement is produced by the therapist pulling the hands away from each other to produce distraction with the MCP joint slightly flexed.
- This slight flexion is maintained by firm pressure against the anterior surface of the patient's metacarpal and phalanx, adjacent to the joints, using the therapist's index finger at the proximal IP joint.

Longitudinal cephalad

- The movement of compression is applied by the squeezing together of the therapist's hands which hold the metacarpal and phalanx firmly.

Variations in the application of forces

- The movements can be performed in isolation or more often combined with flexion, extension, abduction, adduction, AP, PA and rotation.

Uses

- Stiff fingers.
- Very painful joint surface disorders (distraction).
- Minor joint surface disorders (compression).

Metacarpophalangeal and interphalangeal joint posteroanterior and anteroposterior movement (described for the MCP joint) (Figs 6.55 and 6.56)

- *Direction*: Posteroanterior and anteroposterior movement of the proximal phalanx on the adjacent metacarpal or at the IP joint.
- *Symbols*: MCP, IP ↓, ↑
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's side, level with the forearm, facing across the patient's body.

Localization of forces (position of therapist's hands) (for the index finger)

- The left hand holds the patient's second metacarpal firmly with the fully flexed index finger anteriorly and the thumb posteriorly.
- The left thumb makes contact with the posterior surface proximal to the joint.
- The proximal IP joint of the therapist's index finger makes contact with the anterior surface proximal to the joint.
- The right hand grasps the proximal phalanx of the patient's index finger.
- The fingers of the right hand hook around the anterior surface of the phalanx.
- The tip of the right thumb is placed against the head of the proximal phalanx posteriorly.

Application of forces by therapist (method)

- *Posteroanterior* – pressure is applied acting through the tip of the therapist's right thumb against the posterior surface of the head of the proximal phalanx immediately adjacent to the MCP joint. The flexors of the therapist's thumbs must not produce the movement.
- *Anteroposterior* – pressure is applied against the head of the proximal phalanx anteriorly by the IP joint of the therapist's flexed index finger.

Variations in the application of forces

- The movement can also be performed with the joint surfaces distracted or firmly compressed against each other.
- The movement can be inclined in a variety of directions.
- Frequently used in combination with flexion, extension, abduction, adduction or rotation.

Uses

- Stiff fingers (at the limit of the stiff physiological movement).
- Clinical group 1, for very painful joints.

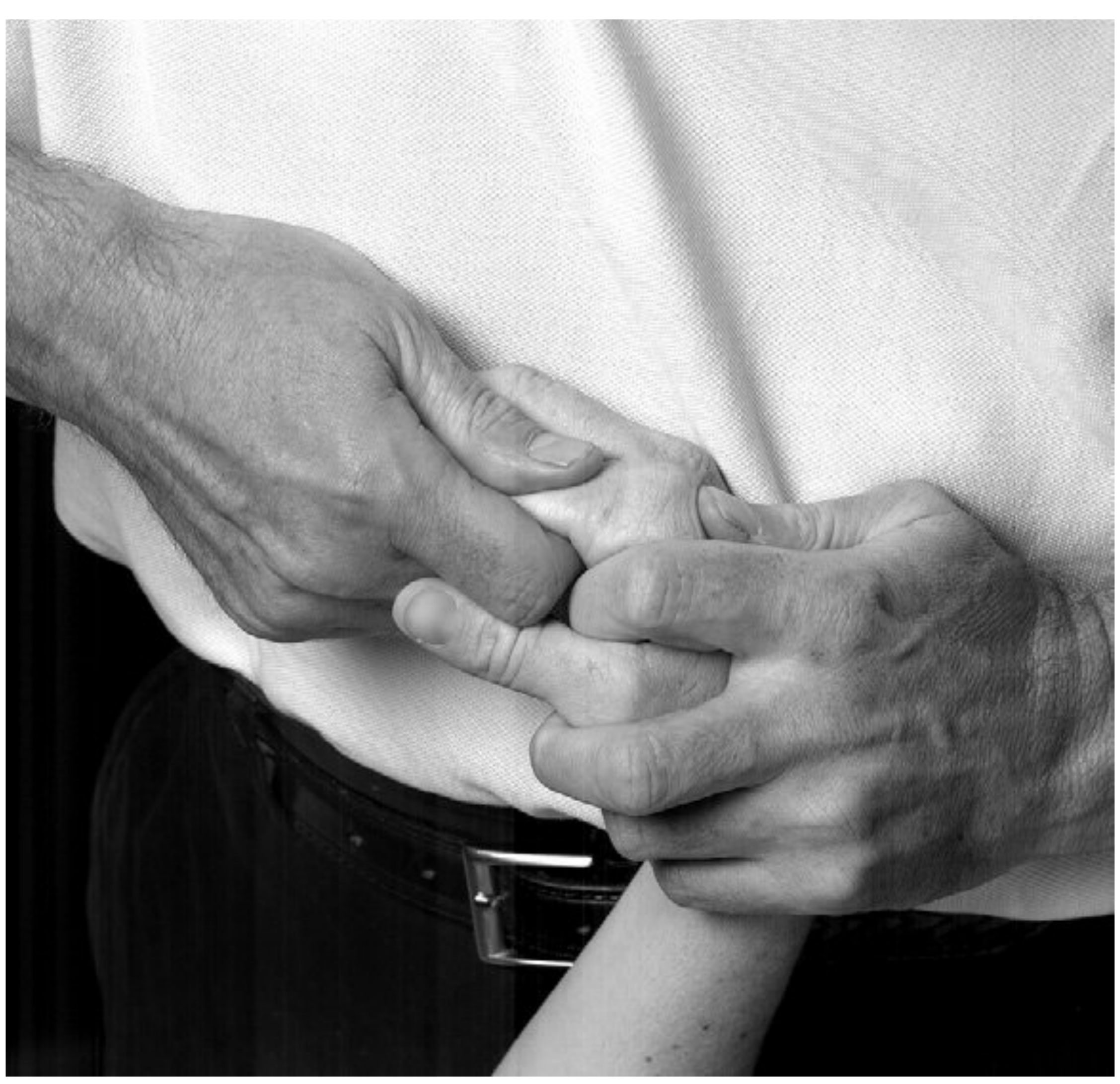

Figure 6.55 • Metacarpophalangeal and interphalangeal joint: posteroanterior movement.

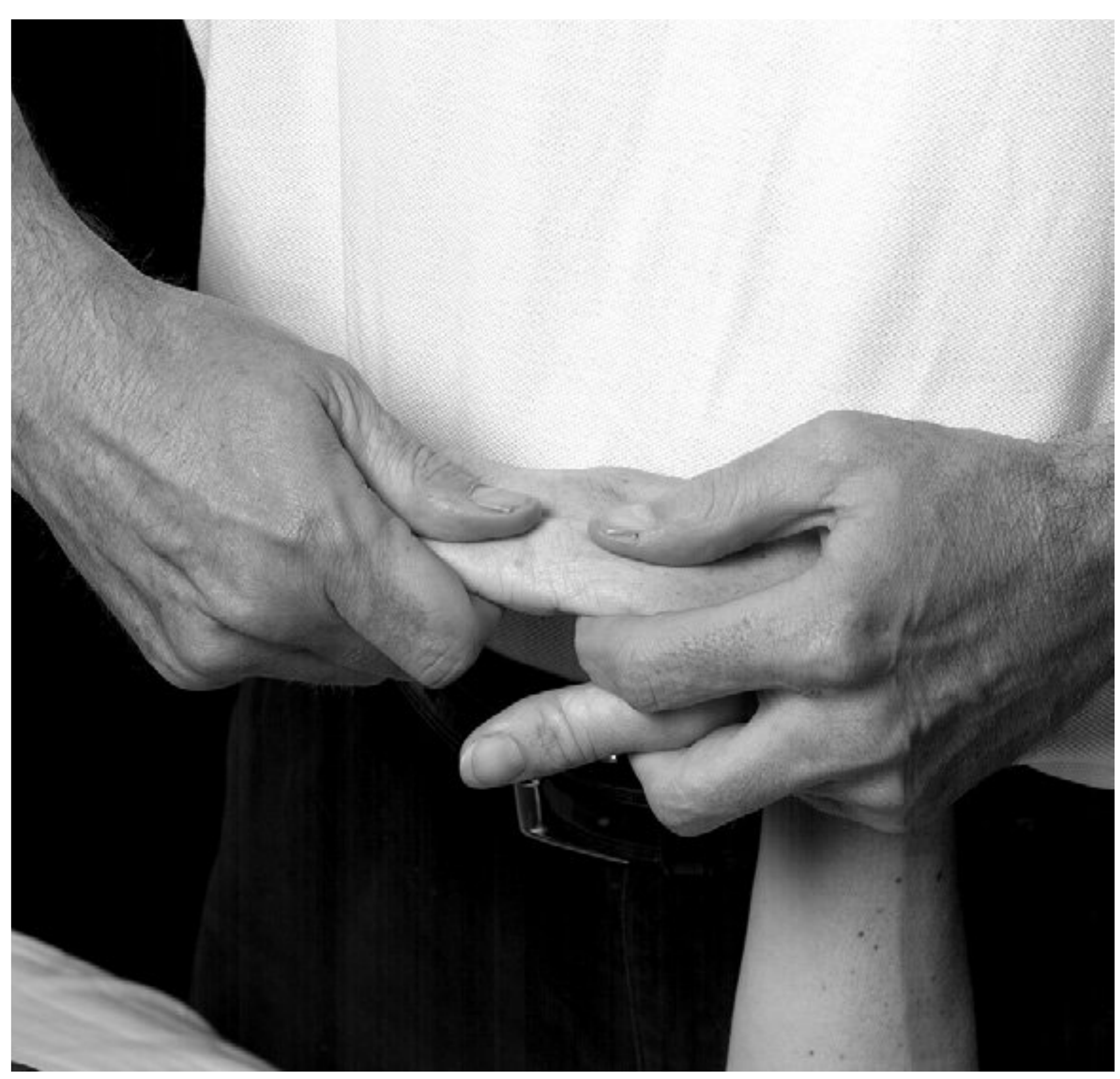

Figure 6.56 • Metacarpophalangeal and interphalangeal joint: anteroposterior movement.

Metacarpophalangeal and interphalangeal joint general flexion, extension and circumduction

- *Direction*: General flexion, extension and circumduction of the MCP and IP joints.
- *Symbols*: MCP, IP F, E, circumduction (general).
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90° and the forearm in its mid-pronation or mid-supination position.
- *Therapist starting position*: Standing by the patient's side, level with the forearm and facing across the patient's body.

Localization of forces (position of therapist's hands)

- The left hand holds across the back of the patient's right hand from the medial side.
- The fingers grasp the first interosseous space to reach the palm of the patient's hand.
- The therapist's thenar eminence and thumb of the right hand hold across the back of the patient's hand.
- The right hand holds the patient's four fingers from the medial side between the fingers anteriorly and the thenar eminence posteriorly.

Application of forces by therapist (method)

With the metacarpals held firmly the following general movements can be performed:

1. MCP joint flexion with IP extension
2. MCP extension with IP flexion
3. MCP circumduction with a circling action of the right hand.

Uses

- As grade II general hand loosening movements.
- As easing off of treatment soreness.
- For general stiffness and pain in all joints as in osteoarthritis or rheumatoid arthritis.
- To loosen off stiffness postimmobilization (e.g. after a Colles' fracture).

Thumb movements (first carpometacarpal joint) (Figs 6.57-6.59)

- *Direction*: Movements of the thumb are identical with those of the fingers even though the planes of the thumb movements are different. The movement of opposition is an additional thumb movement which is a combination of flexion, abduction and rotation.
- *Symbols*: 1st CMC joint F, E, Ad, Ab, opposition, ←•→ ceph, ≻•≺, ↓, ↑, ↺, ↻
- *Patient starting position*: Supine, lying in the middle of the couch with the elbow flexed to 90°.
- *Therapist starting position*: Standing by the patient's side, level with the flexed elbow, facing across the patient's body.

Figure 6.57 • First carpometacarpal flexion.

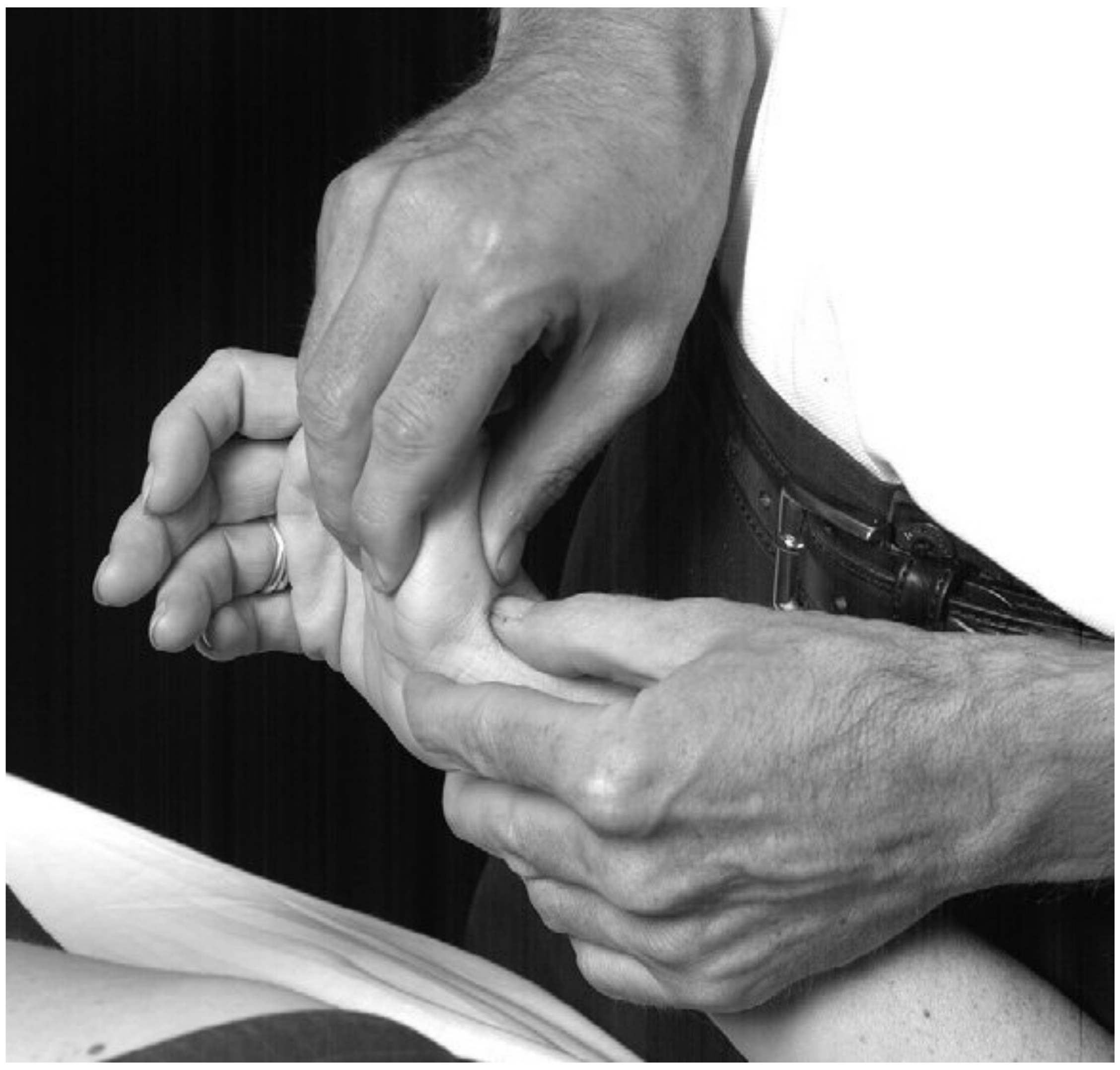

Figure 6.58 • First carpometacarpal extension.

Figure 6.59 • Carpometacarpal posteroanterior movement.

Localization of forces (position of therapist's hands)

Flexion

- The left hand stabilizes the patient's wrist with the fingers across the anterior surface and the thumb posteriorly.
- The left index finger must cross in front of the trapezium to stabilize it during thumb flexion while not obstructing metacarpal movement.
- The right thumb and index finger grasp the patient's thumb with the therapist's thumb across the posterior surface of the metacarpal and the index finger across the anterior surface.
- Extension.
- The same localization of forces as for flexion applies except that the tip of the left thumb is placed against the dorsal surface of the trapezium and the trapezoid.

Adduction, abduction, opposition

- As above, one hand stabilizes the carpus at the trapezium and trapezoid, while the other hand produces the movement of the metacarpal in the desired direction.

Longitudinal cephalad (compression)

- The localization of forces is the same as those described for longitudinal movement cephalad of the index finger.
- Rotation.
- The localization of forces is the same as those described for rotation of the index finger.

Posteroanterior movement (including anteroposterior, and transverse medial and lateral)

- The right hand grasps the patient's thumb.
- The left hand grasps the patient's wrist at its radial border.
- The tips of both thumbs are placed: 1. against the posterior surface of the first metacarpal, immediately adjacent to the CMC joint; 2. against the trapezium; 3. on the joint line.

Application of forces by therapist (method)

- *Flexion*: the flexion movement is produced through the therapist's right hand while the left hand stabilizes the proximal part of the joint.
- *Extension*: the extension movement is produced mainly through the therapist's contact on the anterior surface of the first metacarpal, pivoting it around the therapist's right thumb while the left thumb stabilizes the proximal part of the joint.
- *Adduction, abduction, opposition*: these movements are performed in the appropriate direction by the therapist's left thumb and index finger stabilizing the trapezium and trapezoid while the therapist's right thumb and index finger move the metacarpal. Note that the opposition also includes medial rotation as part of the oscillatory movement.
- *Longitudinal movement cephalad and rotation*: the application of forces for these movements is the same as those described for the index finger.
- *Posteroanterior* (anteroposterior, transverse medial and lateral): the posteroanterior movement, for example, is produced by the pressure of the thumbs against the base of the metacarpal or the index fingers. The pressure should arise from the therapist's arms and must not be produced by the thumb flexors.

Variations in the application of forces

- Any of the above movements can be combined, depending on the directions which are stiff or painful.

Uses

- The thumb is often subjected to osteoarthritic changes so movements which include

Box 6.10

Chronic and minor wrist and hand symptoms

- Supine: flexion and extension
- Supination and pronation (through metacarpals)
- Radial and ulnar deviation
- AP and PA movement
- HF and HE
- Longitudinal caudad and cephalad

compression when the symptoms are minor can be most effective.

- Pain and stiffness in the joint after overuse, trauma or following fracture.

Box 6.10 summarizes the extent of examination required when chronic minor wrist and hand symptoms are present, Box 6.11 shows the screening tests required to prove the wrist and hand are unaffected, and Box 6.12 shows how to examine a thumb with chronic minor symptoms.

Screening tests

Normally screening tests are used after the first treatment. Each new treatment can screen a new structure, which can be better evaluated individually.

Structures to be screened:

- Cervical spine: active flexion, extension, rotation left, right, inferior cervical quadrant and PAIVM's.
- Shoulder complex: active flexion, abduction, HBB, horizontal flexion, and passively medial rotation in 90° abduction, glenohumeral quadrant and locking position.
- Elbow: active flexion, extension, pronation, supination and passively flexion/adduction, flexion/abduction, extension/adduction, extension/abduction, in 90° flexion: pronation, supination combined with compression intra-articular.
- Thoracic spine: cough, active extension, rotation left and right and PAIVMs.
- First rib: cervical extension, lateral flexion and passive accessory movements.

It includes of course a reassessment after each screening test

Box 6.11

Proving the area unaffected

- F and E (fngers to wrist)
- Supination and pronation
- Wrist deviation
- (←•→) ceph, caud

Box 6.12

Chronic and minor base of thumb symptoms

Proving that the thumb is, in fact, unaffected

F/E, E with (↕, ↕), Rotn with compression

Treatment of wrist and hand conditions – an overview

For treatment, the differential functional analysis and the creativity of the therapist is much more relevant than the different laws of biomechanics.

All the techniques described above must have the flexibility to be combined, adapted and modified in unrestricted ways. Thus, for the simple treatment of a monoarthritis of the second carpometacarpal joint of a woman in her fifties, the important accessory movements found to be impaired are rotation and anteroposterior movements, which, if used in treatment alone, would have been ineffective. For effective treatment, however, to completely clear the symptoms and reduce crepitus, rotation and anteroposterior movements were used, firstly combined with distraction, then with compression through the whole physiological range and then along with variations and all possible angulations (for example, rotation and anteroposterior movements in extension or adduction IV−, with compression IV). In this example the key to successful treatment is graded exposure to movement in combinations and functional corners so as to ensure full pain-free capacity of movement at the carpometacarpal joint is achieved.

Sometimes a tiny movement problem with a huge psychosocial component will moderate the effect of manual therapy and limit its effectiveness. A patient, a manual therapist in his forties, lost the motor control and strength of the long flexor of his thumb. There was no pain and no other other restriction. He was unable to work because he was unable to perform accessory movement techniques using his thumb. The whole of his family was referred to a psychiatrist because his doctor thought he was trying to make a fraudulent insurance claim. Medical and manual therapy examination did not show that there was anything wrong with him. A neurologist found that he had a form of Parsonage–Turner syndrome – idiopathic or viral brachial amyotrophic neuralgia. The affected muscle, in this case only the flexor pollicis longus, became weak and atrophied, but after one-and-a-half years resolved completely.

In this very rare type of case (incidence around 1.5 in 100,000, Beghi et al. 1985), manual therapy has no role to play, but in nearly all other peripheral neuropathies, manual therapy shows efficacy. Once again, the potential for the success of manual therapy comes from combining the different possibilities:

- Accessory movements on entrapment sites in neural tension
- Nerve sliders in the functional position
- Cervical gliders in specific ULNT
- Thoracic mobilization in slump position.

Management

Apart from all the mobilization techniques described above, which correspond to more than 95% of all treatment with passive movement, manipulation (V) can be used when joint mobility remains restricted or blocked. The main manipulation techniques for the hand are:

- traction thrust (V) of MCP (Fig. 6.53 or CMC 1 Fig. 6.44B, radioscaphoid, radiolunate, radiotriquetrum (Fig. 6.42);
- PA thrust (V) of MCP (Fig. 6.55), scaphoid, lunate, triquetrum, capitate (Fig. 6.27 or Fig. 6.39 with emphasis of thrust on each carpal bone);
- transverse thrust (V) of CMC1 (Fig. 6.58).

Manipulation consists of a high-velocity, small-amplitude thrust within the anatomical limit of the joint. It is the velocity and not the force which makes the difference to mobilization. The MCP needs a distraction of around 8.3 kg to produce the cracking noise known as cavitation. (Roston & Haines 1947).

Stabilization may be necessary after post-traumatic lesion or because of functional instability. By teaching exercises to the patient, dissociation is learned by reinforcing the deep and short layers (M. lumbricales, interossei) while mobilizing the long and superficial mobilizing muscles (long flexors, extensors, etc.). The patient should, for example, mobilize the fingers against increasing load by stabilizing the carpal and metacarpal bones in a neutral position and then more functionally by finishing in the symptomatic position. At first, stabilization can be supported by a splint or taping.

For real tendinopathy it is sometimes useful, in addition to progressive eccentric loading, to combine exercise with electrotherapy (laser, US, TENS) or ice.

And, if the nociceptive input remains dominant, it may be possible to modulate its intensity by just crossing the hands over the midline! (The analgesic effect of crossing the arms) (Gallace et al. 2011).

Case Study 6.1

Kind of disorder

This is a case example of Mrs I, a 56-year-old woman who, when asked, ‘What do you feel is your main problem at present?’ replied ‘I still cannot use my hand properly; it still hurts after my fall onto it.’

This case study highlights the key clinical features of wrist and hand disorders, a model for identifying movement impairments through detailed physical examination and the context of the use of mobilization or manipulation in the rehabilitation process.

Areas of symptoms

Figure 6.60 shows the use of a ‘real size’ body chart to detail the exact location of the patient’s wrist and hand pain and the referral pattern. Using a larger body chart also allows the therapist to hypothesize about the source of the symptoms in relation to anatomical structures.

Behaviour of symptoms (over a 24-hour period)

Mrs I explained that her main concern was not being able to use her hand properly during necessary daily activities such as holding door handles and pushing doors open. As a housewife she was also having great diffculty pegging her washing on the washing line, amongst other things. Mrs I was fed up because she could not complete her daily tasks and she was in a

Case study 6.1—cont'd

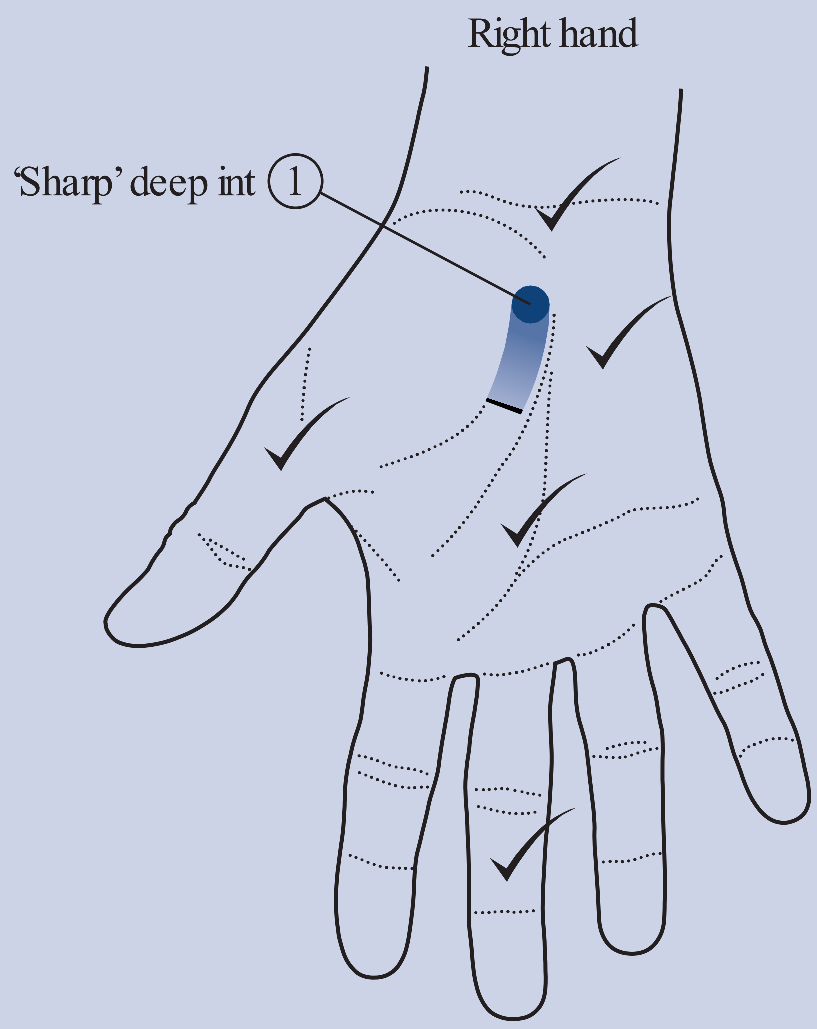

Figure 6.60 • Right hand: area of symptoms.

great deal of pain for a few hours after her attempts to carry out such activities.

However, she was happy that she could use her fngers normally. She experienced most of her symptoms during the day when she tried to use her hand. Her sleep had not been disturbed.

This suggests problems in the carpus, metacarpals or radioulnar region as the fngers were functioning normally. Both prehensile and non-prehensile functions have been impaired quite severely. The disorder also seems to be exhibiting a degree of irritability.

Present and past history of symptoms

Present history

The symptoms began six weeks prior to the date of the physiotherapeutic consultation. Mrs I had been shopping and tripped over a raised paving slab. She fell on her outstretched arm, was helped by passers-by who phoned for an ambulance, and she was taken to the local casualty department.

An X-ray revealed no Colles' fracture but the radiologist suspected a scaphoid fracture. The wrist was put in a cast for 10 days then re-X-rayed. No scaphoid fracture was seen. On having the cast removed Mrs I quickly started to feel the wrist pain again and it gradually became more severe over the next week or so as she tried to use her wrist. Because of this, the casualty offcer decided to re-cast the wrist for a further three weeks. Mrs I was comfortable in the cast. When it was removed in due course the wrist pain was bearable but became unbearable when she tried to use her hand.

Past history

Mrs I could not recall having problems with the wrist in the past but had suffered several bouts of 'spondylosis' in her neck. This was a bit stiff at present, which was nothing out of the ordinary.

Special questions

Mrs I revealed that she was generally in good health, with no recent weight loss. She had taken painkillers which helped a bit, but the wrist was still very painful. There was no family history of osteoporosis that she was aware of and the doctor had not suggested that she have a bone scan.

Overall, from the history, the suggestion is of a local soft tissue injury or bony injury of the wrist and carpus. There may be some contributory mechanisms related to her neck disorder. This may warrant further investigation.

Physical examination

General and specifc observation

On general observation it was clear that Mrs I was reluctant to use her right hand to its full capacity, as revealed when she removed her coat.

Locally there was evidence of swelling having been present around the carpus and wrist but no other abnormal features were evident.

Functional demonstration

Mrs I demonstrated that when she tried to grip a door knob or handle she was unable to do this without experiencing severe pain in the wrist. On analysis of the functional demonstration it was evident that wrist extension and forearm or wrist supination were the main movement components.

When the wrist was in its neutral position Mrs I could grip strongly and without pain, suggesting that the problem was in the wrist or carpus as suspected, rather than the fngers.

Brief appraisal

Active wrist extension on its own was limited to 40° by the wrist pain; active wrist flexion was limited to 70° by the wrist pain; forearm and wrist supination reproduced the wrist pain at 85°.

This clearly indicates that the wrist pain is reproduced most readily in wrist extension and supination.

Screening tests

The cervical spine, shoulder and elbow were screened. The elbow was cleared of any impairment. The shoulder was uncomfortable and stiff in the quadrant (peak)

Case study 6.1—cont'd

position and the cervical spine was stiff into right rotation, right lateral flexion and extension.

In view of the nature of the injury on the outstretched arm and the potential for impairment of the shoulder and neck to contribute to the disorder's recovery, it would be essential to include treatment of these regions as a necessary part of rehabilitation. However, this was done in conjunction with treatment of the wrist and hand and has not been included further in this case example. The neck, shoulder and hand components were treated separately.

Passive movements

The whole hand movement of extension to 40° reproduced Mrs I's wrist pain. Differentiation of wrist extension revealed that pain was reproduced with radiocarpal extension alone; extension of the midcarpal and carpometacarpal joints was much less painful. Supination of the forearm and hand to 85° reproduced the same wrist pain.

Differentiation testing revealed that when the radiocarpal and inferior radioulnar joints were supinated more (and less) in the painful position, the movements of the radiocarpal joint were much more (or less) painful than the radioulnar joint.

The conclusion to draw from this process is that the pain appeared to be related to mechanical stresses imposed on the radiocarpal joint, most likely the bones of the proximal row of the carpal bones.

Other general wrist and hand movements were relatively pain free. Further investigation of intercarpal movements revealed that the same wrist pain could be reproduced in the early part of the range of movement when the scaphoid was moved in an anteroposterior movement in relation to the lunate.

The designated mobilization technique therefore was a grade II anteroposterior intercarpal movement of the scaphoid on the lunate with the desired effects of reducing the movement-related pain, increasing the pain-free range of wrist extension and supination, and facilitating or complementing a home exercise programme designed to restore full function of the wrist and hand.

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7

Management of hip disorders

Di Addison

CHAPTER CONTENTS

Key words

Clinical orthopaedics and related research disorders, intra-articular disorders, periarticular disorders, one-component clinical orthopaedics disorder, multi-component movement disorder, functional disorder

Introduction

Symptoms in the hip region may be caused by *multi-structural and multi-functional factors*. A single pain may arise from different structures whereby associated functional factors (e.g. faulty movement patterns) may further contribute to the morphology, severity or chronicity of symptoms. Pathobiological processes also cause or influence symptoms. Hence optimal management of the patient's problem requires recognition of all causative components which are then weighted according to importance and accordingly treated. The clinical reasoning process utilized by the Maitland Concept provides a clinical tool to cope with this complexity.

Components of hip disorders

Structural sources

Local as well as distant structures capable of referring pain into the hip region are listed in Table 7.1. A knowledge of clinical patterns, differentiation tests and screening procedures will be necessary to distinguish between these structures.

Functional causes (contributing factors)

These may be divided into movement dysfunctions or overload.

1. *Movement dysfunctions*: According to Sahrmann (2002), faulty posture and dysfunctional movement patterns are not only the result of pain and pathology but may also cause these lesions. If the symptomatic structure alone is treated (with passive movement, for example) and the dysfunction or 'cause of the cause' (Maitland 1991) is disregarded, symptoms could well reoccur. In fact, in cases of minor instability or impingement, mobilizing gently in the direction of symptoms to decrease pain may meet with limited or short-lived success. If stronger mobilizing techniques progressing into pain are applied symptoms may suddenly increase. This is a clinical indication that

Table 7.1 Components of hip disorders: the symptomatic structure(s)

Structures	Local sources	Distant sources
Joint	Hip joint including the labrum, and ligamentum teres	Lumbar spine Sacroiliac joint Pubic symphysis Coccygeal joint
Muscle, tendon	Gluteal muscles Piriformis Gemellii Obturatorii iliacus and psoas Tensor fascia lata Rectus femoris Sartorius adductors Pelvic floor muscles	Trigger point activity in distant muscles: Quadratus lumborum External obliquus Iliocostalis lumborum Tensor fascia lata Piriformis Gluteal muscles
Fascia, bursae	Iliotibial tract Trochanteric bursa Ilioinguinal bursa Ischial bursa Pectineal bursa	Abdominal fascia (athlete's groin)
Neural structures	Ilioinguinal nerve (L1) Genitofemoral nerve(L12) Lateral femoral cutaneous nerve (L23) Femoral nerve (L2-L4) Obturator nerve (L2-L4) Sciatic nerve (L4-S1) Superior gluteal nerve (L4-S1)	Plexus lumbalis/lumbosacralis Spinal nerves/rami ventrali (L1-S3) Sympathetic trunk and ganglion
Viscera	Arteries (e.g. femoral) Lymph vessels	Aorta and iliac arteries (aneurysm) Deep vein thrombosis Abdominal and retroperitoneal pathology (hernia)

functional factors need be addressed. In Table 7.2 a number of disorders are listed where the functional cause assumes particular importance.

2. *Overload or overuse per se* may in time lead to degenerative change or stress fracture. If malalignment is also present then otherwise normal stresses may excessively load one part of the hip joint, the surrounding nerves or myofascial structures. Individuals working at heavy jobs (e.g. furniture movers) or individuals engaged in sports with poor technique or inadequate training procedures (e.g. running on hard surfaces) may subject their joints to overload. Similarly, nerve entrapments such as meralgia paraesthetica are reported to have contributing overload factors: obesity, the wearing of tight jeans and wide belts resulting in compression (Butler 1991).

Pathobiological disorders

A range of pathobiological disorders may contribute to movement disorders of the hip (Table 7.3). These disorders may be categorized as:

- Systemic disorders with spontaneous development of acute symptoms. Here medical care is important.
- Developmental and structural disorders: both dysplasia and Perthes' disease may contribute to structural change and the development of femoroacetabular impingement (Fraitzl et al. 2007, Rab 1999, Friend & Kelly 2009, Li & Ganz 2003), which in turn is said to be implicated in the development of degenerative osteoarthritis (Ganz et al. 2003, Beck et al. 2005, Bardakos & Villar 2009). Where structural change is present, surgery may be the priority for treatment.

Table 7.2 Components of hip disorders: functional causes

Functional cause	Disorder
Hypermobility dysfunctions	**Global muscle imbalance**
Functional anterior or anteromedial impingement	Groin pain associated with hypermobile flexion or combined flexion-adduction movements (the high kicks of ballet and martial arts) resulting from a lack of deceleration force from antagonistic muscles such as the deep gluteus maximus or posterior gluteus medius (global stabilizers)
Functional posterior impingement	Buttock pain associated with hypermobile extension/abduction/external rotation movements due to impingement of the posterior labrum and posterior soft tissues. The superior gluteus maximus (global mobilizer) is overactive; the iliacus and the short adductors (global stabilizers) are inhibited
Iliotibial tractitis and/or trochanteric bursitis in flexion	Discomfort or stretching/burning pain in the superior gluteus maximus muscle or it's fascia (lateral hip) with restriction of flexion or combined flexion-adduction activities. Superficial gluteus maximus is overactive or shortened. Confined sitting will produce unavoidable stretch in the muscle if the patient is unable to flex the lumbar spine (lack of knee room) or abduct the hips. Deep turns during skiing and lying on the affected side (compression of soft tissue) or non-affected side (stretching) may also irritate this condition
Iliotibial tractitis and/or trochanteric bursitis in extension	Lateral hip pain associated with repeated extension/rotation activities such as jogging. It results from an overactive tensor fascia lata (global mobilizer) pulling the iliotibial tract forwards over the trochanter. The posterior gluteus medius (global stabilizer) is inhibited. It may be aggravated by lying on the affected or non-affected side
Entrapment of the lateral femoral cutaneous and inguinal nerves	Lateral thigh or groin pain on sustained excessive flexion particularly in obese individuals or those with wide hips, may cause nerve compression and irritation
Athlete's groin	Pain may be widespread over the pubic symphysis, groin, medial thigh and sacroiliac joint or restricted to the falx region adjacent unilaterally to the pubic symphysis. Global stability dysfunction in the pelvic ring as a whole is often involved, associated with inadequate fascial covering in the falx region of the lower abdomen. Pain may be aggravated by forceful rotation movements, stop–go activities or forceful sit-ups
Ischial bursitis/bicipital tendinosus, bursitis, muscle tears (especially in the adductors, psoas and biceps femoris muscles and their associated bursae)	Local pain in the affected structures often associated with pelvic stability dysfunction in the presence of overactive hip muscles seeking to provide stability, particularly during forceful stop-go activities
Restrictive dysfunctions	
Degenerative osteoarthritis	Groin pain or generalized pain associated with weight-bearing (joint surface compression) and end-of-range activities (capsular tightness). Hence restrictions may be present in deep sitting, sitting with crossed legs and getting in and out of a car. In particular, multiple movement directions may be restricted rather than single directions
Excessive intra-joint gliding (minor instabilities)	**Local muscle imbalance**
	Inhibition of tonic activity in psoas, the gemelli and the obturatorii as a unit

Table 7.2 Components of hip disorders: functional causes—cont'd	
Functional cause	**Disorder**
Hypermobility dysfunctions	**Global muscle imbalance**
Anterior gliding dysfunction	Often unspecific or sometimes sharp groin pain due to generalized synovitis or stretch / impingement of anterior structures. Joint blocking may occur if the femoral head remains in an anterior position so that normal coupling of posterior gliding with physiological flexion cannot take place. Open-chain flexion movements (e.g. during stair climbing) may result in labral, chondral and other soft tissue irritation, including iliopsoas tendinopathy. Inhibition of psoas (local stabilizer responsible for tightening the capsule and hence preventing it's impingement) is one of the features of this dysfunction. During open and closed chain extension activities anterior structures will also be stressed. The patient may also avoid trunk movements involving hip lateral rotation in standing
Posterior gliding dysfunction	Buttock pain due to excessive posterior gliding within the joint. Flexion or flexion/adduction movements may be limited due to reactive inhibition and apprehension (fear of posterior subluxation). The patient may avoid sitting or squatting or sit on one buttock with the affected hip in extension over the side of the seat. Standing and lying supine with the affected hip in slight abduction and lateral rotation are preferred positions. It occurs often in association with trauma, e.g. dashboard injury or landing on a hard surface by long-jump
Lateral gliding dysfunction	Generalized pain or lateral pain standing on one leg with adducted (hanging) hip or when lying on the non-affected side. Tonic activity in psoas, gemelli and obturatorii as a unit is lacking. This condition may be found in combination with hip dysplasia

Table 7.3 Components of hip disorders: pathobiological processes	
Systemic disorders	Septic arthritis Rheumatoid arthritis Acute osteoporosis Paget's disease Osteonecrosis Juvenile chronic polyarthritis Ankylosing spondylitis Crohn's disease
Developmental disease and structural disorders	Perthes' disease Congenital dysplasia Slipped femoral epiphysis Structural femoroacetabular impingement (FAI) Structural posterior impingement Note: structural FAI is caused by bony exostoses on the acetabulum or femoral neck (pincer or cam impingement respectively). Here groin pain is associated with restricted flexion activities such as deep sitting, reaching forward in sitting, bending and squatting. Forced or powerful flexion causes pain (Macfarlane & Haddad., 2010). Note: structural posterior impingement. Here groin pain is associated with hypomobile extension/abduction/external rotation movements due to impingement of the anterior labrum and cartilage. This is due to a contra-coup levering of the femoral head forwards in the presence of a posteriorly blocked cam impingement. Posterior hip pain is also expected
Vascular disease	Femoral head necrosis
Traumatic lesions	Fractures of the femoral head, neck, acetabulum and labrum Subluxation Dislocation Contusions Femoral or inguinal hernia

- Traumatic disorders where tissue healing times will affect dosage and progression of treatment.

Utilizing the principles of the Maitland Concept, the therapist can decide which components of the problem deserve priority and which combinations of treatment measures are indicated.

Applied theory

Integration of structural and functional disorders

In order to organize and prioritize treatment the model in Figure 7.1 developed by the author may be useful. In this model, major categories of dysfunction are shown. These are determined by examining the amount of movement taking place in the symptomatic joint in the main symptomatic direction. For example, the hip or a structure primarily related to hip movement produces symptoms on sitting, squatting or stair climbing. These flexion activities as well as isolated hip flexion would be assessed to determine whether or not the amount of movement is excessive or restricted according to generously standardized expected ranges of movement.

1. + *Movement dysfunction* would indicate that the symptomatic movement is excessive or uncontrolled. This dysfunction may be subdivided into excessive physiological (or angular) movement and excessive accessory (or gliding) movement.
   - + *Physiological movement dysfunction.* Here the physiological movement is uncontrolled allowing increased end-of-range movement (hypermobility). Excessive physiological movement is generally readily observable. If

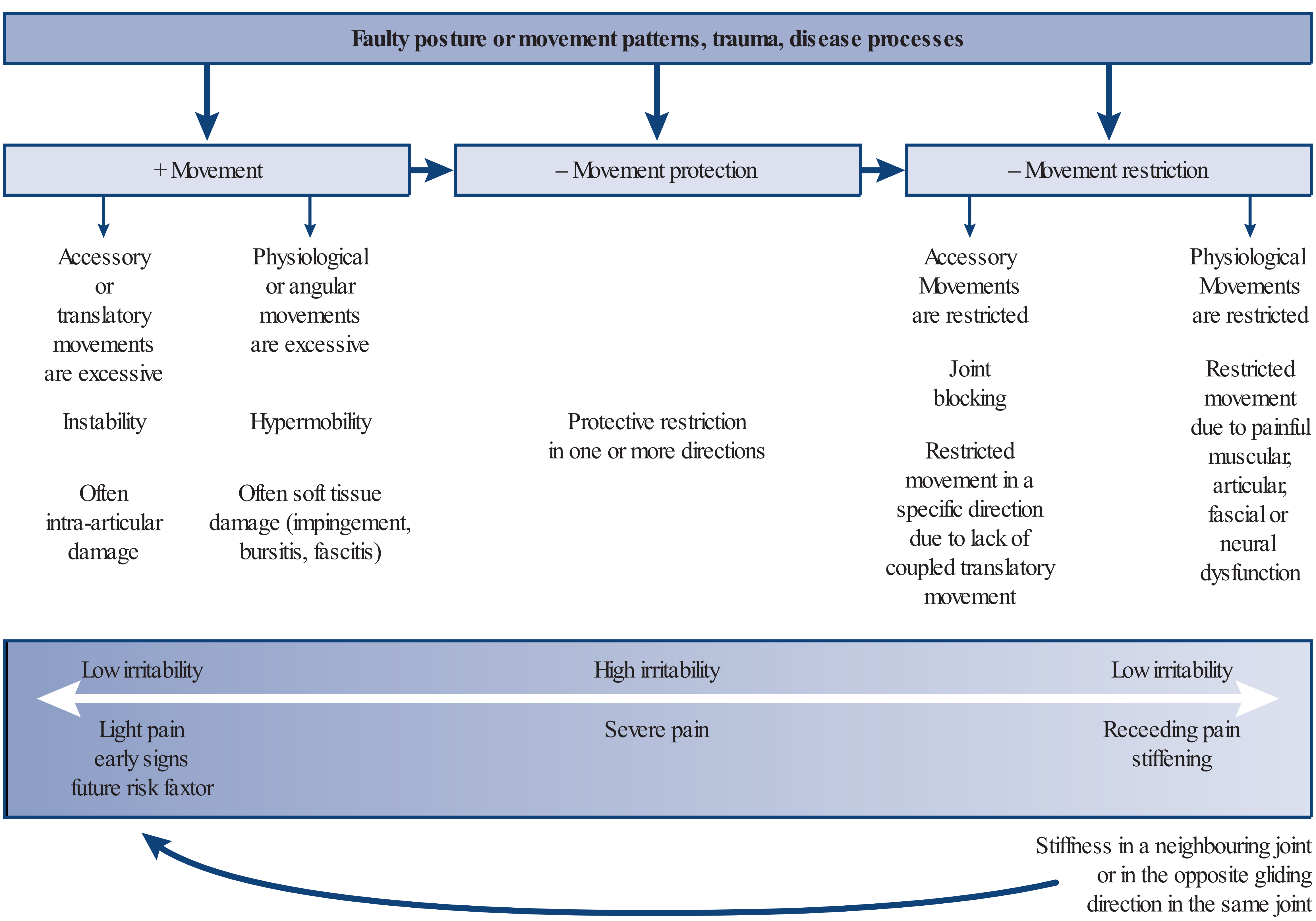

Figure 7.1 • Integration of structural and functional disorders. Reproduced with permission from Addison (2002).

neighbouring joints in the movement chain are also hypermobile, the hip may not become symptomatic as forces would be shared along the chain. However, if the neighbouring lumbar, sacroiliac and knee joints are stiff then repeated bending movements or forceful hip flexion movements during sport may traumatize the hip leading, for example, to impingement of anterior soft tissues including the labrum. According to Martin et al. (2006), labral tears have been arthroscopically identified – although not in isolation – in 90% of mechanical hip pain. A number of authors link labral damage to the development of capsular laxity and vice versa (Schenker et al. 2005, Martin et al. 2006), suggesting that better end-range control of this movement may help reduce symptoms as well as recurrences. Other dysfunctions linked to excessive physiological movement have been listed in Table 7.2.

- + *Accessory movement dysfunction.* Here the translatory or gliding movement is uncontrolled resulting in a variable and undependable centre of rotation. This will also affect physiological movement and may be experienced as a lack of 'through' range movement control; for example, if the patient attempts to stand on one leg with his hip joint in the 'physiological' neutral position (neutral flexion/extension, abduction/adduction, medial rotation [MR] and lateral rotation [LR]), the hip 'jerks' or 'wobbles' and cannot remain still. These joints may not necessarily exhibit increased end-of-range movement but the 'neutral zone' has been shown to be increased (Panjabi 1992) with subsequent loss of a reliable 'translational neutral position' (midposition of three-dimensional translation movements). This may be referred to as 'stability dysfunction'. In addition, excessive gliding may be associated with increased end-of-range movement in the normally coupled physiological direction. A certain amount of posterior gliding is coupled with hip flexion. If this gliding is excessive the flexion movement may also seem excessive. In fact, the actual angular movement in the joint may be restricted but the disturbed gliding produces a hinge-like gapping movement and a seemingly increased flexion. Alternatively, the condition may elicit protective reactions in the effected direction resulting in decreased range of movement. However, in both situations the increased shearing movements are detrimental to the cartilage as well as irritating to the synovium and are thought to contribute to joint effusion and, in time, osteoarthritis. These joints are classed as 'unstable'.

2. – *Movement dysfunction due to protective reactions.* In order to be placed in this category the condition must be 'irritable' according to the Maitland Concept definition. In this case, the protective reactions in a single or multiple direction are considered initially necessary. Whether the symptoms are due to acute trauma, to overuse or abuse of the joint, correction of the symptomatic movement would be detrimental at this stage. Once the irritability factor has been reduced, the condition may be reclassified into one of the other categories.
3. – *Movement dysfunction due to restriction.* This dysfunction may be subdivided into restricted physiological (or angular) movement or restricted accessory (or gliding) movement.
   - – *Physiological movement dysfunction.* If specific ranges of movement are not used, adaptive restriction may occur in time. Disuse may result from habitual patterns or protective reactions. Habitual patterns may be due to restricted movement in non-symptomatic neighbouring joints (see the arrow in Figure 7.1). In the case of pathological disorder (e.g. ankylosing spondylosis), protective reactions may be appropriate and some movement restriction unavoidable. In other cases, a restrictive pattern may remain because the patient failed to fully use the joint although the disorder was no longer irritable.
   - – *Accessory movement dysfunction – the blocked joint.* If gliding movement (e.g. anterior glide) is excessive in one direction it may in time become restricted in the opposite direction (posterior glide) (see the curve in Figure 7.1). Since hip flexion is coupled with posterior glide, the flexion may become restricted. Patients often

describe a bursting feeling at end of range.

Muscle classification and associated muscle imbalance

Muscle classification

Muscles may be generally classified into local stabilizers, global stabilizers and global mobilizers according largely to their biomechanical characteristics (see Table 7.4 and Box 7.1). The classification of lumbar and hip muscles is shown in Box 7.2.

Table 7.4 Biomechanical characteristics of global stabilizers and global mobilizers

Global stabilizers	Global mobilizers
One joint	Two-joint or multi-joint
Deep	Superficial
Direction of pull produces joint compression	Direction of pull: movement-orientated
Muscle length: long	Muscle length: long
Force vector + force lever optimal for joint compression (minimal muscle mass or muscle strength necessary)	Force vector + force lever optimal for large range of movement, speed, acceleration and joint distraction (large muscle mass/muscle force necessary)
Muscle fibres are broad and take an oblique course (shock-absorbing)	Muscle fibres take a linear course (strength is maximally directed)
Control of rotation – especially decelerating	Produce strong flexion/ extension (largely aligned in the sagittal plane)
Control of physiological movement in a particular peripheral joint (responsible for selective movement) or the form of the curve in a vertebral section	Produces movement along the length of the movement chain and is therefore relatively non-selective

(Comerford & Mottram 2001)

Muscle imbalance and associated dysfunction

Muscle imbalance and associated dysfunctions are illustrated in Figure 7.2. From this it may be postulated that pain due to excessive gliding movements in the hip (irrespective of whether physiological movements are hypermobile or restricted) will require better recruitment of the local stabilizers as treatment. For selective physiological movement in a joint it is important that the global stabilizers work efficiently. If physiological hip movement is excessive due to inhibition of the global stabilizers with multi-joint global mobilizers dominating, then the hip – relative to other joints above and below along the movement chain – will move excessively. Hence hypermobility disorders require global stabilizer recruitment/shortening and mobilizer inhibition/ lengthening.

By irritable disorders the local stabilizers may be tonically inhibited (see 'Motor Control' below). Here it is necessary that the capsule can expand to cope with excessive intra-articular swelling. Co-contraction or protection provided by the global muscles will ensure that the joint is temporarily spared. However, the joint will receive little proprioceptive input making it more difficult to recruit the local stabilizers particularly if this situation is maintained once pain and swelling have subsided.

Box 7.1

Biomechanical characteristics of local stabilizers

- One joint (segmental)
- Deepest muscle layer – often with connections to the joint capsule
- Muscle length: very short (Mcgill & Norman 1993, Mcgill 1991)
- Direction of pull: muscle fibres don't run in the direction of primary joint movement:
  - very little shortening
- Poor leverage: designed for compression and translational control
  - little muscle mass essential
- Work constantly – independent of the movement direction

Adapted from Richardson et al. 1995.

Box 7.2

Classification of lumbar and hip muscles

Global stabilizers

M. obliquus internus and externus
M. multifidus (superficial fibres)
M. spinales
M. quadratus lumborum (lateral fibres)
M. iliacus
M. adductor brevis
M. pectineus
M. adductor. magnus
M.gluteus medius + minimus
M. gluteus maximus.(deep fibres)
M. quadratus femoris

Global mobilizers

M. rectus abdominis
M. longissimus
M. iliocostalis
M. quadratus lumborum (medial fibres)
M. tensor fascia lata
M. rectus femoris
M. sartorius
M. gracilis
M. piriformis
M. gluteus maximus.(superficial fibres)
Hamstrings

Local stabilizers

M. transversus abdominis
M. multifidus (deep fibres)
M. intertransversarii
M. interspinales
M. rotatores
M. psoas
M. obturatorius internus + externus
M. gemellus superior + inferior

Adapted from Bergmark (1989), Sahrmann(2002), Richardson et al. (1995), Comerford & Mottram (2001).

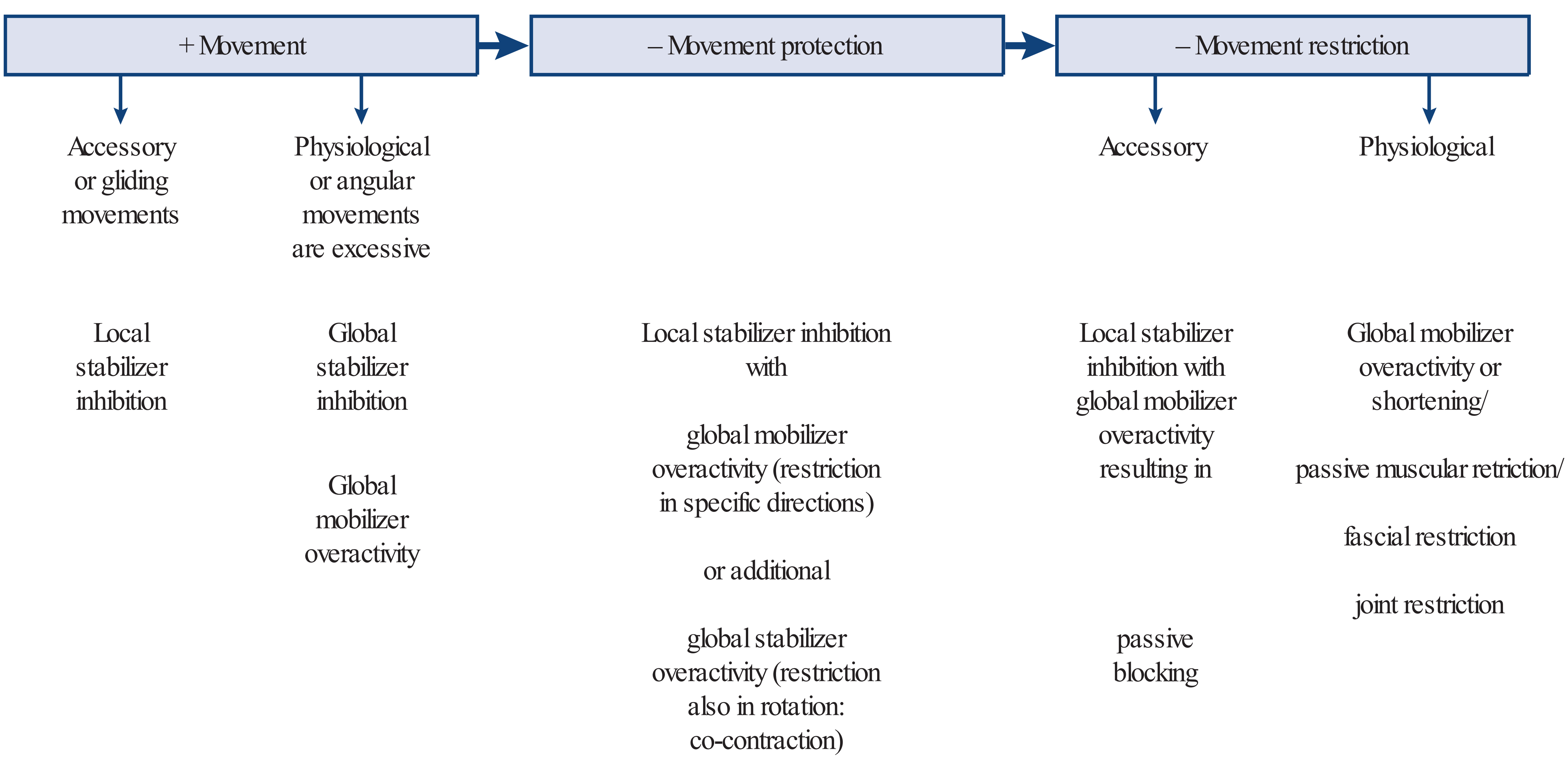

Figure 7.2 • Muscle imbalance and associated dysfunctions. Reproduced with permission from Addison (2002).

Furthermore, if this strategy is maintained longer than necessary adaptive change may produce shortening of muscle (reactive and passive), joint capsules and fascia resulting in restricted physiological movement.

Excessive gliding movements in one direction may in time become fixed in this particular direction. If local tissues (nerves and blood vessels) adapt to this new position then gliding in the excessive direction may no longer produce symptoms. The restricted gliding may then be responsible for symptoms: coupled physiological movement may be blocked producing symptoms of stiffness or 'bursting' at end of range.

Motor control

For adequate motor control the appropriate muscle fibre type should be recruited. All human muscles contain tonic and phasic muscle fibres. Characteristics of these muscle fibres are shown in Figure 7.3.

For low-level activity (activities requiring approximately 25% of a maximal voluntary contraction) selective recruitment of only the tonic fibres is necessary for stability. For high-level activity maximal tonic recruitment together with phasic fibre recruitment is essential. Most activities in daily life require only tonic fibre recruitment. If the phasic fibres alone are recruited both low- and high-level activities will seem strenuous.

In some individuals levels of tonic recruitment are poor. This may be related in part to an inactive lifestyle: proprioceptive input (increased through movement and the interaction with gravity in particular) helps recruitment of tonic fibres. This lack of tone is often seen in the global stabilizers. The global mobilizers must then attempt to provide stability as the last line of defence. However, this will be largely inadequate as their levers are unsuitable requiring an uneconomical use of phasic muscle fibre recruitment.

The presence of pathology also inhibits tonic fibre activity in the local stabilizers and interferes with timing of their contraction. Pain or swelling have been shown to delay their activity (Stokes & Young 1984).

This has consequences for treatment: if low-level activities are symptomatic, then tonic fibre activity should be recruited. Strength training may be inappropriate. Symptomatic high-level activities will require phasic as well as tonic fibre recruitment, i.e strength training.

Treatment principles

For detailed information on the selection and progression of treatment techniques with passive mobilization see Chapter 1 of Hengeveld and Banks (2014).

The following suggestions summarized in Figure 7.4 integrate functional factors.

- If the disorder is irritable or severe and the pain mechanism is nociceptive, gentle passive accessory movement (particularly distraction and rotation techniques) may be used for pain modulation and to help in dispersing swelling. Protective deformities may temporarily be advantageous. Medication and rest – including the use of walking aids – may be necessary.

Characteristics	Tonic Muscle Fibres	Phasic Muscle Fibres Type IIa	Phasic Muscle Fibres Type IIb
Metabolism	Oxidative	Oxidative-glycogenic	Glycogenic
Force	Small	Medium	Large
Fatigue	Slow	Delayed	Fast
Speed	Slow	Medium	Fast

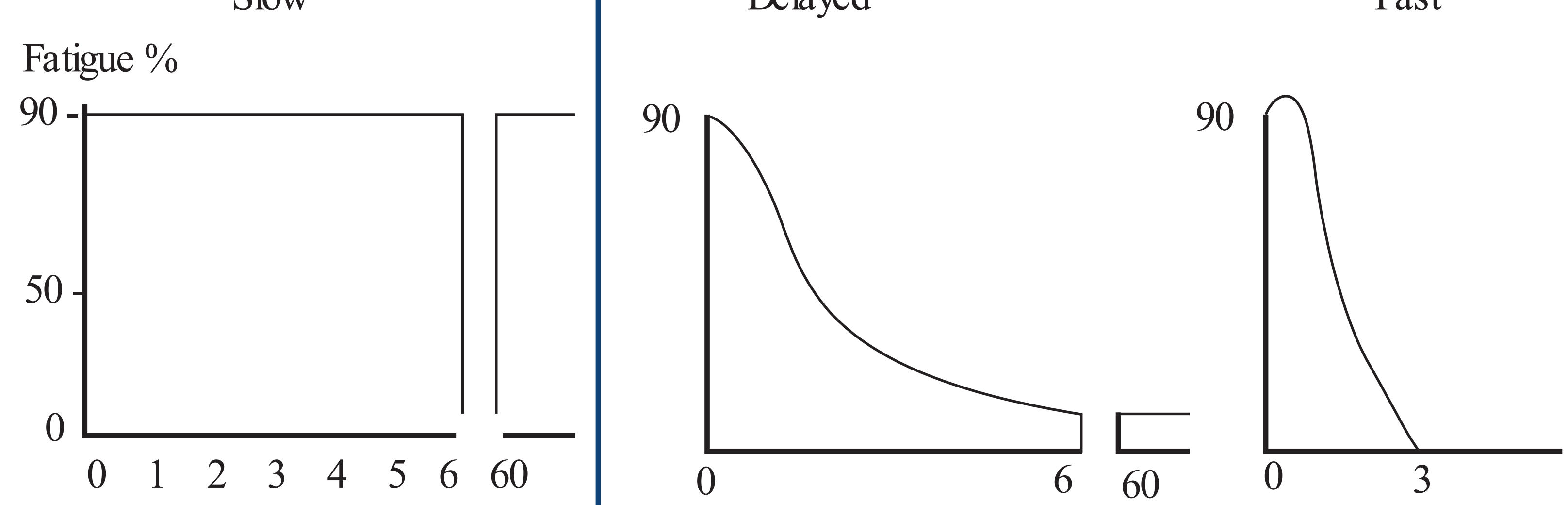

Figure 7.3 • Muscle fibre characteristics. After van den Berg 1999.

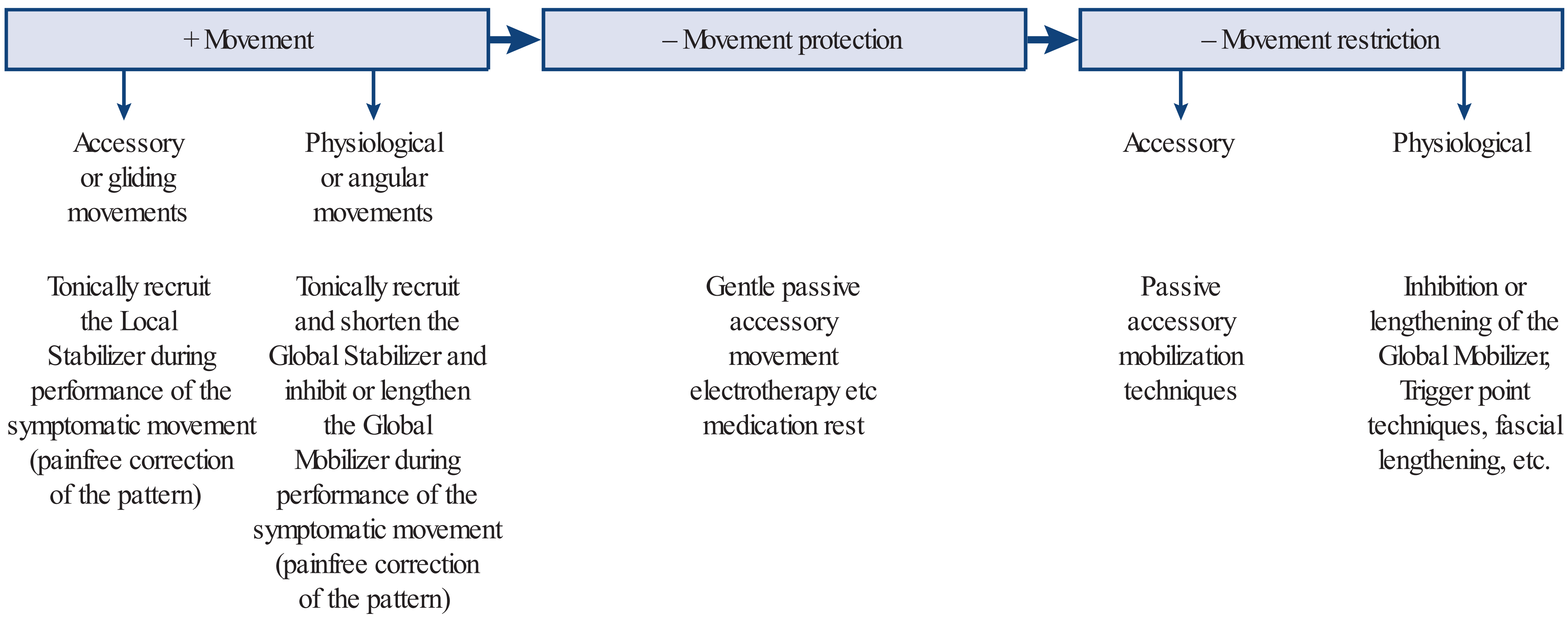

Figure 7.4 • Integrated treatment principles. Reproduced with permission from Addison (2002).

- If the disorder is not irritable or severe, the following guidelines may help determine treatment priorities:
  - Where *excessive physiological movement* (hypermobility) is found in the symptomatic direction active stabilizing exercise may be the treatment of choice (e.g. better end-range control of lateral rotation for specific labral lesions, or athlete's groin). If pain occurs during low-level activity, correcting the movement pattern by tonically recruiting and shortening the global stabilizer and inhibiting overactivity in the global mobilizer will help achieve a pain-free movement pattern. For excessive lateral hip rotation, for example, recruiting the anterior gluteus medius and minimus and the short adductors while inhibiting the piriformis and superior gluteus maximus may achieve this aim.
  - If the hip is compensating with excessive movement for restriction in neighbouring joints these joints can be mobilized at some stage (e.g. excessive hip external rotation during a golf swing may compensate for lumbar spine or knee rotational restrictions).
  - Where *excessive gliding movement* (minor instability) contributes to dysfunction in the symptomatic direction, pain-free tonic recruitment of the segmental stabilizers while maintaining normally painful positions and performing normally painful activities may help restrain excessive gliding. Similarly, passive accessory mobilization in the opposite direction to pain may be necessary if this direction has become stiff.
  - Where *restriction in the coupled gliding direction* is found to block the physiological movement, passive accessory joint mobilization, may be the treatment of choice. Because gliding and physiological movements are coupled (Matles 1975, Simoneau G, Hoenig K Lepley J et al 1998 cited in Sims (2003), mobilizing an accessory movement such as posteroanterior glide may restore extension movement. Sims (2003) states that the migratory 'up and out' presentation of osteoarthrosis may lack longitudinal caudal motion whereas the medial migratory presentations may lack lateral gliding motion.
  - *Restriction in physiological movement* may be helped by a combination of muscle lengthening, trigger-point techniques or fascial techniques, etc.

In restricted joints where compressive force is related to symptom production the use of compression may at some stage be incorporated into treatment. Maitland (1991) suggests that mobilizations with compression may stimulate synovial fluid flow and improve cartilage nutrition, which may be important in the early stages of osteoarthrosis. The peripheral anterior surface of the femoral head is a common site of cartilage lesions (Bullough et al. 1973 cited in Sims 2003). Sims (2003) states that this area will contact in internal rotation and adduction and suggests that this may explain the beneficial effects of the hip flexion–adduction technique.

Where symptoms in the symptomatic direction are related to neural dysfunction, neural techniques may be appropriately incorporated into the treatment (for example, the femoral nerve test in prone knee bend).

Evidence supporting practice

Patients with osteoarthritis are the most commonly referred single group for physiotherapy. Table 7.5 lists evidence-based recommendations for treatment.

In the case of soft tissue injury (including labral injury), there is growing interest in the effects of neuromuscular training as opposed to stretching or strengthening training. Labral tears, for example, have been related to forceful external rotation particularly in sports and activities such as golf, soccer and dancing. According to Martin et al. (2006), labral tears have been arthroscopically identified – although not in isolation – in 90% of mechanical hip pain cases. A number of authors link labral damage to the development of capsular laxity and vice versa (Schenker et al. 2005, Martin et al. 2006), suggesting that better end-range control of this movement may help reduce symptoms as well as recurrences. Some evidence largely from case reports is listed in Table 7.6 to support neuromuscular training and movement re-education (particularly the activation of the appropriate global stabilizers) for various hypermobility dysfunctions.

Subjective examination

In the subjective examination, 'making features fit' (Maitland 1991) is important: a given hypothesis

Table 7.5 Evidenced-based interventions for osteoarthritis

Interventions	Result	Comments	Reference
Hip-strengthening exercises	Beneficial effect in reducing pain and improving function	Meta-analysis of nine studies	Hernández-Molina et al. 2008
Hip-strengthening exercises	Long-term effectiveness in reducing pain, improved self-reported and observed physical function	Systematic review: moderate evidence; results for hip and knee osteoarthritis combined	Pisters et al. 2007
Manual therapy, strengthening and mobilizing exercises	Reduction in pain, increase in passive range of movement, clinically meaningful improvement in function	Case series of seven patients	MacDonald et al. 2006
Exercise programme versus conventional medical treatment	Small positive clinical effect measured by the Harris hip pain scale' 'up and go' test and walking test	Moderate-quality RCT	Tak et al. 2005
Combination of passive mobilization and exercises versus exercises alone	Manual therapy and exercise (flexibility, strengthening and aerobic exercise) combination resulted in better outcomes regarding pain and functional activity	Moderate-quality RCT, high drop-out rate	Hoeksma et al. 2004
Exercises versus standard medical education	Exercise (flexibility, strengthening and aerobic exercise) resulted in better outcomes regarding pain and functional activity	Moderate-quality RCT	van Baar et al. 1998
Aquatic therapy versus standard medical education	Aquatic therapy proved superior in reducing WOMAC pain scores, and improving WOMAC physical function at 12 weeks; small benefit at 12 months; no significant effect at 18 months	Good-quality single blinded RCT; results for hip and knee osteoarthritis combined	Cochrane et al. 2005

Table 7.5 Evidenced-based interventions for osteoarthritis—cont'd

Interventions	Result	Comments	Reference
Aquatic therapy versus a waiting control group	Aquatic therapy improved visual analogue pain score on movement and WOMAC pain scores, stiffness function and physical function at six weeks; sustained at 12 weeks	Moderate-quality single blinded RCT; results for hip and knee osteoarthritis combined	Hinman et al. 2007
Aquatic therapy versus tai chi versus a waiting control group	Aquatic therapy and tai chi improved WOMAC function scores; aquatic therapy alone reduced WOMAC pain scores	Moderate-quality RCT; results for hip and knee osteoarthritis combined	Fransen et al. 2007
Cane in the contralateral hand	Reduction in hip pain and improvement in function	RCT	Neumann 1989

RCT = randomized control trial, WOMAC = Western Ontario and McMaster Universities Arthritis Index
(Royal Australian College of General Practitioners (2009), Cibulka (2009), Zhang et al. (2008))

Table 7.6 Evidence-based interventions for hypermobility syndromes

Disorder	Treatment	Study design	Results/comments	Reference
Piriformis syndrome	Hip-strengthening exercises and movement re-education	Case report	Pain free Lower extremity function scale questionnaire Score from 65/80 to 80/80 Improved kinematics during step-down test	Tonley et al. 2010
Hamstrings injury	Gluteus maximus strengthening and neuromuscular training	Case report	Eliminated exercise-associated cramping Improved hip extensor strengthDecreased activity of hamstrings during terminal swing	Wagner et al. 2010
Hamstrings injury	Progressive agility and trunk stability (neuromuscular control exercises) versus progressive stretching and strengthening	Prospective randomized comparison of two rehabilitation programmes	A progressive agility and trunk stabilization exercise programme is more effective than a programme emphasizing isolated hamstring stretching and strengthening in preventing injury recurrence during the first year of return to sports	Sherry & Best 2004
Athletic groin injury	Strengthening adductors and abdominal muscles versus passive local applications	High-quality RCT	At seven months: Active group: 79% return to sport without residual symptoms Passive group: 14%	Hölmich et al. 1999
Athletic groin injury	Compressive shorts	Retrospective controlled trial	Improved subjective pain scores; no improvement in functional performance	McKim and Taunton 2001

Table 7.6 Evidence-based interventions for hypermobility syndromes—cont'd

Disorder	Treatment	Study design	Results/comments	Reference
Athletic groin injury	Combination of passive joint mobilization and active exercise	Case series No control group	Directly following treatment: Return to sport without symptoms 77% Long-term results: moderately high risk of recurrence	Jansen et al. 2008
Athletic groin injury	Strengthening adductors and abdominal muscles versus controls	Good-quality RCT	Some positive short-term effects; No significant long-term effects	Ekstrand & Ringborg 2001
Osteitis pubis	Local passive therapy (electrostimulation, ultrasound, cryomassage) and progressive physical loading	Poor-quality case report	Symptom free after 10 weeks	Rodriguez et al. 2001
Athletic groin pain	Rest, trunk stabilization exercises and graded return to sport	Case series	At five mths: 63% return to sport (41% without symptoms) At two years: 74% unchanged	Verrall et al. 2007

RCT = randomized control trial

should take on form from different pieces of information in the subjective examination and confirmation should be sought in the physical examination.

Main problem ('Question 1')

Understanding the main problem from the patient's point of view allows the focus of assessment and treatment to be effectively directed. Initially, the kind of disorder being presented is established:

1. Patients may present with the main problem being *pain* which significantly limits daily life activities. This gives some indication of the severity or irritability of the disorder. However, perceived pain should bear some relation to perceived disability – high reports of pain coupled with only limited disability may represent a psychosocial risk factor hindering recovery to full function. Similarly low pain reports may be linked to considerable disability. In fact, where patients have learned to live with their pain by restricting activity, the irritability factor may be underestimated. Such patients may have some pain or discomfort after walking, gardening or driving a car, but if they prolong the activity, they may suffer acute exacerbation
2. Patients may report limitations in daily activities due to large *restrictions of range of motion* with associated pain being less of a problem. Soames (2003) lists the required range of movement for specific activities as follows:
   - Walking on level surfaces: 30° flexion, 10° extension, 5° abduction, 5° adduction, 5° medial rotation, 5° lateral rotation
   - Ascending stairs: 65° flexion, 5° extension
   - Descending stairs: 65° flexion, 5° extension
   - Sitting: 90° flexion
   - Tying shoelaces: 50° flexion.

Magee (2008) gives differing measures. This can be due to a number of factors such as stair and sitting heights and according to the degree of compensation allowed in surrounding joints. For example, tying shoes requires 50° flexion (Soames 2003) but 120° flexion according to Magee. It would be expected that Soames' patients are compensating to a greater extent in neighbouring joints. However, this increased load on surrounding structures may injure them. In fact, the whole lower quadrant movement system is at risk of becoming symptomatic if further impairment of joint mobility occurs.

Focusing on what is important for the patient can be expedient: in assessing movement, many dysfunctions will inevitably be found with some having no connection to the present problem. However, an efficient exercise programme should be streamlined to correct the dysfunctions which are relevant. For example, if sitting and squatting are the main problem, flexion should be assessed in detail for painful restrictions or for painful excessive uncontrolled movement (particularly in relation to other joints in the movement chain). The quality of associated accessory movements during flexion may also be relevant. Correction of the restricted or excessive flexion movement pattern during sitting or squatting activities may thus be the aim of treatment with a specific selection of passive movement techniques, exercise, etc. used to achieve this aim.

Areas of symptoms (body chart)

Typical pain patterns and associated hip dysfunctions are delineated in Figure 7.5. The 'C' sign – demonstrating the area of pain by holding around the hip with fingers anteriorly and thumb posteriorly – is thought to be indicative of intra-articular pathology,

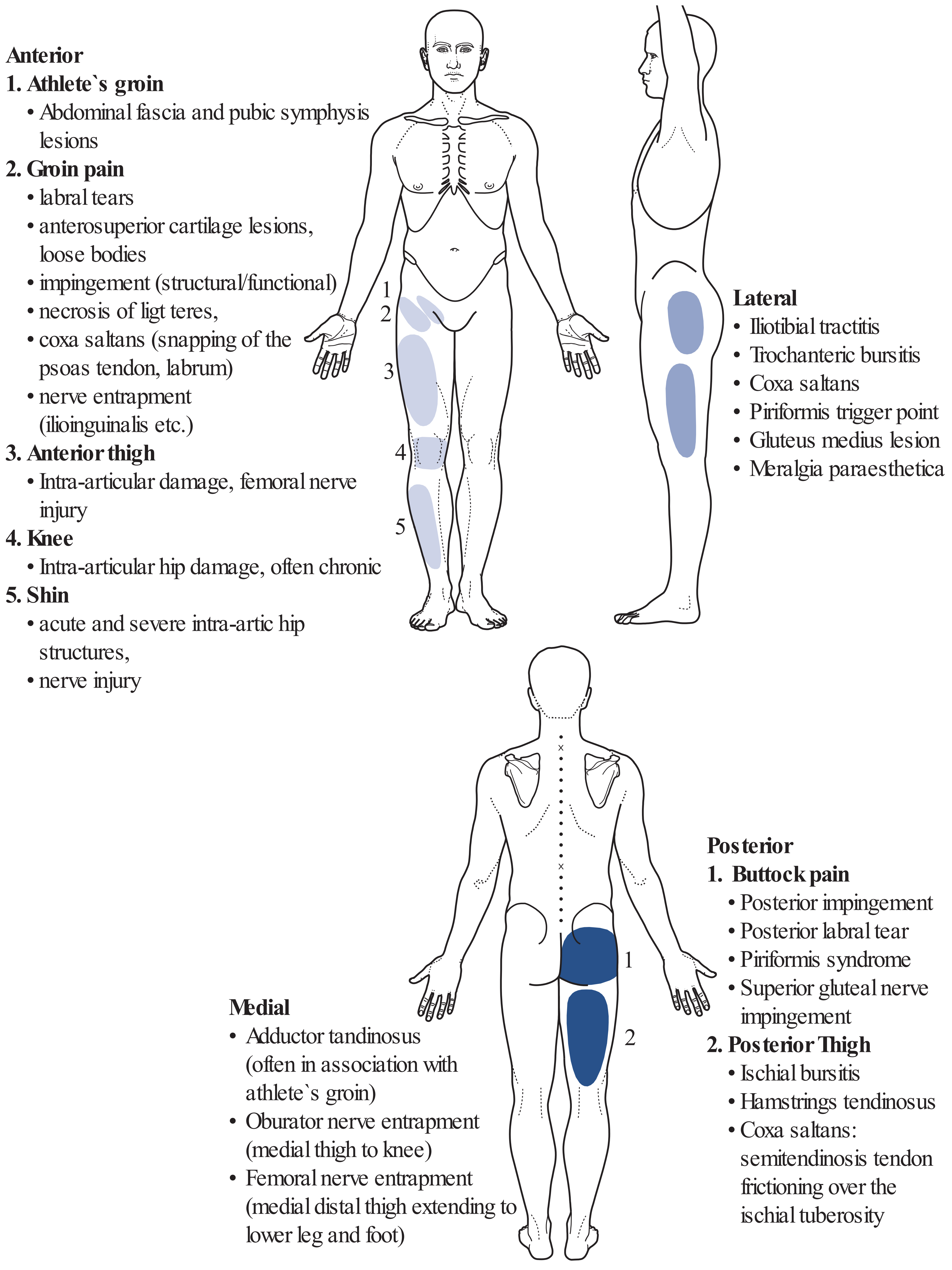

Figure 7.5 • Symptom areas associated with hip movement disorders.

for example, arthritis, cartilage and labral damage, necrosis of ligamentum teres, etc. (Magee 2008). In particular, pain due to degenerative arthritis is often dull deep and aching frequently referring vaguely to the anterior thigh and/or knee (Wroblewski 1978, Poppert & Kullig 2011). Lesions in the anterior superior labrum-cartilage zone are likely to be confined to the groin and to be sudden, sharp and stabbing on weight bearing (Liebold et al. 2010). If radiating tingling or burning pain is present, nerve entrapment should be considered while inflamed fascia (iliotibial tract) may also produce burning pain or a 'numb feeling' without true numbness being present. Painful snapping and weakness should also be noted.

Importantly, other sources such as the sacroiliac joint, lumbar spine, the neurodynamic system and, at times, the thoracic spine may refer symptoms in the same or similar body areas. Pain in the buttock with or without posterolateral thigh referral is typical for L4 nerve root lesions or disc problems. Moreover, physiotherapists working in direct contact should consider possible visceral or vascular sources of the symptoms which may require the attention of a medical practitioner.

Behaviour of symptoms

Here information can be sought regarding irritability of the disorder, clinical patterns and tests providing parameters for reassessment.

Clinical patterns may be related to:

1. Disorders:
   - according to Maitland et al. (2001), an intra-articular disorder with a degree of inflammation might be suspected if symptoms are more constant in their behaviour, are perceived as deeply localized and more restricting in daily life activities and if regular changes in resting positions are needed. Systemic inflammatory disease such as rheumatoid arthritis may occur more spontaneously and episodically with morning pain and stiffness lasting longer than an hour. Concomitant multi-joint involvement is a feature.
2. Structures:
   - labral tears: here forceful rotation is often involved and may be accompanied by a clicking sensation in the groin.
   - Tendinopathies and muscle lesions: pain is clearly pinpointed by the patient and reproduced on stretching or contracting the muscle or during stop-and-go activities (Agre 1985).
   - Joint surface of the hip: reproduction of symptoms occurs during weight-bearing activities, particularly sustained standing. Sudden loading of the joint surface, for example, when moving out of sustained positions such as sitting may also produce symptoms (Arnold et al. 1972).
   - Capsular tightness: end-of-range movements may aggravate symptoms.
   - Fascia: under tension, burning or prickling symptoms may occur.
   - Nerve entrapment (e.g. meralgia paraesthetica): burning pain during the night is typical.
3. Movement dysfunctions:
   - The symptomatic activity and subsequent analysis of the movement direction together with type and area of symptoms (Fig. 7.5) will help establish the dysfunction. It also helps the therapist focus on the movement direction requiring careful assessment and later treatment. Direction-specific aggravating activities with their typical movement dysfunctions are listed in Table 7.7.

The establishing of *easing factors* is as essential as establishing aggravating factors: what has the patient learned so far or what does the patient instinctively do to relieve the symptoms? The patient may, for example, grasp around the leg, shake it or rub it, which may be indicative of a movement disorder stemming from the hip. If the patient intuitively grasps the back or shifts the body weight to the other buttock during sitting, a lumbar spine or sacroiliac movement disorder may be present.

History

Where trauma is involved, the mechanism of injury may give important information:

- Before posterior gliding dysfunction (see Table 7.7) is implicated, a dashboard or similar injury with posterior subluxation of the hip is sought in the history.
- A fall on the outside of the trochanter may result in lateral soft tissue injury, medial cartilage injury (Magee 2008) or fractures depending on the forces involved. Particularly in

Table 7.7 Direction-specific aggravating activities and typical movement dysfunctions

Activities	Dysfunctions
Flexion and flexion/adduction activities	
For example, deep sitting, sitting with crossed legs, reaching forward in sitting, standing from sitting, bending forward, squatting, getting in and out of a car, skiing, high kicks	Anteromedial impingement Structural femoroacetabular Impingement (pincer or cam) Anterior gliding dysfunction Posterior gliding dysfunction Degenerative osteoarthritis Iliotibial tractitis and/or trochanteric bursitis in flexion Entrapment of the lateral femoral cutaneous and inguinal nerves
Extension and extension/ lateral rotation and weightbearing activities	
e.g. sustained standing, walking, Nordic walking, jogging, running, high kicks on the weight-bearing leg, golf swing and other turning activities in standing	Iliotibial tractitis and/or Trochanteric bursitis in extension Functional posterior impingement Structural posterior impingement Anterior gliding dysfunction Degenerative osteoarthritis
Side lying	
For example, provides compression on the lower side and adduction/medial rotation stretch on the upper side	Trochanteric bursitis/ iliotibial tractitis Lateral gliding dysfunction

older patients, osteoporosis may be considered. Musculotendinous lesions are often directly related to trauma (Agre 1985).

If no obvious trauma is present:

- Repeated forceful end-of-range loading may play a role in the more insidious overall development of symptoms. This is typical in sports and activities such as football, martial arts, ballet and golf.
- An assumed relatively sudden onset due to twisting movements on one leg may be indicative of labrum tears (Sims 1999) or local muscular or ligamentous lesions. Hamstring injury, for example, is likely to result from rapid forceful change from concentric to eccentric activity (Verrall et al. 2001) and is likely to reoccur in 34% of cases (Croisier 2004).
- Overuse and misuse of the structures may lead to the gradual development of symptoms over time with little initial interference in daily life activities. Gardening in excessive hip flexion (jackknife position) rather than sharing the flexion proportionally over the knee and spine will gradually stress the hip region.
- Walking with poor motor control at the hip is a further example (Gunn 1980, Weinstein 1992). If excessive hip movement compensates for stiffness or pain in neighbouring joints, the course of symptoms over time may shift from an initially painful lumbar spine or knee to the hip. The importance of correcting compensations as soon as pain and injury levels allow is therefore clear.

Moreover, an originally one-component movement disorder in the lumbar spine, pelvic or hip region may develop into a multi-component disorder over the course of years (Ekberg et al. 1988). For example, poor motor control of the pelvic girdle may be associated in time with a symptomatic sacroiliac joint and pubic symphysis, with irritation of weak abdominal fascia and associated adductor tendinosis (Hölmich 1999). Similarly, complications while giving birth may produce pelvic muscle lesions and asymmetries affecting the entire hip and pelvic region producing long-term debilitating symptoms (Hungerford et al. 2004). Such factors need consideration when planning the first one to three sessions of the physical examination.

In the past history, developmental disorders may have been diagnosed. Dysplasia (particularly in girls) has been shown to develop in later life into femoroacetabular pincer impingement and Perthes' disease or epiphysiolysis of the femoral head (more often in boys) can develop into femoroacetabular cam impingement (Ganz et al. 2003). These structural impingements may initially present as intermittent groin pain which increases with high demands on the joint or from activities such as sustained deep sitting (Leunig & Ganz 2005).

Special questions and medical screening questions

- As well as routine information about the patient's general health, weight loss, radiographic findings, medication intake, etc., particular attention needs to be given to screening questions regarding urogenital and intestinal functions (Boissonnault 1995, Goodman & Snyder 2000).
- In particular where symptoms do not seem to be directly related to movement functions these screening procedures must be taken into consideration.

Physical examination

Box 7.3 provides an overview of examination procedures of the hip and related structures. Detailed information on some test procedures is given below.

Box 7.3

Physical examination of the hip

Observation

- Present pain

Functional demonstration/tests

- Including differentiation of movement components

Brief appraisal

Active movements

- Gait analysis
- In standing:
  - weight bearing: F, E, Ab, Ad, MR, LR
  - swing movements: F, E, Ab, Ad, MR, LR
  - trunk movements: assessment of relative flexibility of the movement chain
- Step-down test
  - Going up and down steps
- Squatting
- In sitting:
  - –flexing knee to chest
  - –flexing knee to opposite shoulder (F/Ad)
  - –flexion trunk to feet
  - –MR, LR
- In prone and supine lying, *including overpressure*:
  - in supine: F, MR and LR in 90°F; Ab, Ad
  - in prone: E, MR, LR

Muscle tests

- Isometric tests
- Muscle length tests (global stabilizers and global mobilizers)

Screening of other structures in 'plan'

- Lumbar spine
- Sacroiliac joint provocation tests
- Thoracic spine
- If applicable: neurodynamic testing (or in later stage during passive testing)

Palpation

- Tenderness of insertions of periarticular muscle groups
- Nerves (e.g. lateral femoral cutaneous nerve in area of inguinal ligament)
- Bursae

Passive movements

If applicable, including subsequent reassessment procedures

- Neurodynamic test procedures:
  - SLR
  - PKB
  - slump
  - modified PKB in side lying ('side lying slump'), including modifications for lateral femoral cutaneous nerve, obturator nerve
- Movement diagram of relevant active tests: F, in 90°F; MR or LR, Ab, Ad
- Physiological movements:
  - F/Ad (if all tests negative so far: add MR, LR; compression through femur shaft; and through collum femoris)
  - in F: do Ab; F/Ab as part of passive circumduction movement
- In E: do Ab, Ad, MR or LR; or combinations of three directions (especially E, Ad, MR)

Accessory movements

As applicable:

↔ ceph and caud; ↓, ↑, →, ←, ↻ ↺ in various hip positions

Add compression (cephalad and medial), where applicable

Stability tests

- Anterior, posterior and lateral gliding dysfunction

Check case records etc.

Highlight main findings with asterisks

Instructions to patient at end of session

Observation

The physical examination from posterior, both sides and anterior usually starts with a general observation of:

- Posture
- Muscle contours – indication of visible wasting, in particular gluteal muscles, quadriceps, abdominal muscles
- The skin and local soft tissues for possible changes in swelling, thickening or colour
- Structural impairments.

See Box 7.4 for alignment measures. Considerable controversy exists regarding measures of ideal alignment (Klein-Vogelbach 1983, Kendall & McCreary 1993, Sahrmann 2002, Magee 2008). Nevertheless a frame of reference is necessary. This should be

Box 7.4

Physical examination: observation of posture

Anterior view

- Pelvis – neutral lateral shift (mid-position of the heels, pubic symphysis, umbilicus and sternum should be vertically aligned):
  - neutral rotation in the transverse plane (a line joining the toes – if the feet are symmetric – should be parallel to a line joining the anterior superior iliac spines). This measure is important to pick up masked rotation in the hip
  - neutral cranial/caudal tilt in the frontal plane
- Femur/hip – thigh should appear to be vertical. (The femoral shaft is then obliquely orientated and 10° externally rotated)
- Patella/knee/tibia – patella aligned over the second metatarsal (patella should lie in the frontal plane)
  - longitudinal axis of the thigh and lower leg are vertical and in direct alignment
- Foot – second metatarsal 8°–10° externally rotated

Functional knee bend: in order to examine alignment more accurately, the patient may be asked to bend the knees slightly (Fig. 7.6). Here it is easier to determine whether or not the patella lies in a line with the axis of the second metatarsal.

Lateral view (both sides)

The plumb line follows a line from approximately midway through the trunk, the greater trochanter, slightly anterior to a midline through the knee and anterior border of the lateral malleolus and the anterior superior iliac spine (ASIS) is in the same vertical plane as the symphysis pubis.

- Pelvis – line joining ASIS (anterior superior iliac spine) and PSIS (posterior superior iliac spine) is horizontal or tilted 5° anteriorly: this should correspond with a neutral lumbar spine curve and neutral hip and knee joint angles
- Knee – neutral extension
- Foot – longitudinal arch neutral

Figure 7.6 • Posture – sagittal view.

Box 7.4—cont'd

Posterior view:

- Pelvis – neutral rotation in the transverse plane (a line joining the heels should be parallel to a line joining the anterior superior iliac spines)
- Knee – knee fold horizontal (or not more than 10° higher laterally). A greater deviation is indicative of structural or functional rotary malalignment
- Foot – subtalar joint neutral in the frontal plane

Adapted from Klein-Vogelbach 1983, Kendall & McCreary 1993, Sahrmann 2002 and Magee 2008.

Table 7.8 Indications implicating specific structural dysfunctions

Indications	Related structural dysfunctions*
Apparent hip medial rotation often compensated with knee external rotation and toeing out	Femoral antetorsion
Apparent hip lateral rotation with toeing out	Femoral retrotorsion
Prominence of the trochanter with hip adduction	Coxavarus
Lack of prominence of the trochanter and a vertical thigh	Coxavalgus
Flexion or medial rotation in flexion are restricted	Femoroacetabular impingement(pincer/cam)
'Bow legged' deformity from the knee joint or the tibial bone respectively	Genu varum and tibia varum
'Knock knee' deformity: 1. If hip medial rotation is present and its correction brings the foot from pronation into neutral, a functional deformity may be present 2. If correction of hip medial rotation brings the foot from an apparently pronated position into inversion and the tibia from an oblique position into a vertical one, restricted subtalar eversion or restricted forefoot pronation may be suspected 3. If correction of the knee or hip is not possible a structural dysfunction in the knee or hip is likely to be present	Genu valgum
Lateral tibial torsion may present with toeing out or hip medial rotation if the foot position is straight	Tibial torsion
With the medial borders of the feet together and the knees in ideal alignment over the second toe, the trochanter is higher on one side	Structural leg length difference

*Note: see Sahrmann (2002) for a description of these conditions.

interpreted generously and deviations should be considered in association with symptoms.

Correction of postural malalignment should follow to determine whether or not:

- A protective reaction is present (as indicated by increase in symptoms),
- Malalignment is causing symptoms (a reduction in symptoms with correction) or
- Malalignment is at all associated with the patient's disorder (no change in symptoms).

If correction is difficult to perform due to tightness, then joint restriction or structural dysfunction may be present in the area of perceived tightness.

Special tests or radiographs may be needed if structural dysfunctions are suspected. Refer to Table 7.8 for clinical tips on indications implicating specific structural dysfunctions.

Functional demonstration tests

- *Present pain* – before performing any tests to reproduce symptoms, the presence and level of paint need be determined.
- *Functional demonstration* – the patient is asked to demonstrate an activity which provokes their main pain. This activity may serve as an asterisk. Performing differentiation procedures, where more stress is added to or removed from the individual movement components, may indicate which components are contributing to the main symptom. This is an essential principle of the Maitland Concept.
- In the case of a painful snapping hip where the patient has difficulty locating the source of symptoms, provocative movements may be performed by the patient while the therapist palpates over the lumbar spine, the sacroiliac joint, the trochanter laterally, the groin and the tuber ischiadicum in turn to locate the click and determine the source.
- It should be clear whether testing is aimed at differentiating the painful structure (source of symptoms) or the causative dysfunction:
  - In a painful deep-sitting position, a decrease of pain after tilting the patient's ilium posteriorly may implicate the hip rather than the lumbar spine as the source of pain.
  - During a step-down test alleviation of hip symptoms with a wedge under the medial heel or longitudinal arch may implicate subtalar or forefoot dysfunction as the cause or contributing factor for the development of pain in hip structures.
- *Brief appraisal* – following differentiation tests, a brief appraisal or reflection on findings so far helps determine whether test procedures may be continued as planned, or if adaptations of the examination are necessary.

Active movements

During active tests various parameters are being assessed and recorded. These are:

- willingness and ability to move
- quality of movement, including muscular recruitment patterns
- range of active movement
- any symptom response.

Gait analysis

Gait analysis is an essential test procedure for patients presenting with hip, knee or foot symptoms. Deviations should be corrected to determine if a direct relationship with the patient's symptoms is present.

Observation takes place from the side, from anterior and from posterior. Precise observation of the different phases of the stance and swing phase is frequently necessary (Whittle 1991):

- Stance phase:
  - heel contact
  - foot flat
  - mid-stance
  - heel off
  - toe off (phase between heel off and toe off – 'terminal rocker').
- Swing phase:
  - mid swing
  - end swing.

Depending on the symptoms and the functional demonstration tests, the patient may be asked to walk in a different manner, for example:

- Walking forwards, sideways, backwards
- Speed
- Small steps, large steps
- Walking with crossed legs
- Walking on toes, heels
- Walking on medial or lateral borders of the feet
- Walking in internal or external rotation of the legs.

Careful observation of any asymmetries of the various determinants of gait is essential (Whittle 1991, Rose & Gamble 1994), for example:

- Transfer of centre of gravity of body
- Pelvis, trunk, foot, knee and hip movements
- Stride length, stride width
- Foot position
- Cadence of movement, frequency of steps
- Stance time and stride time
- Average walking speed.

If movement dysfunctions of the hip are suspected, special attention needs to be given to the following aspects:

- *During stance* – Duchenne sign, Trendelenburg sign, transfer of the pelvis over the leg, especially rotation, adduction and extension movements. According to Grimaldi et al. (2009), a Duchenne sign results from wasting and weakness of the gluteus medius posterior while with the Trendelenburg sign a hypertrophied but excessively long gluteus medius can be expected.

- *At the end of the stance phase* – extension, adduction and medial rotation movements (Klein-Vogelbach 1983).
- If forward walking seems normal, walking backwards, or variations of gait with big steps or with crossed legs may give a more detailed indication of gait deviations due to pain, stiffness or muscular impairments.

Active testing in standing

This is important if the patient's symptoms are related to standing or walking, providing more functionally useful information about quality of movement and the ability to move than tests in lying.

Weight bearing (Fig. 7.7)

The physiotherapist guides the patient in moving the pelvis over the leg, producing flexion/extension, adduction/abduction and internal and external rotation movements or any combinations of these.

These movements may frequently reproduce the symptoms or reveal impaired movements, for example, discomfort with lateral rotation in combination with extension (often indicative of excessive anterior gliding or stress into anterior joint structures); loss of range of motion with adduction; difficulties with balance; or a diminished recruitment pattern of gluteus medius and minimus muscles during abduction movements.

Technique

- *Patient starting position*: Standing on the affected leg, holding the physiotherapist's shoulder to maintain balance.
- *Therapist starting position*: Standing in front of the patient.
- *Localization of forces*: Physiotherapist holds onto the left and right crista iliaca of the patient's pelvis.
- *Application of forces*: Therapist guides the patient's pelvis in F/E direction, Ab/Ad direction and MR/LR direction.

Figure 7.7 • Active movements in weight bearing.

This test may be progressed to perform balance reactions on one leg, which is more provocative.

Swing movement

Similar to the tests in weight bearing, the physiotherapist supports the patient's hands to maintain balance. The patient produces active swinging movements of the affected leg towards flexion, extension, abduction, adduction, medial and lateral rotation. In the athlete or dancer high kicking movements may follow. Pain in association with hypermobile ranges may indicate anterior or posterior functional impingement in the swing or stance leg respectively whereby restricted movement and pain may suggest structural impingement or joint blocking due to restriction of accessory movement. These results may guide the physiotherapist towards more detailed testing for these dysfunctions.

Trunk movements: assessment of relative flexibility of the movement chain

Standardized active examination of recruitment patterns of the trunk and leg muscles during trunk flexion, extension, lateral flexion and rotation provides information for the later treatment of contributing factors. However, these tests are not necessarily a compulsory procedure in the first examination session. Examining the 'relative flexibility' of different structures in the movement chain (Sahrmann 2002) can indicate where stiffness from neighbouring structures needs to be considered in treatment. Recruitment patterns are also analysed during other active test procedures.

Step-down test (Fig. 7.8)

Stepping down from a small height with the test leg above will quickly reveal hip problems on the weight-bearing side. In the presence of weak abductors the hip clearly adducts and medially rotates or deviations of the trunk over the affected side are evident.

Figure 7.8 • Step-down test showing excessive hip adduction and medial rotation.

Getting up and down steps

Assess height of steps, distance to steps, quality and range of the movement.

The patient who ascends with the trunk leaning forward and the lumbar spine and hips in excessive flexion must strenuously pull his centre of gravity upwards using considerable work from the quadriceps of the proximal leg. Here the knee is loaded to a greater degree than necessary and the hip extensors are working in a more lengthened position. A more economical pattern would be to thrust from the opposite leg using the calf muscles to a greater extent.

Descending steps

Follow the same procedure as outlined for the step-down test.

Squatting

The patient may be asked to hold onto the treatment plinth to maintain balance and to squat down to the onset of pain or as far as capable.

Careful observation with correction of any deviations during the movement is essential: abduction and lateral rotation of the hip often occur in order to avoid the impingement position; retraction rotation of the pelvis may be pain-producing due to the extra adduction demanded here. Signs of apprehension should also be noted (e.g. patients with posterior gliding dysfunction may be fearful of squatting). If the weight shifts to the affected side, the hip here is in greater flexion and adduction (the cause of the dysfunction may be excessive flexion or adduction) while shift of weight away is a typical protective reaction. Observe if the patient reaches the end position on the toes or on the heels. Squatting on the toes suggests greater involvement of the knees in comparison to the hips (in the flexion direction) while squatting with feet flat requires comparatively greater flexion stress on the hips and lumbar spine.

Progression of the examination

Rocking over may be used as a progression of the examination. The physiotherapist stands behind the patient to give support to the trunk and guides the patient back and forth from toes to heels, while holding the patient's knees.

As another progression of examination procedures, the patient may be asked to oscillate in the end-of-range squat position.

Active testing in sitting

Many patients have difficulty with leg movements in sitting (e.g. putting on socks, getting out of a car).

The following active tests in sitting may irritate, for example, an anterior impingement (groin pain) or inflammatory or tight iliotibial tract (trochanteric and lateral thigh pain), etc.:

- Flexing the knee to the chest
- Flexing the knee to the opposite shoulder (F/Ad movement)
- Flexion of the trunk towards the feet
- Adduction or abduction of the thigh
- Medial rotation, lateral rotation of the thigh

Note: if the patient habitually sits with the pelvis posteriorly tilted and cannot correct the pelvic position to neutral, the superior gluteus maximus may be overactive or shortened or the joint may be restricted. To differentiate, the knees may be placed minimally further apart and the patient again asked to correct the pelvic position. If correction is now possible tightness or overactivity in the superficial gluteus maximus is implicit; if correction is not possible then the joint is stiff.

Active testing in supine and prone positions, including overpressure

The main physiological movements of the hip (particularly the movement associated with the most painful direction) should be examined in detail. Overpressure is added at the end of range if symptoms have not as yet been reproduced.

A benchmark of appropriate range of movement for every direction would help define whether the movement tested is normal, hypermobile or restricted. However, the literature shows tremendous variation (American Academy of Orthopaedic Surgeons (1966) – Joint Motion (based on the research of four different committees), Kendall and McCreary (1993), Sahrmann (2002), Magee (2008), Klein-Vogelbach (1983), Hoppenfeld (1976), Kapandji (1988)). Variation is due to a number of factors, for example:

- Lack of clarity as to whether active or passive range is being described
- Differences in starting position – flexion has been described with the lumbar spine flat on the plinth, with the patient's hands under the spine to maintain the lordosis and from the patient's resting position
- Lack of clarity as to whether the end position is representative of stretch tolerance or muscle stiffness (Mens et al. 2006).

However, in looking for dysfunction a single measures of ideal range is not as important as defining the extreme measures denoting hypermobility or restriction. Hence for every active movement described below an upper and lower measure is given based on extremes described by the authors above. Flexion range, for example, is given as 110°–125°. A range af 90°–95° would be clearly restricted (especially in the presence of an abnormal end-feel on overpressure) and a flexion range of 140° would clearly be hypermobile (especially if accompanied by a lack of decelerating resistance at the end of range). Measures between 95° and 110° would need to be considered more critically.

The test sequence below is followed by a detailed description of tests:

In supine

- Flexion.
- Medial and lateral rotation in 90° flexion.
- Lateral rotation in supine.
- Abduction.
- Adduction.

In prone

- Extension.
- Medial and lateral rotation.

In four-point kneeling

- Flexion.

In sitting

- Medial and lateral rotation.

Active hip flexion in supine (Fig. 7.9)

- *Indication*: Pain during flexion activities.
- *Patient starting position*: Supine with the patient's hands under lumbar spine (neutral lordosis).
- *Test*: The patient performs one-sided active hip flexion with a bent knee. The therapist observes

Figure 7.9 • Active flexion.

for deviations into abduction, adduction or rotation.

- If there are no deviations hip flexion may be defined as follows:
  - 110°–125° – acceptable
  - > 125° – hypermobile (inhibited deep gluteus maximus)
  - < 110° – reactive inhibition due to pain (if due to excessive posterior gliding apprehension may be present), or overactive/ shortened superior gluteus maximus.
- *Differentiation:* the patient repeats the test in slight abduction (approximately 5 cm deviation laterally):
  - if further flexion takes place then a shortened superior gluteus maximus is presumed to be responsible for the restriction;
  - if flexion remains the same then restriction is due to a shortened posterior capsule or blocked joint: a) restricted posterior gliding (femoral head is too far anteriorly); b) restricted lateral gliding (femoral head lies too deep in acetabulum).

Deviations

- Deviations in other planes of motion during the test should be corrected so that flexion range may be assessed accurately. The pain reaction is observed to assist in determining the dysfunction:
  - *During flexion the hip moves spontaneously into abduction*. If on correction range of movement decreases and/or pain in the groin increases, a protective reaction is present and indicates avoidance of an anteromedial impingement site. If correction is difficult due to resistance and trochanteric pain is present, the superficial gluteus maximus may be overactive/restricted causing friction symptoms.
  - *During flexion the hip moves spontaneously into adduction.* If on correction range of movement increases and/or groin pain decreases, anteromedial impingement due to excessive adduction in flexion is indicated. Spontaneously the impingement site is not avoided. This may be because the movement pattern is so ingrained in the CNS or the pain is not sufficiently annoying or severe. This habitual movement pattern should then be sought in other daily activities. It indicates inhibition or lengthening of gluteus medius and quadratus femoris (global stabilizers) and an overactivity or shortening of the tensor fascia lata or the long adductors (global mobilizers).

Additional manoeuvre

- Repeat active flexion as above with the knee extended to assess hamstrings length and neural involvement:
  - 80°–90° – normal hamstrings length, good neurodynamics.

Flexion in four-point kneeling

- *Patient starting position*: Four-point kneeling with neutral lordosis, knees and feet together, feet over edge of plinth.
- *Test*: The patient shifts weight from the hands on to the knees rocking backwards in the direction of the feet without losing the lumbar lordosis. As soon as the lumbar spine begins to move the patient is asked to stop and the range of hip flexion is measured:
  - 110°–125° – acceptable
  - > 125° – hypermobility: there is greater relative flexibility in the hip in comparison with the lumbar spine in the flexion direction due to an inhibited or lengthened deep gluteus maximus (global stabilizer)
  - < 110° – restriction due to stiff joint structures or muscle stiffness (e.g. superficial gluteus maximus).
- *Differential diagnosis*: Repeat the test with the knees slightly apart and the feet together. If more flexion is now possible in the hips then the superficial gluteus maximus was the cause (the muscle restriction is relieved as a result of hip lateral rotation, with little change to the joint).

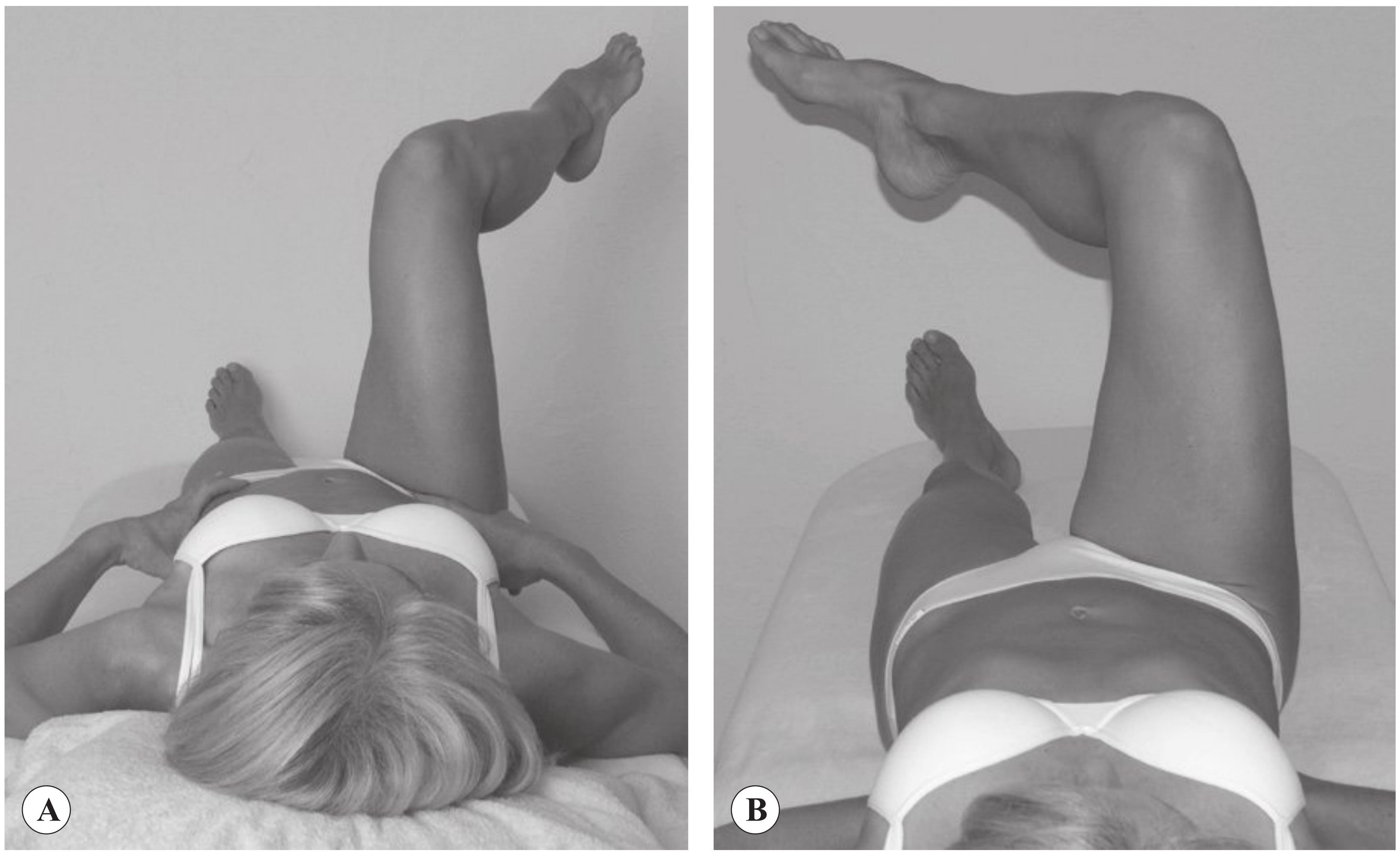

Figure 7.10 • A Medial rotation in 90° flexion. B Lateral rotation in 90° flexion.

- If the same degree of flexion movement occurs then the joint is stiff (posterior capsular restriction).

Comparison of hip fexion test in supine and four-point kneeling

1. If hip flexion is more restricted in supine than in four-point kneeling (e.g. supine 90°, four-point kneeling 110°), then anterior gliding dysfunction may be the cause: the femoral head is anteriorly positioned and cannot glide sufficiently posterior to allow normal movement. In four-point kneeling posterior gliding is helped by the weight of the body on the femoral head. In addition, slight soft tissue resistance in supine may be less significant in 4 point kneeling allowing more movement.
2. If hip flexion is greater in supine than in four-point kneeling, consider posterior gliding dysfunction. The patient may exhibit greater apprehension and hence movement restriction in kneeling.

Medial and lateral rotation in 90° flexion (Fig. 7.10)

- *Indication*: Pain during rotation activities.
- *Patient starting position*: Supine with the hip and knee in 90° flexion and the patient's hands under lumbar spine (neutral lordosis).
- *Test*: The patient performs active medial and lateral rotation. Hip rotation may be defined as follows in medial rotation:
  - 30°–45° – acceptable
  - > 45° – hypermobile (inhibited posterior gluteal muscles or quadratus femoris)
  - < 30° – shortened capsule or structural femoral acetabular impingement (FAI), particularly if extremely restricted.
- *Differentiation*: if medial rotation is much greater when tested in neutral flexion/extension (e.g. supine with the lower extremity resting on the plinth or in prone lying), then FAI is implicated (Ames & Heikes 2010, Enseki et al. 2010). This is because bony exostoses on the femoral neck or acetabulum will block movement in flexion but not in extension.

Lateral rotation

- *Test*: Hip rotation may be defined as follows in lateral rotation:
  - 40°–60° – acceptable
  - > 60° – hypermobile (inhibited anterior gluteal muscles)
  - < 40° – shortened capsule or overactive/shortened piriformis.

Medial and lateral rotation in sitting

- This is an alternative test position for rotation testing in 90° flexion.

Lateral rotation in supine (relative flexibility test) (Fig. 7.11)

- *Indication*: Pain during rotation activities involving trunk rotation away from the test side.
- *Patient starting position*: Supine with the thigh resting on the plinth; the knee is extended; the patient's hands under the lumbar spine (neutral lordosis).
- *Test*: The patient performs active lateral rotation as far as possible without movement of the anterior superior iliac spines or flexion of the knee. Hip rotation may be defined as follows:
  - 30°–45° – acceptable
  - > 45° – hypermobile (iliofemoral ligament laxity – Philippon & Schenker 2005, Kelly et al. 2007)
  - < 30° – restricted hip movement.
- *Note*: If the hip is restricted in lateral rotation but the patient requires a greater range of movement he may compensate by laterally rotating at the knee. The knee must therefore flex slightly in order to rotate. Therefore:
  - if the knee flexes slightly and laterally rotates before 30°–35° of hip lateral rotation is reached, then the knee is relatively more flexible than the hip;
  - if the knee remains extended but the hip rotates further than 40°–45° then the hip is more flexible than the knee in this direction.

Abduction in supine (Fig. 7.12)

- *Indication*: Pain during activities involving abduction.

Figure 7.11 • Lateral rotation showing relative flexibility in hip and knee.

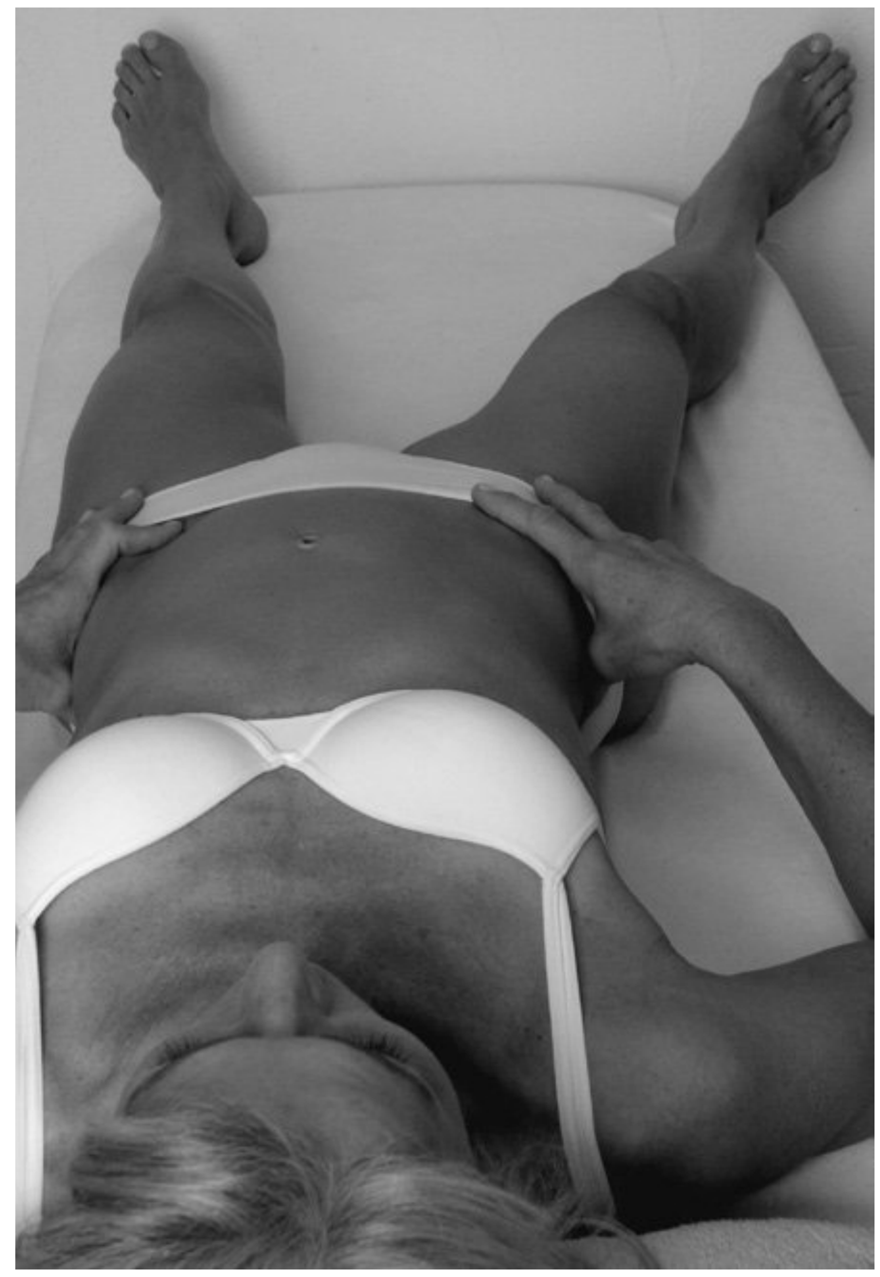

Figure 7.12 • Abduction in supine.

- *Patient starting position*: Supine with the patient's hands under lumbar spine (neutral lordosis); both legs are parallel and 90° to a line joining the anterior superior iliac spines.
- *Test*: The patient performs active abduction as far as possible without movement of the anterior superior iliac spines:
  - 30°–50° – acceptable
  - > 50° – hypermobile (one joint adductors inhibited or lengthened)
  - < 30° –hortened capsule or tight two-joint adductors.

Adduction in supine (Fig. 7.13)

- *Indication*: Pain during activities involving adduction.
- *Patient starting position*: Supine with the patient's hands under lumbar spine (neutral lordosis); the test leg lies 90° to a line joining the anterior superior iliac spines; the opposite leg is flexed at the knee with the foot resting level with the outside of the knee on the test side. It may be necessary for the therapist to hold this leg.
- *Test*: The patient performs active hip adduction as far as possible without movement of the anterior superior iliac spines:

Figure 7.13 • Adduction in supine.

- 10°–30° – acceptable
- > 30° – hypermobile (one joint abductor inhibited or lengthened – gluteus medius and minimus)
- < 10° – shortened capsule or tight tensor fascia lata.

Extension in prone (Fig. 7.14)

- *Indication*: Pain during extension activities.
- *Patient starting position*: Prone lying with the lumbar spine in neutral lordosis; the knee on the test side is in 90° flexion; the therapist palpates the anterior superior iliac spines.
- *Test*: The patient performs active hip extension without a change in position of the anterior superior iliac spines:

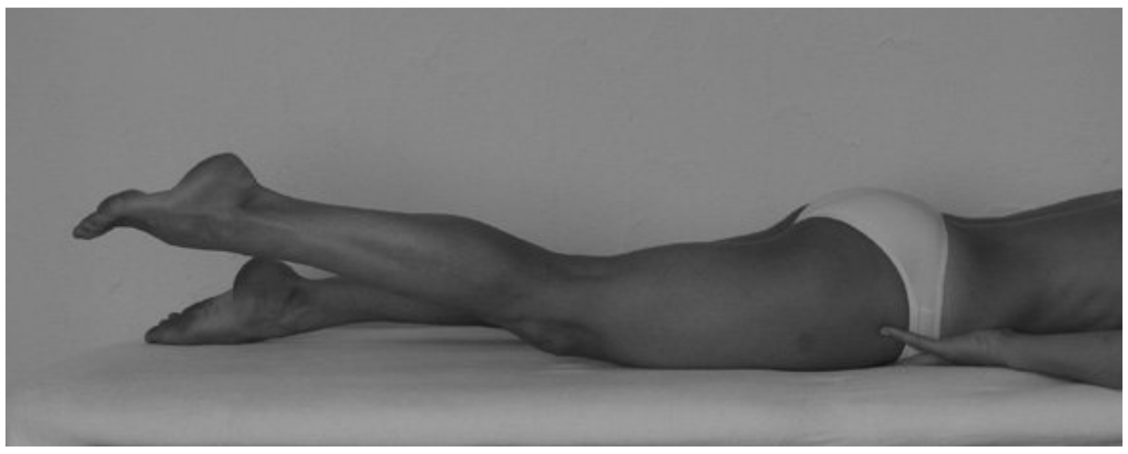

Figure 7.14 • Extension in prone.

- 10°–15° – acceptable
- > 15° – hypermobility (inhibited iliacus) or excessive anterior gliding (see stability tests)
- < 10° – shortened capsule or overactive/shortened rectus femoris and/or tensor fascia lata.

- *Differentiation:* repeat the test in slight abduction. If there is less restriction the tensor is implicated.
- *Note*: Observation of range, general quality and symptom reaction may be augmented by assessment of recruitment patterns of gluteus maximus, hamstrings and lumbar erector trunci muscles.
  - If symptoms are reproduced, further differentiation may follow using overpressure applied in turn to the hip, sacroiliac joint and lumbar spine.

Medial and lateral rotation in prone (Fig. 7.15)

- *Indication*: Pain during rotation activities. When used in conjunction with rotation tests in flexion it may confirm structural impingement as described above or length changes in piriformis. (Piriformis is a lateral rotator in hip extension but a medial rotator when the hip is flexed.)
- *Patient starting position*: Prone lying with the hip and lumbar spine in neutral position, knee on the test side flexed to 90°.
- *Test*: The patient performs active medial and lateral rotation.
- Medial rotation:
  - 20°–45° – acceptable
  - > 45° – hypermobility (inhibited posterior gluteus medius)
  - < 20° – shortened capsule or overactive/short piriformis.
- Lateral rotation:
  - 30°–45° – acceptable
  - > 45° – hypermobile (inhibited anterior gluteus medius, gluteus minimus)
  - < 30° – shortened capsule or overactive/short tensor fascia lata/iliotibial tract.
- *Note*: a 10° difference in medial and lateral rotation is allowable.

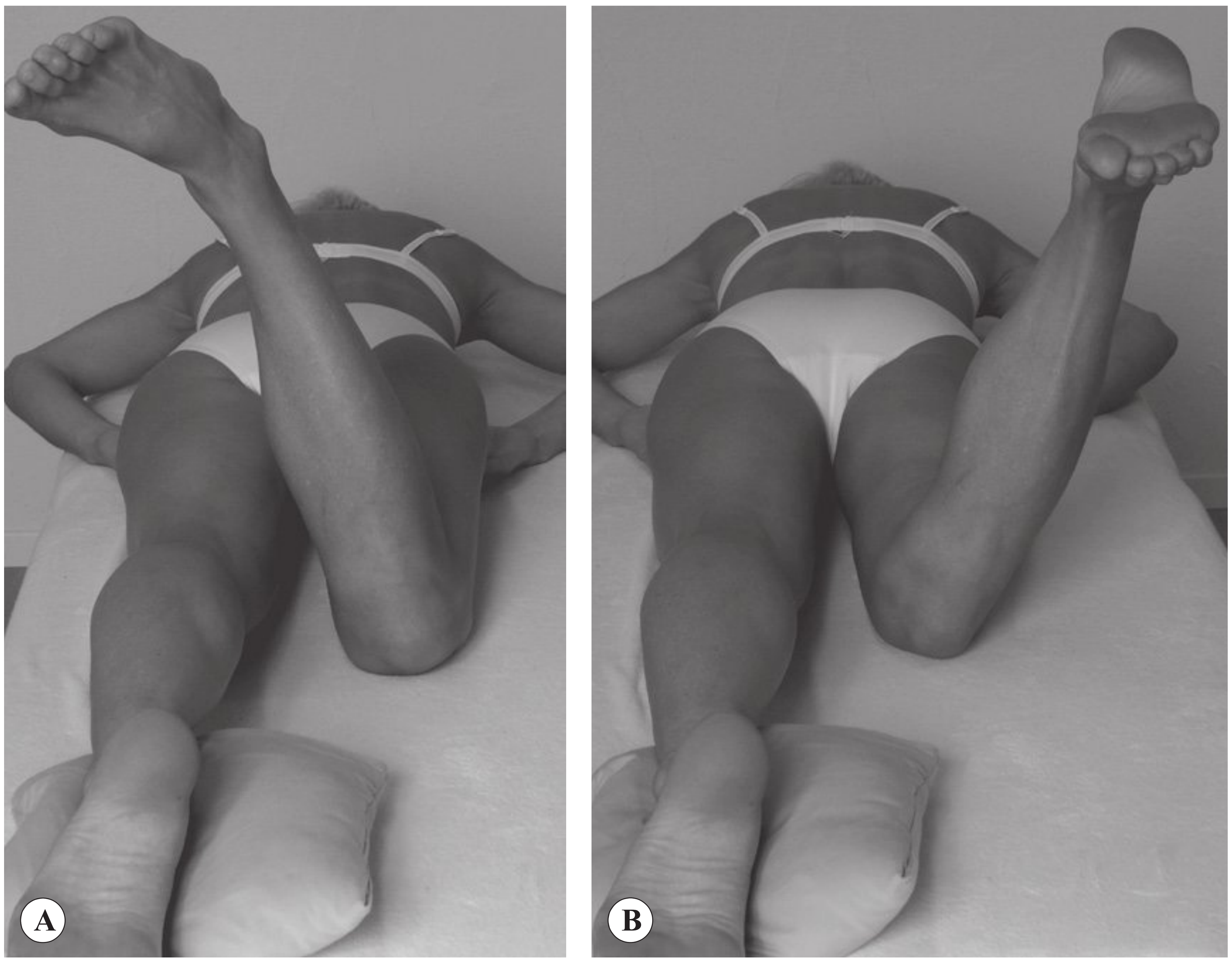

Figure 7.15 • A Medial rotation in prone. B Lateral rotation in prone.

- Change in rotation function of the buttock muscles at approx. 60°/70° flexion:
  - in 0° flexion – only the anterior gluteus medius and gluteus minimus are medial rotators (global stabilizers)
  - in 90° flexion – most of the gluteal muscles are medial rotators including piriformis (a global mobilizer).
- *Note*: test results of ranges of motion for rotation can be misleading if anteversion or retroversion are present.
- Earlier, Craig's test for anteversion/retroversion was used in association with rotation testing. However, research conducted by Souza and Powers (2009) shows that this very popular clinical test exhibits only moderate agreement with MRI measures. Although shown to be substantially reliable and more accurate than flat X-rays (Ruby et al. 1979), the test's clinical use is questioned due to the wide confidence interval (11.8°) found. A description of this test has thus been omitted. However, Souza and Powers'subjects were American adults where obesity played some role whereas the much earlier research involved young English boys. Hence the test should be accurate when assessing individuals with a small body mass index: when the greater trochanter is easily palpable.
- *Note*: Femoral antetorsion may be suspected if – simultaneously – medial rotation is excessive and lateral rotation is strongly diminished. However, an MRI is essential for accurate definition.

Muscle tests

Isometric tests

Isometric tests are performed if muscular lesions are suspected. They need to be combined with other provocation tests such as palpation of the specific muscle to localize tender spots. However, further differentiation tests may still be needed to discount the muscle.

Mens et al. (2006) found that pain during forceful isometric adduction in patients with sports-related groin pain significantly decreased in 68% of patients when the test was repeated using a stabilizing pelvic belt. Moreover, hip adduction force increased more than expected in 39% of cases with the belt. In these cases they suggest that adductor tendinosus was not responsible for pain. Rather, structures in an unstable pelvic ring (sacroiliac joint, pubic symphysis, abdominal fascia) are thought to be injured during load transfer from trunk to lower extremity. In this sense, Verrall et al. (2005)

described three pain provocation tests involving isometric adduction which, when positive, demonstrate a high likelihood for the athlete having MR-detected marrow oedema in the pubic bone around the symphysis area. See also Chapter 7 on pelvic girdle pain in Hengeveld and Banks (2014).

Note: if muscle signs are present in conjunction with joint signs, it is often useful first to treat the joint signs and then utilize those isometric tests that reproduce the symptoms as reassessment parameters.

It is conceivable (Mens et al. 2006) that uncontrolled movements in an unstable pelvic ring may not only harm tendons but that increased tension in surrounding muscles may also stress joints making adductor tendinosis an integral part of an overall groin pain syndrome involving different symptomatic structures. (Biedert et al. 2003, Ekberg et al. 1988 and Albers et al. 2001).

Muscle length tests

The reader should refer to the sections on muscle classification and associated muscle imbalance on pages 381–382.

- These tests may be performed after establishing the status of joint movements.
- In the presence of hypermobility or a lack of normal build-up of resistance at end range in the test direction, the global stabilizers are generally tested for inability to actively shorten. Global mobilizers are tested in the presence of restriction in the symptomatic direction. Here inability to release or lengthen is evaluated.
- As an apparently overactive or shortened muscle may indicate reactive protection of neural tissue, it can be advantageous to test mechanosensitivity to neurodynamic procedures beforehand.

Global stabilizers

A good test result is reached if, while supporting the weight of the lower extremity against gravity, the muscle demonstrates:

- Maximal shortening (the active end-range position of the joint is relatively equal to the passive end-range position)
- Tonic recruitment (the contraction feels effortless and breathing remains normal; extra feedback from the therapist or surroundings is not required and the contraction can be maintained for a minimum of 30 seconds without fatigue/cramping/tremor)
- A correct movement pattern also during the eccentric return to the starting position
- A lack of pain.

Iliacus (Fig. 7.16)

- *Indication*: Excessive hip extension, functional posterior impingement, recurrent hamstring lesions.
- *Patient starting position*: Sitting with the lumbar spine in neutral lordosis, the thigh supported and the feet hanging.
- *Instruction*: The patient is asked to pull the lower stomach in and bend the hip as far as possible without losing the trunk position.
- *Test*:
  - Active and passive range are approximately the same. The therapist tests passive

Figure 7.16 • Iliacus test.

movement by supporting the ilium with one hand and attempting to increase hip flexion with the other.
- ○ No dysfunctional movement pattern is present, for example:
  - – leaning backwards
  - – lumbar flexion (posterior pelvic tilt)
  - – lumbar extension (anterior pelvic tilt)
  - – lumbar und pelvic rotation clockwise (overactive quadratus lumborum)
  - – hip lateral rotation (overactive sartorius)
  - – hip medial rotation (overactive tensor fascia lata)
  - – weight transfer to the contralateral side (overactive quadratus lumborum or iliocostalis)
  - – knee flexion and hip extension (overactive hamstrings)
  - – co-contraction of all global hip muscles.
- ○ The contraction is easily held for 30 seconds without fatigue or tremor.

Deep gluteus maximus (Wagner et al. 2010) (Fig. 7.17)

- *Indication*: Excessive hip flexion, anterior impingement.
- *Patient starting position*: Prone lying with the trunk on the plinth, the lower extremities over the distal end with knees bent; lumbar spine in neutral. No pressure should be applied against the floor with the feet. The patient may grasp the sides of the plinth.
- *Therapist position*: Standing facing sideways on the non-test side, with one hand placed under each of the anterior superior iliac spines and her distal foot under the patient's foot on the non-test side.
- *Instruction*: The patient is asked to pull the lower stomach in, contract the buttock muscles and slide the foot backwards along the floor as far as possible without changing pressure on the therapist's hands or pushing on her foot. If the patient achieves this, the far knee should then be bent to 90°, again without changing the other parameters. When 90° knee flexion is reached, the patient extends the hip towards the ceiling as far as possible.
- *Test*:
  - ○ Active and passive range (~ 10–15°) are compared by the therapist stabilizing the ischial tuberosity with one hand and attempting to increase hip extension with the other. The difference should be small.
  - ○ Dysfunctional movement patterns are sought:
    - – lumbar extension or shearing movement in the spine
    - – lumbar rotation
    - – cramping or dominance of the hamstrings.
  - ○ The contraction is held for 30 seconds.

Figure 7.17 • Deep gluteus maximus test.

Posterior gluteus medius (Fig. 7.18)

- *Indication*: Excessive hip adduction and medial rotation, anteromedial impingement, iliotibial tract problems.
- *Patient starting position*: Side lying with the test side above and the pelvis in neutral (a small towel may be placed under the waist); the trochanters lie vertically in the same plane; the lower leg bent; the upper leg straight with the hip in neutral flexion/extension and full lateral rotation.
- *Therapist position*: Standing behind the patient monitoring the patient's position.
- *Instruction*: The patient is asked to pull the lower stomach in, contract the buttock muscles and lift the leg in the direction of the ceiling keeping the pelvis still, the trochanters over one another, the leg in line with the body and in full rotation towards the ceiling.

Figure 7.18 • Posterior gluteus medius test.

- *Test*:
  - ○ Active and passive range are compared by stabilizing the ilium with one hand and attempting to increase hip abduction with the other. The difference should be small.
  - ○ Dysfunctional movement patterns are sought:
    - – hip flexion or medial rotation (overactive tensor fascia lata)
    - – posterior pelvic rotation backwards (overactive tensor fascia lata
    - – trunk lateral flexion (compensating with trunk muscles).

Anterior gluteus medius and minimus (Fig. 7.19)

- *Indication*: Excessive hip adduction and lateral rotation, anterior labral tears, iliotibial tract problems.
- *Patient starting position*: Side lying with the test side above and the pelvis in neutral (a small towel may be placed under the waist); the trochanters lie vertically in the same plane; the lower leg bent; the upper leg straight with the hip in neutral flexion/extension and full medial rotation.

Figure 7.19 • Anterior gluteus medius and minimus test.

- *Therapist position*: Standing behind the patient monitoring the patient's position.
- *Instruction*: The patient is asked to pull the lower stomach in and lift the leg in the direction of the ceiling keeping the pelvis still, the trochanters over one another, the leg in line with the body and in full medial rotation with the heel pointing towards the ceiling.
- *Test*:
  - ○ Active and passive range are compared by stabilizing the ilium with one hand and attempting to increase hip abduction with the other. The difference should be small.
  - ○ Dysfunctional movement patterns are sought:
    - – hip extension or lateral rotation (overactive superficial gluteus maximus)
    - – posterior pelvic rotation forwards (overactive superficial gluteus maximus)
    - – trunk lateral flexion (compensating with trunk muscles).

Hip adductors: pectineus, adductor brevis, longus and magnus and quadratus femoris (Fig. 7.20)

- *Indication*: Athletic groin pain, recurrent adductor tendinosis.
- *Patient starting position*: Side lying with the test side below and the lumbar spine and pelvis in neutral (a small towel may be placed under the waist); the trochanters lie vertically in the same plane; the lower leg is straight with the hip in neutral flexion/extension and full lateral rotation; the upper leg is flexed 90°/90° with the thigh parallel to the plinth, toes resting lightly on the plinth.

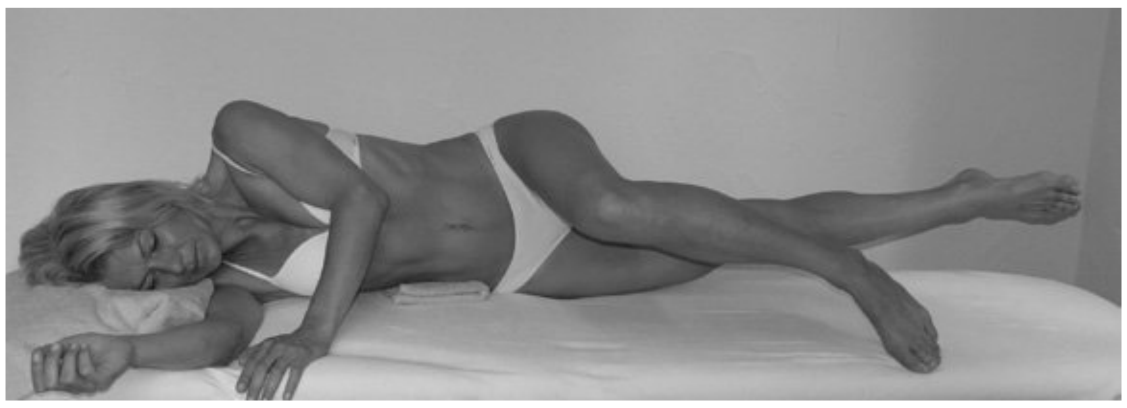

Figure 7.20 • Adductor test.

- *Therapist position*: Standing behind the patient monitoring the patient's position.
- *Instruction*: The patient is asked to lift the lower leg in the direction of the ceiling keeping the pelvis still, the trochanters over one another, the leg in line with the body and the heel towards the ceiling.
- *Test*:
  - ○ Active and passive range are compared by stabilizing the ilium with one hand and attempting to increase hip adduction with the other). The difference should be small.
  - ○ Dysfunctional movement patterns are sought:
    - – hip medial rotation
    - – lumbar lateral flexion
    - – cranial pelvic tilt.

Global mobilizers

- A good test result is reached if, in the lengthened position, a benchmark of hip or knee movement is reached.

Hamstrings (Fig. 7.21)

- *Indication*: Disorders related to restricted hip flexion particularly with the knee straight, weak deep gluteus maximus, sway back posture, recurrent hamstrings lesions.

Figure 7.21 • Hamstrings test.

- *Patient starting position*: Supine with pelvis in neutral, hip flexed to 90°, knee bent.
- *Alternative patient starting position*: Sitting with lumbar spine and pelvis in neutral, acromion vertically aligned with the ischial tuberosity, hip and knees in 90° flexion, feet hanging freely.
- *Instruction*: The patient is asked to extend the knee as far as possible maintaining the lumbar spine in the neutral position.
- *Test result*: The knee extends to the benchmark position of 'knee flexion 10°' without change in proximal joint position(i.e. anterior pelvic tilt and increase of lordosis).
- *Neural differentiation*: Slump test in sitting.

Superior gluteus maximus/iliotibial tracts (see Wagner et al. 2010) (Fig. 7.22)

- *Indication*: Disorders related to restricted hip flexion particularly in sitting; inability to sit with the hips adducted or without a back support or without holding on to the front of the seat, iliotibial tract problems resulting from rotational activities in deep flexion. for example, ski turns.
- The test is carried out exactly as described for active hip flexion in four-point kneeling. Here range of movement is assessed for restriction with the benchmark of 110°–120°.

Tensor fascia lata in standing (Fig. 7.23)

- *Indication*: Disorders related to restricted hip extension, adduction lateral rotation (e.g. iliotibial tract problems, anterior gliding dysfunction).
- *Patient starting position*: Standing with the back against the wall, knees straight; feet hip-width apart and 5–7 cm from the wall.
- *Instruction*: The patient posteriorly tilts the pelvis moving the lumbar spine towards the wall.
- *Test result*: The lumbar spine and lower thoracic spines are flat on the wall.
  - ○ *Dysfunction*: if the spine cannot lie flat the hip flexors or the lumbar longissimus and iliocostalis may be overactive or short.

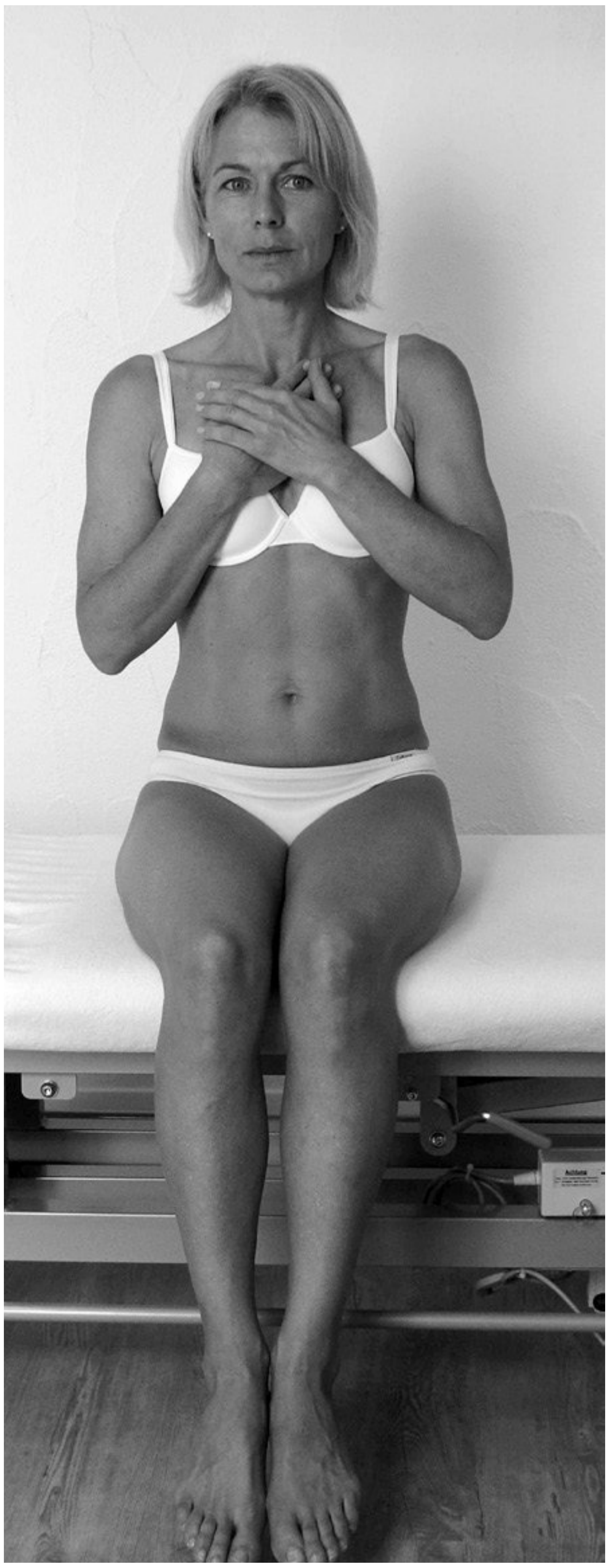

Figure 7.22 • Superior gluteus maximus/iliotibial tract test.

Figure 7.23 • Tensor fascia lata test in standing.

- *Differentiation*:
  1. Repeat the test with hip and knees bent: if flattening is not possible –longissimus and iliocostalis are overactive or short or the lumbar joints stiff; if flattening now occurs, the hip flexors are overactive or short.
  2. Repeat the test with the knees straight but the feet far apart; if flattening is now possible the tensor fascia lata is overactive or short.

Modified Thomas' test (Sahrmann 2002) (Fig. 7.24)

- *Indication*: Disorders related to restricted hip extension, adduction lateral rotation (e.g. iliotibial tract problems, anterior gliding dysfunction, anterior impingement).
- *Patient starting position*: Standing with the backs of the mid-thighs in contact with the end of the plinth and near to the edge of the plinth on the test side. With the therapist supporting the legs, the patient rocks back on to the plinth. The neutral lumbar lordosis position is now located as follows:,the therapist rolls the patient's pelvis away from her using both legs as a lever. The therapist's proximal hand is now placed under the lumbar spine and the pelvis rotated back again. Using the legs as lever flexion and extension movements of the spine are produced until it just rests against the therapist's hand. Once located, the patient is asked to maintain the lordosis by grasping

Figure 7.24 • Modified Thomas' test.

around the proximal thigh on the non-test side and fixing its position throughout the test. The therapist's proximal hand is now placed over the anterior superior iliac spine to monitor its position; the distal hand grasps the posterior proximal tibia and adducts the hip until the medial femoral condyle lies in the midline of the body.

- *Instruction*: The patient is asked to slowly lower the thigh towards the plinth as far as it will go without losing the knee flexion position (90°) or the hip or lumbar spine positions. The therapist monitors these positions.
- *Test result*: The thigh should come to rest again the plinth representative of 10°–15° hip extension.
  - *Dysfunction*: The thigh fails to reach the plinth: overactive/shortened rectus femoris, tensor fascia lata, iliacus or capsule.
  - *Differentiation*: repeat the test with:
    1. The knee extended – if the plinth is reached or the thigh moves more in its direction then resistance from rectus femoris was responsible for this percentage loss of original extension.
    2. The knee extended and hip abducted if the plinth is now reached first then resistance from tensor fascia lata was responsible for the extra difference in extension range.
  - If the plinth is still not reached then resistance from iliacus or the capsule was responsible. After applying overpressure to the hip in this position the patient is asked whether the end-feel is similar to the end-feel experienced when overpressure is applied to the metacarpophalangeal joint in extension (indicates capsule) or when overpressure is applied to the finger, metacarpophalangeal and wrist joints simultaneously (indicates muscle, i.e. iliacus).

Modified ober test: tensor fascia lata (see Ferber et al. 2010, Milner et al. 2010) (Fig. 7.25)

- *Indication*: As for Thomas' test.
- *Patient starting position*: Side lying with the test side above. The right and left trochanters lie vertically in the same plane; the lower leg bent; the test hip is in neutral flexion/extension, full abduction and full lateral rotation with the knee in a few degrees of flexion. The patient's waist is held pressed against the plinth (in lumbar lateral flexion).
- *Therapist starting position*: Standing behind the patient. With the proximal hand stabilizing the pelvis and the right lower arm supporting the weight of the leg in a cradling position (hand proximal to the knee), the therapist leans in the direction of the pelvis.
- *Instruction*: The patient is asked to actively maintain waist contact while allowing the leg to slowly sink in the direction of the plinth. The therapist simultaneously bends in the knee to allow the leg to sink.
- *Test result*: Hip adduction 10° with the heel contacting the plinth (males) or 2.5 cm above (females). If this benchmark is not reached then the tensor fascia lata is overactive or short.

Figure 7.25 • Modified Ober test.

Rectus femoris (Sahrmann 2002) (Fig. 7.26)

- *Indication*: Restricted hip extension.
- *Patient starting position*: Single-leg stance on the non-test side; lumbar spine and hip in neutral.
- *Instruction*: The patient is asked to flex the knee on the test side without changing the position of the proximal joints.
- *Test result*: Benchmark of 120° knee flexion should be reached.

M. piriformis (Tonley et al. 2010) (Fig. 7.27)

- *Indication*: Excessive hip lateral rotation.
- *Patient starting position*: Supine, with the hip flexed to approximately 85°, the knee in 90° flexion passive adduction to R1, light compression.
- *Therapist starting position*: Standing at the side of the plinth with her distal foot resting on the plinth on the far side of the non-test leg adjacent to the knee. The therapist holds the thigh in contact with her trunk, the patient's heel is supported on her distal hand and her thigh. The therapist adducts the hip using weight transfer to the point where the anterior superior iliac spine is about to move. This hip position is stabilized using minimal shaft compression and the hip is carefully laterally rotated using the patient's lower leg, which rests on the therapist's thigh, as a lever.
- *Test result*: Lateral rotation to approximately 45°. Less range indicates piriformis overactivity or shortness.

Figure 7.26 • Rectus femoris test.

Figure 7.27 • M. piriformis test.

Adductors (Fig. 7.28)

- *Indication*: Restricted hip flexion/abduction/lateral rotation.

Figure 7.28 • Adductors – length test.

- *Patient starting position*: Supine, the lumbar spine in neutral, the non-test leg extended on the plinth. On the test side the hip is flexed to approximately 45°, the knee is in 90° flexion with the foot resting on the plinth adjacent to the opposite knee.
- *Instruction*: The patient is asked to let the knee fall outwards as far as possible without movement of the anterior superior iliac spines or foot position.
- *Test result*: Benchmark of 45°–50° lateral rotation is reached without loss of proximal joint positions. Less range indicates adductor overactivity or shortness.

Screening of other structures in 'plan'

It is essential to examine the possible involvement of other components to the patient's symptoms and movement disorder. These components may be examined in the first session; however, as they also include passive test procedures with subsequent reassessment tests of the main physical asterisks, it is suggested that these screening tests be considered in the planning of the second and third treatment sessions.

- *Lumbar spine*: Flexion, extension, rotations. If indicated, lumbar quadrant. PAIVMs, including subsequent reassessment of the main physical asterisks so far.
- *Sacroiliac* provocation tests such as F/Ad with compression, Patrick's test (FABERE sign), anterior and posterior tilts, passive accessory movements including subsequent reassessment.
- *Note*: As F/Ad with compression is also an important procedure for hip movement disorders, it is often useful to complete the hip examination with the relevant passive tests prior to the screening procedures of the sacroiliac joints.
- *Thoracic spine*: Extension, rotations, PAIVMs, including subsequent reassessment.
- *Neurodynamic tests*: straight leg raise (SLR), prone knee bend (PKB), slump, slump in side lying (Fig. 7.29), including modifications to assess obturator or lateral femoral cutaneous nerves. They may be performed during the passive test procedures and, if indicated, followed by reassessment procedures.

Figure 7.29 • Slump in side lying.

For a detailed description of the screening tests see Butler (2000) and Maitland et al. (2001).

As possible contributing factors to the movement disorder of the hip and pelvis region, the knee joint and foot complex frequently need quick screening of their alignment, mobility and recruitment patterns.

Palpation

Palpation of the periarticular structures may take place in various phases of the examination process:

- At the beginning of the physical examination, as one of the first test procedures. This may be particularly indicated if inflammatory signs are being investigated. The findings can be monitored during the subsequent active and passive test procedures as a precautionary measure.
- Before passive examination tests, when the findings can be used as comparable signs in reassessment procedures.
- After passive examination tests.

The following aspects may be palpated:

- Bony landmarks such as the iliac crest, anterior superior iliac spine, greater trochanter, ischial tuberosity and tuberculum pubis. The hip joint may be palpated deeply just below the inguinal ligament lateral to the femoral artery.

- Temperature and swelling. As the hip joint is placed deeply under the muscles, synovial swelling may be appreciated as a vague sensation of fullness or tenderness. A synovial cyst may track anteriorly to present as a swelling in the groin and needs to be differentiated from, for example, a femoral hernia, a saphenous varix, an arteriovenous fistula, a psoas abscess and an iliopsoas bursitis (Corrigan & Maitland 1983).
- Femoral artery and inguinal lymph nodes.
- Tenderness of the greater trochanter, as for example in trochanteric bursitis; over the adductor origin in adductor tendinosis; lesser trochanter or a point deep lateral from the femoral artery in the groin as in psoas tendinosis; symphysis pubis with the abdominal insertions.
- Nerves. The sciatic nerve midway between the greater trochanter and the ischial tuberosity in the buttock; the femoral nerve laterally from the femoral artery over the joint; the lateral femoral cutaneous nerve medially from the anterior superior iliac spine under the inguinal ligament.

Passive test procedures

Passive test movements are essential in the examination of movement disorders of the hip.

Physiological movements and accessory movements need to be examined on the behaviour and relationship of symptoms (P), resistance (R) and motor responses ('spasm' – S). The findings of the tests will guide the therapist in the selection and application of treatment techniques (see also Chapters 1 and 8)).

As many of the passive test procedures may also be used as treatment procedures, frequently the test procedures need to be *followed by a reassessment* of the main physical parameters found so far.

Often it will be useful to establish a *movement diagram* of the most comparable active test movements in order to obtain more detailed parameters regarding the behaviour of symptoms and the range and quality of movement by the establishment of the behaviour and the inter-relationship of pain, resistance and motor responses. For example, flexion, rotation movements, adduction, abduction or extension may be examined in more detail and the findings may be expressed in a movement diagram (see Appendix 1).

Physiological movements of the hip may include:

- Flexion/adduction and variations
- Flexion/abduction and variations
- Extension/adduction/medial rotation
- Extension/abduction/lateral rotation.

Accessory movements may be performed in various positions of the joint and may encompass:

- Posteroanterior movement (on femur, on greater trochanter)
- Anteroposterior movement (on femur, on greater trochanter)
- Transverse lateral movement (on femur)
- Transverse medial movement
- Longitudinal distal movement (parallel to femur shaft)
- Longitudinal proximal movement (parallel to femur shaft)
- Medial rotation
- Lateral rotation movement, including inclination.

Test procedures under compression may need to be added to the test movements if no symptoms have been reproduced, particularly in those cases where an intra-articular movement disorder is suspected.

Neurodynamic testing may be included in this section of passive test procedures.

A selection of passive examination techniques are described in detail as follows:

- Flexion/adduction, including differentiation procedures
- Accessory movements and test procedures under compression.

Flexion/adduction

- *Direction*: Movement of the hip into the arc of flexion/adduction at various points from 80 to 140° of flexion.
- *Symbol*: F/Ad.
- *Patient starting position*: Supine, lying near the right-hand edge of the couch with the hip flexed to 90° and the knee comfortably flexed.
- *Therapist starting position*: Standing by the patient's right thigh facing across the patient's body.

Localization of forces (position of therapist's hands)

- Fingers of both hands are interlocked and lightly cupped over the top of the patient's flexed knee (if the patient has a very painful knee the therapist can support under the knee with one hand to bring the leg out of the painful knee flexion position) (Fig. 7.30).
- The therapist's right knee is placed on the couch, level with the patient's knee to maintain balance.
- The left thigh is pressed firmly against the edge of the couch at the level of the patient's hip to give added control to the pelvis movement and to prevent the therapist's body weight falling fully against the patient's right thigh.

Application of forces by therapist (method)

- The patient's hip is fully adducted until the right ileum begins to lift from the couch.
- The therapist leans against the lateral surface of the patient's femur so that the therapist's chin and hands are close together.
- The hip is adducted further using small oscillatory movements. Release the movement and flex the hip a further few degrees so that the adduction can be repeated at a different point of hip flexion until the whole range (80–140°) has been assessed (Fig. 7.31).
- First series: the patient's hip is adducted until the therapist feels a first increase in resistance ('R_1'). Then a second series of oscillatory F/Ad movements is performed over the whole range and the therapist examines the behaviour of resistance and the possible behaviour of pain until the limit of the range.

Figure 7.30 • Flexion/adduction.

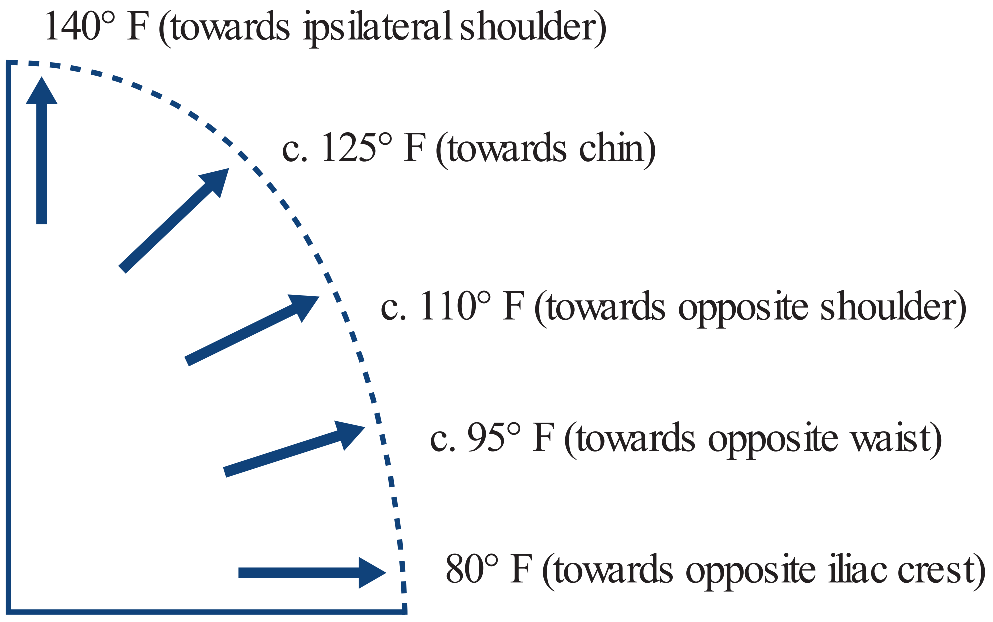

Figure 7.31 • Flexion/adduction – direction of examination movements.

Variations of F/Ad as an examination technique

Progression of examination

If F/Ad is thought to be normal, medial or lateral, rotation and/or compression through the shaft of the femur or through the neck of the femur should be added as a grade IV− to IV+ in several positions before judgeing the movement as normal or ideal (Figs 7.32 and 7.33).

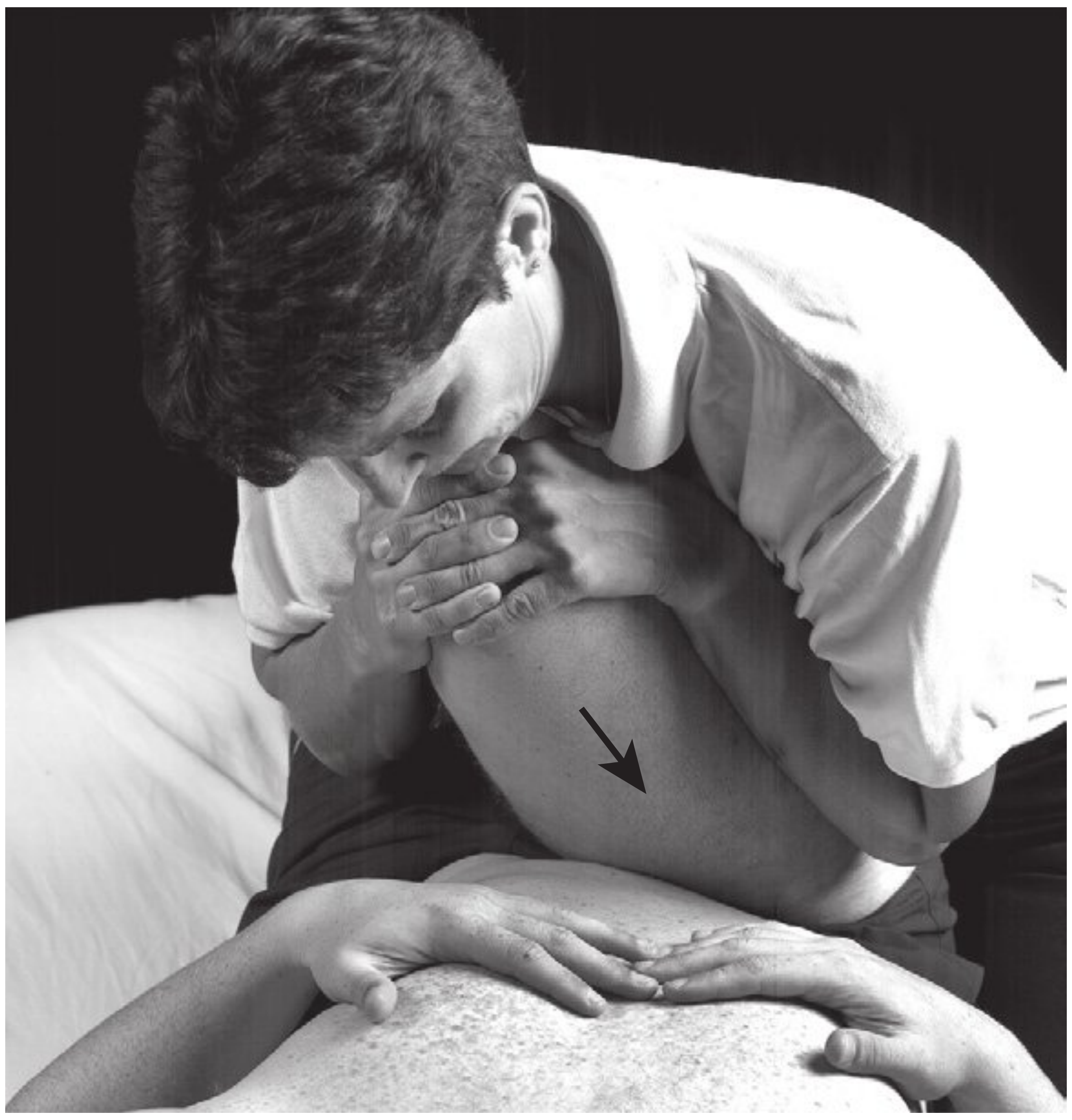

Figure 7.32 • Flexion/adduction with compression through the shaft of the femur (longitudinal cephalad movement).

Figure 7.33 • Flexion/adduction with compression through the neck of the femur (transverse medial movement, inclined cephalad).

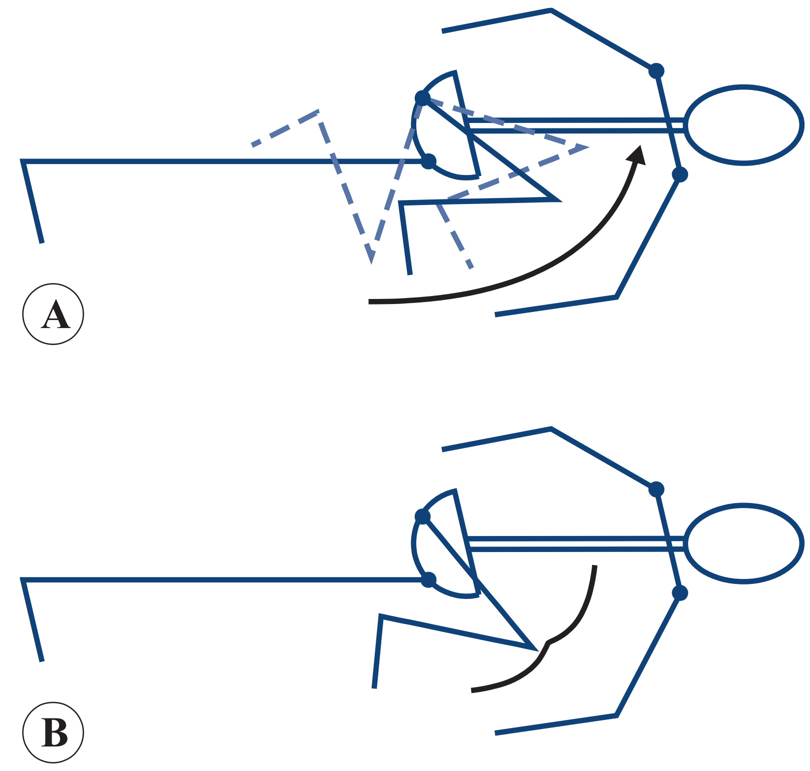

Figure 7.34 • Diagrammatic representation of: A hip flexion/adduction; B hip adduction.

Different combinations are possible, for example, in MR: do F/Ad; in compression through femur shaft do F/Ad, etc.

To find the position of painful limitation the hip can be moved in adduction, through the arc of flexion/adduction from 80 to 140° to the point where the patient's knee is pointing towards the left shoulder from a starting position of the hip in less than 90° of flexion. A constant pressure is maintained through the knee along the shaft of the femur in both the flexion and adduction directions while at the same time moving the patient's thigh through a further 60–70° of flexion. The femur should lie midway between medial and lateral rotation.

If movement is normal or ideal, the knee will follow an arc of a circle (Fig. 7.34A); any small abnormality will be felt as a bump on the smooth arc of the circle (Fig. 7.34B).This point may also be painful. The movement should always be compared with that of the normal hip.

Adduct the hip further so that the right ilium lifts off the table. Increase the hip adduction by applying pressure through the patient's knee downwards in line with the shaft of the femur, thereby pushing the patient's right ilium down onto the couch again. If the shaft of the femur has been retained in its relationship to the vertical, the pelvis will have adducted under the femur at the hip. This method drives the head of the femur posteriorly in the acetabulum.

This technique can produce groin pain in the normal hip. However, if a patient's main problem is groin pain, the pain will be reproduced earlier in the range when compared with the normal hip.

Differentiation tests

Flexion/adduction may be considered as a dominant test and treatment technique of the hip joint; however, other movement components may also be responsible for impairments of the test. While maintaining the leg in the pain-provoking position or slightly short of the painful position, various differentiation tests may be performed to determine the possible contribution of other movement components to the painful movement.

- Neurodynamic system: add knee extension and dorsiflexion of the foot; may add neck flexion (Fig. 7.35).
- Lumbar spine: add rotation towards or away from the hip; alternative: patient may put an arm under the waist to prevent further flexion.
- Sacroiliac joint: tilting pelvis posteriorly or anteriorly; alternative: may add lateral traction to the ilium.
- While tilting the ilium posteriorly the sacroiliac joint increases the movement, while the stress in the hip joint is slightly decreased. If symptoms increase, a sacroiliac movement disorder may be responsible; if symptoms decrease, the hip may be suspected. (*Note*: If symptoms increase, the lumbar spine may be differentiated by repeating the same manoeuvre but the patient extends the lower lumbar spine by putting an arm under the spine.) While tilting anteriorly the opposite may occur.
- Hip joint: add accessory movements.

Figure 7.35 • Hip joint: flexion/adduction with straight leg raise (SLR).

Uses of flexion/adduction and its variations

F/Ad is probably the most useful technique for both examination and treatment. It is as important to the hip as the quadrant is to the shoulder.

F/Ad may be considered as one of the 'functional corners' as described in Chapter 1. The curve of F/Ad may easily be recognized in the circumduction movement as described by Kapandji (1988) (Fig. 7.36). Full mobility of this functional corner permits rotation movements of the trunk while walking and running and is essential in many hip functions such as moving the body or trunk in sitting, putting on socks and so forth. When all other movements are pain free this movement can be painful and restricted.

The test manoeuvre may detect minimal impairments such as local pain and little change in resistance and joint mobility. As described earlier, it is essential to treat impairments leading to degenerative changes in a phase as early as possible. Hence the examination and treatment using F/Ad may play an essential role in the treatment of degenerative osteoarthritis. Figure 7.37 gives some indication of the progression of impairments as they may happen in some pathologies or if maintenance of joint mobility is being neglected.

Accessory movements

For convenience most of these tests are described as treatment techniques later in the text.

Specific tests for restricted gliding movements

In the presence of limited angular or physiological movement where joint blocking (restriction of coupled accessory or gliding movement) is suspected, special tests may be carried out. As joint blocking occurs in association with a faulty axis of rotation it may be related to problems of excessive gliding movements but in the opposite gliding direction.

Restricted posterior gliding (Fig. 7.38)

- *Indication*: Gross restriction of physiological hip flexion normally takes place with approximately 90° flexion (Note: flexion is coupled with posterior gliding movement which due to the curve of the acetabular joint surface also translates further into a slight lateral glide). This may be a feature of the medial migratory OA presentation (see' the section on treatment later in this chapter).
- *Test in flexion*: right hip (modified from Sahrmann,2002).
- *Patient position*: Supine, with the patient's hands supporting under the ilium proximally or alternatively a wedge may be placed here. The knees are extended.
- *Therapist position*: Standing on the test side.
- The patient performs an active SLR without hip rotation to the point of restriction. The therapist supports the leg in this position, asks the patient to relax and then moves the leg approximately 10° away from the limit. After applying an anteroposterior pressure on the femoral head using the lateral border of her left hand adjacent to and parallel to the inguinal crease, the therapist again lifts the leg further into SLR.

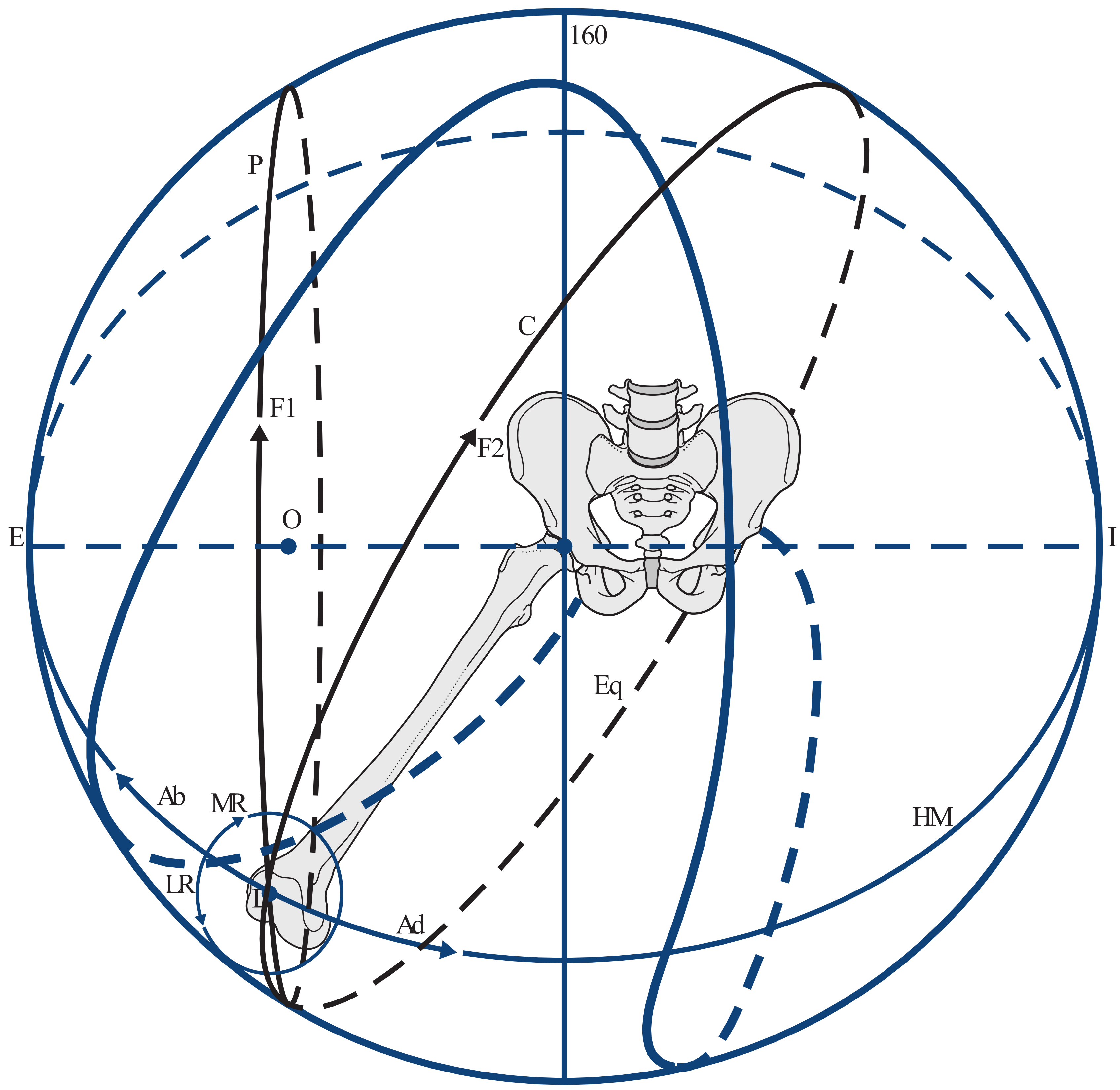

Figure 7.36 • Circumduction of the hip. Reproduced with permission from Kapandji (1988).

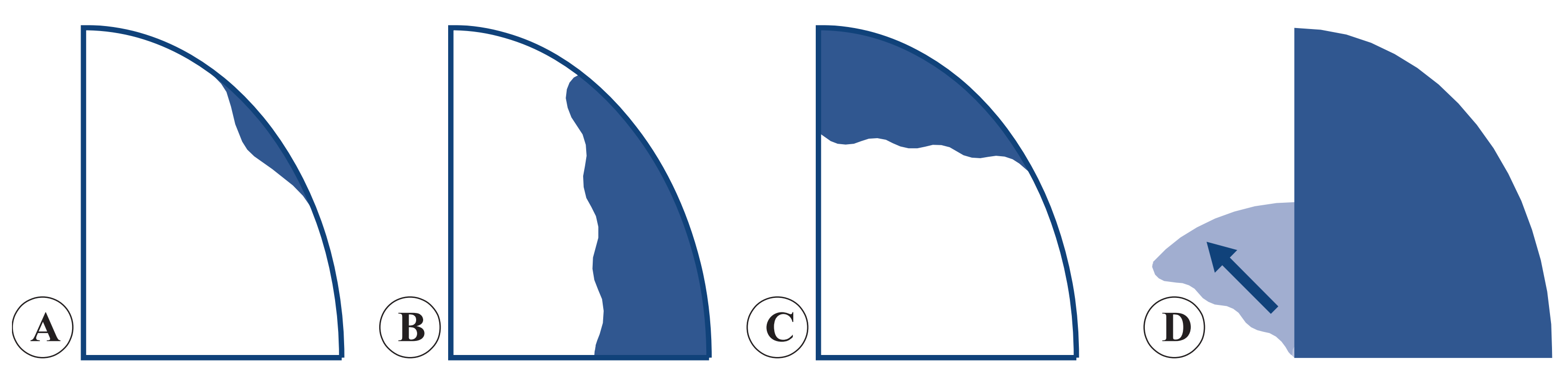

Figure 7.37 • Changes in F/Ad.

Figure 7.38 • Restricted posterior gliding dysfunction. Movement adapted from Sahrmann (2002).

- *Dysfunction*:
  1. If the hip moves remarkably further into flexion then the SLR restriction may be due to blocked posterior accessory movement due to overactivity in posterior joint muscles or inhibition of the anterior local stabilizer.
  2. If the hip does not move further into flexion, or the SLR is even more blocked, then the SLR restriction may be due to blocked posterior accessory movement due to passive tissue restriction, i.e. shortening in posterior joint muscles or capsule. As confirmation, the test (Addison 2004) for excessive anterior gliding in prone may be carried out this time with the

ball of each of the therapist's thumbs under the anterior superior iliac spines and the fingers palpating the femoral head anteriorly. (The therapist's thumbs rest in front of the second metacarpal). If the femoral head feels prominent on the affected side in relation to the anterior superior iliac spine but does not move further forward during active hip extension, the head may be fixed in anterior glide.

Test in flexion/adduction: right hip (Addison 2004)

Use the test position described below for excessive posterior gliding dysfunction (see Fig. 7.41) looking for restricted rather than excessive movement. This is defined at the end of the test.

Restricted anterior gliding

- *Indication*: Marked restriction of physiological hip extension. (Note: extension is coupled with anterior gliding movements.)
- This test for anterior accessory gliding motion may be performed as it is described in the treatment section below comparing left/right for restriction of movement.

Stability tests

Clinical tip:

The local stabilizers (short deep one-joint muscles often inserting into the joint capsule) have been shown to stabilize individual joints without inhibiting or restricting angular or physiological movement in that joint (Panjabi 1992). A muscle such as psoas will help tighten the hip capsule preventing excessive accessory movement while nevertheless allowing flexion or extension movements to take place. This centring effect ensures that the fulcrum of motion lies within the joint. In the presence of inhibited segmental stabilizers and overactive or shortened global mobilizers (e.g. tensor fascia lata, rectus femoris) this fulcrum will migrate allowing the joint to lever or glide forward.

Excessive anterior gliding dysfunction (Sahrmann 2002) (Fig. 7.39)

- *Indications*: See Table 7.8.
- *Patient position*: Prone lying.

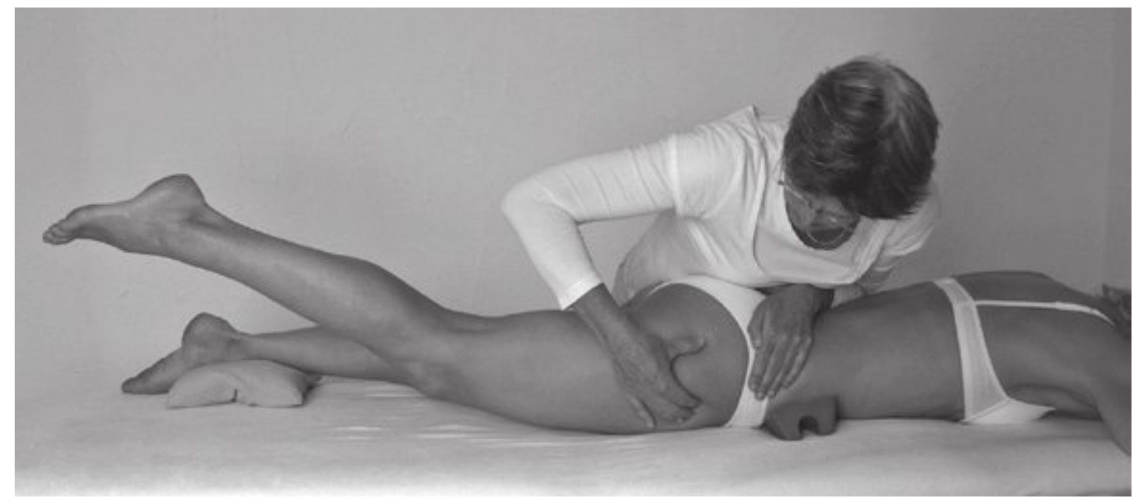

Figure 7.39 • Excessive anterior gliding dysfunction. Movement adapted from Sahrmann (2002).

- *Therapist position*: The therapist stands on the opposite side leaning across the pelvis to fix its position. A wedge may be placed under the anterior superior iliac spine on the test side to provide further stability. The fingers and thumb of the therapist's right hand grasp the trochanter anteriorly and posteriorly.
- The patient lifts the extended leg 10°–15° without hip rotation.
- *Good function*: The position of the trochanter remains constant.
- *Dysfunction*: The trochanter moves towards the plinth: anterior gliding dysfunction.
- *Adaptation*: Instead of extending the hip the patient need only flex the knee.
- *Test variation*: See Fig. 7.40.

Excessive posterior gliding dysfunction (Fig. 7.41)

- *Indications*: See Table 7.8.
- *Test*: For right hip (Addison 2004).
- *Patient position*: Supine in 80° hip flexion, the knee relaxed.
- *Therapist position*: The therapist stands facing the opposite hip with the femur held against her trunk. The middle finger of her right hand

Figure 7.40 • Test variation palpating the femoral head.

Figure 7.41 • A Excessive posterior gliding dysfunction. B Model of excessive posterior gliding dysfunction.

palpates the the ischial tuberosity with the base of the right hand lying against the lateral side of the greater trochanter. Using a trunk movement the therapist adducts the hip to the point where the right anterior superior iliac spine is about to move.

- The therapist then performs a passive longitudinal cranial movement in the direction of the femoral shaft at the same time palpating movement of the greater trochanter in relation to the tuberosity.
- *Good function*: The trochanter moves minimally posteriorly until it engages the acetabular joint surface (a relatively hard end-feel) and then slightly laterally where a normal end-feel is palpated. The lateral movement range should be compared with the opposite side.
- *Dysfunction*: The lateral movement of the trochanter is excessive in comparison with the opposite side and the end-feel is abnormal.
- *Note*: This test may be used to examine restriction of posterior gliding movement which may initially have been caused by excessive anterior gliding: on the above test the trochanter moves minimally posteriorly until it engages the acetabular joint surface but no further lateral movement takes place and the end-feel is hard. If hip flexion is tested it will also be restricted.

Excessive lateral gliding dysfunction

- *Indications*: Pain in side lying with the affected side above, particularly if adduction appears excessive; pain in side lying with the affected side below, particularly if the body habitually lies in a rolled-forward position on this side; pain in standing when 'hanging' sideways on the affected hip; prominence of the trochanter on this side; inability to sit cross-legged in the lotus position due to a lack of abduction. This may be a feature of the 'up and out' migratory OA presentation.
- *Test*: This test for lateral gliding may be performed as described below in the section on passive mobilizing techniques with the additional incorporation of a left/right comparison.

Treatment

Passive mobilizing and active stabilizing techniques are described below.

Passive mobilizing techniques: accessory movements

Lateral movement (Figs 7.42, 7.43)

- *Direction*: Movement of the head of the femur in a lateral direction in relation to the acetabulum.

Figure 7.42 • Lateral movement, grades I and II.

- *Symbol*: ⟶•⟶
- *Patient starting position*:
  - *in side lying* (grades I and II): side lying with pillows placed between the legs for comfort, legs flexed for comfort
  - *in supine* (grades III and IV): supine, lying with the hip flexed to the chosen angle and the knee flexed comfortably.
- *Therapist starting position*:
  - *in side lying*: standing behind the patient facing in line with the line of the femoral shaft
  - *in supine*: standing alongside the patient, level with the hip, facing across the patient's body.

Figure 7.43 • Lateral movement grades III and IV.

Localization of forces (position of therapist's hands)

In side lying

- Both hands grasp around the patient's thigh anteriorly and posteriorly as near to the hip as possible.
- The fingers of both hands spread around the inner thigh.
- The thumbs of both hands spread around the outer thigh.

In supine

- The sternum is pressed against the patient's knee.
- The fingers of both hands interlock and hold round the medial surface of the patient's thigh as near to the hip joint as is practicable.
- The arms and chest stabilize the patient's lower leg.

Application of forces by therapist (method)

In side lying

- The very gentle oscillatory lateral movement is produced by the therapist's body movement through the whole of the palmar surfaces of all the fingers against the inner thigh.

In supine

- In this starting position the oscillatory lateral movement of the head of the femur in the acetabulum is produced by the therapist moving the femur laterally while ensuring that the angle of Ab/Ad does not alter.
- This may require considerable movement of the patient's knee position to avoid the tendency of the patient's pelvis to roll as the therapist's hands help to pull the head of the femur laterally.
- The patient's whole limb and the therapist's hands, arms and thorax should move as one solid entity while the therapist rocks back and forth (grades III and IV especially).

Variations in the application of forces

- The same movement can be performed with the hip in any degree of flexion or extension and in different angles of abduction and adduction or in varying degrees of rotation.
- While producing lateral movement of the hip the therapist may also:

1. Stabilize the patient's knee, preventing its lateral movement so that the lateral movement of the hip is combined with a small degree of hip horizontal adduction
2. Carry the knee in parallel with the hip so that a small degree of hip horizontal abduction takes place.

- To increase range using accessory lateral movement at the limit of physiological range (e.g. medial rotation), the therapist can first of all flex and rotate the hip to its limit; the therapist's trunk must then be turned to face the patient's feet while simultaneously producing the lateral movement. In this way, the patient's whole limb and the therapist's hands, arms and trunk move as an entity as the required movement is produced by the rocking action of the therapist's body.
- Straps and belts can be used but the therapist may then lose the feedback information on the quality and range of movement available. However, a small therapist treating a large patient may require a strong grade IV1 movement in treatment and is therefore justified in using such equipment.

Uses

- Recovery of range following fracture of the femur or acetabular region.
- Capsular tightness or a medially migrated OA hip. with associated loss of flexion.
- Painful hip conditions or stiff ranges of movement.

Longitudinal movement caudad (Figs 7.44-7.47)

- *Direction*: Movement of the head of the femur in a longitudinal caudad direction in relation to the acetabulum.
- *Symbol*: ↔
- *Patient starting position*:
  - *in supine*: lying in the middle of the couch, knee slightly flexed, heel on the couch
  - *in side lying*: lying on the left side with pillows between the legs and the hips positioned in mid-flexion/extension, knees comfortably flexed
  - *in flexion*: supine, lying with hip flexed to 90° or at the limit, knee fully flexed.
- *Therapist starting position*:
  - *in supine*: standing level with the patient's right knee facing the patient's head. The therapist's right knee is placed on the couch supporting under the patient's slightly flexed hip and knee (Fig. 7.45)
  - *in side lying*: if thumb contact is to be used the therapist stands behind the patient in line with the femur (Fig. 7.44). If the patient's femur is to be used as leverage the therapist stands behind the patient and leans across the patient's body so that the pelvis is cradled in the therapist's left axilla (Fig. 7.46)
  - *in flexion*: standing by the patient's side facing the patient's head (Fig. 7.47).

Localization of forces (position of therapist's hands)

In supine

- The therapist kneels (right shin on couch).
- The right thigh is placed diagonally under the patient's knee.
- Alternatively, the therapist sits on the edge of the couch.
- The right leg, fully flexed at the knee and laterally rotated at the hip, placed under the patient's thigh.
- Both hands encircle the distal end of the patient's femur.

In side lying

- Both thumbs are placed on the greater trochanter.
- Fingers spread widely to help stabilize the thumbs.
- Forearms are directed in line with patient's femur.
- If the leg is to be used as leverage, both hands grasp the lower end of the patient's femur just proximal to the femoral condyles.

In flexion

- The fingers of both hands interlock and grasp around the anterior surface of the patient's thigh as far proximal as is practicable.
- The head and shoulders cradle the patient's knee to stabilize the hip and knee angle.

Longitudinal movement caudad

Figure 7.44 • Longitudinal movement caudad, grades I and II.

Figure 7.45 • Longitudinal movement caudad.

Figure 7.46 • Longitudinal movement caudad, alternative method, grades I and II.

Figure 7.47 • Longitudinal movement caudad in flexion, grades III and IV.

Application of forces by therapist (method)

In supine

- The oscillatory longitudinal movement is produced by pulling gently on the patient's femur.
- This technique can be assisted by a rolling or sliding movement of the therapist's supporting thigh under the patient's leg in the direction of the treatment movement.
- The technique should be performed gently with no discomfort for very painful disorders and in varying degrees of flexion.

In side lying

- If the therapist's thumbs are to be used, extremely gentle and comfortable longitudinal movement can be produced.
- The therapist's thumbs should not be the prime movers but should act as spring-like contact points, feeling the movement that is taking place.
- The therapist's arms and body gently rock back and forth in line with the patient's femur.
- If the patient's femur is to be used the therapist's left axilla must stabilize the patient's pelvis to prevent it moving while the technique is being performed.
- In this way the longitudinal movement is produced as an oscillatory movement through the therapist's hands which clasp the distal end of the patient's femur.
- The movement should be produced by the therapist's arms.
- The therapist's body cannot be used because loss of control of the patient's pelvis would occur.

In f exion

- The therapist's grasp of the patient's leg is such that the therapist's feet can rock back and forth as the leg rocks in the same direction.

Variations in the application of forces

- The longitudinal movement performed in flexion can be adapted so that it can be performed in any chosen angle of abduction or adduction.
- In flexion, more flexion can be added as the longitudinal movement is produced (group 2) or flexion can be reduced a few degrees during the technique (group 3b). Flexion may also be combined in flexion/adduction or flexion/abduction positions (group 2).

Uses

- Very soothing for painful hip disorders.
- Superior migrating OA and capsular tightness.

Posteroanterior and anteroposterior movements (Figs 7.48, 7.49)

- *Direction*: Movement of the head of femur in posteroanterior and anteroposterior directions in relation to the acetabulum.
- *Symbols*: ↓, ↑
- *Patient starting position*: Side lying with the upper leg supported by pillows in the neutral position or at the limit of the stiff range (if leg is used a leverage: supine or side lying).
- *Therapist starting position*: *PA* – standing behind the patient; *AP* – standing in front of the patient (if leg is used as leverage: next to patient).

Localization of forces (position of therapist's hands)

Posteroanterior

- The pads of both thumbs, pointing towards each other are placed against the posterior

Figure 7.48 • Posteroanterior movement.

Figure 7.49 • Anteroposterior movement.

surface of the greater trochanter (grades I and II).
- The fingers are spread around the thumbs which should be in direct bone-on-bone contact with the trochanter.
- Alternatively, the heel of the hand is placed against the posterior surface of the greater trochanter (grades III and IV).

Anteroposterior

- The pads of both thumbs pointing towards each other are placed against the anterior surface of the greater trochanter (grades I and II).
- The fingers are spread around the thumbs which should be in direct bone-on-bone contact with the trochanter.
- Alternatively, the heel of the hand can be placed against the anterior surface of the greater trochanter (grades III and IV).

Application of forces by therapist (method): PA and AP

- For grades I and II soft, gentle, small oscillatory movements are produced by the therapist's body and arms through the thumbs stabilized against the trochanter.
- The movement should not be produced by the thumb intrinsic muscles as the movement needs to be both discomfort- and pain-free.
- For grades III and IV the heel of the hand, via the body and arms, produces the stretching movement while the other hand needs to stabilize the patient's pelvis via the anterior superior iliac crest.

Variations in the application of forces

- The thumbs can be used to produce the PA and AP movements in the same way as described above but with the patient lying supine.
- With the patient lying prone the heel of one hand can be used to produce a PA movement on the posterior surface of the greater trochanter while the therapist's other hand is used to take the patient's hip and leg into more extension.
- The point of contact around the greater trochanter can be changed to explore a variety of inclinations to the technique.
- Supine: both hands around the leg – one palm of the hand just below the ischial tubercle, the other hand just below the joint in the inguinal fold. Produce the movement with gentle movements of the trunk.

Uses

- Very little PA and AP movement of the head of the femur takes place in the acetabulum. However, these movements may be useful as a treatment for very painful hip disorders (grades I and II).
- Can be used as an accessory movement at the limit of stiff physiological flexion/extension range (grades III and IV).
- May be a technique to consider in disorders such as subtrochanteric bursitis or piriformis syndrome.
- Treatment techniques under compression

Along the femoral line (longitudinal movement cephalad) (Fig. 7.50)

- *Direction*: Compression of the head of the femur into the acetabulum along the line of the femur (longitudinal cephalad movement).
- *Symbol*: ≻•≺ femur, or ↞•↠ ceph.
- *Patient starting position*: Supine, lying on the couch.
- *Therapist starting position*: Standing beyond the patient's slightly flexed right knee facing the patient's head.

Localization of forces (position of therapist's hands)

- The therapist's thigh supports under the patient's slightly flexed knee.

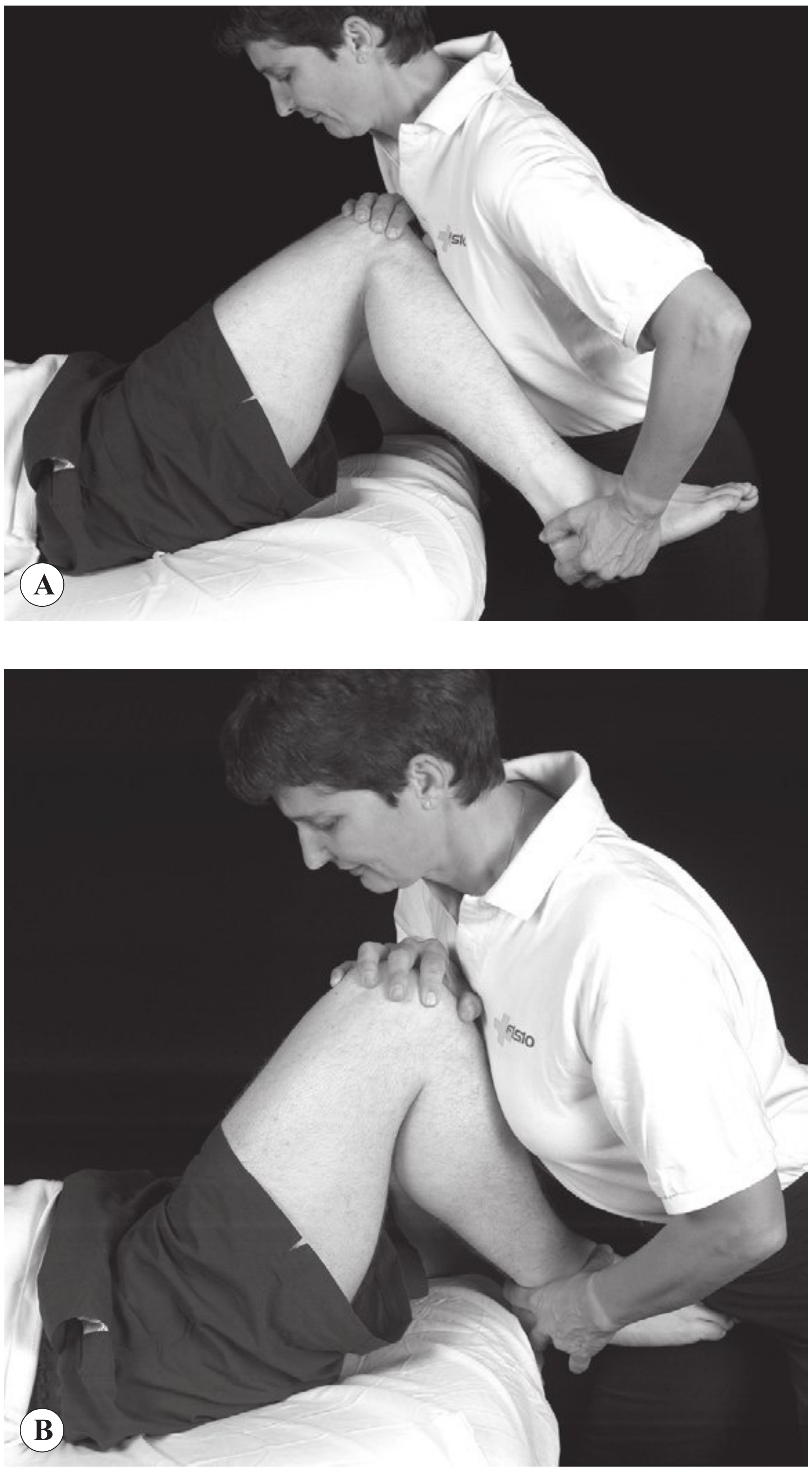

Figure 7.50 • Rotation added to longitudinal cephalad compression: A medial rotation; B lateral rotation.

- The right hand cups over the patient's tibial tuberosity.
- The left hand adds to the support under the patient's knee.

Application of forces by therapist (method)

- The oscillatory movement of pushing of the head of the femur into the acetabulum is performed by the therapist's right hand thrusting against the front of the patient's tibia in the line of the femur.
- The return oscillation is guided by the therapist's left hand against the back of the patient's knee.
- Stronger techniques will produce associated pelvic movement.
- The technique, generally, should be performed into slight pain or discomfort or short of the onset of severe irritable pain.

Variations in the application of forces

- This compression technique can be performed with other movements such as rotation or flexion and extension.
- While compression is maintained, other movements can be added.
- While compression is maintained along the shaft of the femur through the knee, the hip can be medially or laterally rotated via the patient's lower leg and foot.

Uses

- Mild aching in the hip with weight bearing.
- To reproduce and treat joint surface pain.

Compression medially (with transverse medial movements) (Fig. 7.51)

- *Direction*: Compression of the head of the femur into the acetabulum in a medial direction.
- *Symbol*: ≻•≺ neck, or ⟶• medial.
- *Patient starting position*: Lying on the pain-free side (in this case the left side).
- *Therapist starting position*: Leaning across the patient from in front.

Localization of forces (position of therapist's hands)

- The heel of the right hand is cupped over the patient's left greater trochanter.
- The right shoulder is positioned directly over the right hand.
- The left hand and forearm hold round and support the patient's lower leg medially, making maximum contact.

Application of forces by therapist (method)

- The therapist produces a sustained squeezing together of the head of the femur medially into the laterally facing articular surface of the acetabulum.

Application of forces by therapist (method)

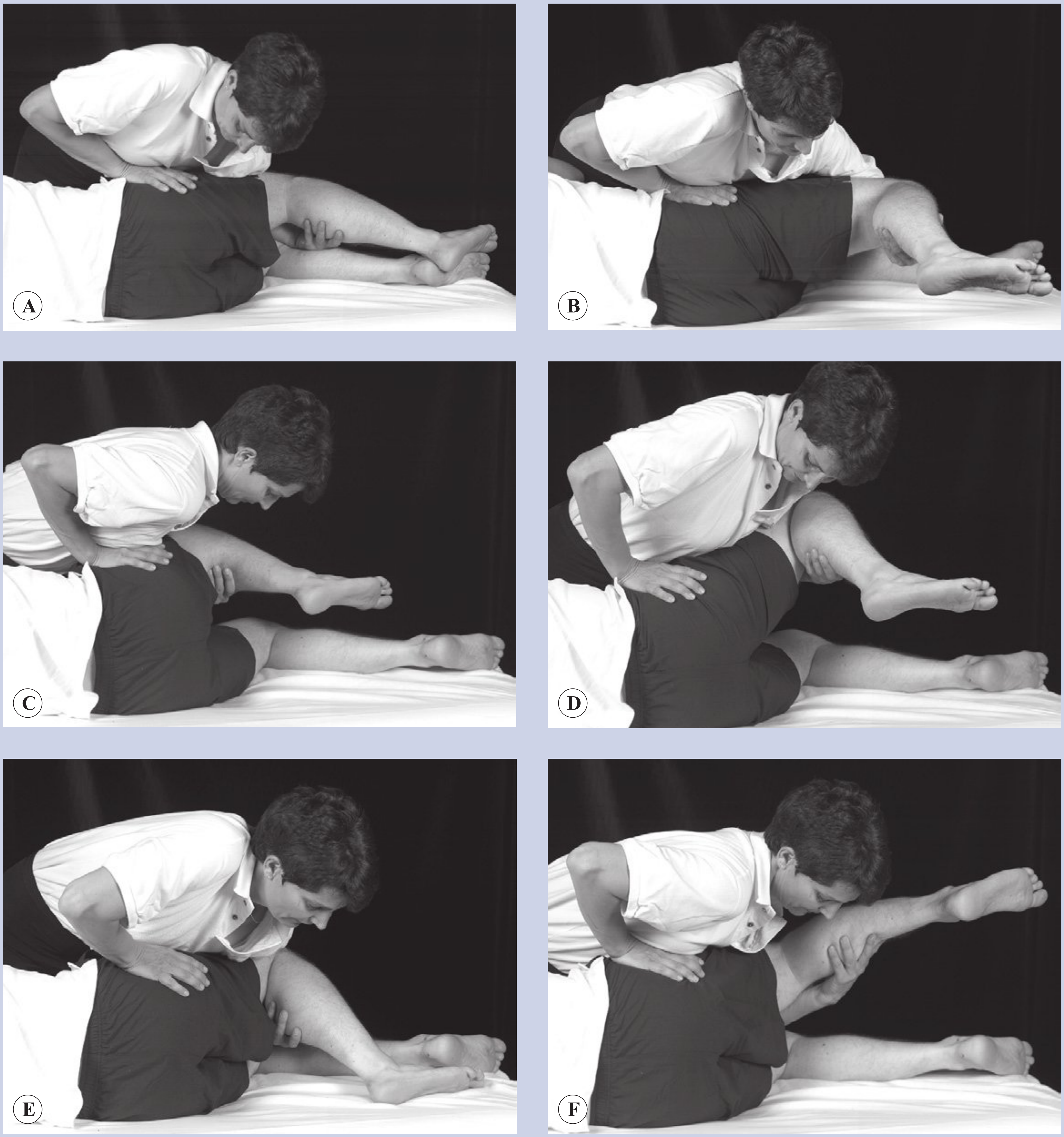

Figure 7.51 • Compression medially: A in neutral; B producing extension; C producing flexion; D producing abduction; E producing lateral rotation; F producing medial rotation.

- Via the therapist's right shoulder the head of the femur is then squashed towards the floor in an oscillatory overpressure fashion.
- The time needed to apply the pressure and reproduce the patient's symptoms should be related to the time the patient is able to lie on the painful hip before becoming aware of the symptoms (Fig. 7.51A).
- While the pressure is sustained the therapist's body and right hand pivot around the patient's

right hip to produce extension (Fig. 7.51B) and flexion (Fig. 7.51C).

- The therapist's trunk is side flexed to produce abduction at the patient's hip (Fig. 7.51D).
- For lateral rotation, the therapist's body is curved forwards over the patient's right hip resulting in the patient's left foot being lowered towards the floor while the knee is retained in mid flexion and extension, abduction and adduction (Fig. 7.51E).
- For medial rotation the reverse action of the therapist's body will produce medial rotation (Fig. 7.51F).

Uses

- Chronic hip symptoms which make it uncomfortable for the patient to lie on the painful hip.
- OA hip which is painful when the patient's lies on the affected side.
- Loss of ability to sit in the lotus or tailor position or to sit with the foot on the opposite knee.

F/Ad as a treatment technique

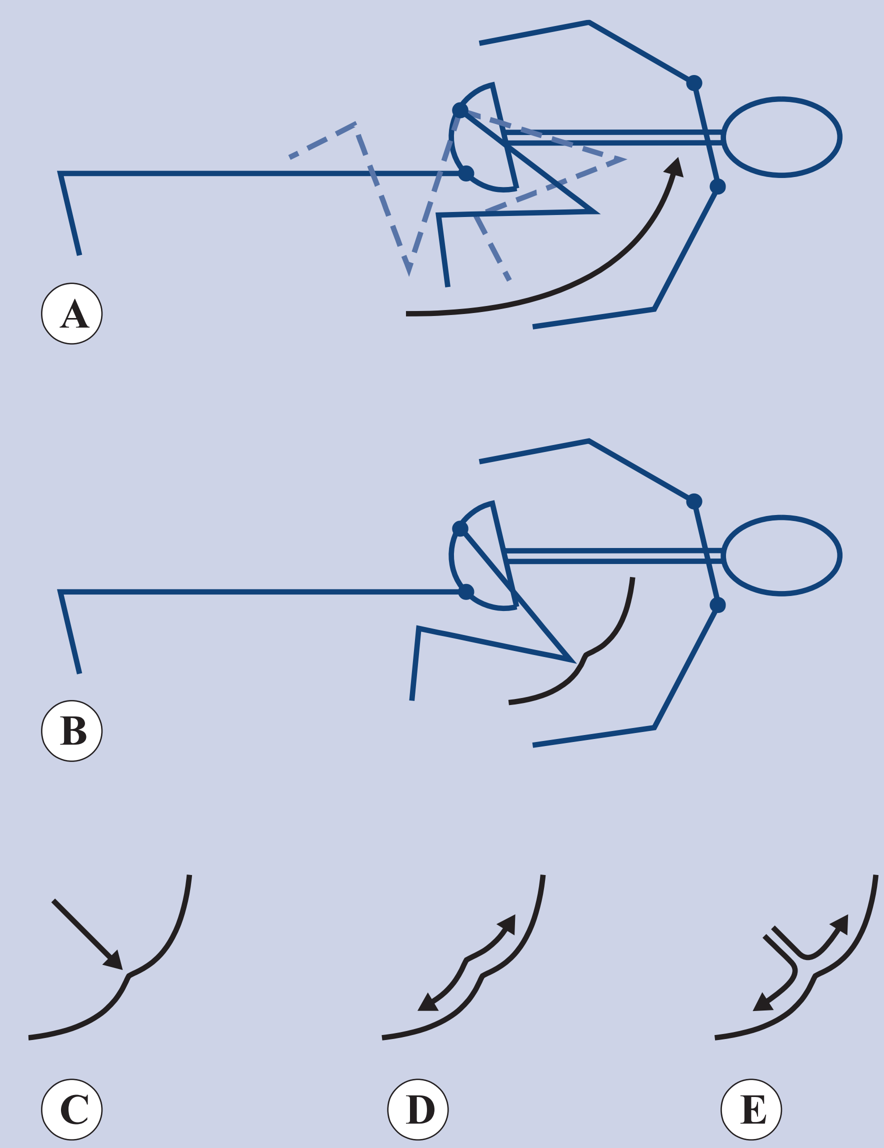

Figure 7.52 • Diagrammatic representations of different hip flexion/adduction movements.

F/Ad as a treatment technique

- F/Ad as a treatment technique can be carried out in grades II, III and IV (Fig. 7.52).

Grade IV

Small oscillations at end of range (grade IV) can be directed against the painful limit as treatment in one of three ways:

1. With a F/Ad movement directed towards the limitation (single headed arrow) (Fig. 7.52C).
2. By moving through an arc of F/Ad backwards and forwards over the limitation (double-headed arrow) ('rolling over') (Fig. 7.52D).
3. Using small oscillatory movements in an arc, back and forth at either side of the limitation (two double-headed arrows) ('scooping') (Fig. 7.52E).

If the patient has a very painful knee the therapist can support under the knee with one hand to bring it out of the painful knee flexion position.

Uses

- Probably the most useful hip technique for both examination and treatment. As important to the hip as the quadrant is to the shoulder.
- When all other movements are pain free, this movement can be painful and restricted when the hip is a source of minor symptoms.
- Hip flexion and adduction are not described separately as F/Ad serves the purpose of both.
- The technique can be used in clinical groups 3b and 2 and group 4 in combination with medial rotation and compression.

Grades II and III (Figs 7.53, 7.54)

- *Patient starting position*: Supine, lying with the hip flexed accordingly and the knee flexed to approximately 90°.
- *Therapist starting position*:
  - *grade II*: standing at the level of the patient's right thigh facing the left shoulder. The therapist's body is positioned as a stop at the

Figure 7.53 • Flexion/adduction grade III.

lateral extent of the F/Ad movement (this would be further away for a grade III)
- ○ *grade III*: standing at the level of the patient's right thigh facing the left shoulder. The right knee rests on the couch and the left thigh leans against the edge of the couch.

Localization of forces (position of therapist's hands)

Grade II

- The left hand holds the patient's right knee.
- The right hand holds the patient's foot.
- The body position is adjusted to face the appropriate direction of F/Ad.

Grade III

- Both hands first hold the patient's flexed knee in order to flex and adduct the hip to the limit of the range at the chosen point in the arc.
- The grip is then altered so that:
  - ○ the left hand supports the patient's knee
  - ○ the right hand supports the patient's foot so as to maintain the mid-rotation position.

Figure 7.54 • Flexion/adduction grade II.

Application of forces by therapist (method)

Grade II

- The large amplitude oscillatory movement should not reach the limit of the range and is performed back and forth by the therapist's arms.
- The depth to which the movement reaches is determined by the onset and increase of pain, and is performed short of any resistance.
- The return movement and therefore the arc of oscillation is determined by the therapist's body position which acts as a stop.

Grade III

- The large amplitude oscillatory movement of approximately 30° (to 90°) is directed towards the limit in a straight line. The amplitude of the patient's foot must equal that of the knee.
- The therapist's body is positioned to form a stop at the outer limit of the movement.
- The therapist swings the patient's knee towards the limit of F/Ad to where the patient's pelvis starts to lift off the couch and into a degree of resistance.
- The discipline is to perform the technique smoothly and without any hip rotation.

Uses

- Clinical group 3a (grade II), 3b (grade III).
- Resolving hip pain or to help restore range of movement after injury.
- To help settle an exacerbation of osteoarthritis.
- As a technique to ease off treatment soreness.

Other passive treatment techniques

Medial rotation (Figs 7.55-7.60)

Medial rotation is frequently restricted and painful, and may be more restricted in hip flexion than in extension or vice versa, and such variations should be sought during examination.

As a treatment technique medial rotation can be performed in grades I, II, III and IV and may be varied in different positions.

Medial rotation

Figure 7.55 • Medial rotation, grades I and II.

Figure 7.56 • Medial rotation, alternative method for grades I and II.

Figure 7.57 • Medial rotation in extension supine for grades III and IV.

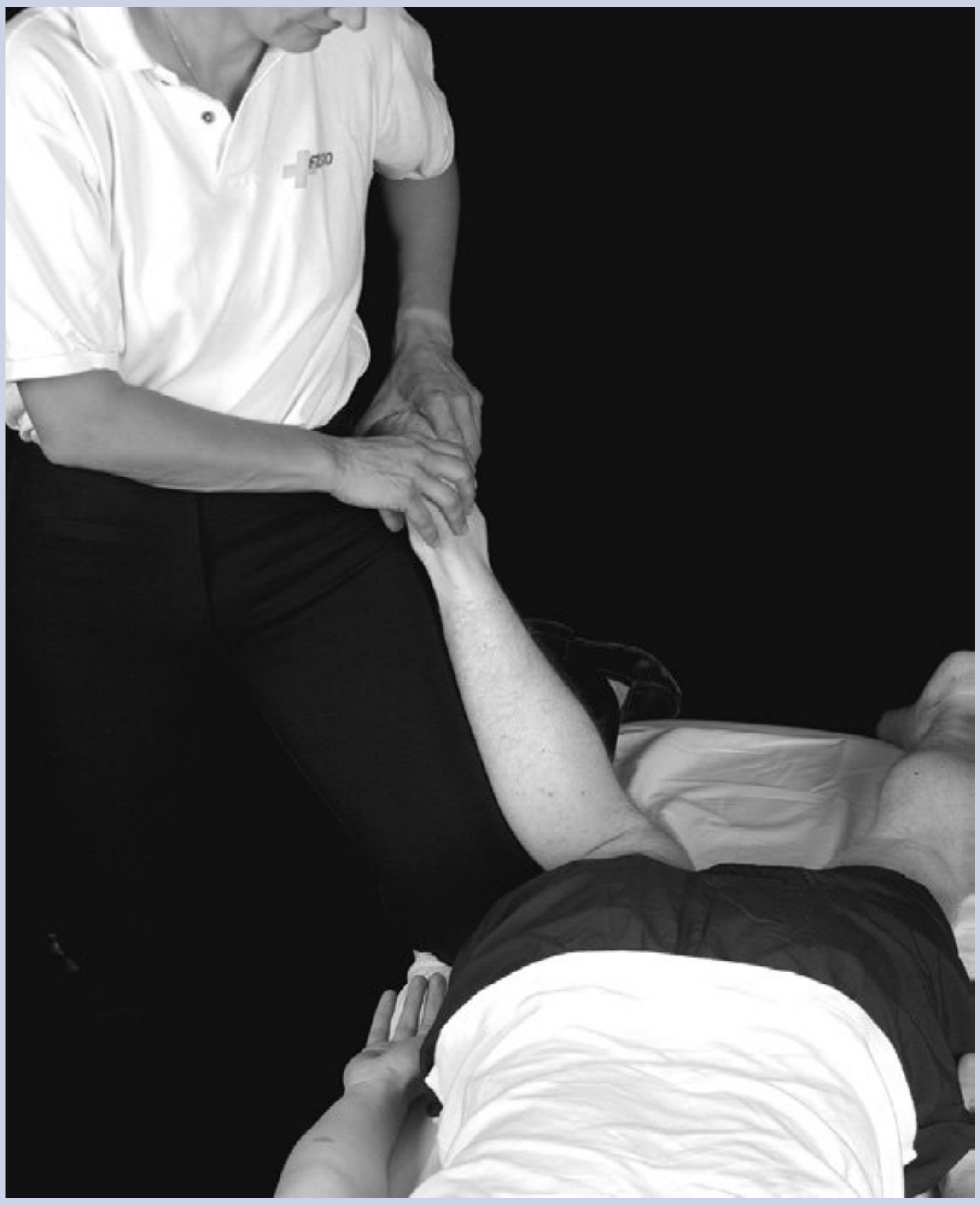

Figure 7.58 • Medial rotation in extension prone for grades III and IV.

Medial rotation—cont'd

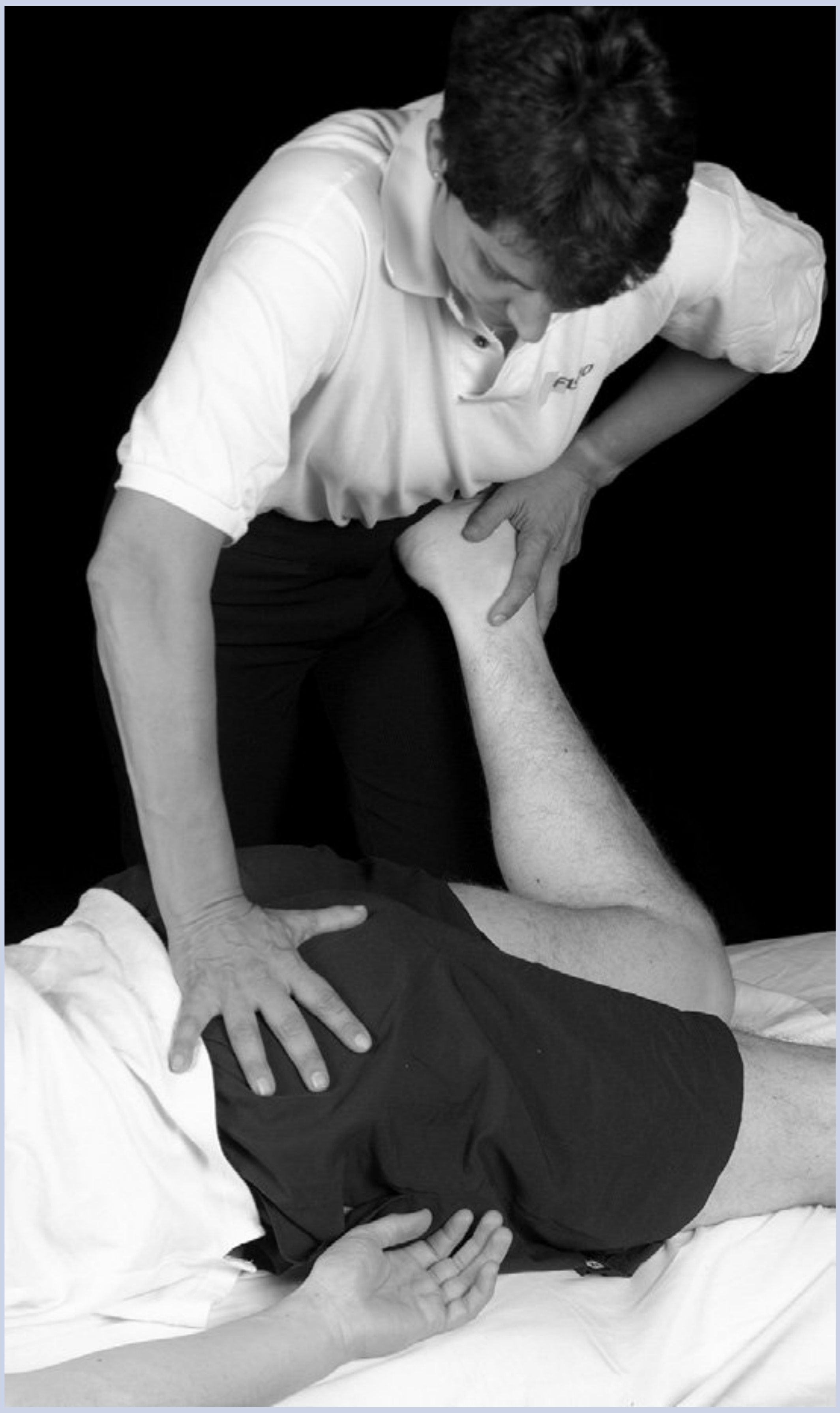

Figure 7.59 • Medial rotation, grade IV, left ilium pushed back towards the couch.

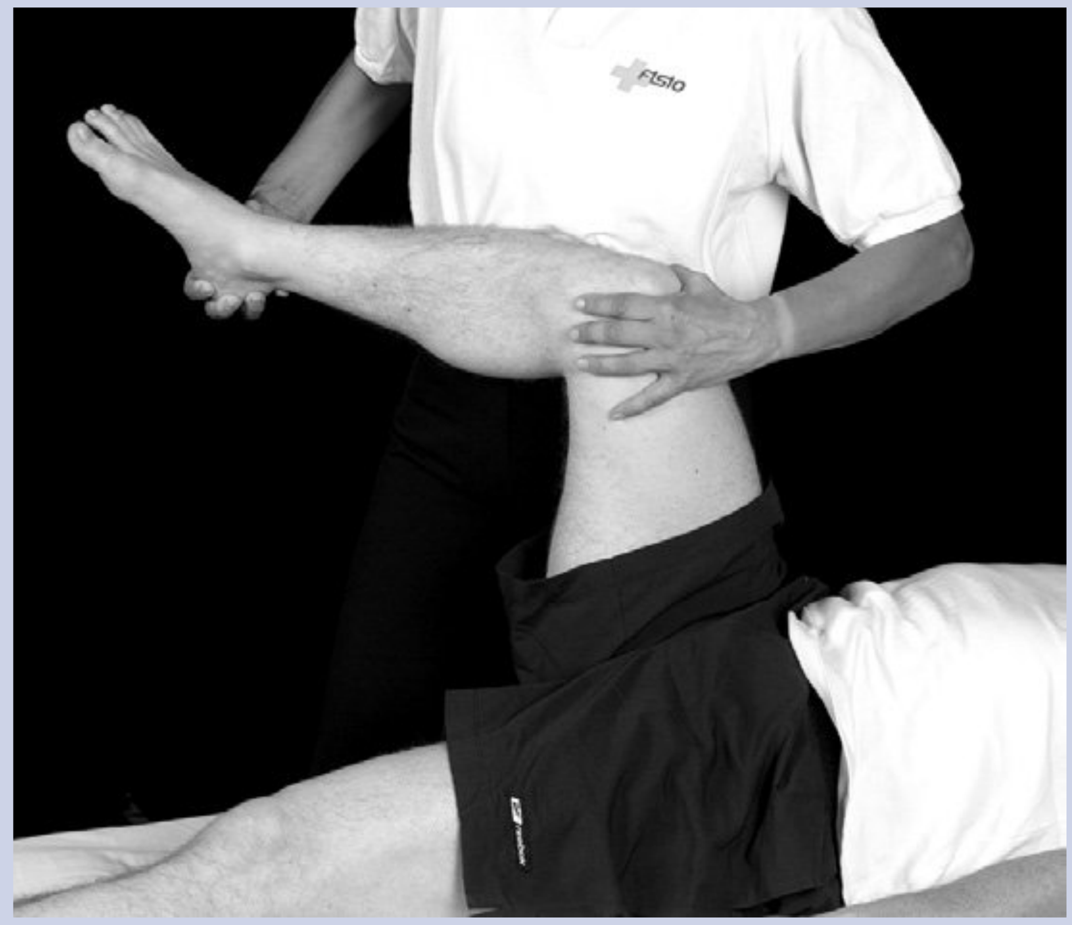

Figure 7.60 • Medial rotation in flexion, grades III and IV.

- *Direction*: Medial rotation of the hip joint in various physiological positions.
- *Symbol*: ↻
- *Patient starting position*:
  - *in supine* (grades I and II): supine, lying near to the right edge of the couch (Fig. 7.55)
  - *in side lying* (grades I and II): left side lying with a pillow between the legs to support the hip in the neutral pain-free position (Fig. 7.56)
  - *in extension supine (grades III and IV)*: supine, lying near the right side of the couch at a slight angle to bring the patient's left foot near the edge of the couch and so that the right knee is free of the edge (Fig. 7.57)
  - *in extension prone (grades III and IV)*: prone, lying with the knee flexed to a right angle (Figs 7.58 and 7.59)
  - *in flexion (grades III and IV)*: supine, lying near to the right edge of the couch with the hip and knee flexed to right angles (Fig. 7.60).
- *Therapist starting position*:
  - *in supine*: standing at the level of the patient's knee facing across the patient's body. Right knee placed on the couch with

the thigh carefully positioned so as to support the patient's thigh and calf for comfort and to allow the patient's hip and knee to flex a few degrees so that the patient's heel rests on the couch (Fig. 7.55)
  - *in side lying*: leaning across the patient's hip from behind (Fig. 7.56)
  - *in extension supine*: kneeling by the patient's right thigh facing the left knee (Fig. 7.57)
  - *in extension prone*: standing by the patient's right knee facing the hip (Figs 7.58 and 7.59)
  - *in flexion*: standing by the patient's right hip facing the left knee (Fig. 7.60).

Localization of forces (position of therapist's hands)

In supine

- Both hands grasp around the patient's right knee.

In side lying

- The left axilla is positioned so as to support the patient's hip.
- The left hand holds round and under the patient's knee to stabilize it and to feel for the hip rotation.
- The right hand holds under the patient's right ankle and foot to stabilize it.

In extension supine

- The left forearm supports under the patient's knee.
- The right hand holds the patient's right foot.
- The left forearm stabilizes the patient's knee.

In extension prone

- The left knee rests on the couch.
- The left thigh forms a comfortable stop to the patient's leg at the limit of hip medial rotation.
- The right hand holds the patient's heel.
- The left hand holds the patient's forefoot.
- The left leg is adjusted to the height required to prevent further medial rotation.

In f exion

- The left hand supports the patient's knee.
- The right hand supports the patient's heel.

Application of forces by therapist (method)

In supine (grades I and II)

- Small or large oscillatory movements of the patient's femur are produced by light pressure against the lateral surface of the patient's knee.

In side lying (grades I and II)

- The therapist holds around the patient's knee using the left hand.
- A constant position of Ab and Ad and flexion/extension must be maintained.
- Small or large oscillatory movements are produced by raising and lowering the patient's foot using the right hand.
- No pain or discomfort should be felt in the hip.

In extension supine (grades III and IV)

- The therapist medially rotates the patient's hip by raising the heel laterally.
- Grade IV movements are produced by moving the patient's foot laterally to the limit of the range while maintaining an equal and opposite counterpressure against the lateral side of the patient's knee using the left forearm.
- Oscillatory movements of medial rotation are controlled by the therapist's left hand; the pressure with the left arm should be quite firm.
- Grade III large amplitude movements are produced by lowering the patient's right foot, which releases the pressure against the therapist's left forearm. While lowering the foot, the therapist must take care to maintain the patient's thigh in a constant position so that only medial rotation is produced.

In extension prone (grades III and IV)

- Medial rotation is produced by the drawing of the patient's foot towards the therapist until it reaches the therapist's thigh as a stop. The patient's foot and leg are then oscillated back and forth by the therapist's arms.
- The use of inversion of the patient's foot, while it is being drawn towards the therapist, makes for a better action.
- The therapist may need to have the right hand positioned against the lateral side of the patient's thigh during medial rotation to prevent hip abduction.

In f exion (grades III and IV)

- The therapist medially rotates the patient's hip and at the same time prevents the hip abducting by using the left hand to apply pressure against the lateral side of the patient's knee.

- The therapist's right hand then moves the patient's foot in an arc around the patient's knee.

Variations in the application of forces

In extension prone

- As with nearly all passive movement treatment techniques the movement of the joint can be produced from either of the bones forming the joint.
- In the case of medial rotation of the hip (grade IV) the same starting position as for medial rotation in extension prone (Figs 7.58 and 7.59 can be adopted but with sufficient medial rotation to allow the patient's ilium to be raised a few centimetres from the couch.
- By stabilizing the patient's lower leg the therapist can produce medial rotation of the patient's right hip by oscillatory pressure on the patient's left buttock, moving the left ilium back towards the couch (Fig. 7.59).

Uses

- Very painful disorders of the hip (clinical groups 1 and 3a).
- Stiff hips which require mobilization to improve range (clinical groups 2 and 3b).
- Frequently restricted movement in many hip disorders.
- If used in conjunction with an anteroposterior accessory glide it may be of help for the blocking which takes place during high kicking. (martial arts and ballet)
- Osteoarthritic hips.
- As a shaft rotation technique to incorporate roll and slide of the femoral head in the acetabulum, including a small degree of Ab and Ad due to the roll of the leg.

Lateral rotation (Figs 7.61, 7.62)

- *Direction*: Lateral rotation of the head of the femur in the acetabulum.
- *Symbol*: ↻
- *Patient starting position*:
  - *in flexion supine*: supine, lying with the hip and knee flexed to 90°
  - *in extension prone*: prone, lying with the knee flexed to 90°.

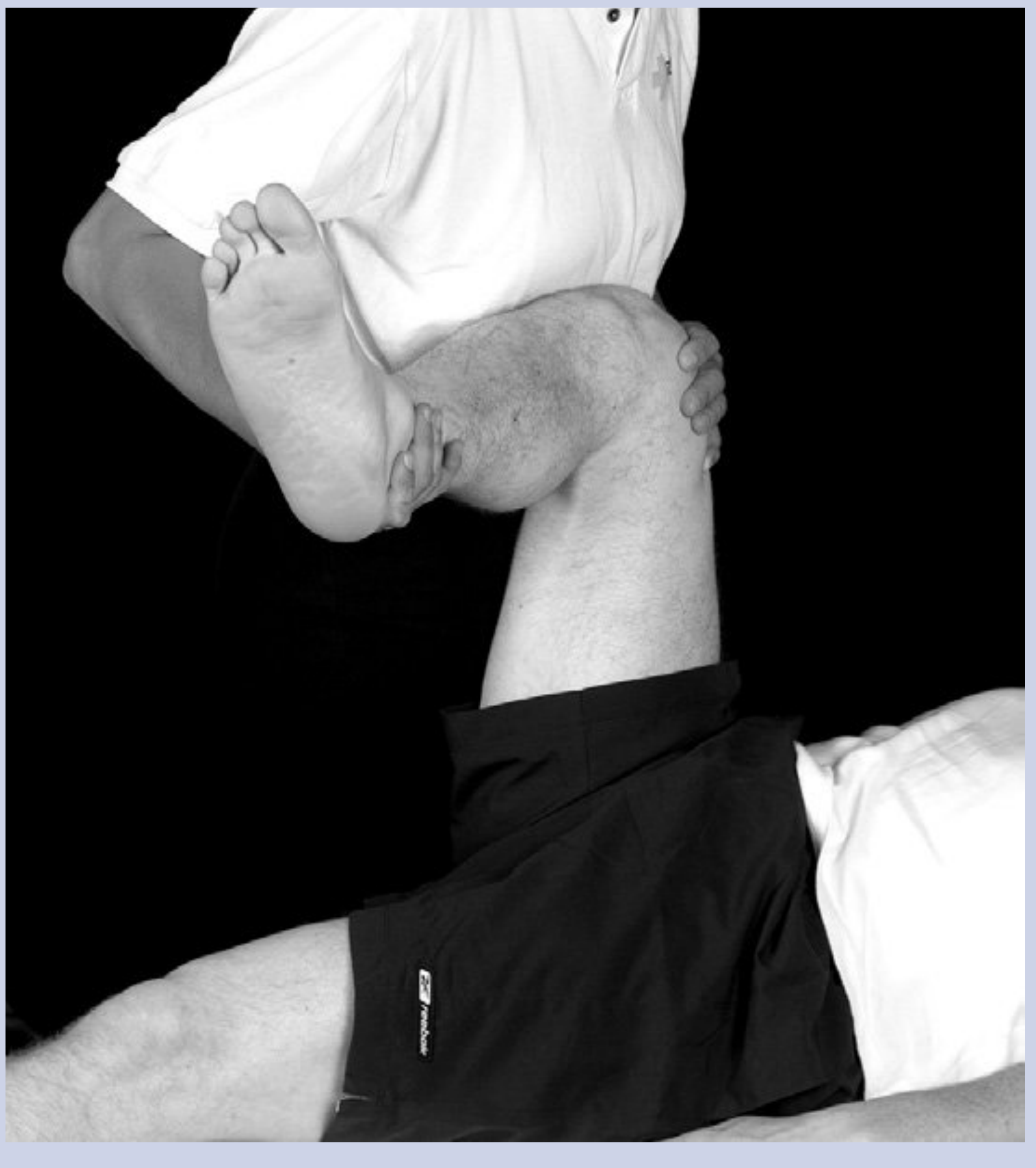

Figure 7.61 • Lateral rotation in 90° flexion, supine.

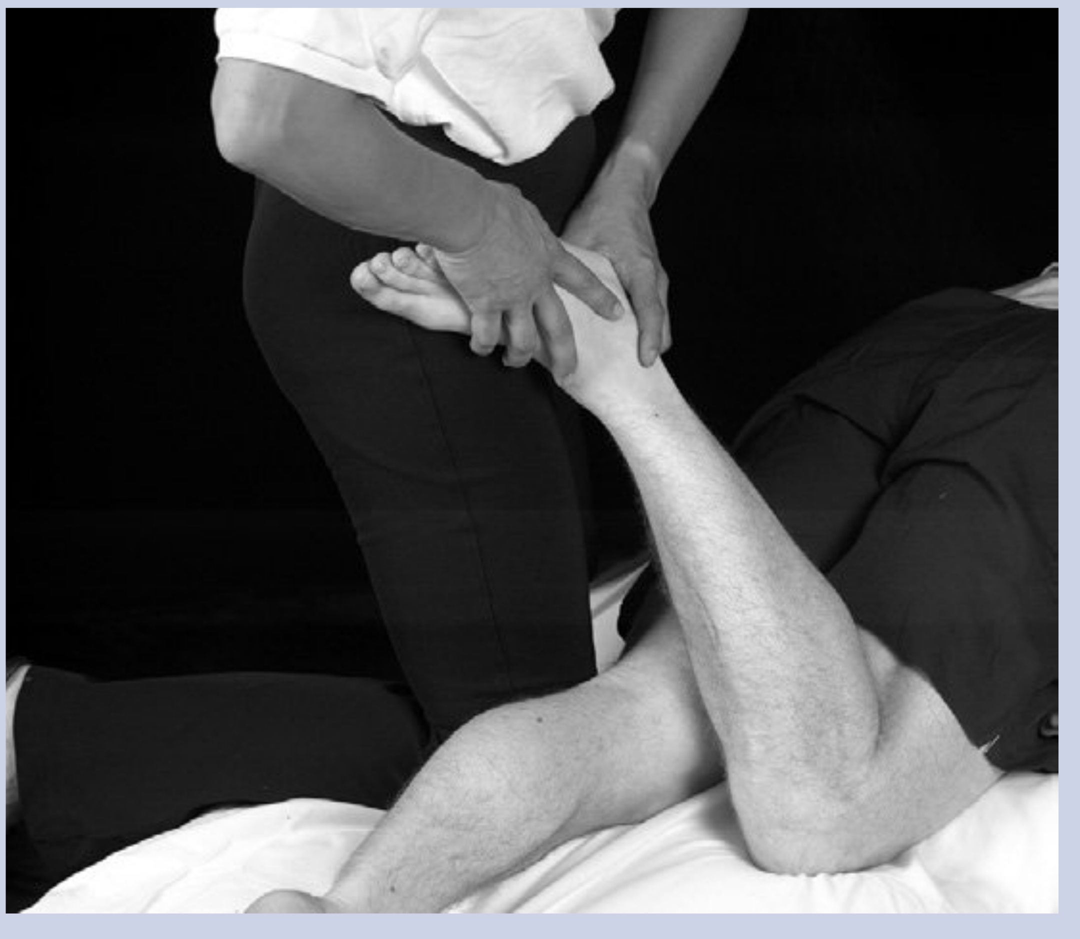

Figure 7.62 • Lateral rotation in extension, prone.

- *Therapist starting position*:
  - *in flexion supine*: standing by the patient's right hip facing the left knee
  - *in extension prone*: standing by the patient's left knee facing the right hip. The therapist's right knee is placed on the couch using the thigh positioned so as to provide a stop at the limit of lateral rotation of the patient's hip.

Localization of forces (position of therapist's hands)

In flexion supine

- The left hand holds the patient's flexed knee and stabilizes it.
- The right hand holds the patient's foot.
- The therapist's body is adjusted to face the patient's left shoulder when the hip is at the limit of lateral rotation.

In extension prone

- The right hand holds the patient's forefoot.
- The left hand holds the patient's heel.

Application of forces by therapist (method)

In flexion supine (grades III and IV)

- The oscillatory movements are produced by moving the patient's foot back and forth in an arc around the knee.
- The therapist's left hand and trunk maintain the position of the knee as the centre of the arc of movement.
- If the hip is flexed a few degrees during the medial rotation phase of the oscillation and then extended back through those few degrees during the lateral rotation phase, the technique is sometimes easier to perform. This action lessens the amount of work required by the right hand.

In extension prone

- Hip lateral rotation is produced by lowering the foot towards the stop until the limit of the range is reached.
- The oscillatory lateral rotation is then performed by a back and forth action of the therapist's arms.
- The movement can be enhanced by flicking the foot into eversion as the hip is laterally rotated.

Variations in the application of forces

- *In side lying*: lateral rotation in side lying can be performed in a similar way to that described for medial rotation (Fig. 7.56) except that the patient's foot is pushed into the pillow to perform oscillatory grade I and II lateral rotation.

Uses

- Used less often than medial rotation and flexion/ adduction.
- Usually best performed in flexion.
- May be useful as a pain-modulating technique, such as medial rotation in supine and in side lying.
- Best used to treat stiffness in flexion or in extension prone.

Abduction (Fig. 7.63)

- *Direction*: Movement of the hip into abduction (either in flexion or extension).
- *Symbols*: Ab, Ab/E, Ab/F.
- *Patient starting position*:
  - *in flexion*: supine, lying with the hip flexed to 20° for very painful disorders or into more degrees of flexion (all positions possible)
  - *in extension*: supine, lying with the hip and knee in extension and the legs abducted comfortably.

Figure 7.63 • Abduction in extension.

- *Therapist starting position*:
  - *in flexion*: standing by the patient's flexed hip and knee, level with the knee and close to the patient's leg to form a stop
  - *in extension*: standing by the patient's right lower leg facing the hip, right shin placed on the couch, sit back on the right heel.

Localization of forces (position of therapist's hands)

In flexion

- The left hand is placed over the femur to support the patient's knee.
- The right hand is placed over the patient's tibia.
- The patient's leg is abducted to the point in range intended for treatment.

In extension *(Fig. 7.63)*

- The left hand supports under the patient's knee.
- The right hand supports under the patient's ankle.

Application of forces by therapist (method)

In flexion

- Small and large amplitude oscillatory movements are produced by the action of the hands on the patient's knee.
- Watch that the movement is not taken beyond the point where the patient's pelvis starts to move.

In extension

- The oscillatory movements usually do not exceed 10–15° and are produced by the therapist's arms and hands with the patient's leg just free of the couch.
- The therapist's right leg acts as a stop at the limit of the abduction range required.

Variations in the application of forces

- In extension the range can be increased by placing a towel under the patient's buttock.

Uses

- To increase the range of hip abduction limited by pain or stiffness.
- OA hip where abduction has become stiff and painful. Particularly for the superiorly migrating OA hips. Here abduction may be combined with a longitudinal caudally and medially directed accessory glide.
- Groin strain where abduction is the painful hip movement.

Extension

- *Direction*: Extension of the hip.
- *Symbol*: E.
- *Patient starting position*: Supine near the edge of the couch with the hip and knee in extension.
- *Therapist starting position*: Standing by the patient's side beyond the knee facing the left knee.

Localization of forces (position of therapist's hands)

- The left hand holds laterally around and under the patient's knee.
- The right hand holds under the patient's heel from the medial side.

Application of forces by therapist (method)

- The therapist's left hand raises the patient's knee 15–20 cm from the couch.
- The right hand keeps the patient's heel off the couch and moves it towards the patient's buttock 7–10 cm.
- The therapist then carries the patient's heel away from the buttock and allows the knee to lower to the limit of extension.
- If the hip disorder is very painful the therapist's thigh can support under the patient's knee to provide a stop.

Variations in the application of forces

- A towel under the patient's buttock can increase the range of the limit of extension.
- The patient's left hip and knee may be flexed for comfort.

Uses

- Where patients are having difficulty with hip extension as in walking.
- Particularly limited in OA hips.

Extension/abduction

- *Direction*: Movement of the hip into extension/abduction.
- *Symbol*: E/Ab.

- *Patient starting position*: Supine, lying with the hip and knee in extension.
- *Therapist starting position*: Standing by the patient beyond the knee and facing the patient's opposite shoulder.

Localization of forces (position of therapist's hands)

- The left hand supports under the patient's knee.
- The right hand supports under the patient's ankle.

Application of forces by therapist (method)

- The therapist rocks backwards to lower the patient's leg into E/Ab.
- A grade II amplitude of 20–40° is performed using the therapist's arms and body, with the hip positioned in mid rotation.

Uses

- When hip extension and abduction are limited by pain or stiffness.

Active techniques

Active correction of posture and movement patterns

This will be particularly important for patients with minor instabilities or hypermobilities. However, patients with a stiff or blocked joint who compensate with excessive lumbar spine and/or knee involvement will also benefit from active correction (incorporating more hip movement) once hip range of movement has been regained (see the clinical tips in Box 7.5).

Box 7.5

Clinical tips: active correction of posture and movement patterns

A. Hypermobile disorders

Correction of the symptomatic position

- Alignment should be corrected in a pain-free position if possible. Initially, temporary external support may be used (pelvic belt) or the position may be adapted to decrease pain (high sitting instead of deep sitting; side lying rolled slightly forward instead of straight)
- Alignment should be corrected tonically:
    - Using minimal effort
    - Experienced as easy and relaxing
    - Maintained for 10 seconds with 10 repetitions
    - Without fatigue, tremor or cramping
- Visual feedback may be used initially to check alignment (use of a mirror, reference points on the body)
- Facilitatory techniques incorporating tactile and proprioceptive input may be incorporated at first: Tape (for example, the McConnell hip tape), use of braces (such as the SERF belt) to control excessive medial rotation or a pelvic belt to provide compression), manual stimulation, light stretch and the use of balance reactions
- Focus initially on single components. Later multiple components may be corrected simultaneously
- Frequent repetition throughout the day
- Encouragement and positive feedback will help
- The level of exercise should not exceed the patient's capabilities

Correction of the symptomatic activity

- Movements should be performed without pain, using tonic recruitment, feedback and facilitatory techniques as above
- Movements should be performed extremely slowly initially with 15–20 repetitions; with the speed progressively increasing
- Dissociation exercises (Sahrmann 2002) may be incorporated initially: the hypermobile hip is maintained in its neutral position while the restricted proximal (lumbar spine) or distal joints (knee) are actively moved, for example, during a golf swing to the left, right hip lateral rotation may be excessive and painful while the lumbar spine and knee show limited rotation. The patient may be given two different dissociation exercises:
    1. While maintaining the hip and lower limb in neutral rotation (no movement from the pelvis to the foot), the patient rotates the lumbar spine and trunk to the left
    2. While maintaining the hip and trunk in neutral rotation, the knee is laterally rotated by rotating the thigh, pelvis and trunk as a fixed unit with respect to the tibia

Box 7.5—cont'd

- Whole body movement can now be incorporated. For the above example this may be achieved by rotating first the trunk, then the knee without any hip involvement; progressing to adding limited hip rotation
- The symptomatic activity may then be simulated without excessive hip rotation and finally the golf swing may be practised with golf club and ball

B. Minor instability disorders

Correction of the symptomatic position

- In correct global alignment as described above, add in tonic contraction of the segmental stabilizers to additionally correct excessive gliding movement

Correction of the symptomatic activity

- Once the segmental stabilizer can be cognitively contracted, follow the steps described for the hypermobilities above while maintaining the contraction

The segmental stabilizers (adapted from Comerford & Mottram 2001, Gibbons 2001)

Psoas (Fig. 7.64)

- *Patient starting position*: As for the right hip, supine, near the edge of the plinth.
- *Therapist starting position*: Standing facing the patient.
  - the therapist's right hand grasps around the posterior surface of the knee holding the medial and lateral femoral condyles with the thumb and fingers.
  - the left hand fixes the ilium.
- *Procedure*: The therapist performs very gentle hip distraction and compression passively. The patient is then instructed to help by slowly and lightly pulling the head of the hip into the socket with as little effort as possible. At the same time the therapist maintains a gentle distraction force. The patient should hold the contraction for 30 seconds without pain, fatigue, tremor or cramping. During this time the therapist tests passive rotation of the hip to ensure that it is relatively free and that the pulling-in movement is not being performed by the larger global muscles. There should be no visible superficial muscle activity. To ensure that the contraction has not been slowly lost during the 30-second hold, the therapist compares the amount of distraction present during and upon release of the contraction.
- *Training*:
  - the patient practices 10 repetitions of the 10-second hold. A minimum of twice daily is recommended However, the exercise can be performed as often as possible.
  - practising in different positions (sitting, standing, side lying, etc.) helps in integrating control into daily activities.

Figure 7.64 • Recruitment of psoas.

Gemelli and obturatorii (Fig. 7.65)

- *Patient position*: In prone, knees apart and in 90° flexion, heels together.
- *Therapist position*: Standing at the side of the affected hip with one finger placed between the patient's heels; the other hand palpating the gemelli and obturatorii muscles just below the piriformis and above the quadratus femoris

Figure 7.65 • Recruitment of the gemelli and obturatorii.

- *Procedure*:
  - the patient is given one of the following instructions: . 'gently pull both hips into their sockets', 'make the width of the hips smaller' or apply gentle slow pressure of the heels against the finger'.
  - the therapist feels for light tonic pressure between the heels and for the contraction of the gemelli and obturatorii. The other buttock muscles should be palpated to check that they are relatively inactive.
- *Training*:
  - the patient practices 10 repetitions of the 10-second hold. A minimum of twice daily is recommended. However, the exercise can be performed as often as possible.
  - practising in different positions (sitting, standing, side lying, etc.) helps in integrating control into daily activities.

The global stabilizers

- Tonically recruiting and shortening the global stabilizers in a particular position does not necessary mean that this recruitment will automatically take place during performance of the symptomatic activity. The brain is concerned with goal-orientated activities and recruiting movement patterns. Therefore, these isolated muscle exercises are no replacement for training to correct the symptomatic position and the symptomatic activity. Nevertheless they are of help.
- For ideal tonic function the aim will be to achieve the perfect test result described for each global stabilizer in the assessment. The test positions are in non-weight-bearing positions where tonic recruitment is more difficult to achieve than in weight-bearing positions due to the reduced proprioceptive input. Therefore, it may be more difficult for a patient to stabilize well in lying than in standing. Hence in cases of stability dysfunction, side lying or turning in bed may be a more painful activity than standing or walking. Patients with trochanteric bursitis or iliotibial tractitis, for example, often have difficulty lying on their good side with the affected side hanging in adduction. If the posterior gluteus medius could be recruited and shortened the patient would automatically choose a more rolled-forward position as the resting position and hence relieve compressive or stretching forces on the involved tissue.
- If training in the test position is too difficult the muscle contraction may be facilitated at first through weight bearing. If the patient cannot do the test with weight bearing, then contact through the sole of the foot will also increase input: an exercise for contracting the gluteus maximus in supine may be facilitated by lightly pressing the foot against the wall or by floor contact over the side of the bed.
- If training in the test position is too difficult the test position may be adapted by shortening the lever, for example, by bending the knee in the test position. (The deep gluteus maximus would be the exception here as bending the knee could tighten an already shortened rectus femoris or tensor fascia lata making the contraction more difficult).
- Training in a weight-bearing position (sitting or standing) is often more 'user-friendly' and will ensure that the patient practises more often, for example, while waiting in a queue. Recruitment of the gluteal muscles may be obtained simply by standing on one leg with the pelvis level and the hip in neutral flexion/extension and neutral abduction/adduction. As a progression the exercise may be performed in increasing external rotation requiring more shortening of the muscle.
- Training should be pain-free if possible: This may require the patient to work at lower levels of activity than the muscle is capable of. For example, a trochanteric bursitis resulting from excessive frictioning of the iliotibial tract over

the greater trochanter (due to an inhibited/lengthened posterior gluteus medius and an overactive/shortened tensor fascia lata), may be exacerbated by strong contractions of the posterior gluteus medius in side lying, convincing the patient that exercise is of no use. On the other hand, gentle tonic contractions in standing or sitting may condition soft tissues to accept greater forces over time.

- Tonic contraction of the muscle should ideally be maintained in the shortened position for 10 seconds. On returning to the starting position the muscle should be relaxed and the exercise immediately repeated. A total of 10 repetitions is ideal. However, if the patient is incapable of holding the contraction without fatigue or phasic activity (tremor, cramping), the exercise should be held for shorter intervals with fewer repetitions but performed more often throughout the day. A minimum performance of 10-second holds with 10 repetitions twice a day is the goal.
- Patience compliance is essential: if the level of exercise is too difficult or the patient feels he will never achieve accurate performance, he may well forget or find that he is too busy to exercise. Insistence on perfection is often therefore detrimental and the patient should be given much positive feedback in order to approach exercise in a relaxed and positive frame of mind.

The global mobilizers

- By performing lengthening exercises actively an antagonistic or more proximal global stabilizer may be used to simultaneously inhibit the global mobilizer to be lengthened. The holding positions described below should be maintained for 30 seconds with three repetitions.

Hamstrings

- *Starting position*: The end test position described in the assessment (see page 406).
- *Procedure*: The patient may be asked to passively hold the knee in the maximum degree of extension achieved where the lumbar spine begins to lose its neutral position and then actively realign the lumbar spine using the superficial multifidus and iliacus to inhibit the hamstrings.

Gluteus maximus (superficial fibres)

- *Starting position*: In a sitting position with the thighs supported, the lumbar spine in neutral and the hips in as maximal adduction to the point where the lumbar spine starts to lose its neutral position.
- *Procedure*: Actively reposition the lumbar spine in neutral and hold. (Activity in the superficial multifidus and iliacus should inhibit gluteus maximus).

Tensor fascia lata

It is possible to lengthen the tensor using an adaptation of the Thomas' test. However, this is not recommended as the exercise is not user-friendly and may subject the joint to excessive anterior gliding stress causing it in time to become unstable. This may be a concern if there is any intra-articular pathology leading to local stabilizer (psoas) inhibition and resultant gliding rather than the aimed-for lengthening of the mobilizer (tensor fascia lata and rectus femoris).

- *In standing against the wall*: This test position is also carries the risk of producing excessive anterior gliding in time. However, it is 'user-friendly' and may therefore be used in the absence of intra-articular pathology (e.g. for iliotibial tractis or gluteal bursitis).
  - *starting position*: Standing with the back against the wall, knees straight; feet hip-width apart and 5–7 cm from the wall. The patient carefully abducts the hips to find the point where the lumbar spine has difficulty maintaining contact with the wall.
  - *procedure*: The patient further actively flexes the lumbar spine using the oblique abdominals and deep gluteus maximus to inhibit the tensor.
- *Using the modified Ober's test position*: This test position is safe but not 'user-friendly'.
- *Starting position*: Side lying with the test side above. The patient's waist is held pressed against the plinth (in lumbar lateral flexion).The right and left trochanters lie vertically in the same plane; the lower leg bent; the test hip is in neutral flexion/extension and full lateral rotation and is supported on towells at the point where the trunk lateral flexion position or the hip rotation position would be difficult to maintain if the hip was adducted further.

- *Procedure*: The patient holds the waist against the plinth to maintain trunk lateral flexion using the oblique abdominals/superficial multifidus or externally rotates the hip using the posterior gluteus medius/quadratus femoris to inhibit the tensor.

Rectus femoris

- *Starting position*: Single-leg stance on the non-test side; lumbar spine and test hip in neutral position. The knee is flexed to resistance while maintaining lumbar and hip positions.
- *Procedure*: The patient may be asked to passively hold the knee (with a belt, for example) in the maximum degree of flexion achieved without losing hip position and then actively contract the gluteal muscles to inhibit the rectus femoris.

Piriformis

- *Starting position*: Supine, with the hip flexed to approximately 85°, the knee in 90° flexion, the hip adducted to resistance and then externally rotated to the point of resistance. (The patient will need the assistance of a family member to hold this position).
- *Procedure*: The patient is asked to actively hip-hitch without losing hip position.
- On release the therapist attempts to externally rotate the hip to a new starting position.

The long adductors

- *Starting position*: Supine, the lumbar spine in neutral, the non-test leg extended on the plinth. On the test side the hip is flexed to approximately 45°, the knee is in 90° flexion with the foot resting on the plinth adjacent to the opposite knee. The patient allows the knee to fall outwards as far as possible without movement of the anterior superior iliac spines or foot position.
- *Procedure*: At the point where the pelvis begins to rotate, the patient is asked to realign the pelvis and hold.

Clinical profiles are presented for the following common disorders related to hip movement dysfunctions:

- Osteoarthritis (Table 7.9)
- Athletic groin pain (Table 7.10)
- Torn acetabular labrum (Table 7.11)
- Trochanteric bursitis (Table 7.12)
- Meralgia paraesthetica (Table 7.13).

Table 7.9 Clinical profile: osteoarthritis

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Pain and restricted mobility in various daily life activities
Body chart features	Symptoms in the groin area, radiating to the medial side of thigh down to the knee. Also symptoms in the right buttock and lower back area, which do not seem related to the symptoms in the thigh area. Symptoms in the groin area are 'pinching', with a pulling sensation in the leg
Activity limitations/24-hour behaviour of symptoms	May include activities such as driving, gardening and walking. Stiffness, especially in the morning when rising from bed and getting up after prolonged periods or sitting or squatting. Easing factors: rotation movements of the leg. Patients may indicate that the disorder needs a balance between rest and activity (but not too much of both)
Present/past history	Gradual onset of symptoms in a prolonged history of constant awareness of discomfort studded with exacerbations. Some patients indicate that the pain and disability increased over time and they may not be symptom free any more. With those patients, symptoms may have progressed from occurring during weight-bearing activities towards symptoms at rest (especially at night). However, other patients may say that they have improved over the years, as, for example, after retirement from sedentary work, more activities (e.g. walking) are being performed

Table 7.9 Clinical profile: osteoarthritis—cont'd	
Examination	Clinical evidence/'brick wall' thinking
Special questions	
Source/mechanisms of symptom production	Pain originating from the subchondral bone exposed by full thickness articular defects. Furthermore, capsular and ligamentous structures may cause nociceptive activity. Neurogenic mechanisms and intraosseous vascular mechanisms may also play a role in symptom production
Cause of the source	
Contributing factors	Habitual gait patterns, lack of muscular control, loss of joint mobility and reduced aerobic condition as neuromusculoskeletal contributing factors
Observations	No local changes (e.g. bony or synovial thickening) visible. Postural changes, especially pelvic position leading to hip flexion. Muscular wasting possible: gluteal muscles, quadriceps. Underactivity of abdominal muscles
Functional demonstration of active movments	Painful leg movements (e.g. putting on socks, squatting, crossing legs active movements in sitting). Many movements, especially F, Ad, MR and E may be restricted and pain provoking. Crepitus is rare. Gait analysis is essential. If symptoms are difficult to reproduce, crossing the legs may be particularly indicative. Tests in weight-bearing, especially Ad, MR and E may provoke symptoms with 'through-range' findings
If necessary tests	Symptoms may increase when the tests movements are performed under compression
Other structures in plan	Essential: screening of lumbar spine, sacroiliac joint. Further tests: muscular recruitment and muscle length
Isometric/muscle length tests	Mostly inconclusive with regard to symptom reproduction
Neurological examination	
Neurodynamic testing	Neurodynamic testing needs to be performed as a routine procedure; however, it may not be involved in the movement disorder
Palpation findings	
Passive/accessory movement	Pain and stiffness through range. In particular, F/Ad, MR and E may be physiologically combined restricted and painful. Accessory movements will react accordingly movements with changes in through-range resistance and pain. The friction-free feel of passive movement may be lost with the joint surfaces compressed together
Mobilization/manipulation	Accessory movements at end-of-range and in-range positions, if techniques preferred and sufficient range of motion is present: F/Ad. Large amplitude treatments should be used in variation with end-of-range amplitudes. Minor symptoms may also respond to passive mobilization with the addition of intermittent joint compression
Other management strategies	NSAIDs and pain-relieving medication may be necessary. Consider joint replacement in severe cases. Restoration of muscular control by coordination, aerobic conditioning, automobilizations of joints and muscle stretching, pain-coping strategies. Advice to take regular, moderate activity (e.g. walking, biking, swimming)
Prognosis/natural history	Osteoarthritis can be classified as a mechanical, degenerative, traumatic or systemic disease. In the mechanical type, if pain and dysfunction are due to a mechanical disorder within the joint and if passive mobilization and exercises can alleviate the mechanical factors, the patient's symptoms should resolve accordingly. The traumatic and degenerative types may have some residual impairments of restricted mobility, but with appropriate management and advice patients can remain symptom free for long periods. The disease type relates to the systemic type of osteoarthritis which generally follows a progressive natural history. In such instances mobilization can be a means of alleviating symptoms but total rheumatological management of this type of osteoarthritis is essential
Evidence base	See Chapter 8 for evidence of passive movement and articular cartilage repair; van Baar et al. (1998), Hoeksma (2004).

Table 7.10 Clinical profile: athletic groin pain (with emphasis on tendinitis)

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Symptoms in groin and pubic area related to certain sports activities
Body chart features	Local symptoms in groin and pubic area
Activity limitations/24-hour behaviour of symptoms	In all sports where sudden rotation and acceleration are required (e.g. rugby, soccer). Symptoms may occur with activities such as kicking a ball, twisting movements of the leg. Occurs in long distance running, usually during speed or hill work. If of muscular origin, symptoms may occur during contraction or stretching of muscles (e.g. adductor tendinitis: squeezing knees together; iliopsoas tendinitis: lifting leg in sitting)
Present/past history	Acute: related to certain sports activities and frequently contracting or stretching affected muscle groups (e.g. adductor tendinitis: for example, in kicking a ball at the same moment as the opposition/through a block tackle)
Special questions	
Source/mechanisms of possible symptom production	The following structures/pathological processes need to be considered as a source of symptoms:
	Referred symptoms: lumbar spine, thoracic spine, sacroiliac joint; neurodynamic system
	Local, other than hip joint: Adductor tendinopathy, adductor longus muscle Iliopsoas tendinopathy Rectus femoris tendinopathy Rectus abdominis tendinopathy Osteitis pubis Pelvic stress fractures Pubic instability (especially if adductor tendinitis seems to occur in conjunction with rectus abdominis tendinitis) Nerve entrapment: ilioinguinal nerve, obturator nerve Hernia inguinalis Genitourinary pathology (e.g. prostatitis)
Cause of the source	
Contributing factors	Repetitive overuse activity
Observations	Swelling or prominence at insertions
Functional demonstration of active movements	Twisting movements, kicking ball. In cases of tendinitis, minor restrictions of hip movements
If necessary tests	
Other structures in plan	Screening of lumbar spine, sacroiliac joints, thoracic spine
Isometric/muscle length tests	Isometric testing may provoke the symptoms. Exact localization of the source may be possible if careful palpation is carried out during the isometric testing
Neurological examination	
Neurodynamic testing	In cases of entrapment neuropathy, modified femoral nerve tests may reproduce symptoms
Palpation findings	In cases of tendinitis: tenderness over insertions, muscle

Table 7.10 Clinical profile: athletic groin pain (with emphasis on tendinitis)—cont'd

Examination	Clinical evidence/'brick wall' thinking
Passive movement, accessory/ physiological combined movements	In cases of tendinitis: often unrevealing
Mobilization/manipulation techniques preferred	Soft tissue techniques, modalities
Other management strategies	In acute phases: rest, ice, compression for about 48 hours. Gently increase stretching and contraction within pain-free limits. Muscular recruitment, instruction regarding warming up/cooling down and self-management (pain- coping strategies, e.g. gentle stretching, soft tissue treatment) essential
Prognosis/natural history	Depends on the identification of the inter-relationship between the actual components and mechanisms. In cases of localized tendinitis with a short and clear history – good prognosis
Evidence base	'There is no consensus on diagnosis, pathophysiology or management'(Orchard et al. 2000)

Table 7.11 Clinical profile: torn acetabular labrum

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Pain in groin area with twisting movements while weight bearing
Body chart features	Sharp 'catching' pain in the groin which may radiate into the thigh. Usually at the front of the joint. Over time pain may become diffuse and difficult to localize
Activity limitations/24-hour	Often provoked by pivoting movements. Initially lasts only for a few behaviour-of-symptoms minutes; may become more frequent and longer lasting. Associated click may be present. Frequently during soccer or other sporting activities
Present/past history	Symptoms may be acute but more commonly occur over a number of months. Related to sports activities such as soccer; can also occur by overuse or by acute trauma from a violent blow to the hip
Special questions	
Source/mechanisms of symptom production	Acetabular labrum
Cause of the source	
Contributing factors	Overuse with repeated twisting movements
Observations	
Functional demonstration of active movements	Twisting movements in weight-bearing positions may provoke the pain of active movements and/or click. Symptoms may be provoked on axial compression. Pinching sensation during hip flexion, adduction, medial rotation and combinations
If necessary tests	
Other structures in plan	Differentiate from other movement components which may refer symptomsinto the same area
Isometric/muscle length tests	Frequently inconclusive

Table 7.11 Clinical profile: torn acetabular labrum—cont'd

Examination	Clinical evidence/'brick wall' thinking
Neurological examination	
Neurodynamic testing	
Palpation findings	
Passive movement, accessory/physiological	Pain and apprehension on impingement provocation tests involving flexion, adduction and internal rotation (anterosuperior tears); hyperextension, combined movements abduction and external rotation (posteroinferior tears). Moving the hip from full flexion, external rotation and abduction to extension with internal rotation and adduction – pain reproduction and/or clicking may be an indication of a labrum tear
Mobilization/manipulation	Depending on the pain, gentle passive movements with accessory movements short of the painful position may influence the pain
Other management strategies	Depending on other impairments and habitual movement patterns found in physical examination
Prognosis/natural history	In minor cases restoration of function may be expected. However, in some persistent cases arthroscopy should be considered. Postoperative management: restoration of full range of motion, muscular control and guidance to normal level of activities and sports
Evidence base	Fitzgerald (1995)

Table 7.12 Clinical profile: trochanteric bursitis

Examination	Clinical evidence/ 'brick wall' thinking
Kind of disorder	Pain localized over local area of greater trochanter
Body chart features	Usually local pain, may radiate down lateral or posterolateral aspect of the thigh
Activity limitations/24-hour	Symptoms with climbing stairs, sleeping on affected side, crossing legs. Pain behaviour of symptoms particularly in lying on the side, walking for longer periods of time
Present/past history	Gradual onset of symptoms; tends to run a protracted course that is punctuated by exacerbations and remissions, often related to activity
Special questions	
Source/mechanisms of symptom production	May be local structure. May be referred symptoms from lower lumbar spine, sacroiliac joint, hip
Cause of the source	
Contributing factors	This overuse lesion tends to occur in two groups of patients: those involved in activities (e.g. extensive running) or in middle-aged (usually female) often overweight patients with associated degenerative changes in the lower lumbar spine
Observations	Muscle wasting; tight iliotibial band
Functional demonstration of active movements	Crossing legs, lying on affected side may reproduce symptoms. Adduction, active movements extension may reproduce symptoms. Local symptoms with lumbar active tests

Table 7.12 Clinical profile: trochanteric bursitis—cont'd

Examination	Clinical evidence/ 'brick wall' thinking
If necessary tests	
Other structures in plan	Screening of lumbar spine, sacroiliac joint, neurodynamic structures essential
Isometric/muscle length tests	Hip abductors may reproduce the symptoms partially
Neurological examination	
Neurodynamic testing	May be symptomatic if lumbar spine is involved
Palpation findings	Increased temperature in local area possible
Passive movement, accessory/physiological combined movements	Hip movements frequently concomitantly painful, e.g. F/Ad; in particular L4–5 accessory movements may partially provoke the symptoms
Mobilization/manipulation techniques preferred	Treatment of concomitant lumbar and hip joint signs is essential
Other management	Soft tissue techniques and application; treat muscle imbalance, especially of gluteal muscles, quadriceps and abdominal muscles, stretching of tensor fasciae latae and iliotibial band. Instruct patients in self-management strategies. Sports people: advice on warming up/cooling down programmes
Prognosis/natural history	Depending on the inter-relationship of contributing components to the movement disorder

Table 7.13 Clinical profile: meralgia paraesthetica (lateral femoral cutaneous nerve entrapment)

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Burning pain at lateral side of thigh
Body chart features	Quality of symptoms: burning, stinging, numbness, paresthesia down the proximal lateral aspect of the thigh. Other symptoms may be present in knee area, buttock and lower back
Activity limitations/24-hour behaviour of symptoms	Symptoms with longer periods of sitting with involved leg under body, prolonged sitting, squatting, increased walking, standing
Present/past history	Gradual, spontaneous onset of symptoms associated with, for example, obesity, wide belts, tight jeans, pregnancy, diabetes mellitus and prior inguinal surgery. At times may be the result of trauma
Special questions	
Source/mechanisms of symptom production	Symptoms typical of peripheral neurogenic mechanisms. May be associated with movement disorders of lumbar spine, hip
Cause of the source	
Contributing factors	Overweight, clothing
Observations	

Table 7.13 Clinical profile: meralgia paraesthetica (lateral femoral cutaneous nerve entrapment)—cont'd

Examination	Clinical evidence/'brick wall' thinking
Functional demonstration of active movements	Frequently inconclusive, as symptoms may develop after remaining for long periods in the same position. Lumbar spine, hip movements need to be routinely examined
If necessary tests	
Other structures in plan	
Isometric/muscle length tests	
Neurological examination	Motor function fully intact. Hyperaesthesia over lateral thigh, increased light touch sensation, increased pin-prick sensation
Neurodynamic testing	Slump test in side lying (including hip extension and adduction) may provoke the symptoms. Variation of the test: patient may lie on the affected side (Butler 2000)
Palpation findings	Deep palpation just below the anterior superior iliac crest may reproduce the symptoms
Passive movement, accessory/ physiological combined movements	Hip movements frequently concomitantly painful or restricted (e.g. F/Ad)
Mobilization/manipulation	Treatment of concomitant lumbar and hip joint signs is essential. Neurodynamic techniques preferred treatment respecting the symptoms
Other management strategies	Infiltration of the nerve at it course at the inguinal ligament. Recommendation on clothing, weight loss. Surgery is rarely considered
Prognosis/natural history	Some authors state that in many cases a spontaneous resolution may occur within two years. However, the results may be dependent on the inter-relationship of all other contributing components in the disorder
Evidence base	See for example Butler (2000)

Case study 7.1

A movement disorder related to degenerative osteoarthritis in combination with a minor lumbar movement disorder

Mr B is a 67-year-old retired construction worker whose hobbies include gardening, biking (2–3× weekly for 2–3 hours), hiking in mountains (at least 1×/week), skiing in winter.

Kind of disorder

Symptoms in leg, especially during walking, getting up from sitting, gardening. Activities in daily life: 'annoying', but carries on with them as usual.

Body chart

As pointed out in Figure 7.66, the symptoms in the buttock and the groin area do not appear to have a relationship.

Activity limitations/24-hour behaviour of symptoms

*□ ↑ Gardening (esp. pulling weeds), after c. 2 h

↓ Gets up and 'shakes' leg a bit; after c. 15' □ 100%

*□ ↑ Squatting (e.g. when playing on floor with grandchild), after 5'□ 'annoying'

↓ Changes position on floor □ ↓ quickly

*□ ↑ Putting on socks (in sitting) – crosses ri. leg over le. leg, 'hard to do', □ little bit

↓ □ ↓ immediately, once leg straight again

*□□ ↑ Currently only after driving a car for 2–3 h; sitting in a cinema after 2–3 h

Case study 7.1—cont'd

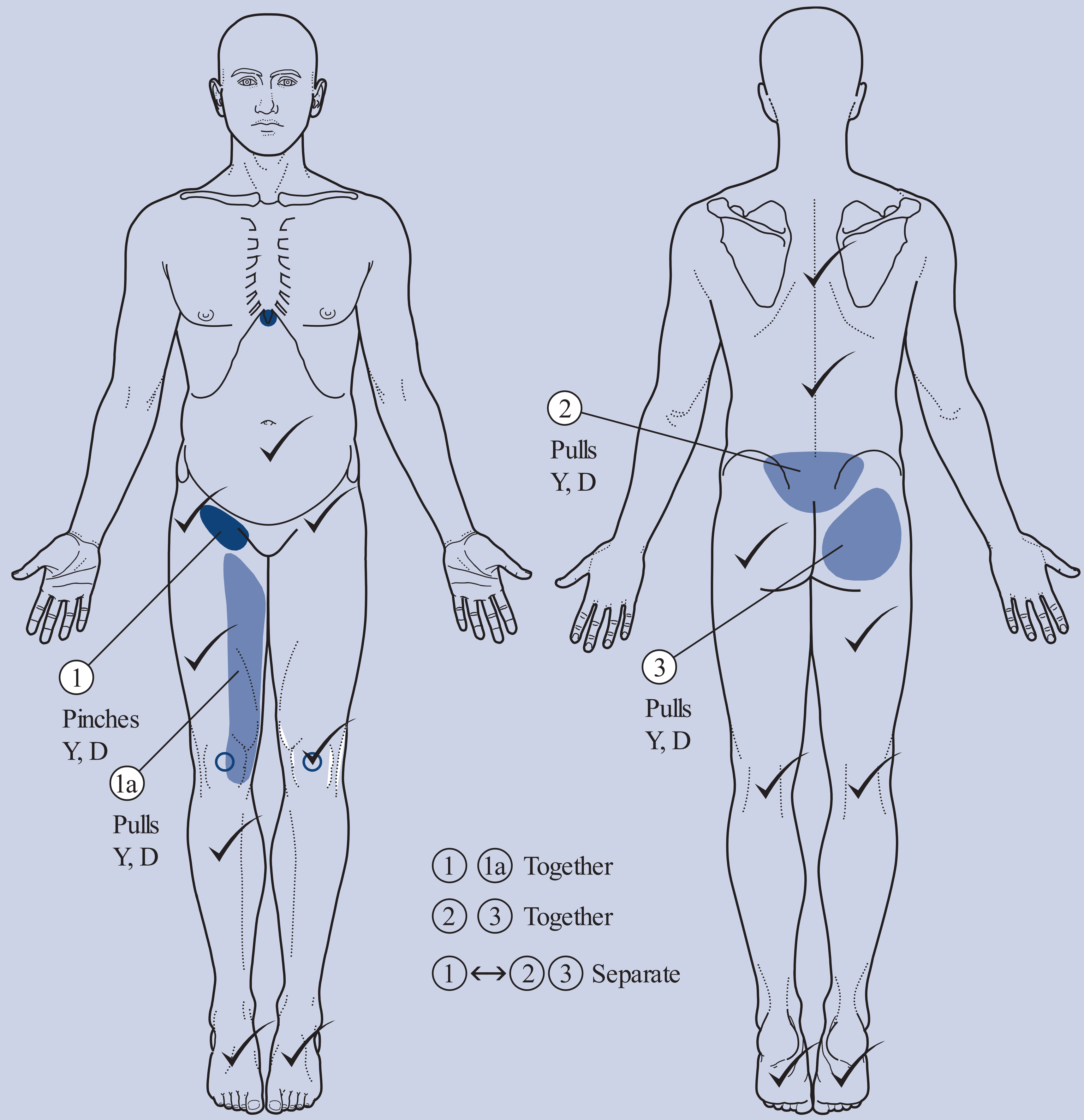

Figure 7.66 • Body chart of Mr B.

↓ Gets up and walks around: settles quickly

Night: □ Morning at getting out of bed stiff* □, esp. in walking – settles after 30'; then □

Day: as above; p.m./a.m.: no difference; in general: needs movement more than resting

Present/past history

Short-term (present) history is illustrated in Figure 7.67.

Past history

- Never had □ □[a], nor restricted movements.
- □ □ since c. 20 years. 5 years ago: □ □++ went to Dr and PT for 1st time; passive mobilizations and self-managements. Good effects; did not continue with exercises.
- Better now than 4–5 years ago: attributes this to increased level of activity (is retired): regular biking, hiking, and skiing.

Special questions

GH: □; Medic. none; no history of accidents or illnesses; X-ray le. and ri. hips: degenerative changes in both hips (no difference left/right).

Planning of physical examination

Hypotheses

- Symptom mechanisms: nociceptive mechanisms (stimulus–response related symptoms). Tissue mechanisms: degenerative changes with OA, however symptoms developed only after fall on right hip.
- Main source of symptoms: hip □; Lx □ □, neural system □ □ □; (later: screen SIJ (sacroiliac joint)).

Case study 7.1—cont'd

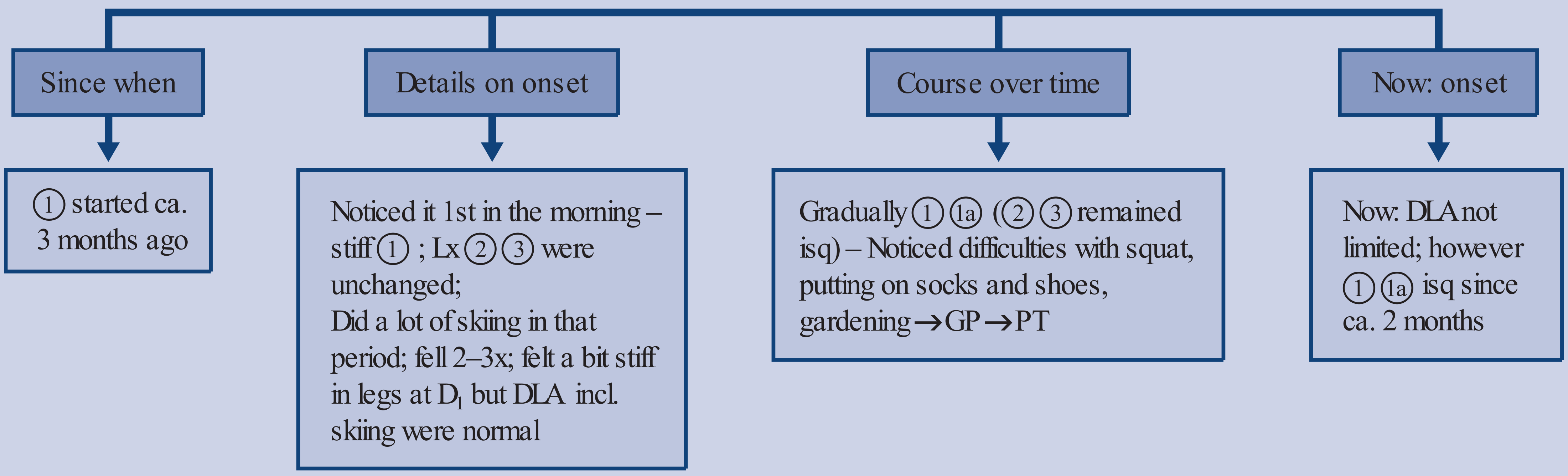

Figure 7.67 • Short-term history.

Procedures of examination

- No specific CI/precautions (not severe/irritable; no specific 'nature' factors) → routine testing possible: until L (resp. P).
- Test hip and Lx movements; after active testing decide: Continuation P/E hip **OR** continuation P/E Lx.

Physical examination (D1)

- PP □
- Inspection: nothing particular; ant. tilt pelvis: correction □
- Functional demonstration and differentiation:
  *Putting on socks (sitting; R leg crossed over L) □
  Diff: Lx, SI stress: ISQ
  NS (Neck flexion): pulls in buttock □
  *Hip (ri. leg) □ ↑
  *Squat: □, deviates in Ab/Lat Rot, □ act EOR
  Corr. deviation: □, □ □a[+][+]
- Gait: forwards, backwards, small steps, large steps:
  *Crossing le. leg over ri. leg: ↓↓, □
- Active tests
  Active tests on 1-leg: F, E, Ab, Ad, MR, LR all □, □]
  Lx: *F 10 cm, □ act 1 NF □ ↑
  E 20°, L1–5 stiff, loc. P Lx-area
  *LF le: □, □ act EOR; ri: □,□
  Rot le 5 ri ↓, □
  Lx Q le ↓, ↓ (loc. P); ri □, □ (loc. P)

Hip supine	*Hip prone*
F 120°, □ IV–	E 10° (ri. 20°), □ IV11
In 90° F: MR ↓↓, □ IV–	MR ↓, □; LR □, □
In 90° F: LR □	
Ab 40°, □	
Ad 25°, □	

Decision: Screening neurodynamics; then continue P/E hip.

Neurodynamic tests

SLR ri. 80°, +DF; +NF SLR le. 60°, +DF PKB side lying: le. = ri. *(Decision: do quick reassessment as ri. seemed to change during tests)*	C/O: ISQ P/E: Fct. Demo (socks) Squat Gait (crossing le. leg) Hip F, in 90° F, do MR — all ISQ Lx: F 5cm, ② act. + NF ② ↑ ☺ LF le. ISQ

Passive tests hip F/Ad

Ri. hip: all directions □,□ (Fig. 7.68) Le. hip: restricted, □ (Fig. 7.69) LE. hip: in F/Ad (pos. c) – before P1 (Fig. 7.70): do P/E accessory movements: *↕ femur, ↔ lat, ↔ lat/caud, ↕ femur, ↕ troch, ↕ troch, ↔ caud: □,□	C/O: 'lighter', 'more comfortable to move' P/E: F 125°, □ IV+ ☺ In 90° F: MR range ↑, □ IV– ☺ Squat: deviation ↓ Lx: F, LF le.: ISQ *Warned patient: P may be more localized and and intense – exp. □* *Should observe AND compare: *stiffness a.m.; *squat; *sitting on floor; *gardening;*

Plan (D4, Rx 2)

- Consideration of hypotheses: movement dysfunction of hip □, with restricted mobility
- Plan session 2: screen Lx – effects of PAIVMs on hip function and Lx function
- Decide: continue Rx Lx? **OR** continue Rx hip? (F/Ad; in EOR F/Ad: acc. mvt; automob. F/Ad)
- (Screening SIJ: Rx 3)

Case study 7.1—cont'd

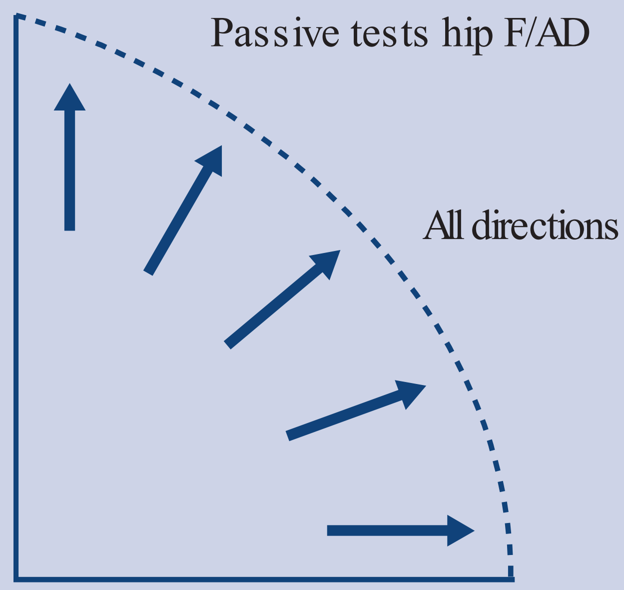

Figure 7.68 • Passive tests: hip flexion/adduction.

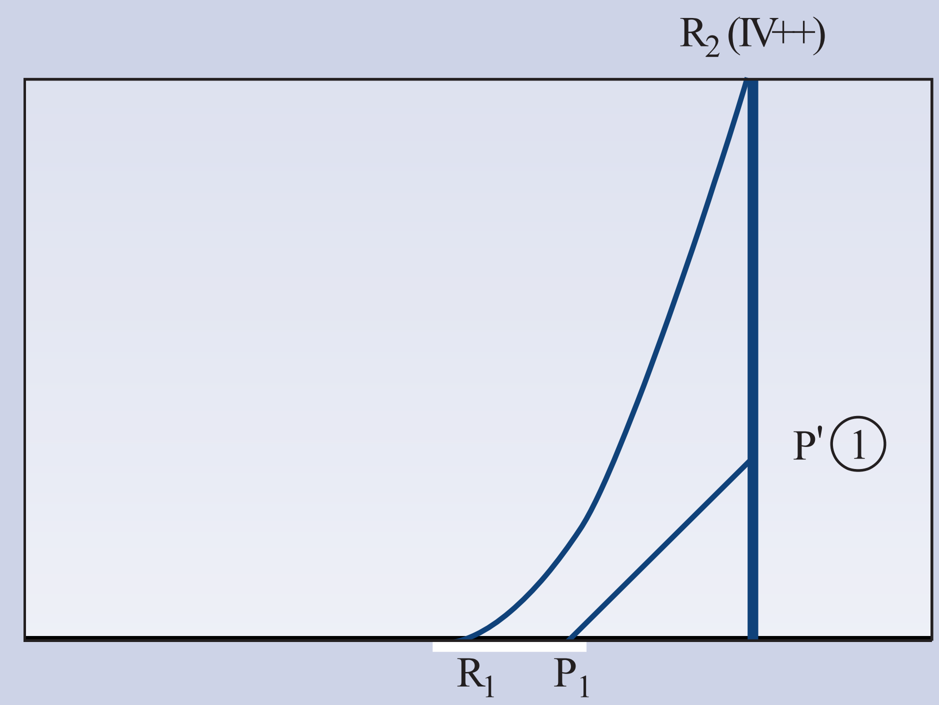

Figure 7.70 • Left hip: in flexion/adduction.

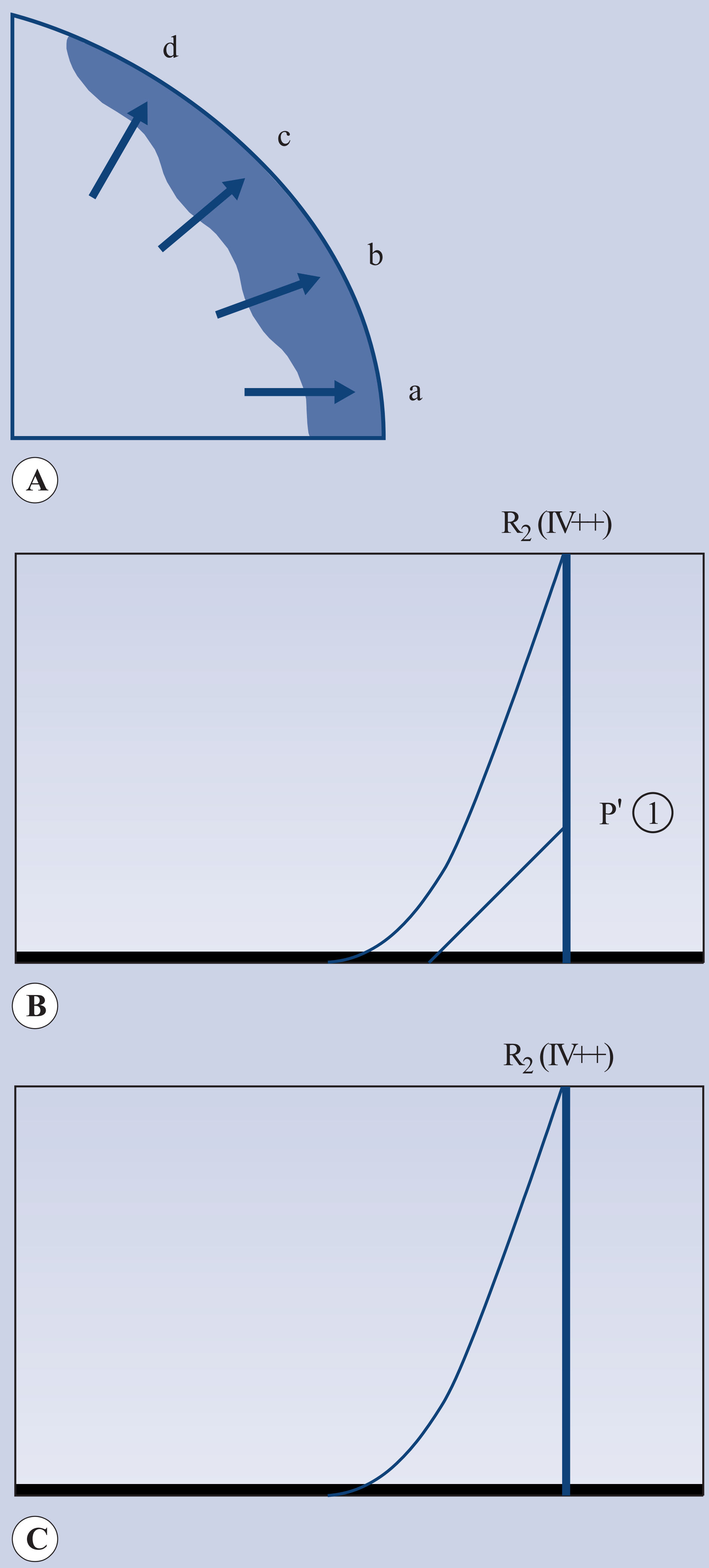

Figure 7.69 • Left hip: restricted.

D4, Rx 2

- C/O:
  Felt lighter in area □ for c. 4 h, then ISQ
  Gardening, squat: ISQ
  Putting on socks: seemed less stiff □
  Morning: seemed less stiff □ – still c. 30 mins
  Lx: no change (did not bother at all; did not sit for longer periods)
- P/E:
  *Lx F 5 cm
  *Lx LF left
  *Putting on socks □ little (overpressure: □ ↑)
  *Squat: little dev in Ab/LR, □ little
  *Gait sideways: ISQ as after Rx 1
  *In supine: hip F 125°, □ IV–
  *In supine, in 90° F: do MR c. 20°, □ IV–
- Palpation and P/E PAIVMs T10–L5/S1 (Fig. 7.71):

Temp, sweating, skin tone, bony alignment, muscle tone: □ Interspin. space (ISS) L2–5, laminae le. and ri. L2–5: 'thick', 'full' ↕ T10–L2; ↓ T10–L5; ↓ T10–L2 □,□; ↕ L3–L5; ↓ L3–L5	C/O: ISQ P/E: Lx: F, LF: range ↑, □ ISQ Hip: Squat, putting on socks, gait, F, MR: ISQ

Decision: continue Rx hip, as described in plan Rx 2.

Summary of remaining treatment sessions

- The hip was treated and cleared with F/Ad techniques (grades IV, IV+, slightly before the onset of pain) as well as with accessory movements in EOR positions of F/Ad. Those accessory movements which were impaired in Rx 1 were selected as treatment intervention.

Case study 7.1—cont'd

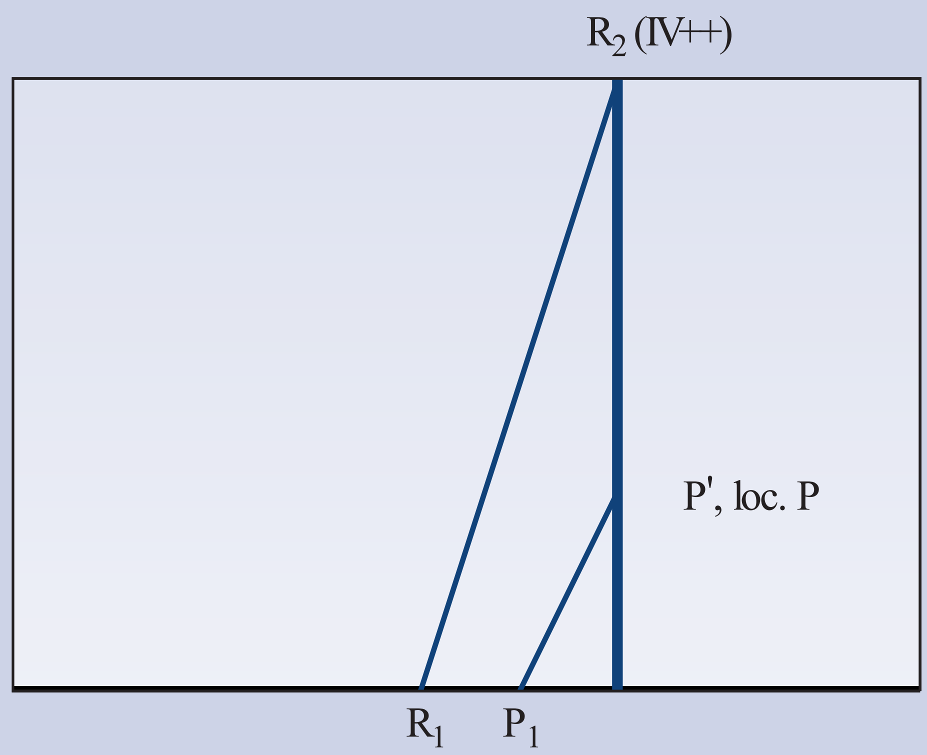

Figure 7.71 • Palpation and physical examination PAIVMs, T10–L5/S1.

- Automobilizations for F/Ad were given:
    - F/Ad in sitting.
    - F/Ad in standing, with the leg on the seat of a chair; trunk flexion and automobilization with AP pressures on the femur.

These exercises were performed 2–3×/day and when symptoms □ were increased.

- Screening of the sacroiliac joint with provocation tests and passive movements: no effect.
- Although the lumbar spine was not fully impairment free, it was decided to repeat some of the self-management strategies that the patient learned c. 5 years ago. The patient indicated beneficial effects of these after longer periods of sitting. In a retrospective assessment in the eighth session, left side flexion was still slightly restricted; however, it was symptom free with overpressure. Lumbar flexion was cleared with regard to the symptoms.
- The patient was encouraged as a 'joint care' to maintain the lumbar and hip self-management strategies (mainly automobilizations) after completion of the treatment. To enhance long-term compliance, it was determined collaboratively with the patient where possible difficulties regarding the execution of the exercises may occur and adaptations to the exercises were performed (Appendix 2).

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Management of knee disorders

8

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CHAPTER CONTENTS

Key words

Lifestyle changes, osteoarthritis, patellofemoral pain, tibial femoral joint, superior tibiofbular joint, patella femoral joint

Introduction

Knee pain is one of the most frequent conditions treated by MSK-physiotherapists and is mentioned as one of the most common disorders of non-communicable diseases. The increased life expectancy recorded in recent decades, together with changes in lifestyle and diet, has led to a rise in the incidence of non-communicable diseases. It has been recognized that musculoskeletal or rheumatic diseases are the major cause of morbidity throughout the world, having a substantial influence on health and quality of life, and inflicting an enormous burden of costs on health services. Within this group 40% of people over the age of 70 suffer from osteoarthritis of the knee, with a substantial number of them having limitations of movement and restrictions in daily life activities (WHO 2003).

In addition, lifestyles in the industrialized world have become more sedentary and diet has changed over the decades since the Second World War. The impact of inactivity and diet on health issues is increasingly acknowledged and it has been recognized that regular physical activity is effective in the primary and secondary prevention of several diseases, for example, cardiovascular disease, diabetes, some forms of cancer, hypertension, obesity, depression, osteoarthritis and osteoporosis. Furthermore, there is an indication that musculoskeletal fitness is of particular importance to elderly people in maintaining their independence (Warburton et al. 2006).

These health effects due to lifestyle choices have been noted not only in the adult population, but also in children. It has been observed that serious health problems are being created by the ongoing decrease in physical activity, both moderate and vigorous, from early childhood onwards. Poor habits as regards regular movement and diet are established early in life and carried into adulthood. Lifestyle choices in childhood may have an impact on the individual's health for many years to come (Thein-Brody & Thein-Nissenbaum 2007).

As it is expected, in the years to come, that the number of individuals suffering from musculoskeletal disorders will increase, the global alliance known as the Bone and Joint Decade 2000–2010 has defined its goals as to improve the health-related quality of life for people with musculoskeletal conditions throughout the world by raising awareness of the suffering and the cost to society associated with these conditions, by empowering patients to participate in decisions concerning their care, by promoting cost-effective prevention and treatment and by advancing the understanding of musculoskeletal conditions and improving prevention and treatment through research (WHO 2003 p. 3). The Bone and Joint Decade has extended its mandate until 2020 with the motto 'Keep people moving' (WHO 2010).

In this process, physiotherapists play a crucial role in the treatment of pain, impairments and disabilities, but also in the prevention of long-term disabilities and in the guidance of individuals towards a healthy, active lifestyle. However, it appears that physiotherapy may still be an underutilized treatment for knee problems in spite of its recommendation as first-line treatment in many guidelines (Jordan et al. 2004).

With regard to the functional capacity of the knee complex, physiotherapists may be confronted with movement dysfunctions of the knee due to disuse, misuse and/or lack of activity of the structures on the one hand, and to pain and disabilities caused by traumatic incidents on the other. In both cases, the rehabilitative process should ultimately lead to an optimization of physical fitness and wellness.

Wellness encompasses social, occupational, physical, spiritual, intellectual and emotional components. The physical aspect of wellness is related to the awareness of the need for regular physical activity, healthy diet and nutrition and avoiding habits that are harmful to wellness (Moffat 2007).

Fitness encompasses the following components (Moffat 2007):

- Aerobic capacity (ability to participate in activity over time using the body's oxygen uptake, delivery and energy-release mechanisms)
- Muscle strength (the ability of muscles to exert or resist a force)
- Muscle endurance (the ability of muscles to perform sustained work)
- Power (the ability of a muscle to exert high force at high speed)
- Balance (the ability to maintain equilibrium when the body is static or moving)
- Agility (the ability to perform power movements in opposite directions)
- Flexibility (the ability to be stretched, easily bent or pliable).

Applied theory and evidence supporting practice

Many movement disorders of the knee may be related to nociceptive processes and concomitant changes in mobility, motor control and aerobic condition. Therefore, in this section a short overview is given of some of the anatomical and mechanical properties of the knee complex, together with a brief outline of some common disorders encountered by physiotherapists in clinical practice.

The knee joint, the largest synovial joint in the body, combines considerable mobility and strength with the stability necessary to lock the knee in the upright position. A bicondylar hinge joint, the knee is made up of three functional units: the medial and lateral tibiofemoral compartments and the patellofemoral joint.

The superior tibiofibular joint is included in the knee complex. It is often overlooked as a source of nociceptive lateral leg and knee pain. It needs to be examined routinely in movement disorders of both the foot and the knee (Corrigan & Maitland 1994).

Anatomy

The femoral condyles rest on the tibia and the intercondylar femoral groove is slightly widened to the lateral side. The femoral condyles are convex from anterior to posterior and from side to side. The medial condyle bulges out more than the lateral condyle. The tibial condyles are relatively flat with a slight posteroinferior inclination of the condyles. The lateral condyle is smaller and rounded, concave from side to side, but concavo-convex from front to back. The articular surfaces of the tibia are deepened by the lateral and medial menisci (Palastanga et al. 1994).

The anatomical shapes allow for a large amount of glide and roll movements on an intra-articular level. The instant centre of rotation of the joint ranges from about 30° to 60° of flexion in a normal joint, indicating a large amount of gliding movement. However, rotation movements also play an essential role in intra-articular movement behaviour, in particular to allow an optimal stability in extension movements in weight bearing (Kapandji 1987, Nordin & Frankel 2001).

The articular surface of the patella is oval and a vertical ridge divides the joint surface into a smaller medial area and a larger lateral area. In flexion the medial side has more contact with the medial condyle. The articular cartilage, having to transmit large stresses, is probably the thickest cartilage of the body (Palastanga et al. 1994).

Stability and mobility

Stability (particularly in extension) and mobility are essential for the knee joint to fulfil the requirements of a weight-bearing joint. Both functions are secured by the interplay of ligaments, menisci, muscles and complex gliding and rolling movements at the articular surfaces (Palastanga et al. 1994, Nordin & Frankel 2001).

Nevertheless, the joint is quite vulnerable to dislocations and strains to the ligaments, muscles and intra-articular structures, including the menisci, as the articular surfaces have a relatively poor degree of interlocking (Palastanga et al. 1994).

In locomotion the knee joint plays an important role in shortening and lengthening the leg, and – in conjunction with the ankle – in the propulsion of the body and transmission of forceful stresses including lateral and rotation movements of the joint (Palastanga et al. 1994).

Motion occurs simultaneously along three axes, although flexion and extension predominate (Nordin & Frankel 2001). However, many functional movements and symptom-provoking activities concerning the knee joint need to be considered in the light of combined movements, for example, extension and adduction or abduction combinations, flexion and rotation combinations and so on, as these specific combinations frequently play an essential role in the delivery of successful treatment with passive movement.

Movement patterns, motor control patterns

During flexion/extension movements of the knee the patella follows a complex three-dimensional movement pattern, with a large amount of gliding over the femoral condyle in combination with rotation movements and laterally and medially directed movements (Kapandji 1987, Van Eijden 1990). The patella may glide approximately 7 cm in relation to the femoral condyles when the knee moves from full extension to 140° of flexion, in which the patella rotates laterally beyond 90° of flexion (Nordin & Frankel 2001).

Stabilization training should contribute to the healing of supporting tissues, such as ligaments, to strengthen surrounding musculature and to re-establish motor control and appropriate movement patterns of that joint (Magee & Zachazewski 2007). It has been stated that, particularly in the last degrees of extension or first 20° of flexion, a balance in the recruitment patterns of the vastus medialis oblique and lateralis is essential to permit optimum tracking of the patella in the femoral groove (McConnell 1996), in which the vastus medialis oblique should react earlier and faster than the vastus lateralis during the movement (Witvrouw et al. 2004). Larger muscle groups, such as hamstrings, adductors, gastrocnemius and particularly the tensor fascia latae with the iliotibial band contribute to the motor control patterns of the knee.

Motor patterns of the knee are influenced by the alignment of the foot and the trunk-pelvis-hip area, and therefore the patterns of the abductors and lateral rotators of the hip, the muscles stabilizing the pelvis and trunk. and also the intrinsic foot muscles and those muscles controlling pronation of the foot, often need to be incorporated in physical examination procedures of the knee (Sahrmann et al. 2011).

The popliteus muscle is active in the monitoring of subtle transverse- and frontal-plane knee joint movements, controlling anterior–posterior lateral meniscus movement and unlocking and internally rotating the knee joint during flexion. In standing, the popliteus assists in a three-dimensional dynamic postural stability of the leg and provides for postural equilibrium adjustments. The popliteus muscle acts in synergy with dynamic hip control of the femoral internal rotation and adduction and with subtalar dynamic control of the tibial abduction-external rotation or tibial adduction-internal rotation respectively. The popliteus assists the quadriceps femoris, hamstrings and gastrocnemius in the knee joint stabilization in the sagittal plane (Nyland et al. 2005).

Range of motion

The following ranges of motion have been described (Soames 2003):

- Active range of flexion to extension: 140° with the hip flexed and 120° with the hip extended.

Passively the range may increase to 160°, allowing the heel to touch the buttock

- Medial and lateral rotation are influenced by the degree of flexion of the joint. In extension rotation is minimal. In 90° of flexion active medial rotation is 30° and lateral rotation is 45°. Beyond 90° of flexion the range of rotation decreases again.

Nerve supply

The knee joint is innervated by fibres of the lumbosacral plexus originating from the levels L2–3 (front of the knee) to S3 (back of the knee). The femoral nerve and saphenous nerve, the posterior branch of the obturator nerve and tibial and common tibial nerves send branches into the joint (Palastanga et al. 1994).

Neurodynamic dysfunctions may contribute to movement disorders of the knee; for example, dysfunctions of the infrapatellar branch of the saphenous nerve, the saphenous nerve in the adductor canal of the thigh, the common peroneal nerve at the head of the fibula and in the popliteal fossa (McCrory et al. 2002).

Pathobiological processes

Most movement disorders treated by physiotherapists include overuse or misuse problems of the tibiofemoral joint and/or patellofemoral joint with their intra- and extra-articular structures, post-traumatic disorders which may or may not have had a surgical intervention, degenerative conditions such as osteoarthritis of the knee and patients with a total knee arthroplasty.

Osteoarthritis of the knee

Osteoarthritis has been described as a degenerative articular disease affecting the cartilage, the underlying bone, soft tissues and synovial fluid of the joint (Flores & Hochberg 1998). These changes result in alteration of the biomechanical properties (Sims 1999, Pearle et al. 2005) with changes of the tensile, compressive, shear properties and hydraulic permeability of the cartilage and increased stiffness of the subchondral bone (Flores & Hochberg 1998).

The basic assumption that osteoarthritis is the result of mechanical ‘wear and tear’ processes has been questioned already some decades ago (Bullough 1984, Dieppe 1994) and it has been recognized that, as well as mechanical factors, chemical, immunological, hormonal and genetic factors may contribute to the condition (Martin 1994).

The American College of Rheumatology has defined the following criteria for the diagnosis of knee osteoarthritis (Hochberg et al. 1995):

- Knee pain and radiographic osteophytes and at least one of the following three items:
  - age > 50 years
  - morning stiffness < 30 minutes’ duration or
  - crepitus on motion
- Within a classification tree in which knee pain and radiographic osteophytes or knee pain, age (> 40 years), morning stiffness and crepitus on motion are occurring together.

However, the prevalence of knee pain and symptomatic knee osteoarthritis has increased significantly over a period of 20 years, while no such trend has been observed in radiographic knee osteoarthritis (Nguyen et al. 2011). It has been accepted that no direct correlation between radiographic changes and pain or disability may be present, although slow progression of the radiographic evidence and gradual increase of pain and disability may be indicative of progressive osteoarthritis (WHO 2003). Therefore, it is suggested that osteoarthritis be diagnosed more by its symptoms rather than by radiographic diagnosis alone (WHO 2003). The following definition has been suggested: ‘osteoarthritis is a condition characterized by use-related joint pain experiences on most days in any given month, for which no other cause is apparent’ (WHO 2003, p. 55).

In addition to pain, patients may complain about limitation of range of motion, crepitus, occasional effusion, local inflammation (Flores & Hochberg 1998), limitation of activity levels and reduced participation (WHO 2003). The changes in quality of life as a consequence of pain and the potential loss of independence in the elderly are a major concern (WHO 2003). Several domains are considered to be important in joint disorders such as osteoarthritis:

- Physical health: physical function, employment, pain and fatigue
- Social health: social function
- Mental health: emotional health, self-image, sexuality
- Participation.

The main health indicators are listed as follows:

- Pain or discomfort
- Mobility
- Physical activity or roles
- Ambulation
- Restricted participation
- Social activities or roles (WHO 2003).

Several risk factors or associated factors that contribute to the pain and disability have been described:

- Prolonged or repeated knee bending, particularly in jobs entailing knee bending with mechanical loading (Cooper et al. 1994). This has been described in a study in the United Kingdom, but also in an observational study in Tibet it has been postulated that the prevalence of knee pain is high and may be related to squatting for longer periods, carrying heavy loads for long distances, wearing poor quality footwear and possibly poor nutrition (Hoy et al. 2010)
- Obesity, helplessness and severity of pain (Creamer et al. 2000)
- Physical inactivity, obesity, stress, smoking, family history, age (meaning that the condition is more common in elderly people) and joint trauma. It seems a greater problem among people of comparatively low socioeconomic status and is possibly associated with factors such as obesity (WHO 2003)
- Malalignment of the hip-knee-ankle angle during gait may be associated with progressive knee osteoarthritis (Sharma et al. 2001)
- It has been shown that quadriceps function is strongly associated with knee pain and disability. Anxiety and depression are more correlated than radiographic changes (O'Reilly et al. 1998). In patients with symptomatic knee osteoarthritis it has been demonstrated that the quality of gait and the activation of the quadriceps muscle was less than in a control group, which was without symptoms (Rudolph et al. 2007)
- Muscle sensorimotor dysfunction (weakness, increased fatigability, proprioceptive deficits) may be implicated in the complex and multifactorial aetiology of osteoarthritis (Hurley 1999, 2002).

Numerous guidelines have been developed for the treatment of knee osteoarthritis, in which specific movements and exercises are endorsed (Altman et al. 2000, Pendleton et al. 2000, Ottawa Panel 2005). Treatment should be aimed at optimizing general activity levels, working on weight loss, reducing smoking and optimizing diet.

Treatment with a focus on movement endorsement aims to:

- optimize movement functions
- restore overall functional capacity and performance
- prevent recurrences of pain and disability
- enhance fitness and wellbeing
- maintain independent, self-supported living in the elderly (WHO 2003, Moffat 2007).

It has been acknowledged, that articular cartilage may have, albeit restricted, regenerative capacities. Therefore, the focus of treatment on local levels encompasses the building up of cartilage, tensile strength of bone and soft tissues in adolescent years. From middle age onwards, these activities should be focused on maintaining and optimizing the quality of bone, cartilage and ligament and their supporting, protective muscular structures. Therapeutic programmes should aim at graduated increase in weight bearing, particularly after periods of non-weight bearing or casting. The effects of unloading, loss of stiffness, and atrophy can be, at least partially, reversed with a gentle programme, which gradually increases the loading of all structures concerned (Lundon & Walker, 2007).

It has been recommended that the mild forms of osteoarthritis should be treated in as early a phase as possible with a focus on the following aspects (Moncur 1996, Dieppe 1998):

- Aerobic endurance, cardiovascular fitness
- Improvement and/or maintenance of joint mobility
- Optimization of motor control pattern to protect the joint structures
- Normalization of movement patterns; for example, gait, walking up and down stairs
- Information, education and instruction with regard to movement, diet, smoking, weight loss and other lifestyle factors, as well as self-management.

As well as:

- Proprioceptive qualities, such as joint position sense (Sharma et al. 1997, Felson et al. 2009).

OA-related research

According to van Baar et al. (1998), specific exercises have direct beneficial effects on pain and disability in patients with hip or knee. The exercises may be aimed at muscle strength, recruitment or coordination and endurance. Low-load repeated exercises, such as, for example, leg presses against low resistance, may influence intra-articular metabolism and may support synthesis of new matrix macromolecules in cases of damage to the chondral matrix and/or cells and/or subchondral bone without visible disruption of the articular cartilage (Buckwalter 1998). Normalization of alignment and movement patterns during weight-bearing activities, such as walking and bicycling, are recommended to enhance equal distribution of loads over the joint structures (Moncur 1996, Sharma et al. 2001).

Neuromuscular control of joint loading, including proprioceptive enhancement, is also recommended. Sharma et al. 1997 concluded in their comparative study of 28 patients with knee osteoarthritis and 29 controls, that the individuals with osteoarthritis demonstrated worse results on proprioceptive tests.

However, Felson et al. (2009) tested proprioception by the accuracy of reproduction of the knee angle in persons with or at high risk of knee osteoarthritis. At 30 months' follow-up they concluded that proprioceptive acuity could have moderate, but not strong, effects on the trajectory of pain and physical dysfunctions in knee osteoarthritis. Regardless of the somewhat inconclusive results, it seems to make sense to include balance and proprioception enhancement exercises in the treatment programme, as these exercises should enhance the patient's confidence and functional self-efficacy when moving in different circumstances and on various surfaces (Harrison 2004).

There is evidence that a combined approach of active treatment with passive mobilization results in better and more lasting outcomes.

Deyle et al. (2005), in a comparative study of patients with knee osteoarthritis, concluded that individualized manual therapy with supervised exercise may lead to greater symptomatic relief; this was also confirmed in a 12-month follow-up comparing the patients to the group which was only given a home exercise programme. Although both groups improved significantly when tested with six-minute walks and WOMAC scores, the people in the first group were less likely to take medication for their pain and were more satisfied with the overall outcome of treatment. In conclusion, it was recommended that a small number of additional clinical visits for the application of manual therapy and supervised exercise should be included in the treatment along with the home programme.

Alamri (2011) concluded that manual therapy may enhance treatment outcomes, particularly in range of motion. In a comparative study between two groups, one group received manual therapeutic techniques and supervised exercise for a period of four weeks and the other group received only supervised exercises. Both groups improved significantly in WOMAC scores and VAS, but the group that had treatment including passive mobilization demonstrated larger significant results in range of motion.

With regard to pain control, there is supportive evidence for the use of passive oscillatory mobilizations in the treatment of osteoarthritis of the knee. Moss et al. (2007) have provided experimental evidence that accessory mobilization of a human osteoarthritic knee joint has both an immediate local and a more widespread hypoalgesic effect. In a study of 38 subjects with knee osteoarthritis and mild or moderate knee pain, passive accessory movements were compared with manual-contact and no-contact interventions. Pressure pain thresholds were described as increasing significantly in the mobilization group, locally in the knee, but also more distally from the affected joints.

Many patients with knee osteoarthritis may also show impairments in the hip, ankle or lumbar spine. Rocha et al. (2006) described in a clinical case study the treatment of the lumbar spine with severe knee pain. The first six treatment sessions of the knee resulted in an improvement of perceived pain and the final six sessions aimed at treating dysfunctions of the lumbar spine resulted in complete relief from pain at 12 months' follow-up. In conclusion, it was recommended that the symptoms and signs of the spine be treated in addition to those of the peripheral structures.

Currier et al. (2007) developed a clinical prediction rule for the integration of hip mobilizations in the treatment programme of knee osteoarthritis (in any combination of two variables):

- Hip or groin pain or paraesthesia
- Anterior thigh pain
- Passive knee flexion less than 122°
- Passive hip internal rotation less than 17°
- Pain with hip distraction.

The role of education and information has been investigated by Hopman-Rock & Westhoff (2000) who conclude that a health education programme, which includes information on a healthy lifestyle and a physical education programme, demonstrated effects on pain, quality of life, muscle function, self-efficacy, BMI, physically active lifestyle and the number of visits to a physiotherapist. No effects were observed in range of motion and functional tasks.

Regarding engagement in sports, fitness programmes and moderate activity it has been shown, that:

> older adults participating for 20 to 30 minutes in moderate activity exercise on most days of the week have better physical function than older persons who are active throughout the day with daily cores or who are inactive. Any type of activity is better than no activity, but exercise confers greater benefit for physical capacity (Brach et al. 2004). There is indication that tai chi exercises may have beneficial effects on pain and disability of osteoarthritis (Hall et al. 2009). Performance of the 12 forms of the Sun-style tai chi by older women for 12 weeks decreased arthritic symptoms and improved balance and physical functioning (Song et al. 2003). A moderate tai chi programme was shown to increase functional mobility and enhance arthritis self-efficacy and quality of life in older adults with osteoarthritis. However, it appears that the quality of studies is relatively low with regard to RCT criteria.
>
> Hall et al. 2009, Hartman et al. 2000

Buckwalter (2003) recommends minimizing the risk of joint injuries and helping people with osteoarthritis to engage in regular physical activity, including low- or medium-impact sports (see the weblink in References for a list of sports in each category). He postulates that lifelong participation in sports that cause minimal joint impact and torsional loading by individuals with normal joints and neuromuscular function does not increase the risk of post-traumatic osteoarthritis.

In contrast, participation in sports that subject joints to high levels of impact and torsional loading increases the risk of joint injury and subsequent joint degeneration. He suggests including the following measures to decrease the risk of joint injury and degeneration when participating in athletics:

- Selecting sports or exercise programmes with low levels of impact, torsional loading and injury
- Using equipment and playing or running surfaces that decrease joint impact and torsional loading
- Maintaining and/or improving muscle strength and endurance to decrease joint impact loading and protect joints from injury
- Maintaining and/or improving general conditioning to decrease the risk of joint injury due to fatigue
- Alternate sports or exercise activities (cross-training) to decrease repetition of the same patterns of joint loading and motion.

To conclude, it is important to customize the treatment of knee osteoarthritis to the individual symptoms and signs of the patient and to select an integrated approach with active and passive movement. Patient education should promote understanding of the role of associated factors and lifestyle and enhance motivation to move regularly. Movement programmes have to be individualized and adapted to the patient's needs, preferences and movement potential. It is possible that short-term compliance to follow up with exercises and other self-management strategies is high in an early phase when supervised treatment is taking place; however, it may reduce once patients are performing independently (Campbell et al. 2001).

With regard to exercise and activity it is crucial to allow the patient to experience the benefits of a programme, as Hurley (2002) passionately states:

> Even when delivered with whole hearted conviction, advising people to exercise will only have a limited effect on increasing people's participation in regular physical activity. To get patients more physically active they must *believe* in the benefits of exercise and believe they have the ability to perform the exercises effectively. To achieve this they need to *experience* the benefits of a *simple, practicable, and enjoyable rehabilitation* regimen that can easily be integrated into their daily lives, and must include specific advice how to continue exercising at home or in the community.

And, additionally:

> Exercise doesn't have to involve strenuous, lengthy sessions in a gym. 30 minutes of accumulated physical activity is as beneficial as a strenuous jog, but should be performed on most, preferably all, days of the week. This physical activity could be accumulated during three 10-minute brisk walks, 30 minutes' gardening or housework, or an enjoyable day out. For patients such advice is more achievable and acceptable than 'going for the burn' in a gym. It is more likely to increase compliance and deliver the psychological benefits of exercise – increased feelings of self achievement,

> self-confidence, self-esteem, and personal independence.
>
> Hurley 2002, p. 674

See also Chapter 8 on sustaining functional capacity and performance in Hengeveld & Banks (2014).

'Anterior knee pain'

Anterior knee pain is a condition, which has received quite some attention in research and clinical practice since McConnell described a treatment approach for patella-femoral pain syndromes for this condition (McConnell 1996).

It has been suggested to improve motor control patterns of the patella, particularly in the last 30° of knee extension and first 30° of knee flexion with emphasis on the relationship between the vastus medialis obliquus (VMO) and the vastus lateralis (VL) of the quadriceps muscle acting as the primay stabilizing muscles in this range. It has been suggested that patients should train the recruitment of the muscle groups concerned within a closed or open kinetic chain with correction of pelvis-leg-ankle alignment (Witvrouw et al. 2004, Herrington & Al-Sherhi 2007). Corrective tapes may be applied to the patella if pain free exercising would not be possible (McConnell 1996). The training of the quadriceps with the emphasis on the VMO-VL relationship should occur within the chains of stabilizing muscle groups from the pelvis down to the knee and stabilisers of the foot (Cowan et al. 2002). Increasing attention is given to the role of the popliteus muscle within the overall dynamic chain of the pelvis and leg complex (Nyland et al. 2005).

Various effects have been attributed to the role of patellar taping the rehabilitation of patella-femoral symptoms. However it appears that the main, consistent effect lies in the reduction of pain during exercising (Crossley et al. 2000).

The effect of physiotherapeutic treatment on the electromyographic (EMG) timing of the activity of the vasti with the correlation of pain reduction was investigated in 65 participants diagnosed with patella femoral pain syndrome. It was concluded that before treatment the EMG onset of the VL occurred earlier than that of VMO in the treatment group and a control group. After treatment the onset of VMO preceded VL in the eccentric phase and occurred at the same moment in the concentric phase, while in the control group no EMG changes were demonstrated. This improvement of EMG function was associated the reduction in symptoms (Cowan et al. 2002). Next to muscular recruitment training, also passive mobilization and soft tissue techniques of the patella appear to lead to beneficial outcomes regarding pain on a short term basis. Van den Dolder and Roberts (2006) investigated the effects of six sessions of manual therapy (joint mobilization and soft tissue techniques) in one group, while the control group remained on a waiting list for two weeks. The experimental group improved significantly with regard to pain, active knee flexion range of motion, pain and velocity while walking stairs.

In spite of the attention to the localized treatment and improvement of motor control patterns, it is important to consider other sources and contributing factors to the onset, development and maintenance of anterior knee pain. Pain in this area may result from nociceptive (and peripheral neurogenic) mechanisms of the lumbar spine, pelvis, hip, neurodynamic processes and soft tissues as for example trigger points. These components need to be incorporated in examination, before a comprehensive, multimodal treatment programme may be developed for this condition (Collins et al. 2012).

Further information on the clinical profile may be found in Tables 8.1 and 8.2 and Case Study 8.1.

Total knee replacement

Total joint replacements are a common surgical intervention in many degenerative, inflammatory types of osteoarthritis and in some post-traumatic situations.

Although many protocols describe maintenance and improvement of joint mobility as one of the treatment objectives, they are not explicit in the use of active, assisted active (or assisted passive) or passive movements (Moncur 1996, Atkinson et al. 1999, Trudelle-Jackson et al. 2002, Thomas 2003).

Gentle passive mobilizations may complement the postoperative treatment. However, they may need an approach of 'wise action' (Higgs & Jones 2008; see also Chapter 2 on clinical reasoning in Hengeveld & Banks 2014) bearing in mind with the following considerations:

- Employ mainly accessory movements
- Localization of forces should be as close as possible to the joint line
- Application of forces should take place as much as possible parallel to the line through the joint surfaces

Table 8.1 Clinical prof le: osteoarthritis

Examination	Clinical evidence and ‘brick wall’ thinking
Kind of disorder	Pain and restricted mobility in various daily life activities
Body chart features	The patient may grasp around the knee and indicate that the pain is felt deeply in the joint or in the bone. Pain which is felt more superf cially at the anterior side may indicate that movements of the patella are painful as well
Activity limitations and 24-hour behaviour of symptoms	Getting up from a deep chair, walking up and down stairs, walking for longer periods Patient indicates that neither too much activity nor too little are benef cial – needs to f nd a balance between active and rest periods. Pain may be strong at night (vascular mechanisms?)
Present and past history	Gradual onset of symptoms in a prolonged history of constant awareness of discomfort studded with exacerbations Some patients indicate that the pain and disability increased over time and they may not be symptom free anymore. With those patients symptoms may have progressed from occurring during weight-bearing activities towards symptoms at rest (especially at night). However, other patients may describe that they have improved over the years, as, for example, after retirement from sedentary work, more activities (e.g. walking) are being performed
Special questions	
Source or mechanisms of symptom production	Pain originating from the subchondral bone exposed by symptom production of full thickness defects. Capsular and ligamentous structures may cause nociceptive activity Neurogenic and intra-osseous vascular mechanisms may contribute to the pain
Cause of the source	
Contributing factors	Habitual gait patterns, loss of joint mobility (esp. in extension), loss of muscle strength (e.g. coming up from squatting not performed for years), reduced aerobic condition
Observations	Genu varum, valgus position possible. Wasting of quadriceps, gluteal muscles; tight iliotibial band
Functional demonstration of active movements	Weight-bearing activities (e.g. getting up from a chair) and squatting may provoke symptoms. Differentiation testing of the tibiofemoral and patellofemoral joints is frequently possible. Often, however, both joints involved. Flexion, extension, rotations (esp. under compression) may be pain provoking. Often with through-range f ndings, crepitus may be present (may be deep in tibiofemoral joint or more superf cial in patellofemoral joint)
If necessary tests	See above: compression
Other structures in plan	Relation to lumbar movement dysfunction; hip, neurodynamic structures
Isometric and muscle length tests	Mostly inconclusive regarding symptom reproduction as contributing factors usually weak
Neurological examination	
Neurodynamic testing	
Palpation f ndings	Tenderness of soft tissues surrounding the joint
Passive movement, accessory/ physiological combined movements	Accessory and physiological movement of tibiofemoral (and perhaps patellofemoral) joints may be pain provoking and restricted. Compression may elicit crepitus and increase pain

Table 8.1 Clinical profile: osteoarthritis—cont'd

Examination	Clinical evidence and 'brick wall' thinking
Mobilization/manipulation techniques preferred	Accessory movement at end of range and through range positions. Large amplitudes, progression to compression may be necessary. If the problem is stable, physiological movements, particularly in extension combinations, may be utilized
Other management strategies	NSAIDs and pain-relieving medication if necessary; improvement of aerobic conditioning (e.g. on ergometer without resistance), muscle control, habitual (gait) movement patterns. Encouragement to exercise regularly, maintaining mobility, muscle strength, aerobic condition; pain-coping strategies, e.g. with automobilizations, repeated movements
Prognosis and natural history	Functional limitations may be influenced favourably with active and passive movement therapies in spite of the presence of degenerative changes in X-ray findings
Evidence base	It has been demonstrated that passive oscillatory techniques applied to the knee influence perceived pain (Moss et al. 2007). It has also been shown that active exercises have beneficial effects on outcomes such as pain, mobility and function (Moncur 1996, van Baar et al. 1998). However, there is an indication that a combined approach using both active and passive treatments leads to better long-term outcomes than either active or passive techniques used alone (Deyle et al. 2005, Alamri 2011)

Table 8.2 Anterior knee pain (due to peri- or intra-articular patellofemoral movement disorders)

Examination	Clinical evidence/'brick wall' thinking
Kind of disorder	Symptoms in anterior area of knee, may limit daily life activities strongly
Body chart features	Symptoms may be felt superficially in area of patella or more deeply underneath patella
Activity limitations and 24-hour behaviour of symptoms	Squat, getting up/down stairs, bike riding, downhill skiing, jumping may be mildly/severely restricted due to pain
Present and past history	Symptoms may have developed gradually, usually in periods of growth spurts and active integration in sports (e.g. running). May occur post-traumatic (e.g. after a fall on the knee, as in volleyball)
Special questions	
Source or mechanisms of symptom production	(Peri- and/or intra-articular oriented) patellofemoral movements or the soft tissues surrounding the joint may be causes of the nociceptive processes
Cause of the source	
Contributing factors	Muscle imbalance: recruitment pattern of VMO disturbed. VMO activity to late responses. Abductors of hip, pronation position of foot influence activity of VMO
	Contribution of Q angle inconclusive
Observations	Postural analysis is essential – alignment of tibia to femur; pronation of foot? Medial rotation pelvis or retraction of pelvis?
Functional demonstration of active movements	Squatting, getting down stairs. Observe quality of the movement: leg may fall into adduction and medial rotation of the hip. Pain may occur especially between 0 and 60° of flexion. Pain provocation with hip extension and adduction or position of lateral tibial rotation: indicative of short and tight tensor fasciae latae and iliotibial bands

Table 8.2 Anterior knee pain (due to peri- or intra-articular patellofemoral movement disorders)—cont'd

Examination	Clinical evidence/'brick wall' thinking
If necessary tests	
Other structures in plan	Relation to lumbar movement dysfunction, hip, neurodynamics
Isometric or muscle length tests	Tests of quadriceps, VMO in particular may provoke pain; coordination changes
Neurological examination	
Neurodynamic testing	
Palpation findings	Soft tissue tenderness. Patella position in 20° of flexion: parallel to frontal and sagittal planes? Midway between femur condyles?
Passive movement, accessory/physiological combined	Accessory movements of patellofemoral joints may provoke symptoms, including crepitus, especially if compression is applied movements
Mobilization/manipulation techniques preferred	Accessory movements; if very painful (group 1) gentle, large amplitude techniques short of P_1. Progression: in other positions of F and F/Ab of the knee; in later stages compression may be added. Lateral retinaculum may need to be stretched (e.g. in side lying and adding transverse medial movements and rotary movements along a longitudinal axis)
Other management strategies	Normalize tracking of patella in femoral groove with recruitment exercises of VMO within the muscle chain of foot and pelvis. Stretch tight iliotibial bands and tensor fasciae latae. Corrective taping of patella (medial; rotary; tilting cephalad, medially) may be helpful if weight-bearing exercises are too painful. Condition: corrective tape has to reduce the pain
Prognosis and natural history	'The need for surgery for patellofemoral pain has almost been eliminated due to improved understanding of its aetiology, taping of the patella to reduce the symptoms, and specific training of the VMO and gluteals. However the patient needs to be aware that the symptoms are managed … and the pain may recur, particularly when the activity level has increased and there has been a lapse in the exercise program' (McConnell 1996, p. 65)
Evidence base	McConnell 1996, Stiene et al. 1996, Witvrouw et al. 2004, Herrington and Payton 1997, Ernst et al. 1999

- Long leverage or techniques, which *may* move the bone around the prosthesis should be avoided (e.g. longitudinal caudad movement localized at the distal part of the tibia in knee treatment, distal part of femur in hip movement, distal part of humerus in shoulder movement)
- Progression of treatment is possible as described on pages 481–485.

If active movements achieve the goals of treatment, passive movements become superfluous. However, in an early phase after the operation in which the focus lies on active movement within pain-free limits, gentle passive movements may support the active movement of the patient, e.g. many patients with a joint replacement of the hip may have difficulties with active flexion of the knee in supine lying. Gentle AP movement, applied to the joint, may 'centralize' the hip better which then allows the patient to actively flex further into the range; many patients with a knee arthroplasty may have difficulties, and/or pain, in actively flexing and extending the knee in sitting. Gentle accessory movement applied closely to the joint may enhance the movement. In later stages, when tissue healing is nearly complete and joint mobility seems more restricted than would be expected in this phase, passive movements may become the first treatment of choice to enhance mobility.

It appears that gentle passive movements as a support to active motion are underutilized in physiotherapy practice in the postoperative treatment of total knee arthroplasty. This may be due to the dominant biomechanical perspective on the effects of passive movements. However, it has been demonstrated that these theories have not found an acceptable scientific basis (Twomey 1992). Particularly neurophysiological effects have received much attention in many publications (Wright 1995). In the case of total knee arthroplasty, passive movements may be considered in the light of central learning theory and neuroplasticity:

1. Input by repeated stimuli (for example, oscillatory passive movement and its progression) would lead to a desensitization of the nervous system with restoration of normal system sensory processing
2. Based on central learning theory and neuroplasticity, habituation of sensomotor processes, in which synaptic learning would lead to decreased behavioural responses to repeated stimulation
3. Averse memory – extinction of protective, unfavourable sensomotoric patterns, by offering the nervous system different, normal sensomotor stimuli with passive and active movements (Zusman 2004).

Clinical reasoning

Most disorders of the knee treated by physiotherapists include overuse or misuse problems, such as patellofemoral pain syndrome (PFPS), traumatic injuries and degenerative conditions such as osteoarthritis of the knee. Frequently the problems are based on dominant nociceptive processes, which may need to be treated with passive mobilization to normalize joint function, muscle control exercises, aerobic endurance, agility and proprioceptive training and restoration of functional activities. It is crucial to consider all possible movement components contributing to the pain and disability of the patient, as well as factors relating to compliance enhancement and motivation to change, in order to individualize treatment.

The reader should refer to Chapter 1 of this volume and Chapter 2 of *Vertebral Manipulation* for a description of clinical reasoning and clinical reasoning theory. The clinical profiles in Tables 8.1 and 8.2 demonstrate how different hypotheses categories may be implemented in the procedures of examination and treatment of some common movement disorders of the knee.

Subjective examination

Subjective examination, as in all other areas of movement dysfunctions as described in this book, is essential to determine the possible sources of symptoms, contributing factors, precautions and contraindications to examination and treatment procedures and the overall level of disability, leading to treatment objectives in activity and participation levels as described in the International Classification of Functioning, Disability and Health (ICF) (WHO 2001).

The main movement components to be analyzed during the subjective and the physical examination are:

- Tibiofemoral joint, including peri- and intra-articular structures
- Patellofemoral joint, including peri- and intra-articular structures
- Soft tissues (if not to be localized as periarticular structures of the above-mentioned joints) and musculotendinous structures
- Superior tibiofibular joint (often needs to be examined in foot and ankle disorders as well).

However, if symptoms appear vague and difficult to localize or the symptoms have not developed based on a clear incident, other contributing components (e.g. hip joint, lumbar spine, neurodynamic system) to the movement disorder also have to be taken into consideration. This may also be the case in those circumstances where an injury has led to the symptoms but recuperation of function seems to take longer than would be expected.

Important points in the subjective examination include (Corrigan & Maitland 1994):

- Whether the onset of pain is gradual or sudden
- The relationship of pain to any trauma and the mechanism of such trauma
- The presence of any swelling and how rapidly or gradually it developed
- A feeling of instability or 'giving way' during use
- Any locking of the knee
- Clicking or catching, especially if it reproduces pain
- Whether the knee problem is stable, progressive, recurrent or intermittent, or brought on by certain activities
- The presence of any stiffness
- Whether other joints are involved
- The effects of any previous treatments.

Main problem ('Question 1')

Next to pain, the patient may describe various other complaints as the main problem.

Locking

A careful evaluation of this symptom is essential. Locking may result from a torn meniscus, a loose bony fragment (e.g. from osteochondritis dissecans), a torn cruciate ligament or avulsed anterior tibial spine, chondromalacia patellae, a dislocated patella or a medial plica. Locking is not an appropriate term as it implies that no movement at all should be possible. Locking usually means a sudden complete block to full extension of the knee which is nevertheless able to flex fully. The knee usually lacks 30° of extension and the screw-home mechanism is lost. The end-feel extension in a locked knee provides a characteristic rubbery sensation with an associated motor response (spasm).

Catching

Catching is a sensation which indicates that something is getting in the way of joint movement and it may be painful. Its mechanism of production is similar to locking.

Instability – 'giving way'

Stability is provided by the ligamentous structures (passive stability) and the surrounding muscles (dynamic stability). A feeling of instability, giving way or 'buckling' of the knee on use is a common symptom. It may be produced in chondromalacia patellae, a torn meniscus, a loose bone foreign body or arthritis. A feeling of instability may also arise after cruciate ligament tear with true rotatory instability.

The knee usually gives way suddenly without any warning or pain, but often with a feeling that one bone has moved or slipped on the other. This tends to occur on walking down stairs or on uneven ground when the leg supports the body weight. It is particularly common when a runner changes direction or steps off the involved leg.

Swelling

Swelling indicates the presence of some intra-articular damage. Haemarthrosis comes on more rapidly after injury than synovitis so that its onset is measured in minutes rather than hours. The knee is usually extremely painful, warm, tender and held in some degree of flexion. The most common cause of a haemarthrosis is a ruptured anterior cruciate ligament. Less common causes are tears in the capsular ligament or an osteochondral fracture. Non-traumatic causes are rare and include blood dyscrasias, anticoagulant therapy, pigmented villonodular synovitis or neoplasms. Haemarthrosis may need to be differentiated from crystal deposition diseases, inflammatory arthritis and septic arthritis. Diagnosis is then made after aspirating the knee of synovial fluid.

Areas of symptoms (body chart)

The localization of symptoms may be indicative of the movement component causing the symptoms.

- Disorders from the tibiofemoral joint usually produce pain within the knee itself. The patient may grasp around the knee and indicate that 'it' is deep within. The pain may be associated with stiffness, especially after sitting for a time
- Disorders of the patellofemoral joint usually produce pain in the retropatellar area or the anterior side of the knee and are more superficially indicated than disorders from the tibiofemoral joint. Occasionally some symptoms may be felt deep in the knee fold on the posterior side
- Soft tissue lesions (e.g. of ligamentous structures or tendons and their insertions) are often felt locally and the patient may be able to pinpoint the painful spot by touching it.

Pain may also be felt in the knee area as a result of dysfunctions in more proximal structures. Frequently this type of pain is more vague, dull and more difficult to localize. In particular, the hip joint may refer to ventromedial areas of the knee, while the lumbar spine may radiate to the dorsal side. In certain circumstances dysfunctions of neurodynamic structures may contribute to the symptoms.

Behaviour of symptoms – activity limitations

While hypotheses with regard to the sources of the symptoms may already have been generated during the first phase of the subjective examination, the behaviour of the symptoms and the concomitant activity limitations may serve to modulate or confirm some of these hypotheses (principle: 'make features fit'):

- Symptoms arising from the tibiofemoral joint are often worse when the patient first stands up to walk or after walking for some distance, are often worse with weight bearing on the affected leg and are worse on going up or down stairs. Pain may also be associated with stiffness, particularly after sitting for a time.
- Disorders of the patellofemoral joint are usually made worse by activities such as walking, running, riding a bicycle, going up stairs or walking downhill for some time. The symptoms may also occur after a prolonged period of sitting, for example, in a car or at the theatre.
- Local ligamentous lesions may be provoked with activities which involve stretching the ligament concerned. Furthermore, tendinous lesions may be provoked with activities involving contraction of the muscle or stretching or compression the tendon.

It is essential to establish the current levels of activities and the preferred levels of activities. Particularly in cases of osteoarthritis of the knee activities as walking, climbing stairs, self-care, carrying bags, bending, kneeling and so on need to be established in sufficient detail in order to allow for the development of an individualized treatment programme based on the patient's complaints, functional limitations and movement preferences.

History

If the symptoms are of *traumatic onset*, information on the injuring movement is essential. In acute cases it may give an indication of the structures involved. If total ligamentous ruptures, torn menisci or fractures are suspected, the physiotherapist may need to consult a medical practitioner before continuation of treatment. If symptoms are more minor, or the disorder has recuperated to a degree, and it no longer limits most daily life activities, the injuring movement may become an essential element of physical examination and may be used in treatment with passive mobilization (Maitland 1991).

If symptoms are of *spontaneous onset*, it is necessary to investigate if any overuse or misuse of the structures or reduced capability to bear stress (e.g. due to muscular imbalances or lack of aerobic condition) has contributed to the development of the nociceptive processes.

In cases of pain in the inferior patellar area the activities leading to the symptoms may give an indication of the possible structures involved:

- Eccentric loading (e.g. jumping in ball sports or increased hill work during running) mainly provokes the patellar tendon.
- Symptoms developed after tumble turning or vigorous kicking in a swimming pool may indicate the presence of an irritated fat pad (McConnell 1996).

Medical and health screening questions

Next to the routine information regarding the patient's health, weight loss, radiographic findings, medication intake and so on, screening questions should be posed with regard to vascular and neurogenic disease such as varicosis, deep venous thrombosis or polyneuropathy (see also Chapter 2 on clinical reasoning in Hengeveld & Banks 2014).

Physical examination

Depending on the plan after the subjective examination, the physiotherapist may decide to focus the examination on one of the main components of the joint, be they tibiofemoral, patellofemoral or superior tibiofibular movements. First, active movements will provide the therapist and patient with parameters for reassessment procedures. The components may be examined passively, with subsequent reassessment of the active parameters to confirm the possible involvement of one or more components in the movement disorder.

If soft tissue lesions are suspected, it is often recommended that the joint components be examined first, as they frequently constitute a part of the periarticular structures which may be influenced by mobilizations with accessory and physiological movements.

In many cases screening of movement functions of hip, lumbar spine and neurodynamic structures is necessary.

Box 8.1 provides an overview of examination procedures of the knee complex and its related structures. Detailed information on some test procedures is given below.

Box 8.1

Physical examination of the knee complex

Observation

- First palpation of temperature, swelling or effusion
- Present pain

***Functional demonstration/tests**, including differentiation of movement components

Brief appraisal

Active movements

- Gait analysis: forwards, backwards, on heels (esp. backwards), on toes; may assess: sprint, running
- Squat: on toes, on heels, bouncing
- Height of step
- Quadrupedal position: sit towards heels
- Getting up or down a step (forwards, backwards, sideways)
- Hopping, jumping
- Extension of knee in standing
- In supine, lying, including overpressure:
  - F, E, in 90°F, MR and LR
  - 'If necessary' tests:

F/Ab, F/Ad, incl. combinations in rotation; F + Ab, F + Ad

E/Ad, E/Ab (= E with ↑ on tibia)

In different positions of F or E: MR, LR

Ab/Ad (in E and 20°F)

'Injuring movement'

Muscle tests

- Isometric tests: symptom reproduction. Quadriceps, biceps femoris, semitendinosus, semimembranosus, adductors
- Recruitment patterns: VMO, VL in different positions of F in standing
- Muscle length tests (mostly at end of passive testing – after neurodynamic testing)
- Motor control and recruitment patterns: VMO, VL, etc.

Screening of other structures in 'plan'

- Hip, lumbar spine, sacroiliac joint, neurodynamic structures

Palpation

- Temperature, swelling, effusion
- Tenderness

Passive movements

- Neurodynamic test procedures
- Movement diagram of relevant active tests: F, E, in 90°F, MR or LR
- Meniscus tests, ligamentous tests (stability testing)
- Tibiofemoral joint:
  - Physiological movements: F combinations; E/Ab, E/Ad as treatment technique
  - Accessory movements: Ab, Ad (in E and 20°F), ↓, ↑, →, ←, ↔ caud and ceph ↻, ↺
  - Test procedures under compression
- Patellofemoral joint:
  - Accessory movements: ↔ caud and ceph,
  - →, ←, >-<, distraction, ↻, ↺, longitudinal and sagittal
  - In different positions
  - Test procedures under compression
- Superior tibiofibular joint:
  - Accessory movements: ↓ ↑, ↔, caud and ceph, ↻, ↺ >-<
  - In different positions, incl. SLR and inversion of foot (common peroneal nerve)
  - Test procedures under compression

  Check case records etc.

  Highlight main findings with asterisks

  Instructions to patient at end of session
- Warning: possible exacerbations
- Instructions: observe and compare symptoms and activities
- Other recommendations: self-management strategies, etc.

Present Pain

Before performing any tests it is necessary to determine if the patient has any pain at rest.

Observation

The patient must be suitably undressed. If possible the observation will be done first in weight bearing. It includes observation of:

- Any kind of structural changes, swelling, temperature
- Is weight bearing symmetrical? Are any aids used in weight bearing?
- Alignment of the legs, the pelvis and the spine
- Willingness to move.

Alignment

When patients present with knee problems the assessment of the alignment is an important point in the assessment of contributing factors. The assessment of the alignment should include multiple alignment characteristics which may interact with or cause compensations at other bony and soft tissue segments (Nguyen & Shultz 2009, Daneshmandi & Saki 2009).

Lower extremity alignment has been shown to be a risk factor for knee injury especially in females (Loudon et al. 1996) and for structural progression of knee osteoarthritis (Brouwer et al. 2007, Sharma et al. 2001) and patellofemoral problems (Powers et al. 2012). The assessment of the alignment includes not only the orientation of bony landmarks but also the muscular and fasciae contour.

In clinical practice six alignment measurements are commonly used.

- *The quadriceps angle (Q-angle)* is formed by a caudally oriented line from the anterior superior iliac spine (ASIS) to the patella centre and a line from the patella centre to the tibial tuberosity and can be measured in lying, standing and one-leg standing. Normal Q-angle values for women are < 20° and for men <15° (Horton & Hall 1989, McKeon & Hertel 2009). Alterations of the Q-angle influence the tibiofemoral and patellofemoral kinematics (Mizuno et al. 2001). Q-angle is influenced by pelvic, hip, knee and foot position and their related muscular control. Shultz et al. (2006) reported an intra-class correlation coefficient (ICC) of 0.89 to 0.98 intra-tester reliability. The Q-angle determines the lateral pull of the quadriceps on the patella. Clinically relevant is the dynamic Q-angle in one-leg standing or squatting (Massada et al. 2011).

  In addition, the alignment of the patella in relation to glide, tilt rotation and anteroposterior tilt has to be assessed. This is done in standing but later on also in supine position with the knee in a slight flexed position. Kalichman et al. (2007) have shown that patellar malalignment can cause excess stress on the articular surfaces of the patellofemoral joints and may be a reason for degenerative changes in the knee.
- *The tibiofemoral angle* is measured by the intersection of the axis of the femur with the axis of the tibia. A varus-aligned (bow-legged) individual has a tibiofemoral angle less than 5° valgus. Normal alignment is 5–7° valgus. A valgus-aligned (knock-kneed) individual has a tibiofemoral angle greater than 7° valgus (Karachalios et al. 1994). Sharma et al. 2001 showed that individuals with a varus knee alignment have an increased risk of medial compartment and individuals with a valgus knee alignment have an increased risk of lateral compartment osteoarthritis progression.
- *Navicular drop test* (Brody 1982): in a seated position with the knees and hips at 90-degree angles the subtalar joint neutral position is found. The distance of the midpoint of navicular tuberosity of the foot to the floor is measured. The subject then stands up and the standing navicular position is measured. Navicular drop is calculated as the difference between the sitting and standing positions. This method has been reported to have an ICC of 0.91 to 0.97 for intra-tester reliability (Shultz et al. 2006). The minimum (Trimble et al. 2002) and maximum (Moul 1998) reported average measurements for navicular drop test are 7 and 9 mm, respectively.
- *Genu recurvatum* is measured, if possible, in standing; the patient is asked to extend the knee as fully as possible. Measurement is taken from the central point of the greater trochanter to the central point of the lateral femoral epicondyle and from the most lateral point of the proximal joint line of the knee through the lateral malleolus (McKeon & Hertel 2009). This method has been reported to have an ICC of 0.88 to 0.97 for intra-rater reliability. The range of averages reported for tibial varum for healthy limbs is 4° to 8.7°. More than 10° of knee hyperextension is a potential risk factor for overuse injuries in the lower limb (Devan et al. 2004).
- *Anterior pelvic tilt* is measured using an imaginary line from the anterior superior iliac spine to the posterior superior iliac spine as it diverges from the horizontal. Pelvic tilt is measured as the degree of anterior tilt of the pelvis in the sagittal plane. This method has been reported to have an ICC of 0.77 to 0.99 for intra-tester reliability (Shultz et al. 2006, Krawiec et al. 2003). The average anterior pelvic tilt angle is 10–15° (Shultz et al. 2006).
- *Femoral anteversion* is measured with the patient positioned prone and the knee flexed to 90°. The greater trochanter is palpated at its most lateral position (passive femur internal

rotation is used to find this position). Femoral anteversion is determined as the acute angle formed by the tibia and an imaginary vertical line. Shultz et al. (2006) reported an ICC of 0.77 to 0.97 for intra-tester reliability of the femoral anteversion test. Normal femoral anteversion values range from 8°–15° (Magee 1987).

It has been described that women demonstrate larger measures for Q-angle, genu recurvatum, anterior pelvic tilt and femoral anteversion compared with men (McKeon & Hertel 2009).

Other aspects that may be considered during observation are:

- Any indication of swelling or an inflammatory process (in some cases it may be important to commence the observation with a quick palpation of temperature and swelling. If found positive, as a precautionary measure the tests should be repeated regularly during the steps of physical examination to ensure that the temperature and swelling do not increase due to the testing procedures (see 'Palpation' below)
- Any indication of muscular imbalance and wasting (e.g. weakness of the vastus medialis and hip abductors, shortened iliotibial band). Be aware to assess the trunk as well as the lower limb. Current evidence suggests that decreased core stability may predispose to injury of the lower extremity (Willson et al. 2005).

Functional demonstration tests

The patient is asked to *demonstrate a functional activity* which provokes the pain as described in the subjective examination. This activity may serve as a functional reassessment parameter ('physical asterisk').

Differentiation procedures may also be performed, which add or subtract stress to the movement components involved in the activity. For example, the patient may demonstrate symptoms at the medial side of the knee during the demonstration of a tennis movement (forehand). The patellofemoral joint may be examined when medial or lateral gliding movements, including compression, are added to the activity. The tibiofemoral joint may be additionally stressed by increasing, for example, the medial rotation of the femur over the tibia, and the hip joint may be put under more stress (while at the same time the therapist controls the knee joint to control its position) by rotatory movements of the pelvis over the femur. Changes in symptoms during the manoeuvres indicate the movement component(s) responsible for the symptoms.

Brief appraisal

After the differentiation tests a *brief appraisal* or reflection is necessary in which the physiotherapist determines if the test procedures may be continued as planned or if an adaptation of the examination sequences seems necessary.

Active movements

Weight bearing

It is recommended to include active movement tests of the knee in weight bearing (unless contra-indicated) before performing active tests in supine or prone lying.

- *Gait analysis*. Some aspects of gait analysis have been described in Chapter 7. In the examination of movement disorders of the knee, particular attention should be given to walking forwards, backwards, walking on heels (especially backwards) and walking on toes. If necessary, gait analysis is performed at different speeds. In sports people often running and sudden changes in direction also need to be assessed.
- *Standing on one leg*. Special attention should be given to the alignment of the pelvis, hip, knee (Q-angle) and foot. Muscular activation (decreased or increased) and possible recruitment faults should be assessed.
- *Standing on one leg and half or full flexion test*. The full flexion test is only performed if symptoms have not yet been reproduced and the problem presents as stable. Most commonly it is used to test sports people.
- *Standing on one leg and rotation test*. This test can be used to increase the rotational stress on the knee joint if symptoms have not yet been reproduced.
- *Step-up and step-down test forward, backward and to the side*. As with the one-leg standing test, special attention should be given to the alignment (functional Q-angle; pelvic, knee and foot alignment) and muscle activation.

- *Squatting on toes (knee squat), on heels (hip squat)*. Assess quality of movement, amount of movement and symptoms. If necessary, progress to bouncing and bouncing sideways (with the pelvis laterally and medially from the affected knee).
- *Sitting on heels*. The patient moves from the quadruped position gradually from the buttock towards the heels. The same test can be done starting in the kneeling position.
- *Active knee extension in standing*. The patient should place both feet in line with the centre of the hip joint and move both knees in active extension or hyperextension. If necessary, a light bounce can be performed.
- *Hopping, jumping on both legs or one leg*. If necessary, the stress on the knee joint can be increased by hopping, jumping on both legs and one leg or any other sport-related activities, which might be relevant for assessment.

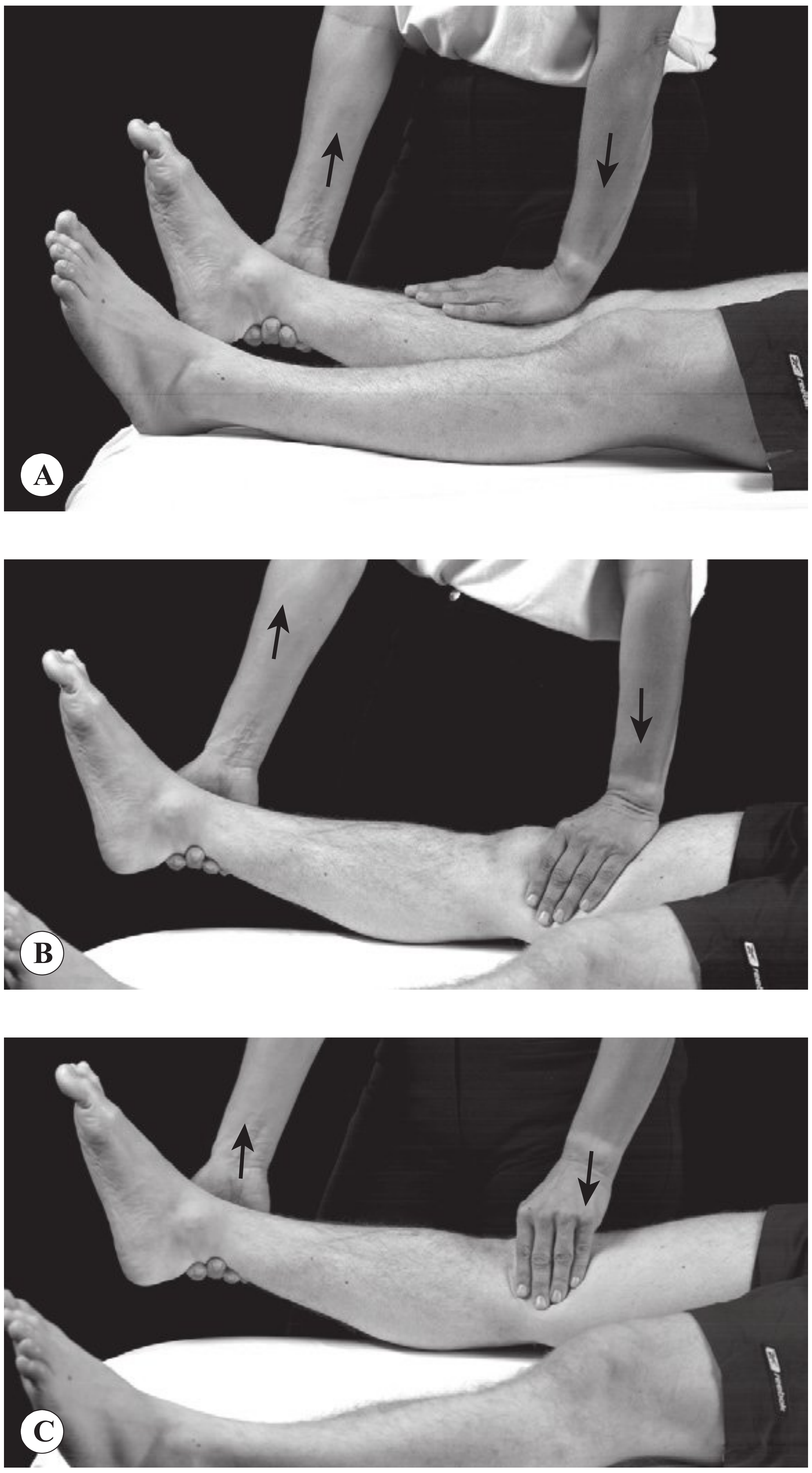


Figure 8.1 • Extension overpressure applied: A to the tibia; B to the femur; C over the joint line.

Active tests of the knee (in non-weight bearing)

The active movement tests of the knee joint in non-weight bearing are done if the active tests in weight bearing are not indicated or if range of movement has still to be measured. The standard tests include extension, flexion and in 90° of flexion, medial and lateral rotation. Overpressure may be added at the end of range of active movement if symptoms are not reproduced.

Extension (supine)

- The patient actively extends the knee. Observe range, quality (including muscle recruitment patterns) and symptom reaction.
- Overpressure should be applied in three different ways:
  1. Towards the proximal aspect of the tibia (Fig. 8.1A)
  2. Over the distal aspect of the femur (Fig. 8.1B)
  3. Over the joint line (Fig. 8.1C).
- The *end-feel* may be appreciated in a different way, i.e. with the knee fully extended and relaxed. Passively flex the knee approximately 20° and then allow it to drop back into full extension. A normal knee can fall into full extension with a typical painless hard end-feel. In patients with osteoarthritis a similar end-feel may be found, but the joint lacks full extension. A meniscus lesion may produce a softer end-feel and the leg may bounce slightly more once dropped from flexion to extension.

Flexion (Fig. 8.2)

- The patient is asked to pull the knee towards the buttock. Observe range, quality and symptom response.
- Mobility may be measured with a goniometer, but as an alternative the distance between the heel and the ischial tubercle may be measured in centimetres.

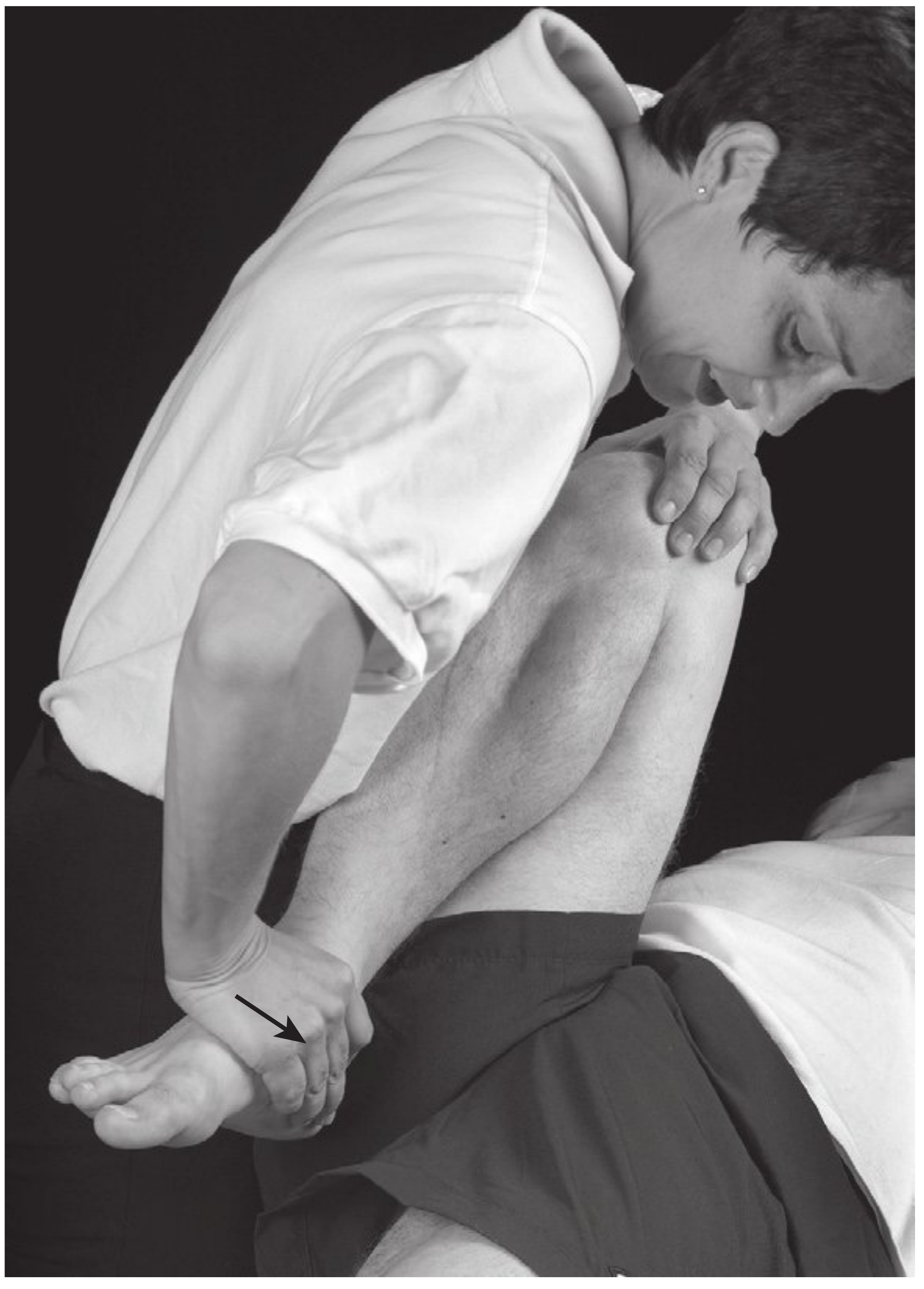


Figure 8.2 • Flexion overpressure.

In 90° of flexion: medial rotation, lateral rotation

- The test may be performed in supine (Fig. 8.3), as well as in sitting.

If necessary tests

These need to be performed if the 'standard' tests insufficiently produce symptoms. Usually combinations of physiological movements are performed, either passively or assisted actively, as follows:

- Produce medial and/or lateral rotation in different positions of flexion and extension.
- (Passive) abduction, adduction (see 'Description of techniques' below).
- Extension/adduction, extension/abduction (including anteroposterior movement on the tibia) (Fig. 8.4).
- Flexion/abduction, flexion/adduction, including combinations in rotation (see 'Passive test procedures' below) (see Fig. 8.5).
- Test movements may be produced under compression (see 'Passive test procedures' below).

Muscle tests

Muscle tests may be performed with different purposes:

- Symptom reproduction
- Muscle strength, endurance, coordination and recruitment patterns
- Muscle length.

Isometric tests – as symptom reproduction

Isometric tests are carried out if muscle or tendon lesions are suspected. The tests frequently need to be combined with palpation of the tender spot(s) to confirm the structure at fault. The following structures may frequently cause symptoms and require soft tissue treatment:

- Biceps femoris with the insertion at the fibular head
- Quadriceps, with the patellar ligament
- Adductors as part of the pes anserinus.

Note: If soft tissue lesions occur in conjunction with joint dysfunctions, it is recommended that joint signs are treated first, with the isometric pain-provoking tests used as one of the parameters in reassessment procedures.

Recruitment patterns, patellar alignment and symptom reproduction

The recruitment of the vastus medialis oblique (VMO) in weight-bearing positions merits particular attention in movement disorders of both the tibiofemoral and the patellofemoral joints. In different positions of high sitting (e.g. 0°, 20–30°, 60°, 90°) the following factors may be observed (Hilyard 1990):

- Symptom reproduction
- Patellar movement: does correction of the patella (manually or with tape) reduce the symptoms?
- Quadriceps activity within the overall muscle chain: timing and amount of activity of VL versus VMO. Is there earlier and greater

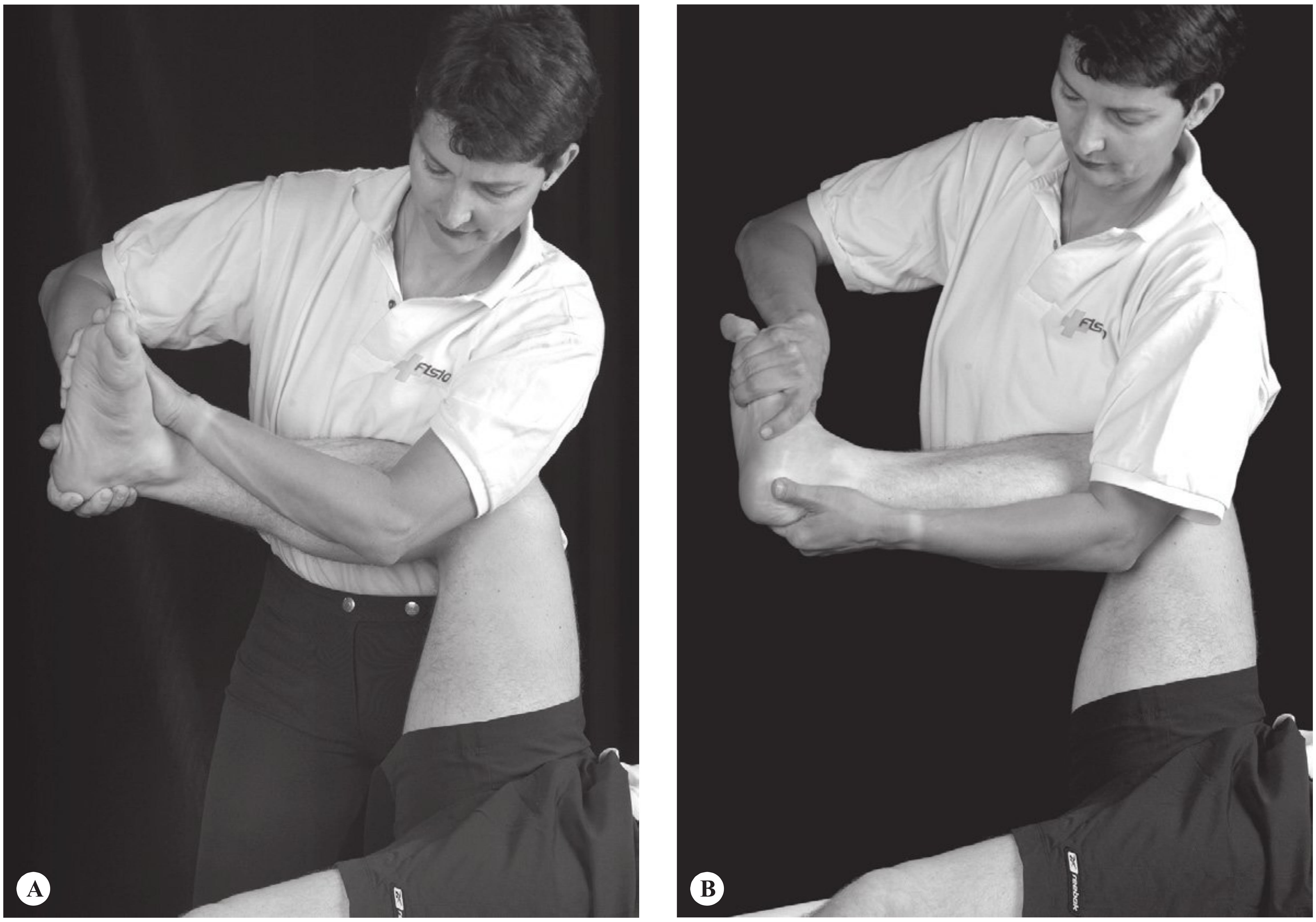


Figure 8.3 • Active rotation, including overpressure: A medial; B lateral.

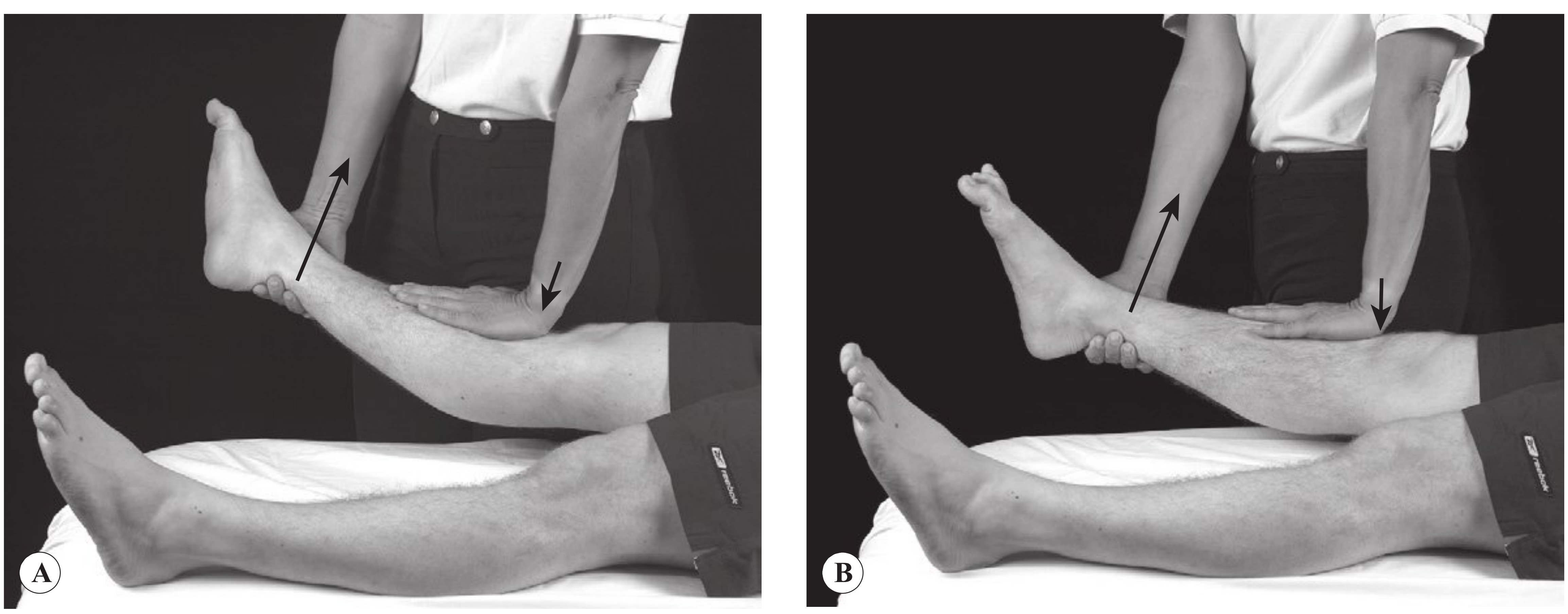


Figure 8.4 • If necessary tests: A extension/adduction; B extension/abduction.

amount of activity in VL? McConnell (1996) proposed that there should be an equal amount and similar timing in the VL and VMO. A delayed onset of VMO in relation to the vastus lateralis was observed in subjects with PFPS (Cowan et al. 2002, Tang et al. 2001). In management, VMO training will be an important part of therapy if there is a difference between VL and VMO (Fig. 8.6).

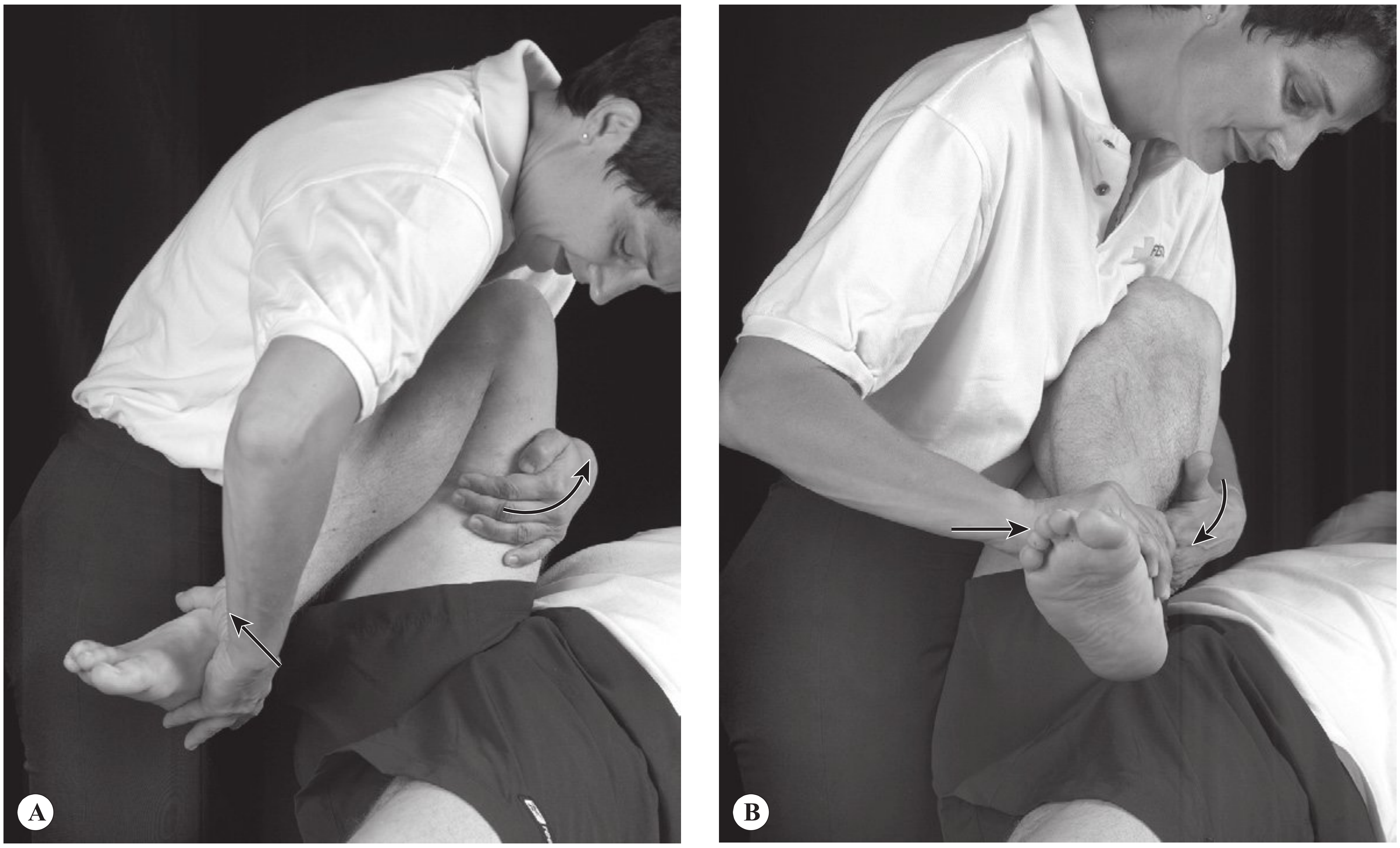


Figure 8.5 • Tibiofemoral movements in fexion: A fexion/abduction; B fexion/adduction.

Figure 8.6 • Examination of the recruitment patterns of the vastus medialis oblique.

Muscle function and strength tests

Not only knee muscle function and strength has to be assessed but also the muscles of the adjacent joints, for example, the hip and foot. Weakness of hip muscles (e.g. gluteus medius, external rotators, gluteus maximus) and poor stability of the foot is commonly associated with knee joint problems (especially with patellofemoral problems) (Powers 2010, Prins & van der Wurff 2009).

Muscle length tests

Tests of the rectus femoris, tensor fasciae latae (including iliotibial band), hamstrings, adductors, gastrocnemius and soleus may be performed in this stage of the examination. However, it is often recommended that an impression of the mechanosensitivity of the neurodynamic system should be obtained first (Edgar et al. 1994) and that muscle length tests be performed during the sequence of passive movement testing.

Screening of other structures 'in plan'

Screening tests are performed to determine if other movement components contribute to the movement disorder of the knee. It is also necessary to establish whether these components should be *included* in the treatment. The test procedures mentioned are minimum requirements. If some of the tests are *not* impairment free, the movement components need to be examined in more detail.

- *Hip joint*: movement tests should be performed routinely in most movement disorders of a spontaneous onset. Active movements include: flexion, in 90° of flexion: medial and lateral rotation, extension. Passive tests include: flexion/adduction, including combinations and subsequent reassessment.
- *Lumbar spine*: extension, rotations, quadrant (if possible). PAIVMs, including subsequent reassessment.
- *Sacroiliac joint*: sacroiliac provocation tests such as F/Ad with compression, Patrick's test (FABER test), anterior and posterior tilts, passive accessory movements including subsequent reassessment.

(*Note*: as F/Ad with compression is also an important procedure in the examination of hip movement disorders, frequently it is useful to complete the hip examination with the relevant passive tests prior to the screening procedures of the sacroiliac joints.)

- *Neurodynamic system*: SLR and modifications (tibial, common peroneal nerve). PKB and slump in side lying, including modifications (femoral nerve, saphenous nerve, obturator nerve) (see Butler 2000). Box 8.2 describes tests for the nervous system.

Box 8.2

Tests for the nervous system

Clinically the nervous system can be assessed in three ways: neurological examination, neurodynamic tests and nerve palpation (Butler 2000).

- *Neurological examination* with sensory, motor and reflex testing is only necessary if a peripheral or central nervous system conduction problem is suspected. In orthopaedic patients with knee pain a neurological examination is commonly not indicated.
- *Neurodynamic tests* are designed to test the mechanosensitivity of peripheral nerves and their mobility. For anterior and medial knee pain the neurodynamic tests for the femoral and saphenous nerves are being used. For posterior knee pain the neurodynamic tests for the sciatic nerve and tibial nerve are being performed. Lateral knee pain is an indication to test the communal peroneal nerve.

Femoral nerve test: (Fig. 8.7)

- Patient starting position: prone, arms beside the body.
- Application of forces: therapist passively flexes the knee.
- Remark: differentiation between N. femoralis and quadriceps muscle is diffcult in this position. Therefore this test is most commonly done in slump side lying (trunk flexion and neck flexion).

Slump side lying (see Fig. 8.8)

- The patient is positioned in side lying, the therapist brings the leg of the upper side into hip extension and passively flexes the knee. If symptoms are reproduced the structural differentiation would take place by releasing the neck flexion (hence reducing neural tension) and to ask the patient to report any changes in symptoms.

Saphenous nerve test (Fig. 8.9):

- *Patient and therapist starting position*: As in slump side lying.
- *Application of forces*: Therapist extends and abducts the hip of the upper side, extends the knee, externally rotates the hip and positions the foot in eversion and plantar flexion or eversion and dorsiflexion (N. saphenous can run in front or behind the flexion/extension axis of the foot).

Figure 8.7 • Femoral nerve test.

Box 8.2—cont'd

Sciatic nerve, with emphasis in the tibial nerve (Fig. 8.10)

- *Patient starting position*: Supine, straight legs.
- *Therapist starting position*: The therapist is standing on the side of the leg that is tested watching towards the patients feet.
- *Localization of forces*: the therapist hands are placed under the toes and on the heel of the patient's foot.
- *Application of forces*: starting with dorsiflexion and eversion of the foot, followed by knee extension and hip flexion. Knee and/or lower leg symptoms may need to be differentiated by neck flexion, trunk or hip movements.
- *Variation*: the therapist frst positions the leg in SLR and then she moves the foot in dorsiflexion and eversion.

Sciatic nerve, with emphasis in the communal peroneal nerve (Fig. 8.11)

- *Patient starting position*: Supine, straight legs.
- *Therapist starting position*: The therapist is standing on the side of the leg that is tested watching towards the patient's feet.
- *Localization of forces*: One hand is placed on the dorsum and the other hand on the heel of the patient's foot.
- *Application of forces*: starting with plantarflexion and inversion of the foot, followed by knee extension and hip flexion. Knee and/or lower leg symptoms may need to be differentiated by neck flexion, trunk or hip movements.
- *Variation*: the therapist frst positions the leg in SLR and then she moves the foot in plantarflexion and inversion.

Figure 8.8 • Slump in side lying.

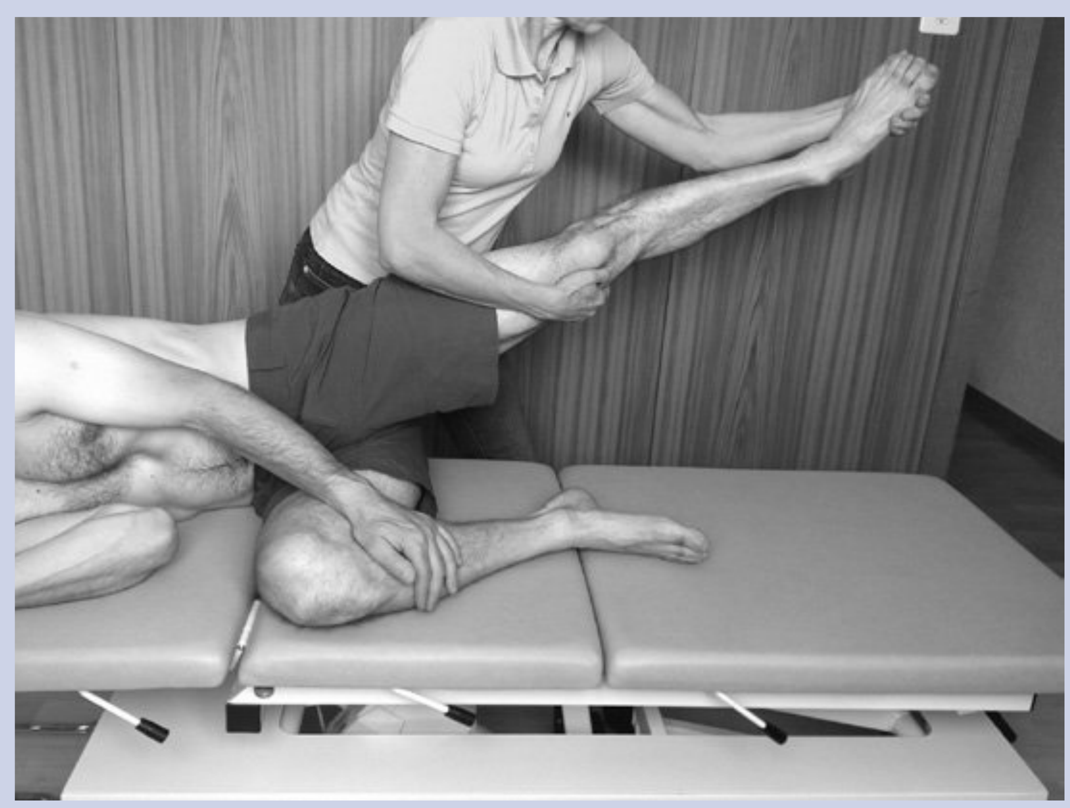


Figure 8.9 • Saphenous nerve test.

Figure 8.10 • Sciatic nerve test, with emphasis on the tibial nerve.

Figure 8.11 • Sciatic nerve test, with emphasis on the communal peroneal nerve.

Box 8.2—cont'd

A neurodynamic test is positive if the symptoms of the patient are reproduced and altered (increase or decrease) with structural differentiation procedures.

- *Nerve palpation:* tissue palpation quality of peripheral nerves and its surrounding tissues, transverse gliding and the mechanosenitivity will be assessed with nerve palpation. A prerequisite for nerve palpation tests is the knowledge of the anatomical course of the peripheral nerves and that there can be variations. Nerve palpation is positive if the symptoms of the patient can be reproduced and/or if tissue quality differences during palpation of the peripheral nerves are present. Involvement of peripheral nerves may be suspected. In case of a trauma or operation in history and the clinical presentation of the quality of symptoms indicates neurogenic involvement (see subjective examination). Nerve palpation can be performed in neutral and in any physiological position, such as, for example, functional demonstration positions. Furthermore, nerve palpation may be performed in combination with the neurodynamic tests. The following spots are frequently palpated:

- *Femoral nerve*: in the groin and along the course of the quadriceps (Fig. 8.12).
- *Saphenous nerve*: near the knee joint line between the tendons of gracillis and sartorius muscles (Fig. 8.13).
- *Infrapatellar branches of the saphenous nerve* (Fig. 8.14): on the front of the tibia plateau.
- *Tibial nerve* (Fig. 8.15): posterior in the centre of the knee fold. Palpation is easier when the nervous system is positioned in some tension via the hip (flexion) and the foot (dorsiflexion and eversion).

Figure 8.12 • Palpation of the femoral nerve: in the groin and along the course of the quadriceps.

Figure 8.13 • Palpation of the saphenous nerve.

Figure 8.14 • Palpation of infrapatellar branches of the saphenous nerve.

Figure 8.15 • Palpation of the tibial nerve.

Box 8.2—cont'd

Figure 8.16 • Palpation of the communal peroneal nerve.

- *Communal peroneal nerve* (Fig. 8.16): just behind the tendon on the M. biceps femoris (the foot is in plantarflexion inversion) and around the collum or head of the fbula.

Palpation

Temperature

Compare the temperature of various areas around the knee with the non-affected side. A decrease in temperature is a sign of autonomic output dysfunction.

Effusion

- Place the thumb and index finger of one hand on either side of the patella. The other hand places the web space over the suprapatellar pouch and squeezes fluid distally. A large effusion may be appreciated if the finger and thumb at the side of the patella are separated and a fluctuant feeling is produced.
- A small effusion may be found with the *bulge sign*:
  1. Fluid is stroked out of the medial gutter next to the patella.
  2. The suprapatellar pouch is compressed in the same way as described under (1).
  3. Fluid bulges out into the medial gutter as a result of (2).
  4. Alternative: step (1), then the lateral gutter of the patella is compressed.

Swelling

Most swellings are best appreciated by inspection, but palpation is necessary to confirm their presence, for example:

- A tender swelling of the tibial tubercle may be present in Osgood–Schlatter's disease
- Cyst of the menisci, involving the lateral meniscus, with a tender swelling over the joint line
- Prepatellar bursitis: soft tissue swelling anterior to the patella
- Chronic synovial thickening: along the suprapatellar pouch with a characteristic doughy sensation when rolled under the fingers; over the medial joint compartment in the gutter at the medial side of the patella, just cephalad of the joint line.

Tenderness

- Tenderness may occur at times in combination with local swelling of ligaments, insertions and muscles (see Fig. 8.17). Positive findings serve as a comparable sign in reassessment procedures and may indicate the necessity of soft tissue treatment. Tenderness is best palpated in supine with the knee in flexion.

- Meniscus injuries may produce tenderness over the anterior, middle or posterior third of the joint line. The points of tenderness may displace if the knee is moved towards extension.
- Ligament sprains frequently are tender over the upper and lower attachments. If tender over the joint line, this may be difficult to distinguish from tenderness stemming from a meniscus lesion.

Tenderness or symptom provocation of nerves (e.g. infrapatellar branches of saphenous nerve, tibial nerve, common peroneal nerve).

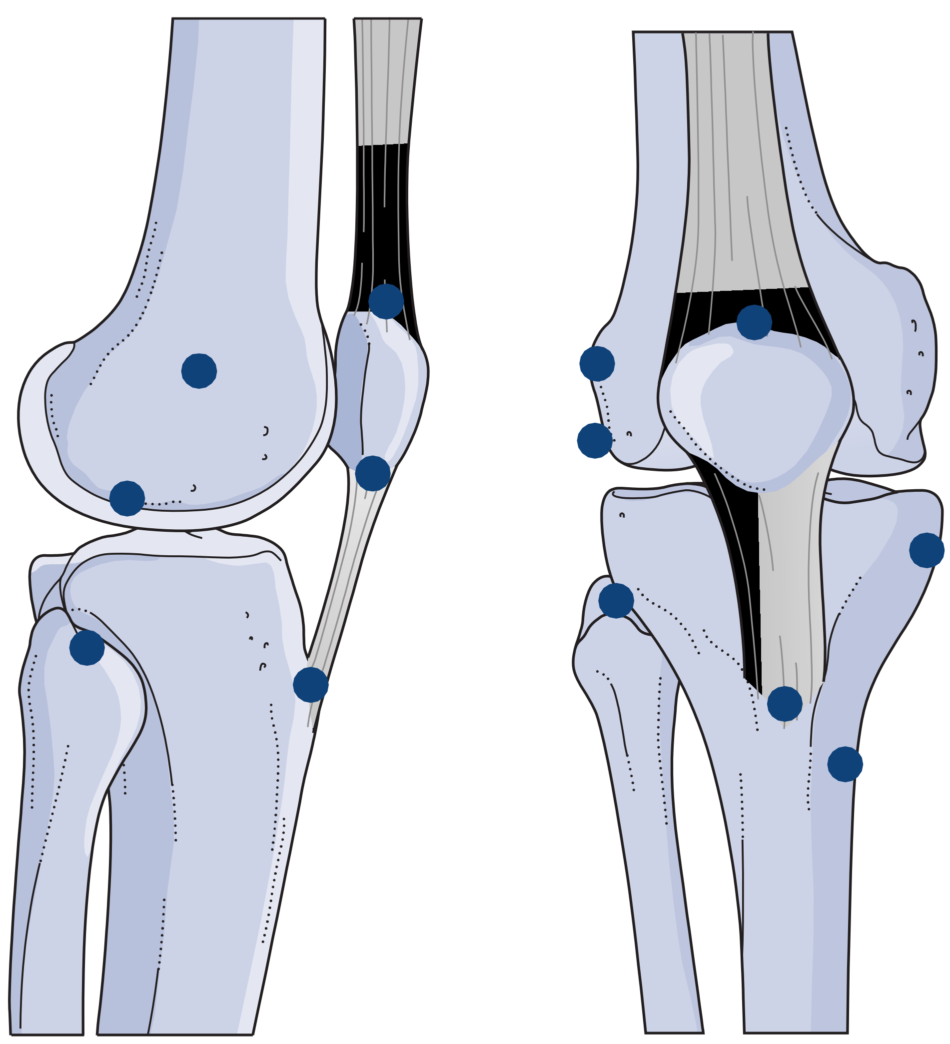


Figure 8.17 • Areas of soft tissue lesions of the knee.

Passive tests

Passive tests include physiological and accessory movements. Many of the passive test procedures can be used as therapeutic techniques and, therefore, these test procedures frequently need to be followed by a reassessment of the main physical parameters ('asterisks') identified so far.

The passive tests can be used as physical asterisks in the reassessment procedures if there are comparable signs or symptom reproduction.

Movement diagram

The establishment of a movement diagram of the most comparable active movements gives more detailed information on the behaviour and interrelationship of pain, resistance and possible motor responses ('spasm'). Such information may guide the therapist in the determination of treatment techniques by passive movement; additionally the test(s) may be used as physical asterisks in reassessment procedures.

Stability, integrity and meniscus testing

In acute lesions with a traumatic onset, stability and meniscus tests may need to be carried out. However, it is emphasized that many active and passive test procedures may have already provided indications as to whether lesions in the above-mentioned structures are present. A description of these orthopaedic test procedures may be found in Box 8.3.

Box 8.3

Orthopaedic testing of stability and integrity of ligaments and menisci

If indicated, stability and integrity tests are performed for the anterior cruciate ligament, posterior cruciate ligament, medial and lateral collateral ligament , medial and lateral meniscus, anteromedial, anterolateral and posterolateral instability.

Anterior drawer test (anterior cruciate ligament integrity test, posterior oblique ligament, posteromedial and posterolateral capsules, medial collateral ligament, iliotibial band)

- *Patient starting position*: In supine, 90° knee flexion.
- *Therapist starting position*: Sitting on the edge of the treatment table and slightly on the patient's foot to stabilize it.
- *Localization of forces*: Therapist puts the thumbs on the joint line either side of the patella tendon.
- *Application of forces*: Therapist pulls the tibia forward. The movement is either performed as a slow anterior glide of the tibia on the femur, or a quick jerking movement.
- *Positive result*: Excessive anterior translation (more than 6 mm) or a soft end-feel compared to the non-affected knee.
- Benjaminse et al. (2006) found in a meta-analysis of 28 studies that the sensitivity of this test is 92% (pooled value) and the specifcity is 91% (pooled value).

Box 8.3—cont'd

Lachmann's Test (anterior cruciate ligament integrity test)

- *Patient starting position*: Long sitting or supine on the treatment table, knee is positioned in 15° flexion, the foot is resting on the plinth.
- *Therapist starting position*: Standing next to the patient's leg, facing the patient's head.
- *Application of forces*: Therapist stabilizes with one hand the femur and the other hand grasps the calf, below the knee joint line. The patient must relax the hamstrings and quadriceps, as they could produce a false positive result.
- *Application of forces*: Therapist then initiates a clean forward 'jerk' motion of the hand on the calf, to quickly draw the tibia forward.
- *Positive result*: Excessive anterior translation or a soft end-feel of the anterior translation compared to the non-affected knee.
- The sensitivity of this test is 85% (pooled from 28 studies) and the specificity 94% (Benjaminse et al. 2006).

Pivot shift test (anterior cruciate ligament integrity test)

- *Patient starting position*: Supine or long sitting on a treatment table. The knee is flexed to 45°. The limb is supported by the physiotherapist.
- *Localization of forces*: Therapist applies pressure to the outer surface of the leg, just below the joint line onto the head of the fibula. The other hand stabilizes the foot while a valgus force is produced by applying an inward pressure through the upper hand. Simultaneously, a medial rotation force is applied to the lower leg as the clinician slowly extends the knee.
- *Positive result*: An obvious 'slip' or a palpable 'clunk' at around 10–20° of knee flexion.
- The pooled sensitivity is 24% and the pooled specificity value is 98% (Benjaminse et al. 2006).

Posterior sag sign (posterior cruciate ligament integrity sign, arcuate popliteus complex, posterior oblique ligament, anterior cruciate ligament)

- *Patient starting position*: Supine, the knee is positioned in 90° flexion, the foot is resting on the plinth, hamstrings and quadriceps are relaxed.
- *Therapist starting position*: Therapist observes the knee from the lateral aspect for a step at the knee joint line.
- *Positive result*: A visible posterior sag of the tibia on the femur.
- The sensitivity of this test is 79% and the specificity 100% (Malanga et al. 2003).

Posterior drawer test (posterior cruciate ligament integrity test, arcuate popliteus complex, posterior oblique ligament, anterior cruciate ligament)

- *Therapist and patient starting position*: In the same position as for the anterior drawer test.
- *Localization of forces*: One hand of the therapist is stabilizing the tibia and the other hand is applying an anterior posterior glide to the tibia just below the joint line.
- *Positive result*: An increased glide of the tibia posteriorly compared to the non-affected knee.
- The sensitivity of this test is 51–100% and the specificity 99% (in one study) (Malanga et al. 2003).

Quadriceps active test (posterior cruciate ligament integrity test and posterior joint complex)

- *Patient starting position*: Supine with the knee in 80–90° of flexion, the foot resting flat on the plinth.
- *Therapist starting position*: Therapist is observing the affected knee for an anterior translation of the tibia from a lateral view while the patient contracts the thigh muscles.
- *Positive result*: If the tibia translates more than 2 mm.
- The sensitivity of this test ranges between 54–98% and the specificity from 97–100% (Malanga et al. 2003).

Abduction (valgus) stress test (medial collateral ligament)

- *Patient starting position*: Supine lying on a treatment table.
- *Therapist starting position*: At side of patient's leg, facing patient's head.
- *Application of forces*: Therapist applies a valgus force to the knee in 20–30° flexion compared to 0° extension.
- *Positive result*:
  - At 20° pain over the medial joint line – mild injury to the medial collateral ligament;
  - At 20° pain over the medial joint line and some laxity – partly intact medial collateral ligament;
  - 20° pain and gross instability – complete rupture of the medial collateral ligament and involvement of the posterior oblique ligament, posterior cruciate ligament, posteromedial capsule;
  - 0° – any instability in this position suggests that there may be a medial collateral ligament tear,

Box 8.3—cont'd

anterior cruciate ligament, medial quadriceps expansion, semimembranosus muscle, posterior oblique ligament, posterior cruciate ligament, posteromedial capsule).

- The sensitivity of this test is 86–96% and the specifcity is not reported (Malanga et al. 2003).

Adduction (varus) stress test

- Like the medial collateral ligament stress test but the therapist applies a varus force to the knee in 20–30° compared to 0° extension.
- *Positive result*:
  - At 20° pain over the lateral joint line with no laxity – mild injury of the lateral collateral ligament
  - At 20° pain over the lateral joint line and some laxity – moderate injury with partly intact lateral collateral ligament;
  - At 20° pain over the lateral joint line and gross instability – may suggest a complete rupture of the lateral collateral ligament, arcuate popliteus complex, posterolateral capsule, iliotibial band, biceps femoris tendon)
  - 0° – any instability in this position suggests that there may be a lateral collateral ligament tear, cruciate ligament, lateral gastrocnemius, iliotibial band or biceps femoris tendon involvement.
- The sensitivity of this test is 25% and the specifcity is not reported (Malanga et al. 2003).

McMurray's test (integrity test of menisci)

- *Patient starting position*: The patient is lying supine on the plinth with the knee fully flexed. Laterally rotate the tibia and passively extend to 90° whilst palpating joint line.
- *Positive result*: An audible 'click' or 'pop' with reported pain on the medial side may suggest a tear of the medial.
- The sensitivity of this test was reported to range from 10–66% (Scholten et al. 2003) and the specifcity 57–98% (Malanga et al. 2003 and Scholten et al. 2003).

Appley's grind test (integrity test of menisci)

- *Patient starting position*: The patient is lying prone with the knee 90° flexed. The therapist applies traction to the knee joint and then adds medial and lateral rotation. Secondly, she applies compression combined with medial and lateral rotation.
- *Positive result*: Pain reported during the application of compression in combination with rotation may suggest a meniscal injury; distraction pain may suggest ligamentous strain.
- The sensitivity of this test ranges from 13–58% and the specifcity 80–99% (Malanga et al. 2003, Scholten et al. 2003).

Passive test movements of the various knee components

As described previously, in some cases the test procedures may need to be performed under *compression*.

Many of the passive test procedures can also be used as therapeutic techniques and therefore these test procedures frequently need to be followed by a reassessment of the main physical parameters ('asterisks') identified so far.

Tibiofemoral joint

Physiological movements may include:

- Extension variations:
  - extension (see Fig. 8.1A)
  - extension/adduction (Fig. 8.18A)
  - extension/abduction (Fig. 8.18B)
  - extension/adduction, including anteroposterior movement (see Fig. 8.1B)
  - extension/abduction, including anteroposterior movement (see Fig. 8.4B).

The *end-feel* may be appreciated in two different ways, i.e. with the knee fully extended and relaxed or passively flex the knee approximately 20° than allow it to drop back into full extension. A normal knee can fall into full extension with a typical painless hard end-feel. In patients with osteoarthritis a similar end-feel may be found, but the joint lacks full extension. A meniscus lesion may produce a softer end-feel and the leg may bounce slightly more once dropped from flexion to extension.

- Flexion variations:
  - flexion (see Fig. 8.2)
  - flexion/adduction, including rotations (see Fig. 8.5B)
  - flexion/abduction, including rotations (see Fig. 8.5A)

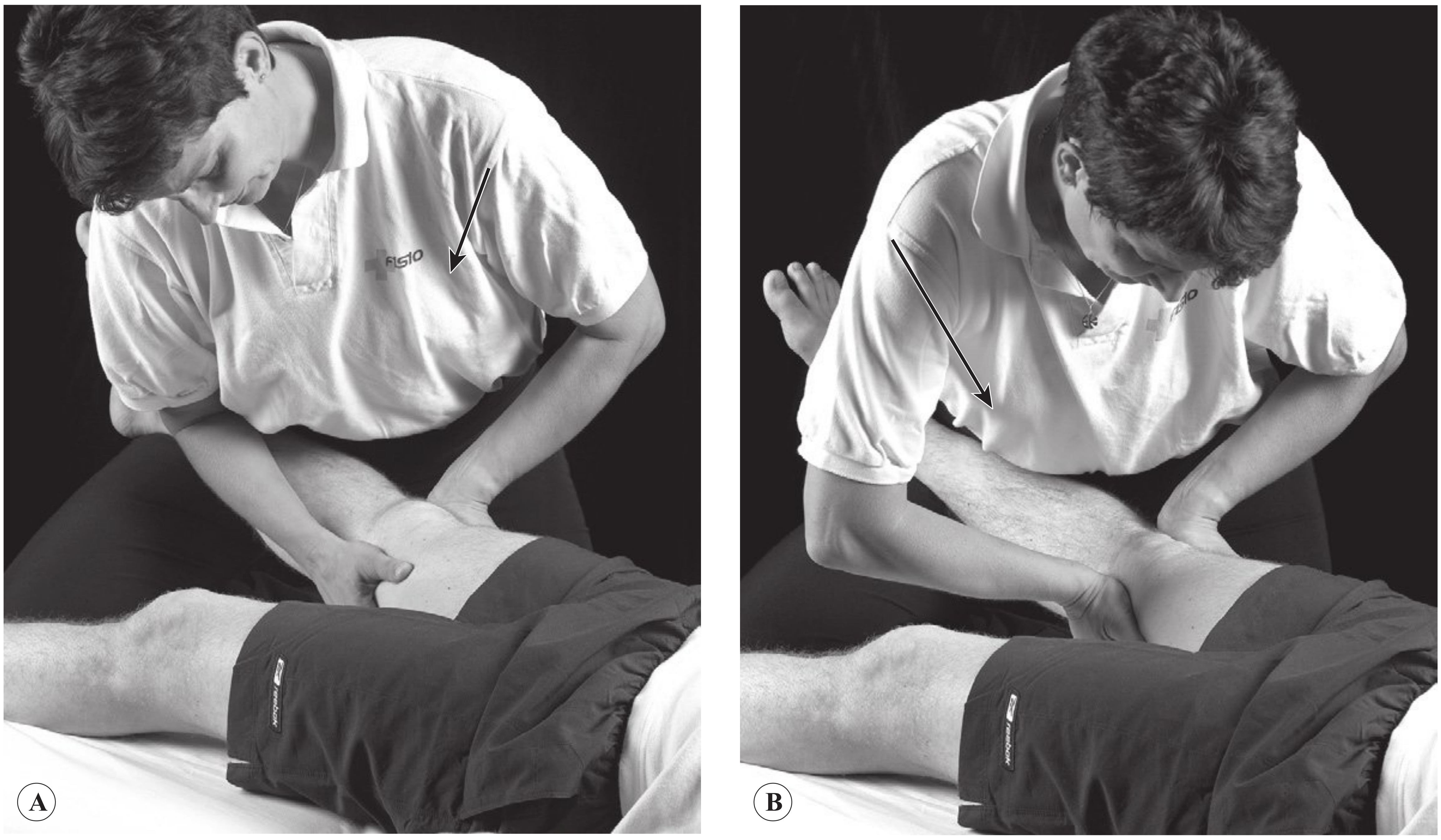


Figure 8.18 • Tibiofemoral movements in extension: A extension/adduction; B extension/abduction.

  - medial rotation, lateral rotation (see Figs 8.3, 8.32) (may also be carried out as accessory movements).
- Accessory movements may include:
  - abduction, adduction
  - posteroanterior movement, anteroposterior movement
  - longitudinal caudad, longitudinal cephalad
  - transverse medially, transverse laterally
  - medial rotation, lateral rotation.
- The accessory movements are most frequently applied to the tibia; however, they can be carried out on the femur as well.

A detailed description of the examination and treatment techniques may be found on pages 487–496.

Patellofemoral joint

The patellofemoral joint needs to be examined with accessory movements which may include (Fig. 8.19):

- longitudinal movement caudad and cephalad, including inclinations (see Fig. 8.40)
- transverse movement medially and laterally, including inclinations (see Fig. 8.39)
- distraction (Fig. 8.20)
- compression (Fig. 8.21)
- rotation around the sagittal axis (Fig. 8.22) and around the longitudinal axis.

The examination (and treatment) procedures frequently need to be carried out in *various positions*

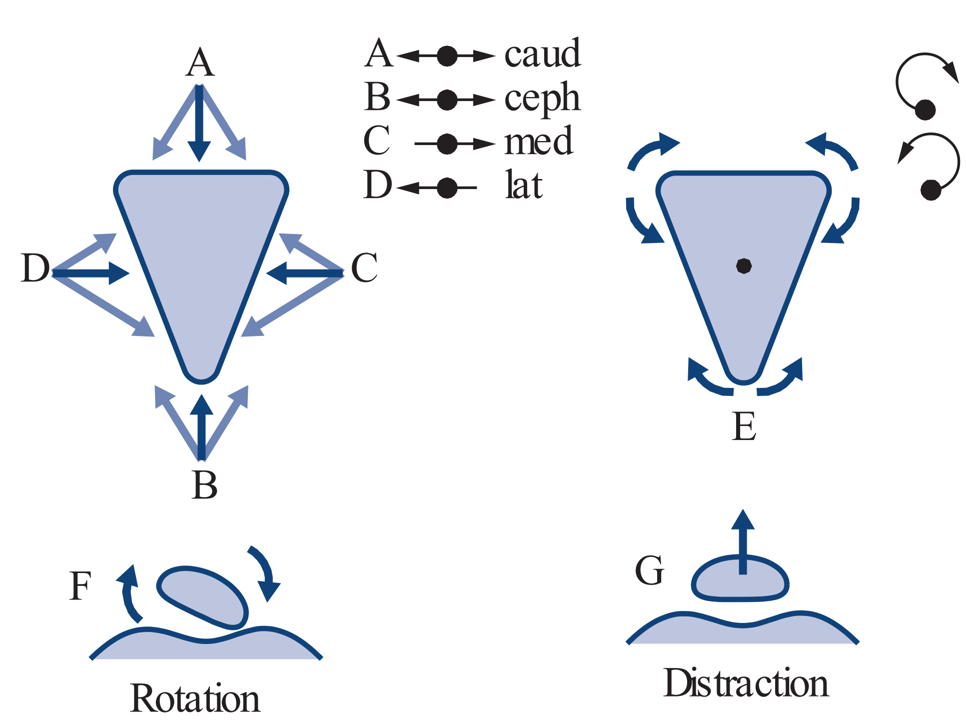


Figure 8.19 • Accessory movements of the patella.

Figure 8.20 • Patellofemoral movements: A distraction; B distraction – alternative.

Figure 8.21 • Patellofemoral compression.

Figure 8.22 • Patellofemoral rotation (sagittal axis).

of flexion or flexion/abduction. Furthermore, it may be necessary to add a certain degree of *compression* to the movements and in some cases movements may need to be performed *in weight-bearing* positions (see Fig. 8.41).

A detailed description of examination and treatment techniques may be found on pages 498–502.

Crepitus is best appreciated by palpating the patellofemoral joint while flexing and extending the knee. A fine crepitus may be present in chondromalacia of the patella (sensation of fine sand or glass) whereas a coarse crepitus (sensation of 'dry wood') may indicate osteoarthritis. If the crepitus occurs in combination with pain, it is an important comparable sign which has to be assessed during the application of treatment and in reassessment procedures.

Clinical tip:

If during the application of passive movement the crepitus seems to become less, immediate reassessment of the main test procedures may show benefcial changes.

In certain cases of recurrent subluxation of the patella, lateral movement of the patella may provoke pain. The patient may then become acutely aware that the patella is about to dislocate and any further attempts to move the patella are actively resisted by contractions of the quadriceps, i.e. *apprehension*.

Superior tibiofbular joint

The superior tibiofibular joint is often forgotten when seeking the source of lateral leg and knee pain. Although not a frequent cause of pain, it is sufficiently common to warrant inclusion in routine examination. A detailed description of the examination and treatment techniques may be found on pages 502–504.

- The joint needs to be examined with accessory movements.
- Test (and treatment) procedures may need to be carried out in various foot positions and different positions of knee flexion. Additionally, it may be necessary to add compression to the test and treatment procedures.
- Frequently these procedures with their different positions are easiest to perform in side lying, with the affected leg above and the tibia well supported by the plinth in front of the unaffected leg.

Examination and treatment of the superior tibiofibular joint may include:

- Anteroposterior movement (Fig. 8.23)
- Posteroanterior movement (Fig. 8.24)

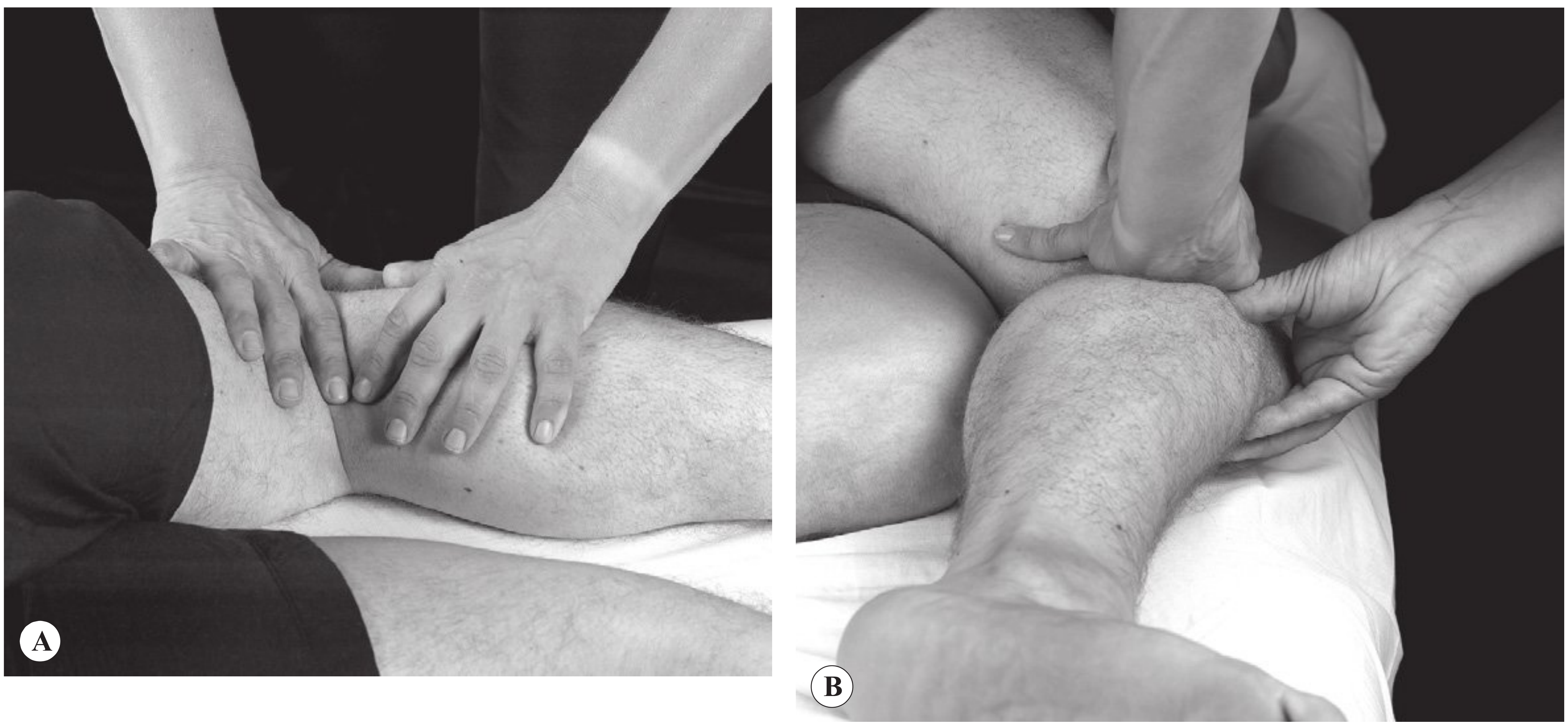
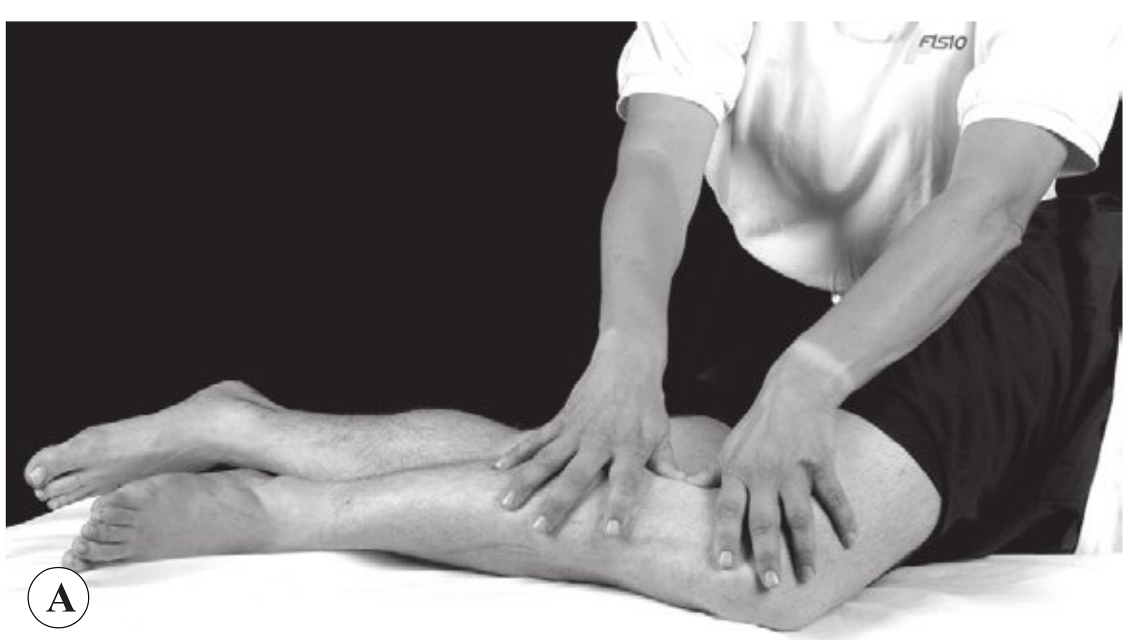


Figure 8.23 • Superior tibiofibular joint: A anteroposterior movement; B anteroposterior movement with compression.



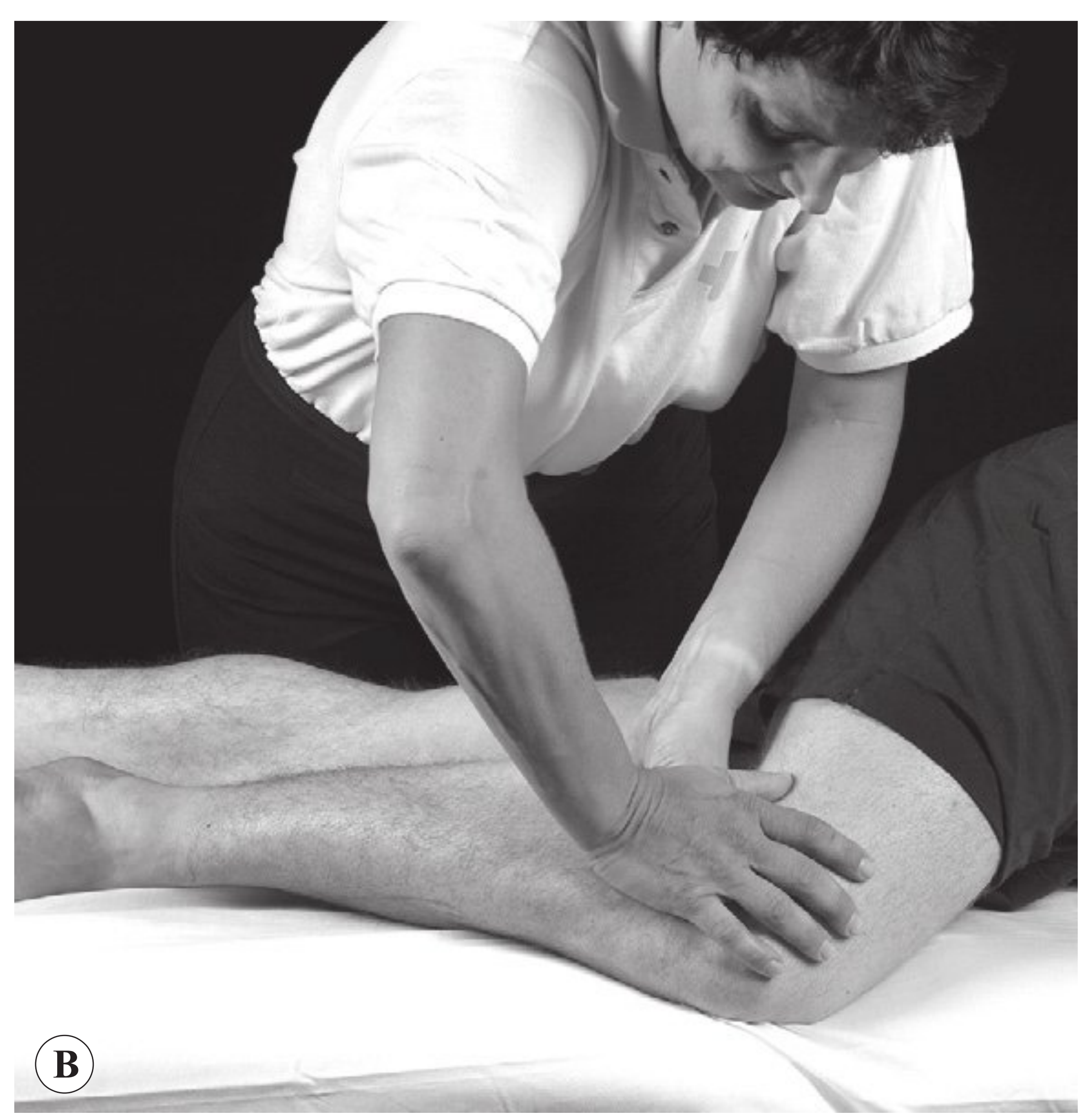


Figure 8.24 • Superior tibiofibular joint: A posteroanterior movement; B posteroanterior movement with compression.

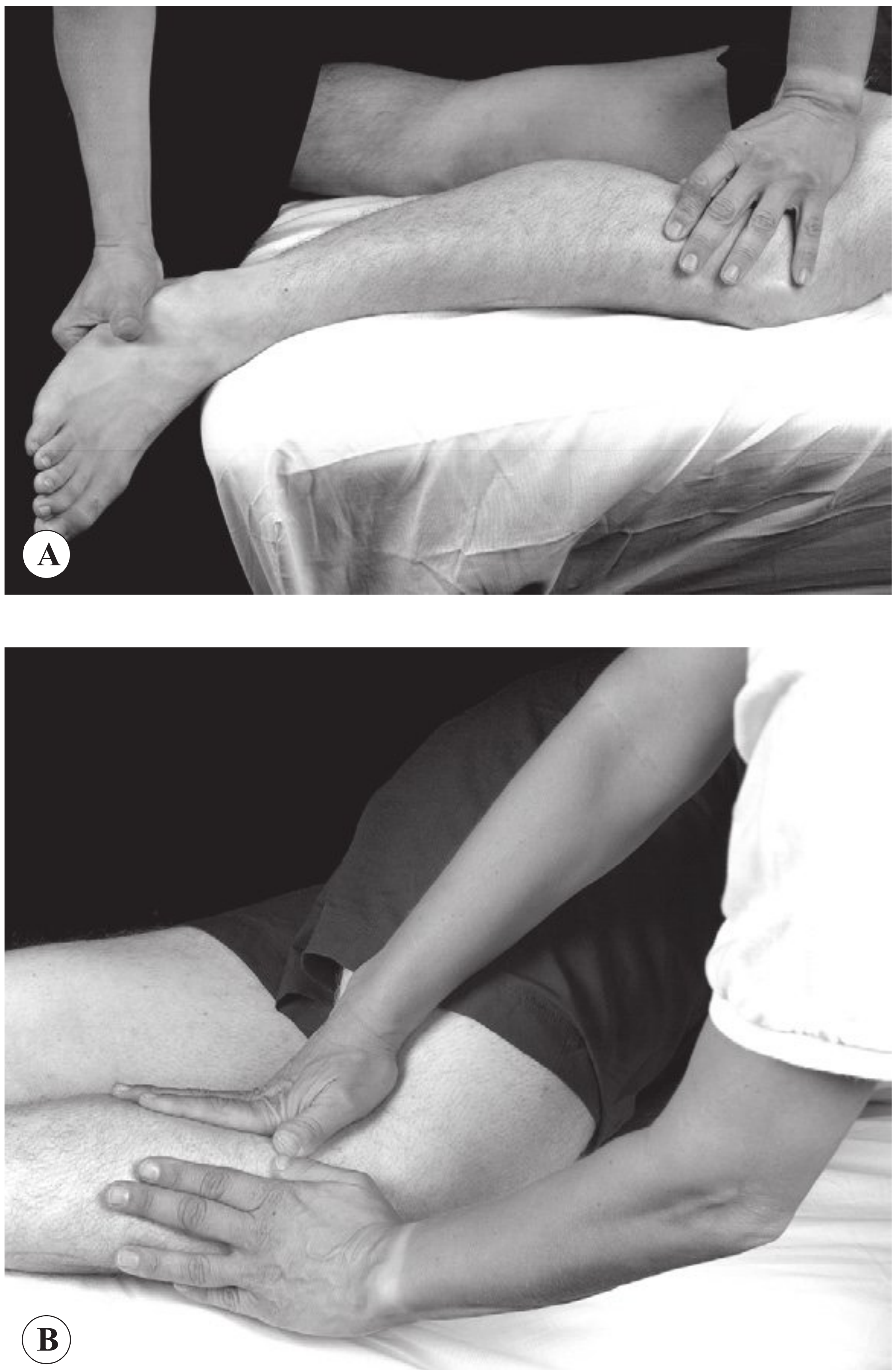


Figure 8.25 • Superior tibiofibular joint:B longitudinal movement with lever of foot; B longitudinal movement applied locally to head of the fibula.

- Longitudinal movement caudad (Fig. 8.25)
- Longitudinal movement cephalad (may be carried out with the lever of the foot or directly to the head of the fibula)
- Compression
- Rotary movements (with the lever of the foot).

Treatment

In clinical practice, manipulative physiotherapists have established competencies and skills to deal with impairments of segmental mobility (arthrogenic), motor control and postural stability (myogenic) and nerve mechanosensitivity. Physiotherapists should design individualized treatment programmes, collaboratively with the patient, based on the contemporary scope of practice, including an understanding of contextual mediators of the pain and disability and a comprehension of whether they would be modifiable or not. All impairment-oriented treatments should follow up with an emphasis on restoring functional capacity, and guiding patients in the transition from health care needs to healthy lifestyles and healthy living.

Passive mobilization may play a central role in the treatment of many movement disorders of the knee; however, treatment often needs to be complemented with automobilization, exercises to regain motor control over movement patterns, restoration of proprioceptive feedback, normalization of gait patterns and guidance to the full level of activities needed in daily life, as well as a towards an active lifestyle to maintain healthy movement behaviours. Integrated approaches may include passive mobilizations of the patellofemoral or tibiofemoral joint combined with soft tissue techniques or neurodynamic treatment technique. Comprehensive strategies for motor control of the knee and lower extremity are widely available in companion texts and supporting references (Sahrmann et al. (2011).

To Maitland, the selection and application of treatment was an art, in which it was essential to know 'when to apply, which technique and in which form' (Maitland 1986). This viewpoint was meant as a counterpoint to the almost automatic selection of treatment techniques, based on biomechanical theoretical rules. Treatment techniques should be considered within the overall context of the disabilities of the patient and local impairments such as symptom behaviour, motor reactions ('spasm') and perceived resistance to the movement. Techniques have to be adapted at all times to the changes in symptoms and signs of the relevant movement impairments.

The section below describes the selection and progression of treatment with passive mobilization, based on the information gained during subjective examination, and active as well as passive movement tests.

Selection

The passive movement techniques from which a selection can be made in the treatment of movement disorders of peripheral joints are as follows:

1. The physiological movements:
   - Flexion and extension
   - Rotation

2. The localized accessory movements, which can be produced by direct pressure being applied to the tibia or femur as part of the tibiofemoral joint, or to the patella and the fibula as part of the superior tibiofibular joint. The directions of the pressures that produce these accessory movements are:
   - Tibia and/or femur: posteroanterior, anteroposterior, transverse lateral, transverse medial, medial shaft rotation, lateral shaft rotation, longitudinal caudad and cephalad movements.
   - Patella: longitudinal caudad and cephalad, transverse lateral, transverse medial, medial rotation, lateral rotation movements, as well as distraction and medial and lateral 'shelling'
   - Fibula: mainly posteroanterior and anteroposterior, longitudinal caudad and cephalad movements.

   The directions of the above pressures can be varied by inclining them medially, laterally, cephalad and caudad, and also by minimally varying the points of contact.
3. Passive mobilizations in combination with active movements (see also Chapter 5). All of the above movements can be used in different grades and rhythms, and they can be combined in many varied sequences, often related to the patient's functional demonstration or injuring movement. The movements can be used to treat four groups of presentation as follows:
   1. Pain
   2. Stiffness
   3. Pain associated with stiffness
   4. Momentary jabs of pain.

These groupings parallel those in Maitland (1986).

Since the severity of referred symptoms can vary so widely, it is useful when selecting techniques if the selection is initially related to the two extremes of severity. The first extreme to be described will be the pain-limiting movement at the beginning of range of the 'pain-through-range' situation (group 1), where pain is severe and inhibits the patient's movements – there is no stiffness or muscle spasm limiting movement. The other extreme is where the patient complains of stiffness, not pain, although pain is provoked when the stiff movements are stretched (group 2). This is the end-of-range situation, where pain is minimal.

Group 1 – pain

Group 1 patients have severe pain-limiting movement, rather than it being limited by any other factors. The techniques that can be used are as follows.

Accessory movements in a part of the range that is totally free of any pain or discomfort

The joint to be treated must be positioned in a totally symptom-free position. The amplitude of the movement should be the largest possible amplitude that can be achieved painlessly. To make the amplitude large, it may be necessary to start from a point well back in the range. The rhythm of the movement must be smooth and slow.

As the patient's symptoms improve, so the treatment movement can be moved further into the range and the position of the patient's knee may be carefully changed towards the painful restriction. The technique may also be advanced to a stage where the large amplitude movement is taken into a degree of discomfort.

Physiological movements

When physiological movements are used to treat pain, they too must be performed without provoking pain or discomfort. As with the accessory movements, the joint being treated must be positioned painlessly in a mid-position for the main directions of movement; for example, in the case of the knee, this would be the mid-position of flexion and extension. The treatment with the physiological movement should be in the most painless direction, and the large, slow, smooth amplitude must end before the onset of any discomfort.

As the patient's symptoms and movement signs improve, so the treatment movement can be taken further into the range and the amplitude of the movement thereby increased. A later progression, as mentioned above, is that the movement can be taken into a controlled degree of discomfort.

The duration of the application of a treatment technique depends mainly on the 'assessment while performing the technique'. During the application of the technique the therapist should monitor any changes in pain, discomfort, resistance and motor reactions. If the changes are favourabe, the technique can be continued. If undesired effects (for example, discomfort) occur, the technique should be stopped and the effects of the treatment need to be reassessed. In the next session often the first sign of progression is that the technique being used may be performed for a longer period without provoking any of the undesired effects.

Group 2 – stiffness

Group 2 refers to patients who seek treatment because stiffness limits normal function or because a stiff joint is slightly painful when stretched strongly. They are not seeking treatment because of severe pain, but because they have difficulty in squatting or extending the knee fully. There are many other similar circumstances. When the therapist is examining the patient's movements, all movements are restricted. When these movements are stretched, they are either pain-free or minimally painful.

When selecting the techniques to treat the above problems, the therapist should use two kinds of stretching movements and alternate them. After selection of the primary movement needing to be stretched (e.g. extension of the knee), the first kind of movement is the physiological movement of extension or extension-abduction or extension-abduction as an oscillatory stretching movement at the limit of the range. This should be performed for approximately a minute or so, varying between strong and gentler strengths, while monitoring the possible changes in pain, light discomfort and protective motor respeonses. The second kind of movement involves accessory movements (again stretching and oscillatory movements of varying strengths) while the knee joint is positioned at the limit of the range of extension. All directions of accessory movement should be utilized. Following the accessory movements, the physiological extension technique is repeated. And so the routine continues, alternating accessory movements at the limit of the physiological range with the primary physiological movement. The same principles can be used in conjunction with any primary physiological movement.

Sometimes a patient may have a restricted range of movement, where the restriction is caused by one particular accessory movement rather than the physiological movement itself. This is determined during the examination when the ranges of accessory movements are assessed at the limit of the stiff movement. On such examination, the particular accessory movement will be found to be stiffer than the remainder, and if all are stretched equally strongly the primary accessory movement will not only be less 'giving' but will also cause greater discomfort.

Group 3 – pain with stiffness

Having discussed the two extremes of presentation – all pain and no stiffness, and all stiffness and no pain – we now come to the third group of patients, where pain and stiffness occur together. This is the largest group and the most challenging to treat. These patients will have pain, either as a constant symptom or as a pain on movement. In both examples the movements will have an element of stiffness. On examining the movements, there will be a relationship between the point of onset of the pain in the range and the limit of the available range. There should be a 'matching' comparison between the symptoms of which the patient complains and the findings on examining his knee movements. Patients having constant symptoms will have pain commencing early in a range of movement, and the pain will continue and increase until the limit of the range is reached (i.e. a 'pain-through-range' situation). With the majority of disorders that cause a patient to have pain only on movement, he will have this pain provoked at the end of the available range of an appropriate movement (i.e. an end-of-range-pain situation).

In addition to the patient having through-range pain or end-of-range pain, there is another feature to be clarified. With the patient who worsens with pain at the end of range, it is necessary to determine whether the restriction of the movement is the dominant factor or whether pain is more dominant.

The use of the movement diagram (see Appendix 1) explains this clearly.

When pain is the dominant factor, P_1 will start before R_1 and even if it is R_2 that limits movement, P′ ('P prime', prime being an engineering and mathematical term) will be very high on the R_2L vertical line above L.

When stiffness is the dominant element, P_1 may start before R_1, after R_1, or at the same point in the range as R_1, but R_2 will be the factor that limits the available range, while P′ will be at any level on the R_2L vertical line above L, well below R_2. However, the more dominant the stiffness factor, the lower P′ will be on the R_2L vertical line.

When pain is by far the more dominant element, the choice of techniques will be identical with that already described above for 'pain' (group 1).

When stiffness and pain are equally dominant, it is important for the less experienced practitioners always to limit the initial techniques to those already described for treating 'pain'. It is only when these fail to improve the patient's symptoms or his test movements that using techniques for treating stiffness should be considered. When stiffness is by far the more dominant element, the technique will be the same as has been described above for 'stiffness'. The only differences will be the following:

1. Initially *only* the accessory or physiological movements will be used (not both), either because the amount of treatment should be limited at the beginning or so as to make assessment of the value of the relative techniques more effective.
2. It is necessary to decide whether the most painful and restricted (i.e. primary) accessory movements near (not at) the limit of the primary physiological range should be selected or whether the most painful and restricted (i.e. primary) physiological movement should be selected.
3. The firmness and rhythm of the techniques may need to be modified in response to respecting the discomfort felt during the technique. The discomfort felt during the performing of the technique at a constant rhythm and position in the range should lessen or at least remain unchanged; it must not be allowed to continue worsening.
4. Initially, a stretching technique should not reproduce a patient's referred pain.

Clinical experience shows that some structures that have been sprained or strained need, at some stage, to be hurt in a controlled manner to set the healing processes in motion. Perhaps this fact bears some relationship to the mechanical measures resorted to in order to stimulate union in un-uniting fractures. When such a technique is being performed, the patient will often spontaneously say, 'It's hurting but it's a nice hurt'. Such a comment nearly always means that the right choice of technique has been made, but proof lies in the assessment. Other painful disorders decidedly 'object' to being hurt. If the first steps in selection are to choose techniques for treating 'pain' described earlier, and to progress to treating pain only by using a technique that provokes pain as described above, no wrong steps will be taken. There is no method of determining whether the patient's disorder requires to be hurt to make it heal, other than to use the technique provoking minimal discomfort for a very brief time and then to assess its effect over 24 hours. Therefore, this means that when first using a technique that provokes local pain:

1. The discomfort must be kept to a minimum
2. The technique must be performed slowly and smoothly with the patient totally relaxed
3. During the first few oscillations of the technique, performed at a constant rhythm and position in the range, the manipulative physiotherapist must know:
   - **a.** If the hurt is only slight and in rhythm with the technique, in which case the technique is continued for another 10 seconds; if the hurt in rhythm is increasing, STOP.
   - **b.** If the technique is causing an ache, irrespective of whether it is also causing a hurt in rhythm, STOP.
   - **c.** That the technique is continued only if the hurt decreases or remains unchanged.
4. The technique is performed only for a maximum of half a minute before reassessing the patient's symptoms and signs
5. It is important to remember that it is better to do only a little treatment and make use of the 24-hour assessment and find that nothing has been gained, than it is to do a little too much and find later the patient was much worse half an hour after treatment. It is the 24-hour period that is the most informative and useful of the types of assessment.

Group 4 – momentary pain

This patient experiences his pain as a sudden momentary jab, which occurs unexpectedly. It is always associated with movement, although the movement may be so minimal that the patient is not aware that there has been a movement.

The selection of technique under these circumstances is entirely dependent upon the examination defining the movement(s) that provoke this pain. The movement is usually a physiological movement and position, which includes accessory movements.

The treatment technique selected is the accessory movement in the combined position that reproduces the 'momentary pain'. The technique is nearly always quite a strong grade IV movement followed by gentle grade III movements to relieve any treatment soreness.

Tibiofemoral joint

When the knee is very painful, worse when walking or with the first few steps following rest, the treatment techniques are directed towards treating pain (group 1). Although all accessory movements may be considered, frequently rotary movements may be the most successful as an initial treatment.

- The knee may be positioned comfortably in a neutral, pain-free position on an easily moulded pillow. The therapist palpates the joint line with one hand and the other hand grasps around the malleoli and performs the rotation movements of the tibiofemoral joint with the latter hand.
- For minor symptoms, extension/abduction, extension/adduction, flexion/adduction and flexion/abduction may be used in treatment.
- If movements are very restricted but provoke only minor symptoms, physiological movements (e.g. extension or flexion combinations in abduction and adduction) need to be taken into consideration.
- If, for example, flexion is very restricted, both the tibiofemoral joint and the patellofemoral joint need to be treated while holding the leg at the end of the limited range.

Patellofemoral joint

The treatment of patellofemoral disorders calls for a high degree of skill and considerable delicacy. When patellofemoral movement is painful, the initial session(s) need to be carried out extremely gently. It is far better to perform movements too gently and for too short a time than to find out at the following session that they had been performed too excessively, even to the smallest degree.

- Oscillatory distraction may be the first choice for treatment if any other movement of the patella seems to be too vigorous for the current condition of the patient. A slow progression of treatment can take place once it is established how the patient reacts to this gentle treatment.
- On the other hand, there are times when maximum amplitude movement should be performed in one or more directions, at the same time maintaining a strong compressive force on the patella. See Box 8.4 for the use of passive movement with compression).
- If, for example, it is found that the patient is able to squat fully without pain and all

Box 8.4

The use of passive movement with compression in examination and treatment

One of the original contributions of Maitland to the world of manipulative physiotherapy is the treatment of joint surfaces with passive mobilization, while holding the joint surfaces under a certain amount of compression (Maitland 1980, 1985).

Indications for the examination of movements of a synovial joint with its surfaces compressed together include:

- When the information of the subjective examination suggests the presence of a joint surface disorder (e.g. in the knee: particular problems with the patellofemoral joint while squatting down, or walking on stairs in the weight bearing phase in the case of tibiofemoral movement disorders)
- When the history indicates that the injuring activity includes joint loading
- Reproducing the patient's symptoms when other test movements have failed to do so
- When through-range-pain is present and the pain response is greater when compression is added, therefore confrming the presence of joint surface-related problems
- Assessing any changes in the friction-free feel to joint movement when compression is added
- Determining the most appropriate technique to progress the treatment of a joint surface disorder
- Exploring the most comfortable means of treating a very painful periarticular disorder (Maitland 1991).

Compression can be applied to any synovial or non-synovial joint. In the knee complex the techniques

Box 8.4—cont'd

may be applied to the tibiofemoral joint and to the patellofemoral joint.

Examples of compression applied to the patellofemoral joint (Figs 8.26–8.29):

- *Patient starting position*: The tibiofemoral joint should be positioned in extension and also in different positions of flexion. The reason for this is that in different positions of tibiofemoral flexion the undersurface of the patella will have different points of contact with the femoral condyles.
- *Therapist starting position*: Standing by the side of the couch facing across the patient's body
- *Localization of forces*: One hand should cup around the patella in order to direct the movement. The other hand should be placed so that the heel of the hand is in contact with the margin of the patella at a point relevant to the direction of movement required. When compression is required the hand which is cupped around the patella is used to apply pressure through its anterior surface while the other hand moves the patella. The examiner's elbows should be positioned in line with the movement direction to be performed
- *Application of forces*: The patella should be moved cephalad, caudad, medially, laterally and in a direction of axial rotation (especially with the medial border of the patella moving anteroposteriorly into the femoral intercondylar area). The fndings

Figure 8.26 • Cephalad movement with compression with the knee extended.

Figure 8.27 • Caudad movement with compression with the knee extended.

Figure 8.28 • Caudad movement with compression with the knee fexed.

Figure 8.29 • Cephalad movement with compression with the knee fexed.

Box 8.4—cont'd

regarding smoothness of movement and pain response should be compared with the patient's complaint and the normal knee

- *Application in treatment*: Patellofemoral disorders which are mechanical or degenerative in origin respond well to treatment by passive movement and a degree of compression which permits movement without pain or with only a small amount of discomfort. The technique is performed as described above and the movement is oscillated for one–two minutes while monitoring the change in symptoms, the behaviour of crepitus and through-range smoothness of synovial fluid (see examination of the patellofemoral joint on pages 478–479). Assessment of changes effected is then carried out and the degree of compression used in treatment is based on the assessed response. A stage may be reached where strong compression is used without increase in discomfort. The patient should by then notice improvements in both symptoms and function.

At times it may be necessary to use functional weight-bearing positions in which the techniques under compression are being applied (Fig. 8.30, see also Fig. 8.41C).

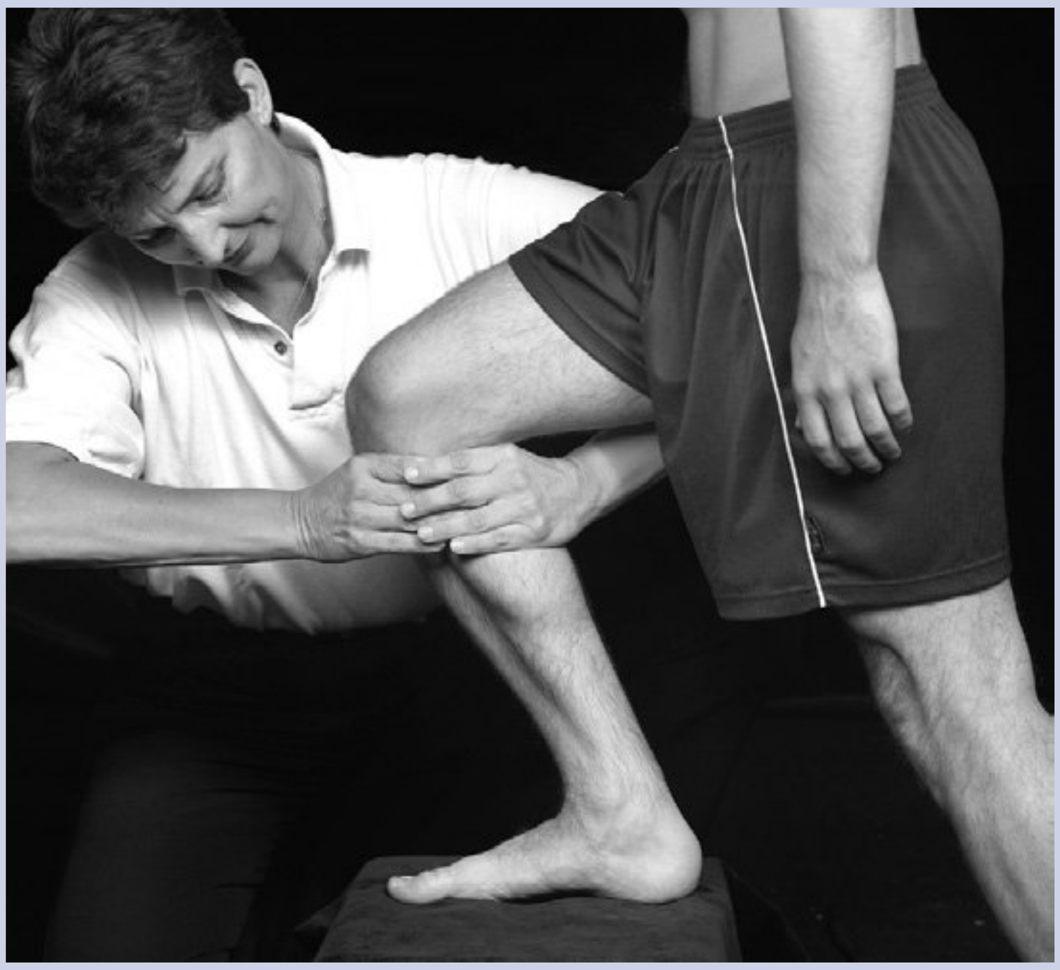


Figure 8.30 • Mobilization of the tibiofemoral joint in weight-bearing position.

Numerous publications describe how static and dynamic loading may have beneficial effects on joint surfaces. Mechanical loading of articular cartilage stimulates the metabolism of resident chondrocytes and induces the synthesis of molecules to maintain the integrity of the cartilage. Mechanical signals modulate biochemical activity and changes in cell behaviour through mechanotransduction. Compression of cartilage results in complex changes within the tissue including matrix and cell deformation, hydrostatic and osmotic pressure, fluid flow, altered matrix water content, ion concentration and fixed charge density. These changes are detected by mechanoreceptors on the cell surface, which include mechanosensitive ion channels and integrins that on activation initiate intra-cellular signalling cascades leading to tissue remodelling. Excessive mechanical loading also influences chondrocyte metabolism but unlike physiological stimulation leads to a quantitative imbalance between anabolic and catabolic activity resulting in depletion of matrix components (Ramage et al. 2009).

However, there does not seem to be sufficient research available to underpin the clinical notion that 'loading' the structures (meaning moving the joints passively while gently holding the joint surfaces compressed) leads to better clinical outcomes than just making repeated loading and distraction movements.

In the rehabilitation after cartilage repair controlled loading should occur through range of motion, with sufficient rest periods between loading sessions in the early rehabilitation phases. It has been described that gentle graduated weight bearing should be included and it appears that dynamic loading is better than static loading and longer low-intensity exercise is better than shorter high-intensity exercise (Lundon & Walker 2007). It has been described that static and oscillatory mechanical compression and oscillatory tissue shear can enhance or inhibit extracellular matrix synthesis and gene expression in chondrocytes (Leipzig & Athanasiou 2005). Application of oscillatory tension in a fibrin construct culture system influenced proliferation and matrix production in both chondrocyte and fibrochondrocyte synthesis (Vanderploeg et al. 2004).

Gentle passive movements with the joint surfaces compressed together, while monitoring the symptom responses of the patient may be considered within this context, such as a gradual increase of the loading of the joint structures. However, further research is needed to underpin this clinical observation.

examination tests have revealed only minimal signs, it may be necessary to move the patella quite forcibly while the tibiofemoral joint is flexed approximately 40° and compression applied by the physiotherapist's hand.

- Next to passive mobilizations of the patella, it has been stated that rehabilitation of muscular control should take place as early as possible to allow optimum tracking of the patella in the femoral groove during the first 20–30° of flexion. In particular, the recruitment of the vastus medialis oblique in relation to the vastus lateralis within the overall muscular chain of the foot and pelvis merits special attention. Corrective tape may be applied to the patella if movements would be too painful to start in an early phase (Hilyard 1990, McConnell 1996).

Superior tibiofbular joint

Often it may not be easy to determine whether the superior tibiofibular joint is responsible for a patient's symptoms. Frequently this needs be ascertained by performing stronger techniques with compression and comparing these with the unaffected leg.

- When a comparable sign is found this movement should be used in treatment.
- Initially it should be performed firmly but not vigorously.
- Posteroanterior and anteroposterior movements can be performed. In the progression of treatment they may be carried out under firm compression. However, it needs to be emphasized that if symptoms are being produced during the treatment technique, they should occur in the rhythm of the movement and they should settle fairly quickly once the treatment has stopped.
- When the superior tibiofibular joint is responsible for symptoms, frequently it responds very readily and rapidly to massive mobilizing techniques.

In the following section passive physiological and accessory movements of the tibiofemoral, patellofemoral and superior tibiofibular joint are described.

Description of techniques

Physiological movements of the tibiofemoral joint: examination and treatment techniques

Extension (Fig. 8.31)

- *Direction*: Extension of the tibia on the femur.
- *Symbol*: E.
- *Patient starting position*: Supine, lying in the middle of the couch.

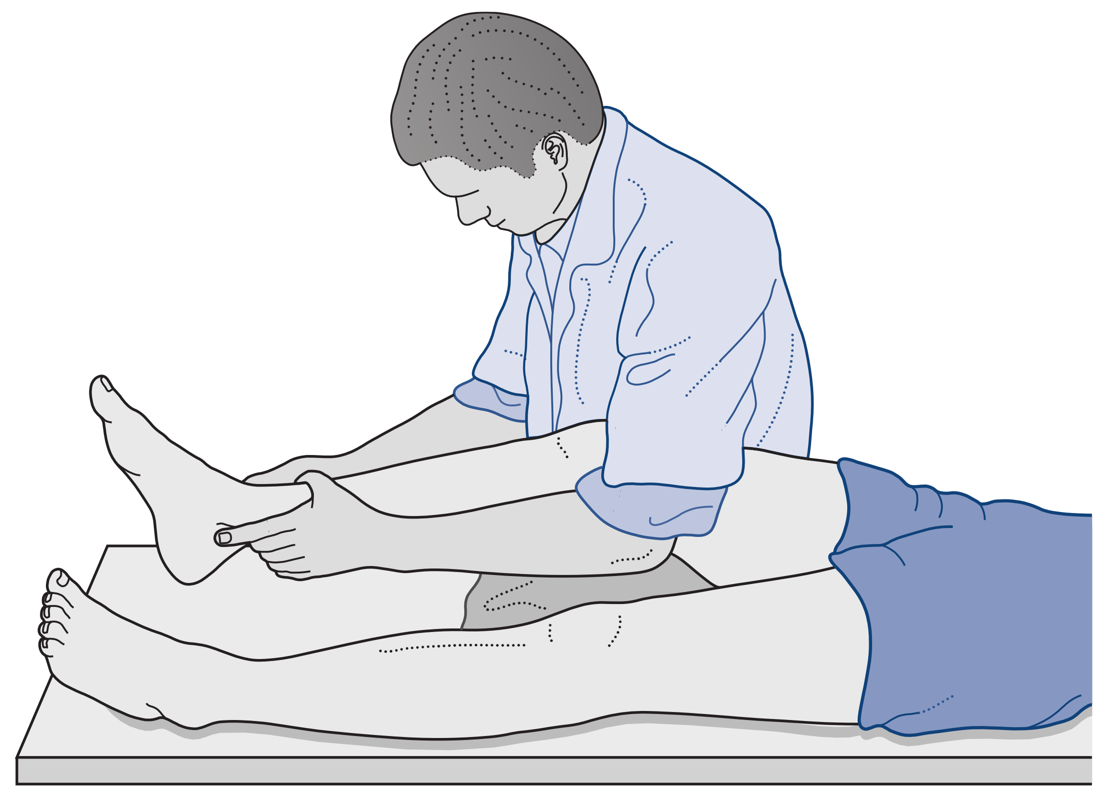


Figure 8.31 • Extension of the tibia on the femur.

- *Therapist starting position*: Standing by the patient's right thigh facing the feet, kneeling on own left shin to support under the lower end of the patient's femur with the left thigh. When the patient's knee is flexed, the therapist's left thigh also moves to the patient's calf.

Localization of forces (position of therapist's hands)

- Both hands hold distally around the patient's lower leg from behind.
- The left elbow is placed by the side of the patient's knee so that the axis of the therapist's left arm coincides with the axis of the knee movement.

Application of forces by therapist (method)

- The lower leg is moved through a range of 25–30° by the therapist lowering and raising the patient's leg through an arc of movement. The therapist's arms are used to achieve this.

Variations in the application of forces

- Adduction and abduction can be added to this movement as required. This will require firm but comfortable control of femoral rotation with the insides of both elbows and distal parts of the upper arms.
- Alternatively, perform extension as described below in extension/abduction and extension/adduction.

Uses

- Most useful as a grade III movement.
- For through-range pain and stiffness, especially in OA.

- To help recovery of range after injury, immobilization or disuse.

Extension/abduction, extension/adduction (extension) (see Fig. 8.18)

An example of this concept's approach

Some manipulative therapist authors argue the axiom that all examination and treatment passive movements must be performed in the directions (roll, spin, slide) in which they occur actively. This is anathema to the concept propounded in this book: in fact, the Maitland Concept says the opposite, on the basis of the very positive importance of the '*pain* provoked with movement' principle. The 'comparable', 'appropriate' pain response is nearly always found with the non-physiological rather than the physiological movement.

- *Direction*: Extension/abduction, extension/adduction (and extension) of the tibiofemoral joint.
- *Symbols*: E/Ab, E/Ad (E).
- *Patient starting position*: Supine, lying in the middle of the couch.
- *Therapist starting position*:
  - *For grades III and IV* (see Fig. 8.18): standing by the patient's right ankle facing the left hip; the therapist's right knee and lower leg rest on the couch at right angles to the patient's leg; the patient's heel is supported across the therapist's thigh adjacent to the ASIS.
  - *For grades IV and IV+* (see Figs 8.1, 8.4): standing by the patient's right knee.

Localization of forces (position of therapist's hands)

Grades III and IV – E/Ab

- The right hand supports the patient's knee medially around the medial aspect of the joint.
- The fingers reach the medial condyle of the tibia posteromedially.
- The thenar eminence is anteromedial.
- The heel of the left hand is placed: (1) over the lateral epicondyle of the femur; (2) on the lateral condyle of the tibia; (3) over the joint line laterally.
- The fingers of the left hand reach posteriorly.
- The thenar eminence of the left hand is placed slightly anterior.
- The left forearm is directed at right angles to the shaft of the femur and tibia so that the abduction component can be produced.

Grades III and IV – E/Ad

- The left hand supports the patient's knee laterally around the lateral aspect of the joint.
- The fingers of the left hand reach the lateral condyle of the tibia posterolaterally.
- The thenar eminence is anterolateral.
- The heel of the right hand is placed: (1) over the medial epicondyle of the femur; (2) on the medial condyle of the tibia; (3) over the joint line medially.
- The fingers of the right hand reach posteriorly.
- The thenar eminence of the right hand is placed slightly anteriorly.
- The right forearm is directed at right angles to the shaft of the femur and tibia so that the adduction component can be produced.

Grades IV and IV+ – E/Ab (see Figs 8.1, 8.4)

- With the patient's leg medially rotated.
- The right hand holds under the patient's heel from the lateral side.
- The left hand is placed anterolaterally: (1) on the femur; (2) on the tibia; (3) on the joint line.

Grades IV and IV+ – E/Ad (see Figs 8.1, 8.4)

- With the patient's leg laterally rotated.
- The right hand holds under the patient's heel from the medial side.
- The left hand is placed anteromedially: (1) on the femur; (2) on the tibia; (3) on the joint line.

Application of forces by therapist (method)

Grades III and IV – E/Ab

- The patient's knee is raised and lowered through a distance of approximately 13–15 cm by the therapist's hands.
- A constant pressure is maintained against the lateral surface of the patient's knee by the heel of the left hand placed in one of three positions as described above.
- Each of the three positions will produce a different movement of the tibiofemoral joint:

  1. When the heel of the left hand is against the femur with a strong abduction force (abduction of the tibial shaft), the femur will

tend to move slightly medially on the tibia during extension/abduction

2. When the heel of the left hand is against the tibia, the tibia will tend to move medially on the femur during the extension/abduction movement
3. When the heel of the left hand is over the joint line the whole movement will simply be extension/abduction.

- Note that the stronger the abduction pressure required the more the therapist needs to crouch over to bring the left shoulder closer to the patient's knee.

Grades III and IV – E/Ad

- The same application of forces applies to extension/adduction as for extension/abduction with the exception that the left hand becomes the right hand, the medial movement of the tibia and femur becomes lateral movement, extension/abduction becomes extension/adduction, abduction becomes adduction, and the left shoulder becomes the right shoulder.

Grades IV and IV+ – E/Ab

- With the patient's leg medially rotated, support under the patient's heel and contact against the anterolateral aspect of the knee (with left elbow only slightly flexed), the therapist's trunk is rotated to the left and back again to produce the small oscillatory movements in the direction of extension/abduction.

Grades IV and IV+ – E/Ad

- With the patient's leg laterally rotated, support under the patient's heel and contact against the anteromedial aspect of the knee (with the left elbow straight), the therapist's trunk is side flexed to the left and back again to produce the small oscillatory movements in the direction of extension/adduction.

Variations in the application of forces: extension (E)

- The above methods can be adjusted so that movement of the tibiofemoral joint is produced into extension only.
- For grade III, for example, the left hand is placed laterally around the joint and the right hand is placed medially around the joint during the movement of raising and lowering the knee. In this way the movement will be into tibiofemoral extension only.
- For grade IV, the patient's leg is not rotated for convenience, the right hand supports the heel and the left hand is placed either directly anterior on the femur, anteriorly over the joint line (around the patella) or anteriorly on the tibial tubercle. In this way with the hand on the upper leg, the femur will move anteroposteriorly in relation to the tibia. With the hand over the joint line the tibiofemoral joint movement will be extension only and with the hand on the tibia, the tibia will move anteroposteriorly in relation to the femur during extension.

Uses

- As special examination tests when knee symptoms are minimal and there is a full painless range of flexion and extension.
- As functional corners to be examined and treated to ensure the joint regains its ideal movement capacity after injury or disuse.
- As excluding or screening tests for the knee.
- To confirm ligamentous injury or internal mechanical derangement.

Flexion/abduction, flexion/adduction (see Fig. 8.5)

- *Direction*: Abduction or adduction of the tibia on the femur at the limit of full flexion of the knee.
- *Symbols*: F/Ab, F/Ad.
- *Patient starting position*: Supine, lying at the edge of the couch with the hip flexed to 90° or beyond, and the knee fully flexed (see Fig. 8.2).
- *Therapist starting position*: Standing beside the patient's right knee facing the patient's head.

Localization of forces (position of therapist's hands)

- The left hand supports the patient's thigh.
- The right hand grasps anteriorly around the patient's ankle.

For F/Ab

- The fingers of the right hand push laterally against the medial surface of the patient's calcaneum posteriorly.
- The right thumb is hooked around the patient's lateral malleolus.

For F/Ad

- The fingers of the right hand hook around the patient's medial malleolus.
- The thumb and metacarpophalangeal joint of the index finger of the right hand apply pressure in a posterior direction on the anterior surface of the tibia.

Application of forces by therapist (method)

- Small or large amplitude oscillatory movements can be performed as diagonal movements into F/Ab and F/Ad while strongly maintaining medial rotation of the tibia (*for F/Ab*) or lateral rotation of the tibia (*for F/Ad*).
- The patient's heel should then move lateral to the ischial tuberosity (*for F/Ab*) and medial to the ischial tuberosity (*for F/Ad*).
- Counterpressure needs to be applied to the thigh so that rotation of the hip is prevented (either over the soft tissues of the thigh or by blocking the greater trochanter with the physiotherapist's leg).
- The therapist needs to keep close to the patient's lower leg to enable control of the pressure through the patient's ankle.

Uses

- Examination technique as an 'if necessary' procedure.
- To restore the range of movement into F/Ab and F/Ad in cases of minor intermittent knee symptoms.
- To help to thoroughly screen the knee.
- To remobilize the knee after injury, immobilization or disuse.

Medial rotation, lateral rotation (Fig. 8.32, see also Fig. 8.3)

- *Direction*: Medial and lateral rotation of the tibia in relation to the femoral condyles.
- *Symbols*: ↺ ↻

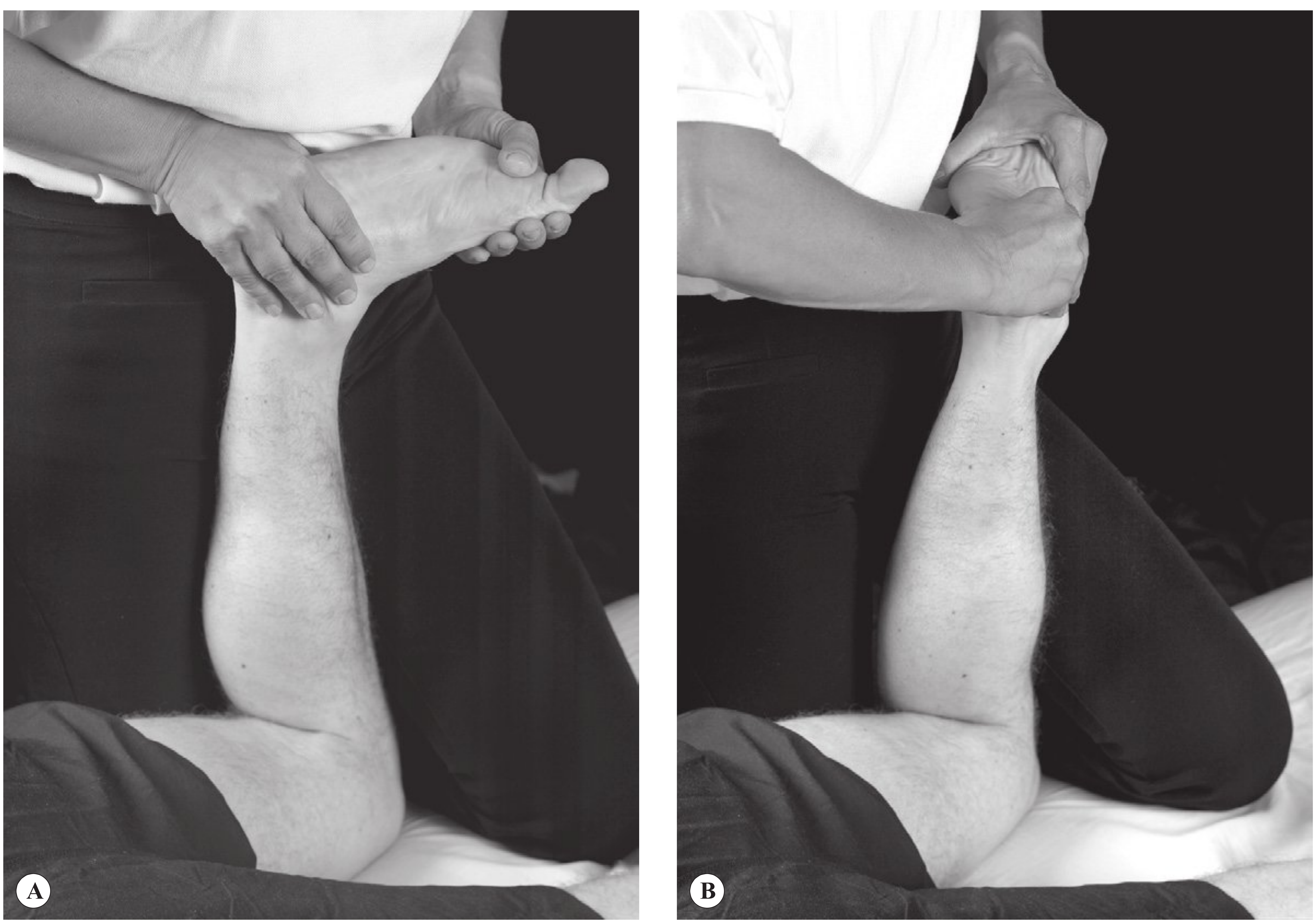


Figure 8.32 • Tibiofemoral rotation prone: A medial; B lateral.

- *Patient starting position*:
  - *in flexion supine*: supine, hip and knee flexed to 90°, foot in the air (see Fig. 8.3)
  - *in flexion prone*: prone with the knee flexed to 90° (see Fig. 8.32).
- Therapist starting position:
  - *in flexion supine*: standing by the patient's right hip facing the patient's foot (see Fig. 8.3)
  - *in flexion prone*: standing by the patient's right thigh facing the patient's foot (see Fig. 8.32).

Localization of forces (position of therapist's hands)

In flexion supine

- The left arm and side hold the patient's knee.
- The left hand, pronated, holds the patient's forefoot from the lateral side.
- The right hand holds the patient's heel posteriorly and medially.

In flexion prone

- The heel of the right hand holds the medial surface of the patient's heel.
- The fingers spread over the sole of the heel with the tips of the fingers reaching the lateral surface.
- The left hand grasps the dorsum of the patient's forefoot.
- The heel of the left hand holds against the foot's lateral border.
- The thumb is placed over the sole of the foot.
- The forearms are directed opposite each other.

Application of forces by therapist (method)

In flexion supine

- The rotation (medial or lateral) is produced by a pulling action of both hands while the therapist's body stabilizes the patient's knee.
- Large amplitude movements involving 30° of movement can be performed easily.
- Small amplitude grade IV stretching movements can also be performed easily in this position.
- Foot and ankle movement will also occur during the knee rotation.

In flexion prone

- Small and large amplitude movements can be produced by a pulling and pushing action of both hands in opposite directions.
- It is essential to prevent the forefoot from inverting (*for medial rotation*) and everting (*for lateral rotation*) when pressure is applied to its lateral surface by the left hand (*MR*) or its medial surface by the left hand (*LR*).
- Movement takes place at the foot and ankle as well as the knee. This does not make the technique any less effective in producing knee rotation.
- *Variations in the application of forces*
- If the foot and ankle are very painful, the knee rotation may need to be produced by grasping the malleoli.
- The techniques of AP and PA in slight flexion can be adapted so that grades I and II medial and lateral rotation are produced (see Figs 8.34, 8.35).
- For grades I and II medial rotation of the tibia in this position, an AP pressure through the therapist's thumbs can be applied to the medial tibial condyle near the joint at the same time as a PA pressure is applied by the therapist's fingertips against the lateral condyle of the tibia posteriorly and near the joint line. Lateral rotation will be produced if the thumbs apply pressure to the lateral tibial condyle anteriorly at the same time as the fingertips apply pressure to the medial tibial condyle posteriorly.
- Grades I and II: supine, knee over a soft pillow. One of the therapist's hands palpates the joint line, the other hand grasps around the distal part of the tibia around the malleoli. Rotation is applied by gently rotating the malleoli and fixating the knee and femur.

Uses

- Most useful as a grade IV stretching movement in flexion.
- Very painful joints (variation, grades I and II).
- Medial rotation is usually more valuable in treatment than lateral rotation.
- Tibial medial rotation corresponds to anterior cruciate restraint; tibial lateral rotation corresponds to medial ligament and posterior cruciate restraint.
- Where functional demonstration indicates knee rotation is stiff or painful.
- As part of postmeniscectomy rehabilitation.
- As part of post-tibial plateau fracture rehabilitation.

- To encourage restoration of proprioceptive function.

Accessory movements of the tibiofemoral joint: examination and treatment techniques

Abduction and adduction (see Fig. 8.18)

- *Direction*: Abduction and adduction of the tibia in relation to the femur, best achieved with the knee held approximately 10° short of full extension.
- *Symbol*: Ab, Ad.
- *Patient starting position, therapist starting position, localization of forces*:
  - the position adopted is identical to that described for extension/abduction
  - the therapist maintains 10–20° of flexion by finger support under the patient's knee.

Application of forces by therapist (method)

- Abduction movement is produced by the pressure of the therapist's left hand against the lateral surface of the patient's knee.
- Adduction is produced by pressure against the medial side of the patient's knee from the therapist's right hand.

Uses

- Examination of end-feel on adduction and abduction: in extension only minimal range of movement should take place with a characteristic end-feel to the movement. If a collateral ligament is ruptured, the range of movement may be excessive and this end-feel becomes 'mushy' (Corrigan & Maitland 1994).
- To recover lost range of abduction and adduction in 10° of flexion.

Longitudinal movement caudad and cephalad (see Fig. 8.33)

- *Direction*: Movement of the tibial plateau in a longitudinal caudad direction in relation to the femoral condyles and femoral joint surfaces.
- *Symbol*: ←•→
- *Patient starting position*: Supine, lying near the right-hand edge of the couch with the knee supported in a few degrees of flexion with a soft pillow.

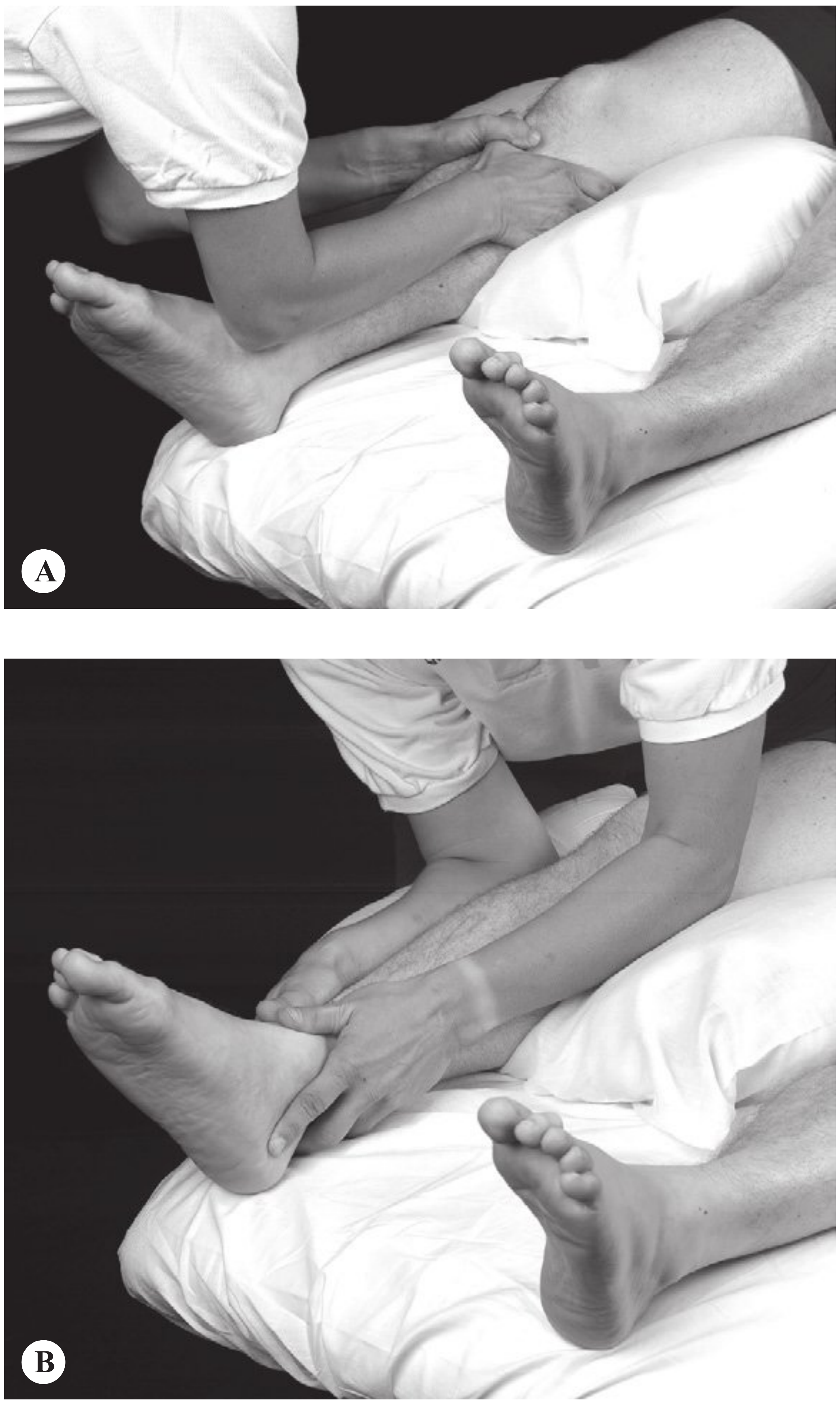


Figure 8.33 • Tibiofemoral longitudinal movements: A caudad; B caudad – alternative.

- *Therapist starting position*: Standing by the patient's right foot facing the knee (see Fig. 8.33A).

Localization of forces (position of therapist's hands)

- Both hands grasp around the tibia as close to the joint line as is possible.
- The thumbs overlap to reach the opposite side of the tibial tubercle.
- The fingers reach around the medial and lateral borders of the tibia to the posterior surface.

Application of forces by therapist (method)

- Small or large amplitude oscillatory movements are produced by pulling lightly or strongly on the tibia near to the joint line and in line with the shaft of the femur.

Variations in the application of forces

- Therapist stands by patient's right knee facing the foot; both hands grasp around the malleoli and the therapist's forearms support the tibia. Oscillatory movements are produced by the therapist's arms and upper body (see Fig. 8.33B).

Longitudinal movement cephalad

- Occasionally compression (longitudinal cephalad movement) of the joint surfaces becomes important when combined with other accessory or physiological movements in the treatment of joint surface pain (see Box 8.4).
- This compression can be produced as described above with the exception that the tibia is moved towards the femoral condyles in line with the shaft of the femur.
- While the joint surfaces are held together (which may serve the purpose of reproducing the ache emanating from the joint surfaces) other movements may be carried out such as AP, PA or flexion/extension with abduction/adduction or rotation.

Uses

- Very painful joints (*longitudinal caudad*).
- Minor aching with joint surface loading (*longitudinal cephalad*).
- In conjunction with other accessory or physiological movements.
- Stretching stiff collateral ligaments or reducing the loading on very painful joint surface disorders (*longitudinal caudad*).
- Adding to (for example) extension/abduction to reproduce momentary pain – clinical group 4 (*longitudinal cephalad*).

Posteroanterior movement (see Fig. 8.34)

- *Direction*: Movement of the tibial plateau in relation to the femoral condyles in a posterior to anterior direction.
- *Symbol*: ↨
- *Patient starting position*:
  - *for grades I and II*: supine, lying with the knee carefully supported in a few degrees of flexion by a soft pillow (see Fig. 8.34A)

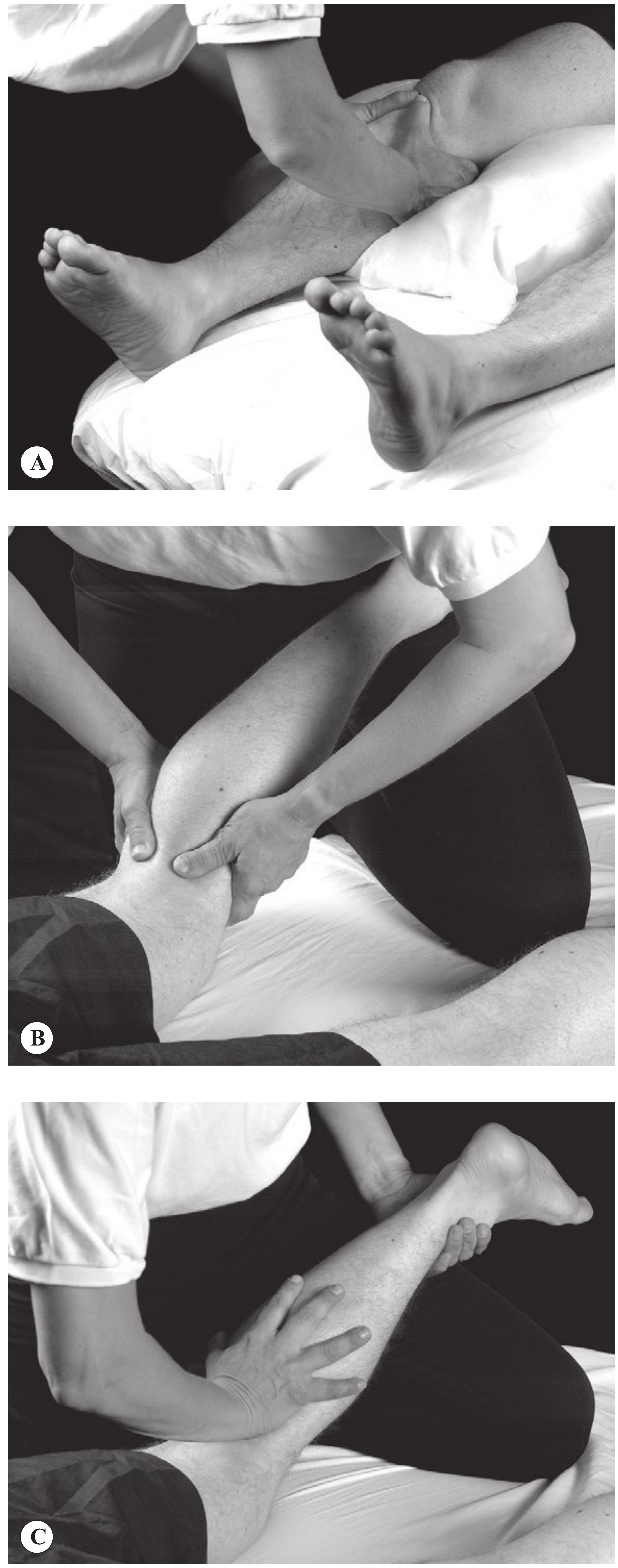


Figure 8.34 • Tibiofemoral posteroanterior movement.

  - *for grades III and IV*: prone, lying with the knee flexed to approximately 70° or at the available limit (see Figs 8.34B, C).
- Therapist starting position:
  - *for grades I and II*: standing by the patient's side facing the patient's head (see Fig. 8.34A)
  - *for grades III and IV*: standing by the side of the patient beyond the flexed knee and facing the patient's head; the left tibia rests on the couch, the therapist's knee is fully flexed so that the upper thigh supports across the patient's distal shin (see Figs 8.34B, C).

Localization of forces (position of therapist's hands)

For grades I and II

- The hands grasp the patient's knee from both sides.
- The thumbs and heels of both hands are placed around the joint medially and laterally.
- The thumbs extend anteriorly over the joint line.
- The fingertips of both hands are placed along the posterior surface of the tibia adjacent to the joint line.

For grades III and IV

- As much of the thumb pads as possible are placed on the posterior surface of the medial and lateral condyles of the tibia with the fingers spread across the tibia laterally, medially and anteriorly.
- The left hand supports the patient's right shin, the heel of the right hand is placed on the posterior surface of the tibia as far proximally as possible, the fingers of the right hand lie over gastrocnemius.

Application of forces by therapist (method)

For grades I and II

- The gentle oscillatory posteroanterior movement is produced by the therapist's pressure transmitted through the fingertips against the posterior surface of the tibia proximally.

For grades III and IV

- The stretching oscillatory movements are produced by the therapist's arms and body acting through the thumbs (the thumb flexors should never be used as this may produce discomfort and the therapist will be unable to appreciate the extent and feel of the movement) or the heel of the hand.
- If the heel of the hand is to be used to produce the movement, the pressure against the tibia should originate from the therapist's arm and trunk.
- Three distinct movements can be produced in this case:
  1. As the tibia is moved forwards the therapist can, with the right hand, carry the distal end of the tibia an equal distance so that the whole lower leg moves through a parallel line.
  2. As the pressure is exerted posteroanteriorly through the therapist's left hand, the therapist can slightly lift the patient's distal tibia so that, combined with the PA movement, there will be a degree of knee flexion taking place.
  3. As the PA movement of the tibia is taking place, the therapist's right hand can lower the distal end of the tibia so that there is a degree of tibiofemoral extension as the PA movement is taking place.

Uses

Grades I and II

- Painful joint movements.
- Clinical groups 1 and 3a.
- Acute injury or flare-up of OA.
- Commencement of mobilization after surgery or immobilization.

Grades III and IV

- To restore range in a stiff joint at the limit of flexion or other movements.
- Clinical groups 2 and 3b.
- Postinjury or immobilization stiffness.

Anteroposterior movement (see Fig. 8.35)

- *Direction*: Movement of the tibial plateau in relation to the femoral condyles in an anterior to posterior direction. The greatest range will be achieved in 10–70° of knee flexion.
- *Symbol*: ↟

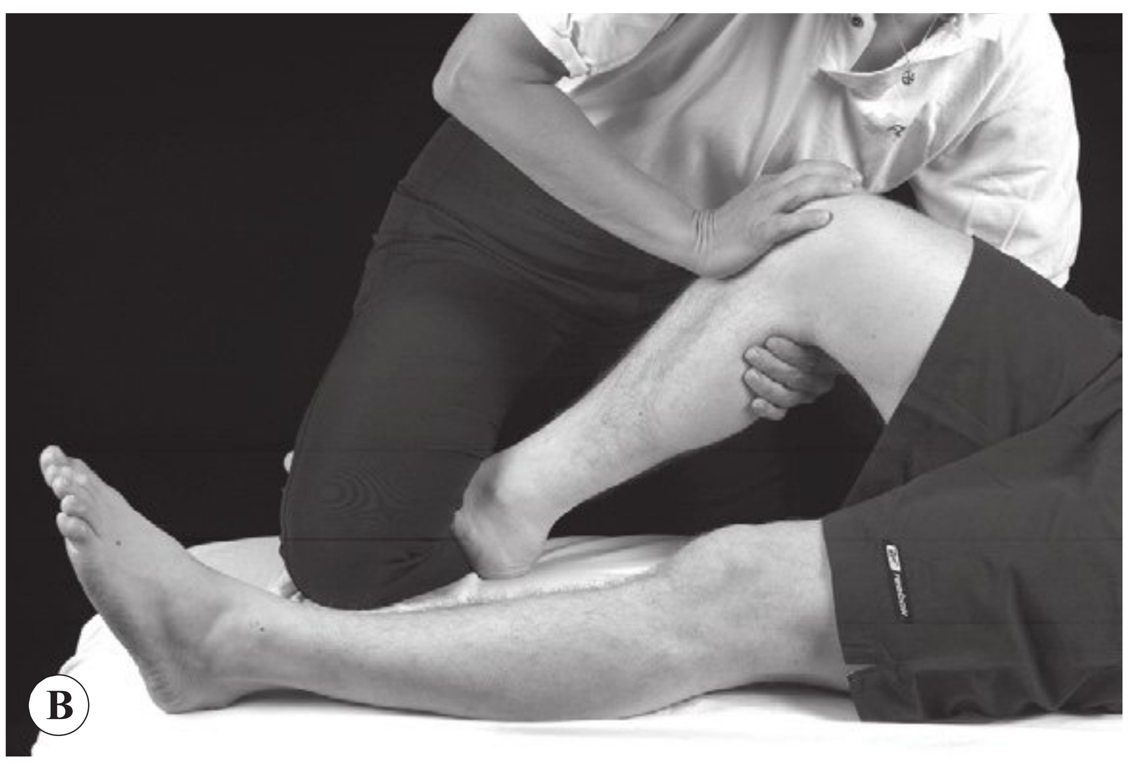


Figure 8.35 • Tibiofemoral anteroposterior movement: A grade I; B grade II.

- *Patient starting position*:
  - *for grades I and II*: supine, lying with a soft pillow carefully placed under the patient's knee supporting the femur more than the tibia and in not more than 10° of knee flexion
  - *for grades III and IV*: supine, lying with the foot resting on the couch so that the knee is flexed to approximately 70° or to its available limit.
- Therapist starting position:
  - *for grades I and II*: standing by the patient's right lower leg facing the patient's knee
  - *for grades III and IV*: standing by the patient's right ankle, right lower leg resting across the patient's foot to stabilize the position.

Localization of forces (position of therapist's hands)

For grades I and II

- The pads of the thumbs are placed against the anterior surface of the tibia either side of the tibial tuberosity.
- The fingers rest against the adjacent surfaces of the tibia and fibula.
- The metacarpophalangeal joints of the thumbs are positioned almost vertically above the pads of the thumbs so that the pressure is directed through these joints.

For grades III and IV

- The heel of the right hand is positioned over the anterior surface of the tibia immediately adjacent to the joint line.
- The fingers spread over the front of the patient's knee.
- The left hand is placed behind the patient's knee and the palm over the upper calf posteriorly.

Application of forces by therapist (method)

For grades I and II

- Small or large but gentle oscillatory movements are produced by the therapist's arms acting through the thumbs.
- These finely controlled movements should never be performed by the flexor muscles of the thumb.

For grades III and IV

- The AP movement of large or small amplitude is produced by pressure against the upper end of the tibia.
- The patient's hand posteriorly acts as a support and produces the return movement when a large amplitude is required.

Uses

Grades I and II

- Extremely painful knees.
- Clinical groups 1 and 3a.
- Acute injury.
- Acute flare-up of OA.
- Commencement of mobilization after arthroplasty or other surgical interventions.

Grades III and IV

- To restore range in a stiff joint at the limit of flexion (can be performed in other positions such as extension, rotation, abduction, adduction).
- Clinical groups 2 and 3b.
- Postinjury or immobilization stiffness.

Lateral movement and medial movement (Fig. 8.36)

- *Direction*: Movement laterally or medially of the tibial plateau in relation to the femoral condyles, in any position of flexion or extension of the knee (90° of flexion in this case).
- *Symbols* →→ ↔→

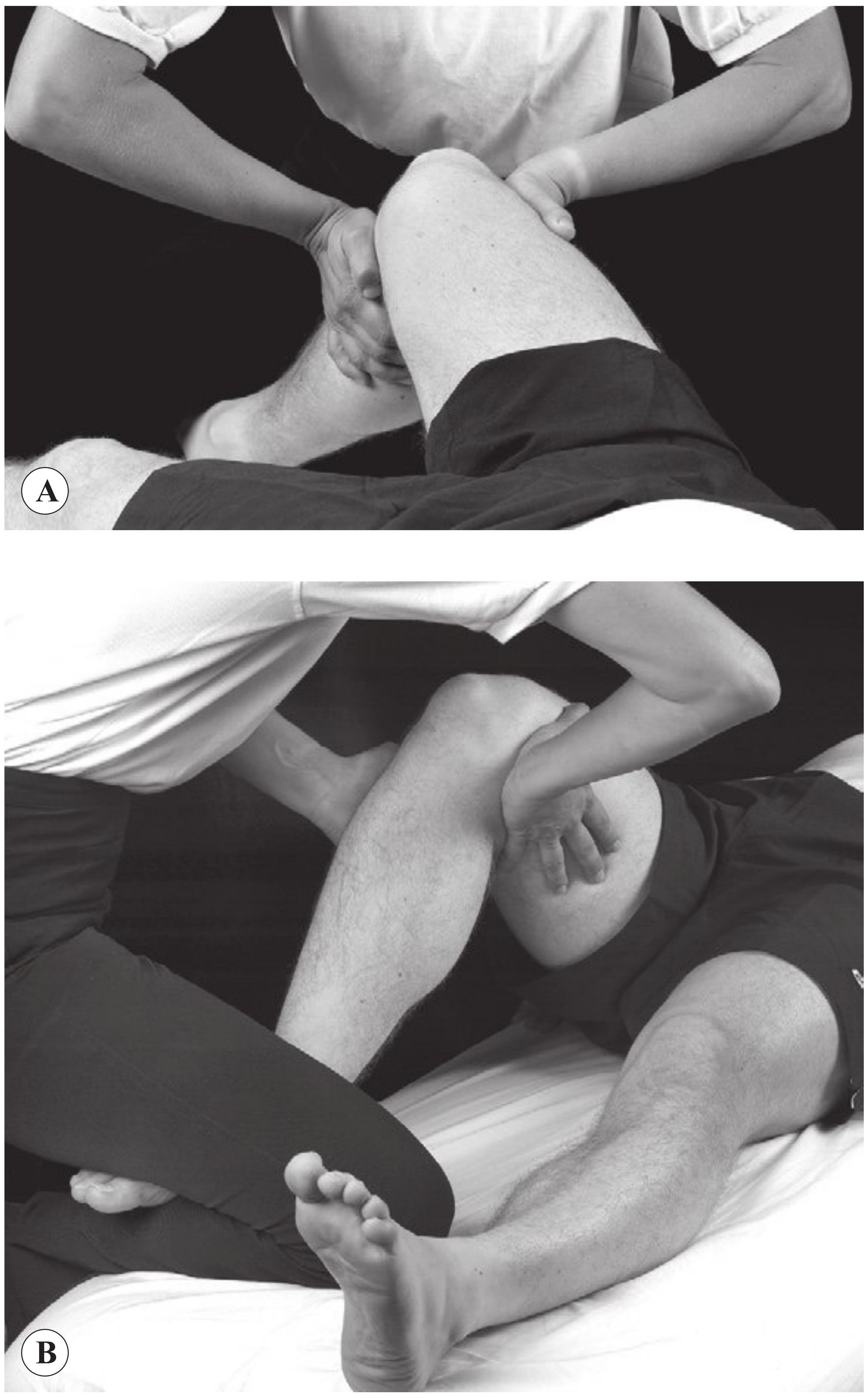


Figure 8.36 • Tibiofemoral movements: A lateral; B medial.

- *Patient starting position*: Supine, hip and knee flexed accordingly and the foot resting on the couch.
- *Therapist starting position*: Standing level with the patient's foot facing the patient's head.

Localization of forces (position of therapist's hands)

Lateral movement (Fig. 8.36A)

- The heel of the right hand is placed on the medial condyle of the tibia.
- The heel of the left hand is placed on the lateral epicondylar area of the femur.
- The therapist leans forward and extends both wrists so that both forearms are directed parallel to each other.
- The right forearm is positioned in a slightly lower plane to the left hand.

Medial movement (Fig. 8.36B)

- The heel of the right hand is placed on the medial epicondylar area of the femur.
- The heel of the left hand is placed on the lateral condyle of the tibia.
- The left forearm will be positioned in a slightly lower plane than the right.

Application of forces by therapist (method)

- The technique is merely one of pushing the arms towards each other.
- *For lateral movement* it is essential to apply the pressure along the line of each forearm in the correct plane such that, if the patient's knee was not there, the therapist's right arm would pass parallel to but below the left arm.
- *For medial movement* the left arm would pass parallel to but below the right arm.

Uses

- Pain and stiffness of the knee in the lateral and medial directions.
- To complement the recovery of Ab or Ad or E/Ab, E/Ad, F/Ab, F/Ad.
- After knee debridement to help to regain natural shearing forces across the joint surfaces.
- To complement recovery after collateral ligament injury.

Tibiofemoral treatment techniques under compression

Figures 8.37 and 8.38 are examples of how treatment techniques may be adapted under compression.

Accessory movements of the patellofemoral joint: examination and treatment techniques

Compression (see Fig. 8.21)

- *Direction*: Compression of the posterior surface of the patella against the intercondylar articular surfaces of the femur.
- *Symbol*: ≻•≺
- *Patient starting position*: Supine, lying with a pillow under the knee and the knee in a few degrees of flexion.
- *Therapist starting position*: Standing by the patient's right knee facing the patient's head.

Localization of forces (position of therapist's hands)

- The left hand is placed under the posterior surface of the patient's femur distally.
- The heel of the right hand is placed over the patella.
- The centre of the patella fits between the therapist's thenar and hyperthenar eminences.
- The right forearm should be directed vertically through the patient's knee.

Application of forces by therapist (method)

- The technique is produced by a gentle squeezing of the patella against the femur.
- Pressure should be applied gently and slowly against the patella.
- The patient should report any discomfort or pain as the pressure is applied.
- If no discomfort is felt, maximum pressure can be applied against the patella and a strong small amplitude grade IV+ movement produced.

Variations in the application of forces

- When this technique is painless or only minimally painful a technique can be used where the patella is hit sharply by the heel of the therapist's hand so as to knock the patella sharply against the femur.
- The first session should be very short (not exceeding 20 seconds) and an assessment made on the following day to guide whether stronger techniques can be used or whether, because an exacerbation has been caused, gentler techniques are included.
- Can be useful as a means of identifying patellofemoral pain by adding compression of

Figure 8.37 • Example of treatment under compression: fexion or accessory movement in fexion position.

Figure 8.38 • Example of treatment in weight-bearing position: fexion or PA/AP movements.

the patella to functional activities such as squatting. This can also then serve as a progression of treatment.

Uses

- Minimal pain emanating from the patellofemoral articulation during loaded activities such as squatting, descending stairs or sitting to standing.
- To reproduce pain originating from the patellofemoral joint surfaces.
- In combination with other patellar movement such as longitudinal movements.
- Patellofemoral OA.

Distraction (see Fig. 8.20)

- *Direction*: Movement of the patella away from the femoral articular surfaces.
- *Symbol*: Distr.
- *Patient starting position*: Supine, knee in extension (or pain-free position).
- *Therapist starting position*: Standing level with the patient's knee, facing across the patient's body.

Localization of forces (position of therapist's hands) (see Fig. 8.20A)

- Both thumbs are placed in the space between the patella and femur medially (or laterally).
- Both index fingers are then placed in the space on the opposite side.
- The fingers and thumbs are then gently squeezed together to reach under the patella.
- At the same time the wrists are extended and radially deviated so that the fingers and thumbs lift against the undersurface of the patella.

Application of forces by therapist (method)

- The technique is a very gentle, slow oscillatory movement consisting of raising and lowering the patella.
- The patella should not be lowered to the extent whereby it comes into full contact with the femur.
- Care should be taken to avoid discomfort under the patella.

Variations in the application of forces

- The therapist places the bases of both hands lateral and medial to the patella, and performs the distraction movement by gently moving both elbows towards each other (see Fig. 8.20b).
- As well as a technique in its own right the distraction of the patella can then be accompanied by other patellar movements (e.g. medial, lateral, longitudinal, rotational and diagonal).

Uses

- Very painful patellofemoral joint surface disorders (clinical groups 1 and 3a).
- Pain relief in chondromalacia patellae.
- As a means of progressing pain-free movements of the patella in other directions.
- Stretching the retinaculum and soft tissue attachments of the patella (clinical groups 2 and 3b).

Transverse movement medially and laterally (Fig. 8.39)

- *Direction*: Movement of the patella in a transverse medial direction in relation to the femoral intercondylar articular surfaces.

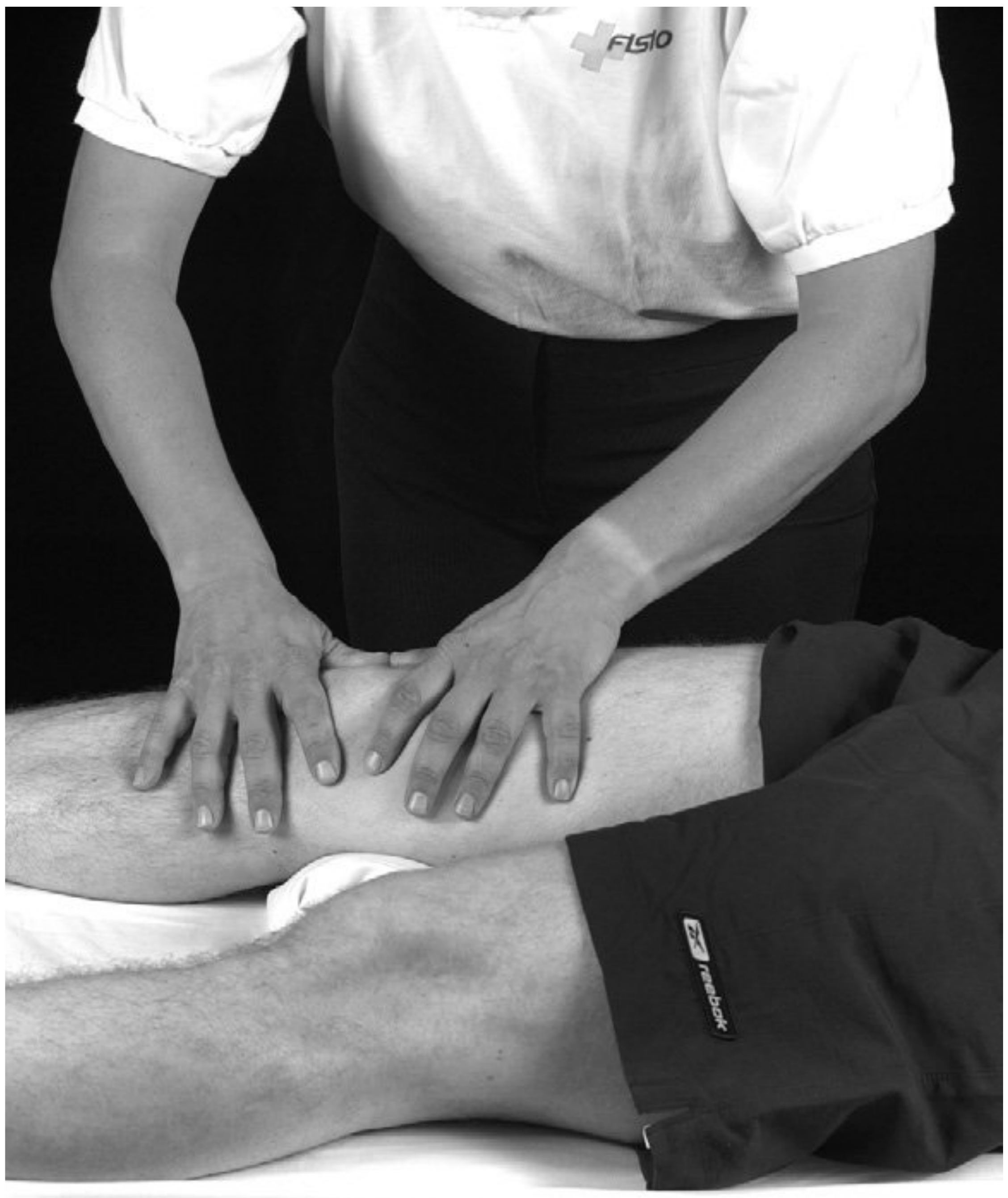


Figure 8.39 • Patellofemoral transverse movement medially.

- *Symbols*: →→ ↔→
- *Patient starting position*: Supine, lying with knee in extension.
- *Therapist starting position*: Standing by the patient's right knee, facing across the patient's body.

Localization of forces (position of therapist's hands)

- The pads of both thumbs are placed, pointing towards each other, against the lateral border of the patella.
- The fingers of the left and right hands point medially to rest across the distal end of the patient's femur and proximal end of the tibia, respectively.
- The thumbs are hyperextended at the interphalangeal joints to bring as much of the pads as possible into contact with the lateral border of the patella.

Application of forces by therapist (method)

- Oscillatory movements of the patella are produced by the therapist's arms acting through the thumbs.
- Grade I should produce 5 mm of movement of the patella from its resting position.
- For other grades of movement the patella is displaced more medially, reaching the limit of its excursion for grade III and grade IV movements.

Variations in the application of forces

- *Transverse laterally* is merely the reverse of the transverse medial movement.
- The patella can also be mobilized in the transverse direction while the patient adopts a position of the knee which relates to a painful or stiff activity (e.g. squatting).
- Alternatively, the patient's patella can be realigned with a transverse pressure during an activity which is painful (e.g. stepping up).
- If the pain diminishes with the realigned transverse pressure the therapist can utilize this in treatment and rehabilitation.

Uses

- Painful or restricted transverse movement of the patella.
- In combination with pain-relieving distraction or discomfort-provoking compression.

Longitudinal movement caudad and cephalad (Fig. 8.40)

- *Direction*: Movement of the patella in a longitudinal caudad direction in relation to the femoral intercondylar articular surfaces.
- *Symbol*: ↔→
- *Patient starting position*: Supine, lying with knee in extension.
- *Therapist starting position*: Standing by the patient's right knee facing across the patient's body, or facing the patient's feet for stronger grades of movement.

Localization of forces (position of therapist's hands)

- The heel of the left hand, near to the pisiform bone, is placed against the superior margin of the patella.

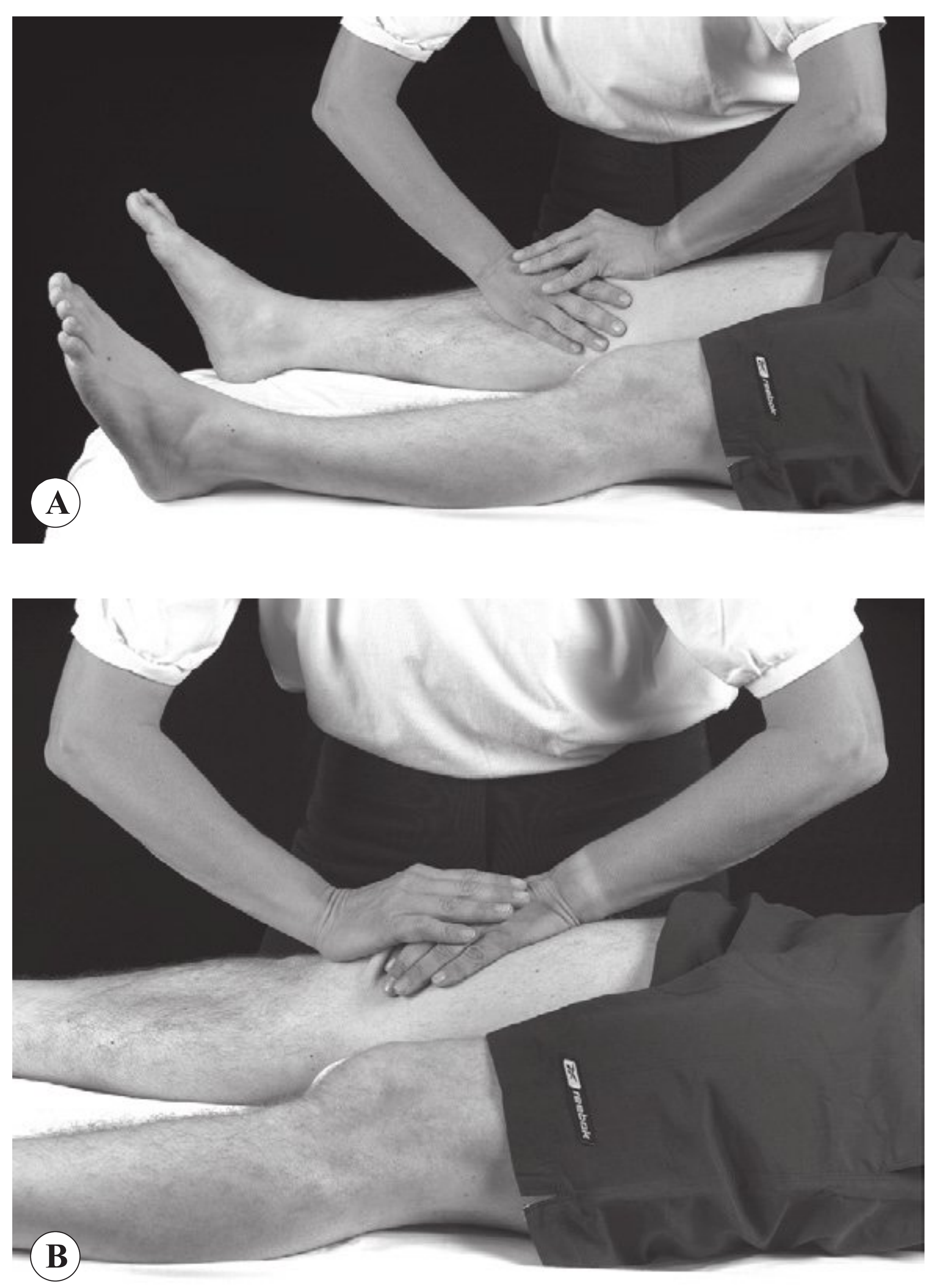


Figure 8.40 • Patellofemoral longitudinal movements: A caudad; B cephalad.

- The left wrist is extended.
- The left forearm is directed distally.
- The right hand, pointing proximally, is placed over the patella.
- The fingers and thumb of the right hand pass either side of the heel of the left hand.
- The right hand serves three purposes:

  1. Providing stability for the left hand
  2. Guiding the patella during movement
  3. Applying compression to the patella if desired.

Application of forces by therapist (method)

- The caudad movement of the patella is produced by the heel of the therapist's left hand while the direction of the movement is guided by the right hand.
- The therapist's two hands and the patient's patella should move as a single unit.

Variations in the application of forces

- *Longitudinal cephalad movement*: the same hand positions over the patella are used as for the caudad technique, but the movement is produced through the ulnar border of the therapist's right hand. To guide the direction of the movement the therapist uses the palm of the right hand (cupped over the patella) and the cupped base of the palm of the left hand.
- If compression is required during the movement, the patella can be pressed against the femur by the therapist's right hand.
- If the movement signs indicate, the movement described above can be combined with a medial inclination whereby the point of contact against the superior border of the patella is moved slightly laterally and the direction of the arms altered so that the diagonal movement direction can be performed. Likewise, a lateral inclination can be performed.

Uses

- Patellofemoral OA (clinical group 3b).
- Pain with this or inclined longitudinal movement directions.
- In combination with compression or distraction as progressions of treatment.
- Rotation around longitudinal axis or sagittal axis.

Special testing

The purpose of special tests is to move the patella through a full amplitude of movement by moving the patella in any radius of a circle while applying a compressive force against the anterior surface of the patella, thereby rubbing the posterior surface of the patella against the femur.

Two rotary movements

The directions of the rotary movement are illustrated in Figure 8.19.

- Rotation of the patella about the anatomical longitudinal axis producing contact between the medial articular facet of the patella and the medial condyle of the femur.
- Rotation in the coronal plane around a sagittal axis (see Fig. 8.22).

Patellofemoral movements in knee flexion (examples of treatment) (Fig. 8.41)

- *Direction*: Any direction of movement of the patella in relation to the femur with the patient's knee in flexion.
- *Symbols:* In knee F 60°, DId P/F ←•→ caud and ceph, →•→ med.
- *Patient starting position:* Sitting with the knee over the edge of the couch; alternatively, weight bearing.
- *Therapist starting position*: Standing by the side of the patient's knee.

Localization of forces (position of therapist's hands)

- The right palm is cupped over the patella.
- The heel and ulnar border of the left hand is placed against the superior margin of the patella.
- The lower legs stabilize the patient's lower leg in the required degree of flexion.

Application of forces by therapist (method)

- From this starting position the therapist can produce a variety of oscillatory movement directions (cephalad, caudad, angled, rotary, medial, lateral, with the addition of compression).
- Movement is produced by arm movement acting through the hands.

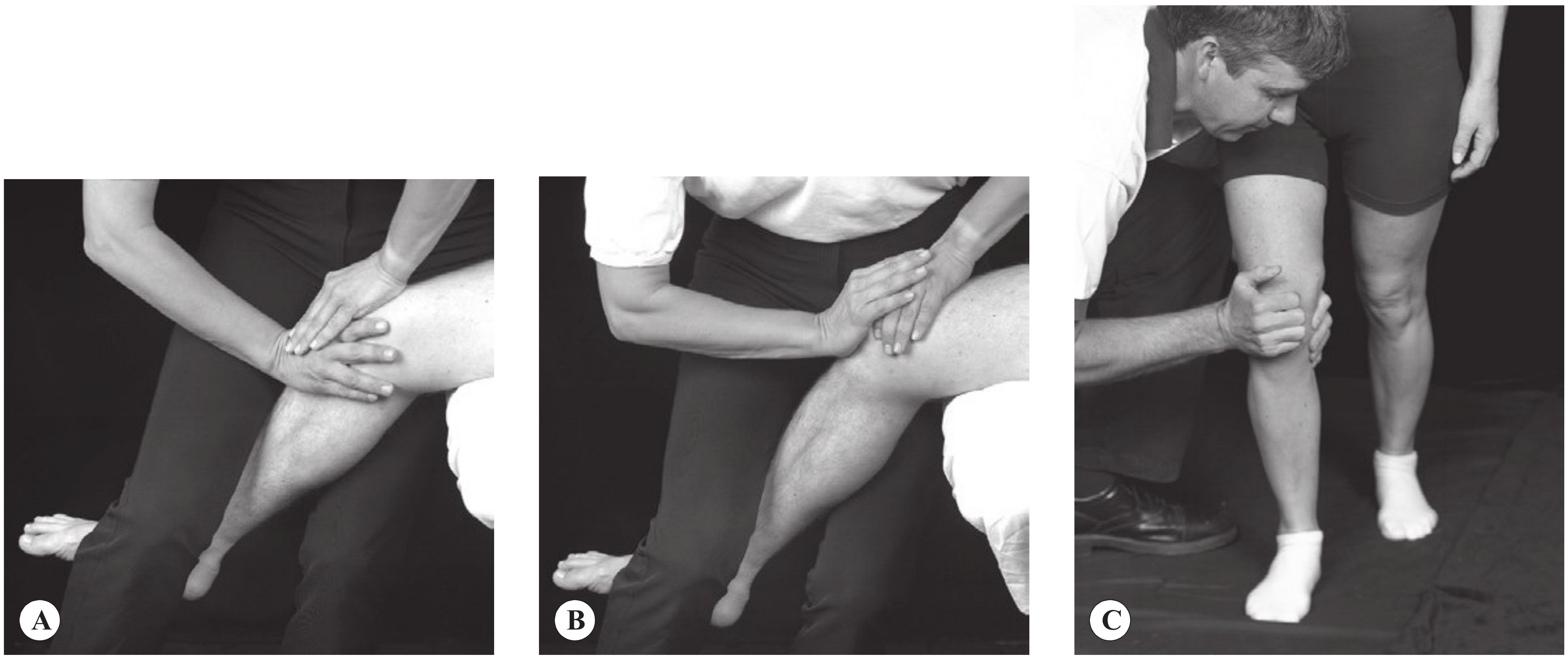


Figure 8.41 • Treatment example: in 60° fexion, longitudinal movements of patellofemoral joint: A caudad; B cephalad; C transverse medial.

Uses

- Stiff knee flexion after injury or prolonged periods of immobilization (Fig. 8.41A, B).
- Minor symptoms (group IV) (Fig. 8.41A–C).

Accessory movements of the superior tibiofbular joint: examination and treatment techniques

Examination and treatment techniques may be performed in any position: supine, prone or side lying. Side lying permits many adaptations of the techniques to the knee and foot positions.

Anteroposterior movement (see Fig. 8.23)

- *Direction*: Movement of the head of the fibula in an anterior to posterior direction in relation to the fibular articular facet on the tibia.
- *Symbol*: ↕
- *Patient starting position*: Side lying with the right hip and knee flexed and the lower leg resting on the couch.
- *Therapist starting position*: Standing in front of the patient's knee (if carried out in supine with knee flexion: sitting on the patient's foot to stabilize it, facing the patient's knee).

Localization of forces (position of therapist's hands)

- The pads of both thumbs are placed against the anterior border of the head of the fibula.
- Both thumbs point posteriorly.
- The fingers of both hands spread around the patient's knee to help stabilize the thumbs.

Application of forces by therapist (method)

- Anteroposterior movements are exerted against the head of the fibula through stable thumbs.
- It is extremely difficult to differentiate between different grades of movement but they can be varied by altering the strength of the pressures.

Variations in the application of forces

- If the addition of *compression* is necessary, the heel of the left hand is placed over the head of the fibula laterally while the fingers lie over the knee. The right thumb maintains its contact against the anterior margin of the fibula. The left forearm is directed so that it can apply a medially directed pressure against the head of the fibula as well as assisting the right thumb in its anteroposterior pressure (see Fig. 8.23B).
- Anteroposterior movement without or with compression can be performed with the patient in side lying. The medial aspect of the lower leg should be fully supported on the couch and the patient's ankle must be in a loose neutral

mid-range position. The movement is then produced through the therapist's thumbs or cupped hands in much the same way as shown for the inferior tibiofibular joint.

Uses

- Pain and stiffness of the superior tibiofibular joint.
- To help the recovery from peroneal nerve entrapment at the head of the fibula.
- To complement mobility of the inferior tibiofibular joint and thus the foot and ankle.

Posteroanterior movement (see Fig. 8.24)

- *Direction*: Movement of the head of the fibula in a posterior to anterior direction in relation to the fibular articular facet on the tibia.
- *Symbol*: ↓
- *Patient starting position*: Side lying, with right leg in hip and knee flexion, lower leg resting on plinth (if carried out in prone, lying near the right edge of the couch with the knee flexed approximately 30° for convenience).
- *Therapist starting position*: Standing behind the patient.

Localization of forces (position of therapist's hands)

- The pads of both thumbs are placed against the posterior border of the head of the fibula.
- The fingers of the left hand spread medially across the patient's upper calf.
- The fingers of the right hand reach anteriorly around the fibula.

Application of forces by therapist (method)

- Posteroanterior mobilizing is performed by pressure from the therapist's arms through the thumbs against the head of the fibula.
- The movement must not be produced by the muscles of the thumbs as this immediately becomes uncomfortable for the patient.

Variations in the application of forces

- The movement can be performed under *compression* by changing the position of the therapist's hands so that the heel of the hand is placed against the lateral surface of the head of the fibula while the thumb of the other hand produces the PA movement (see Fig. 8.24B).
- The posteroanterior movement can also be performed with or without compression with the patient in side lying in the same way as that described for anteroposterior movement, apart from the thumbs or heel of the hand being placed against the anterior border of the head of the fibula.
- For examination purposes the posteroanterior movement can be tested with the patient lying supine with the hip and knee flexed. A pulling pressure is then applied behind the head of the fibula with the fingers of the left hand.
- The PA mobilization can also be performed using the left thumb with the patient in supine and the leg in a degree of SLR in cases of nerve entrapment.

Uses

- Pain and stiffness of the superior tibiofibular joint in this direction.
- To help in the recovery of peroneal nerve entrapment at the head of the fibula.
- To complement mobility of the inferior tibiofibular joint and therefore the foot and ankle.

Longitudinal movement caudad and cephalad (see Fig. 8.25)

- *Directions*: Movement of the fibula in a longitudinal caudad and cephalad direction in relation to the tibia.
- *Symbol*: ↔
- *Patient starting position*: Prone, lying with the knee flexed to a right angle.
- *Therapist starting position*: Standing next to the patient's foot, facing across the patient's body.

Localization of forces (position of therapist's hands)

- One hand holds the patient's foot, the other palpates movement of the fibula.

Application of forces by therapist (method)

- Caudad movement is produced by strongly inverting the patient's heel (see Fig. 8.25A).
- Cephalad movement is produced by the therapist everting the patient's heel, at the

same time pushing the inferior angle of the fibula cephalad with both thumb pads.

- This movement can readily be felt in the normal subject by palpating the head of the fibula with one hand while inverting and everting the patient's heel with the other hand.

Variations in the application of forces

- The longitudinal movements of the fibula can be produced with the addition of compression. One hand can be used to apply compression laterally to the head of the fibula while the other hand inverts and everts the patient's heel.
- The longitudinal movements with or without compression can also be performed with the patient in side lying with the foot free of the edge of the couch so that the patient's heel can be inverted and everted readily.
- Longitudinal movement caudad can be *applied locally* to the head of the fibula (see Fig. 8.25B).

Uses

- Stiffness of the fibula in the longitudinal directions principally in relation to inversion and eversion injuries or disorders of the foot and ankle.

Case study 8.1

Anterior knee pain

John D is a 24-year-old student whose hobbies include volleyball, mountain biking, jogging and ski touring.

Kind of disorder

Symptoms in knee area: stabbing pain. Had arthroscopy – nothing special revealed. After a series of treatments in open-chain quadriceps bench, symptoms increased. Has diffculties in walking and running. No sports possible at the time.

Body chart

As illustrated in Figure 8.42.

Activity limitations and 24-hour behaviour of symptoms

□ □ ↑ normal walking, after c. 50 m. Can continue, limps slightly.
↓ 100% immediately when sitting down.
*□ (la) ↑ when sitting with legs bent gets restless after c. 10′ and slightly painful. Needs to move leg continuously.
*Running, jumping, volleyball training not possible because pain becomes too severe. Tried volleyball training 2 weeks ago; symptoms increased for about 2 days.

Past and present history

Present history

In volleyball match c. 4 months ago fell on knee; slight pain in □ which increased over the next few days □ (la). Doctor advised quadriceps strengthening and stretching. Fitness studio (self-supported): pain increased after intense exercises on open-chain quadriceps bench. Orthopaedic surgeon: X-ray, MRI, arthroscopy – nothing revealed, no results. GP: sent to physiotherapy.

Past history

Never had problems with knee, hip or lumbar spine (light backache in middle of spine after longer periods of sitting, never sought help).

Special questions

GH □; no medication; X-ray, MRI normal; arthroscopy (6 weeks ago: normal. Report: cartilage at spot of □ can be dented lightly).

Planning of physical examination

- Moderately severe symptoms: → tests procedures until onset of P_1.
- Symptom mechanisms: nociceptive (stimulus–response related).
- Possible sources of dysfunction: PF joint, TF joint (*may* refer from hip, lumbar spine, neurodynamics).

Physical examination

- Observation: wasting of medial aspect of quadriceps
- PP □
- Functional demonstration: getting up step – taking weight of body on leg (= c. 30° knee flexion) □ (la) ↑
- Knee active movements:
- F, F/Ad, E, E/Ad □,□
- F/Ab, E/Ab: slightly restricted, □IV–
- VMO recruitment in weight-bearing in 20°F (moving from plinth to weight bearing on both legs) □; correction of patella medially: □ slightly ↓

Case study 8.1—cont'd

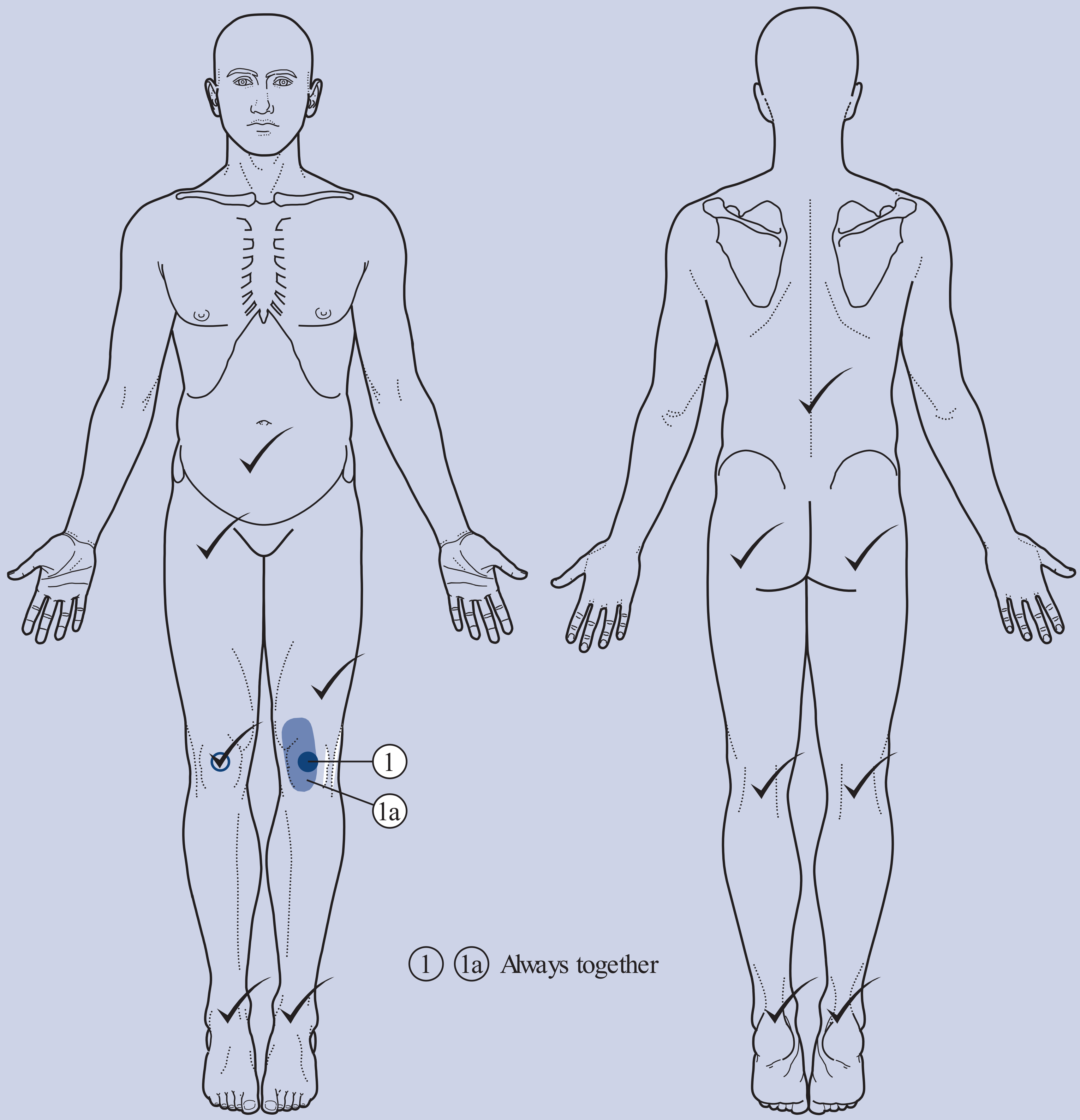


Figure 8.42 • Body chart of John D.

- Accessory movements of TF joint in EOR F as well as in EOR E: all □,□
- PF joint: in c. 15°F (no pain)

Do: P/E accessory movements	PP: ISQ
←•→ caud, ceph, caud/med, ceph/med (Fig. 8.43) —•→ med, med/caud (Fig. 8.43) All other P/F movements □,□	

Decision: Treat P/F signs, short of P_1

D1, Rx1

In supine, 15°F (before P) do P/F ←•→ caud, ceph, caud/med, ceph/med —•→ med, med/caud III–, rhythm smooth, rel. slow speed c. 5′, alternating techniques Assessment while: after c. 3–4′ P_1 later in range, after c. 5′: ISQ	C/O: 'lighter' P/E: Fct. demo □+, *but* can step up ☺ E/Ab □,□ ☺ F/Ab □, □ ↓ ☺ *Warned patient: may increase; should compare walking, night, sitting*

Case study 8.1—cont'd

Plan (D2, Rx2)

- Hypotheses reg. sources: P/F dysfunction confrmed; T/F impairment seems to improve with P/F treatment (hip, Lx, NS: probably not involved, however will need quick screening in next few sessions).
- Procedures P/E:

  Cave: may lose P/E **! Add in squat, getting up from chair

  Screen: hip, screen Lx (both components IF no changes in reassessment; if changes: screen only one component and leave other to Rx3)

  Rx: P/F (probably as in Rx1)

  Self-management: objective – control P:
  - 'stretch' rectus femoris?
  - automobilizations patella?
  - may consider corrective tape to enhance VMO recruitment in weight bearing.

D2, Rx2

- C/O: Felt lighter after Rx1; *walking was possible for a longer range – c. 500 m without pain

  *Sitting: pain intensity ↓ (before c. 7/10, now c. 4/10).

  *Getting up stairs was possible, however became very painful □ ⓛa after c. 6 steps.
- P/E: *PP □

  Fct. demo: getting up step – is possible; □ ⓛa 30–60°F

  *Squat (holds plinth): c. 50°F, □ ⓛa

  *VMO test in 20°F, take weight on both legs: □

  E/Ab □,□

  *F/Ab □, □ little
- Screening hip (Fig. 8.44):

F; in 90° F:MR; in 90° F:LR: all ✓,✓
F/Ad, all ✓, ✓

C/O: PP ✓ (ISQ)
P/E: Fct. Demo, Squat, VMO test } ISQ
F/Ab

Screening Lx:

F, E, Quadrant left, right: all ✓,✓
T10–L5: all ✓,✓

C/O: PP ✓ (ISQ)
P/E: Fct. Demo
Squat, VMO test, F/Ab } ISQ

Rx2a

as Rx1 – grade III c. 5′ (after c. 4′ P_1, R_1 later in range)

C/O: PP 'lighter'
P/E: Fct. Demo (get up stairs)
□ ↓↓30–60°F ☺
Squat □ □ª 50° (intensity ↓) ☺
VMO test □, 20° (intensity ↓) ☺
F/Ab □,□ ☺

Rx2b

Stretching rectus femoris in standing
Hip E 10°, knee F full range
Pulls frontal side
5×, c. 10′

C/O: ISQ
P/E: Fct. Demo (get up stairs)
1 step □,□ ☺
2nd step: P_1 □ ⓛa of thigh
3rd step □ ⓛa++
Squat □ ⓛa 70° (intensity ↓) ☺

- *Info/Instr. at end of session*: should perform RF exercise at least 3–4×/day; each time 1 series/5× rep.; additionally should try exercise 3–5× if □ ⓛa↑

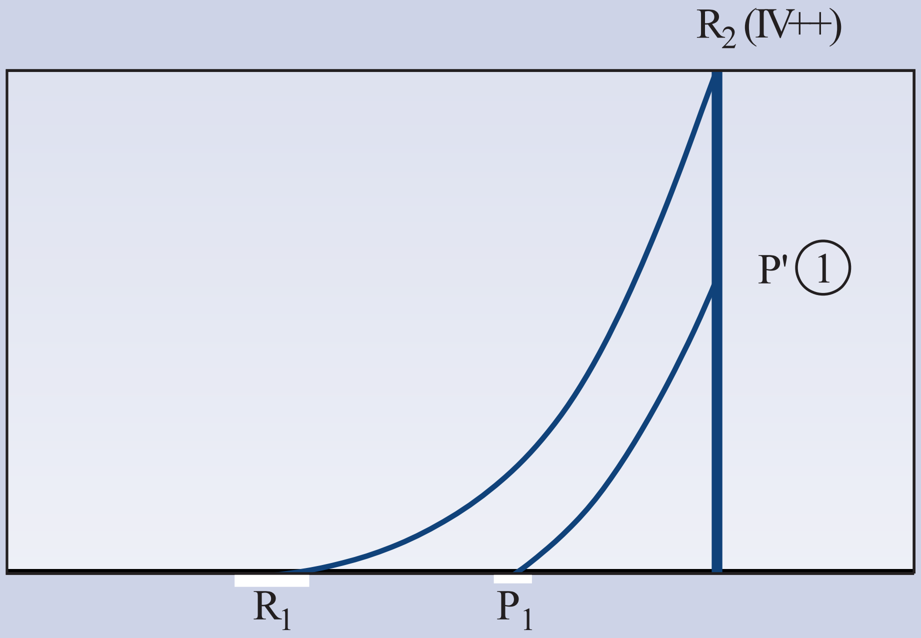


Figure 8.43 • P/E accessory movements.

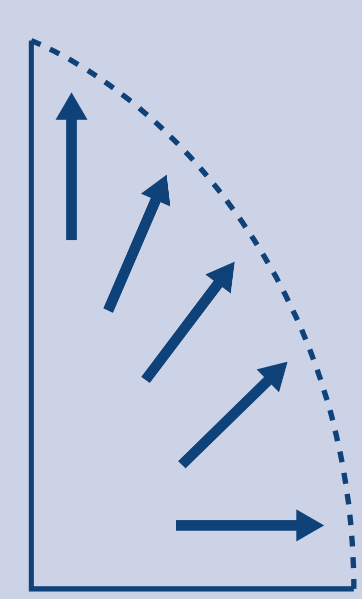


Figure 8.44 • F/Add of hip.

Case study 8.1—cont'd

Plan (Rx3)

- Continue R× of PF joint; passive mobs may progress towards position of 30–40°F
- Check RF exercise
- Further automob. necessary?
- VMO exercise? (maybe with corrective tape?)

D5,Rx3

- C/O: 'Better', 'Walking hardly painful'
  *Getting up stairs: 1 stairway (15 steps) possible without P; 2nd stairway (15 steps) □ increases, but may continue
  *Getting down stairs: □+ after c. 10 steps
  *Squat: seems easier
  Does not run or jump yet
- Effect of RF exercise: did it c. 3×/day; forgot to do it once on stairs P ↑

P/E:	PP □
* Fct. Demo: Stairs up: after 10× P_1 □30–60°F Stairs down: after 5× P_1 □30–60°F *Squat: full range, □ ⓐ 70°F – EOR *VMO in 20°F: takes on weight without pain; after c. 3× P_1 □	

Rx3a

As Rx2a: no symptoms During Rx: progression: In 30°F: do Rx ↔ caud, caud/med; → med; ↔ lat/caud III–, short of P c. 5–6′ After c. 4′ P_1 later in range; after c. 5′ ISQ	C/O: ↑ P/E: Stairs ↓ 20× without pain ☺ Stairs ↓ 10× without pain ☺ Squat: range ISQ, P intensity ↓↓ (5/10) ☺ Jump: small jump possible s P ☺

Rx3b

As Rx3a Progress to 45°F	C/O: ↑ P/E: Stairs ↑ 30× without pain ☺ Stairs ↑ 20× without pain ☺ Squat: range ISQ, P intensity ↓↓ (2/10) ☺ Jump: small jump possible s P ☺

Rx3c

Repetition of RF exercise; 5x/ca 10′ without pain	Jumping seems lighter Squat hardly painful

Rx3d

Automob. PF – large amplitude caudad movements Without pain. c. 2′	Jumping also lighter Squat: pain free

Rx3e

VMO recruitment 5×, then P; did automob. PF: could continue with exercise

After 5× VMO ex. P started again: tried RF ex → P decreased; however felt that PF automob. helped better to influence pain

End of session: info and instr. to patient

- Should perform RF exercise/automob. if ever symptoms
- VMO exercise: series of 5×; if symptoms, perform either RF or PF automobilization; should continue if possible in 3–4 series

Plan (Rx4)

- Continue treatment as in Rx3
- May progress activities to jumping and running. If P increases: perform automob. and/or RF exercise

Rx4: Retrospective assessment

- Patient feels much better: squat hardly painful; getting up stairs: almost 2 stairs up and down without pain. However, if moving quicker, P may start.
- Tried to run for c. 1 km – then symptoms started; forgot to do exercises at moment of increase of pain.
- Overall level of activity has increased, especially normal walking and stairs. However, did not continue running; did not start volleyball training and jumping. Would like to start training ASAP.
- Patient felt that particularly passive mobilizations helped him best. Knows that exercises may control pain in daily life; however, forgets it too often.
- P/E ** remained as after Rx3.

Summary of remaining sessions

- Overall treatment lasted 9 sessions.
- Passive mobilizations were continued as above until session 8; progression towards 60°F; after 6th session compression IV– was added to the passive movement series.
- VMO recruitment exercises continued as started in Rx3.
- Self-management to control pain included RF stretches and light large amplitude automobilizations of patella.

Case study 8.1—cont'd

- Resumed volleyball training after 4th session. However, jumping as in smash training was still painful and patient was not able to jump fully until about the 10th session.
- After 9th session: DLA 100% symptom free; did not feel capable yet to full explosive jumping during volleyball. Stretching and PF automobilizations influenced pain directly and patient integrated these strategies in movement behaviour during warming up and during volleyball training.
- After 9th session: interruption of treatment; reassessment after 2 weeks: patient had continued improving and felt c. 95% back to normal daily life and sports activities.
- Reassessment after another 4 weeks: 100% normal daily life and sports activities. Patient continued with self-management exercises and with VMO training, especially during warming-up of volleyball training (3×/week).

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9

Management of foot and ankle disorders

Jukka Kangas

CHAPTER CONTENTS

Key words

Anatomy and biomechanics, classification, clinical practice framework, examination, interventions, motor control impairment, movement behaviour, movement impairment, therapeutic exercise, passive movement

Introduction

Foot and ankle problems are highly prevalent. Population-based studies indicate that between 18 and 63% of people report pain, aching, or stiffness in their feet (Hill et al. 2008, Menz et al. 2010). Musculoskeletal foot and ankle problems are commonly seen in primary care consisting of 8% of all musculoskeletal consultations (Menz et al. 2010). The role of manual therapy in the intervention of musculoskeletal foot and ankle disorders is well established (Bronfort et al. 2010).

In contemporary manual therapy practice musculoskeletal foot and ankle disorders should be considered in a multifactorial bio-psychosocial framework (Kangas et al. 2011). Therefore, the role of manual therapy extends far beyond manual techniques. Manual therapy practice should be a process involving the evaluation of the disorder and implementing an intervention based on evaluation. This process should consider the physical and the psychosocial dimensions of the disorder.

Anatomy and regions of the foot and ankle

The foot consists of 28 irregularly shaped bones, over 30 joints, 32 muscles and over 100 ligaments. All these structures have to work synchronously to fulfill the high requirements of the foot and ankle. The foot alternates in form and function between a flexible structure for shock-absorption during loading response and a rigid lever for propulsion during terminal stance of the gait cycle. Considerable forces act on the foot and ankle during normal daily activities. For example, a joint contact force for the talocrural joint (TCJ) can range from three to five times the body weight during the stance phase of gait (Kleipool & Blankevoort 2010).

The foot can be divided into different regions based on anatomy, arches of the feet, functional regions and for examination and treatment purposes.

Anatomically the foot can be divided into hindfoot, midfoot, and forefoot (Fig. 9.1). The hindfoot consists of the talus and the calcaneus, the midfoot consists of the navicular, cuboid and cuneiform bones and the forefoot consists of the metatarsals (referred to as *rays)* and phalanges (Hamill et al. 1995). Classically, the arches of the foot have been defined as medial longitudinal, lateral longitudinal and transverse. From a functional perspective, the arches can be divided into medial, central and lateral (Fig. 9.2). The medial arch consists of the talus, calcaneus, navicular, medial cuneiform and the first metatarsal bones. The first metatarsal, medial cuneiform and the navicular bones form the first ray. The central arch consists of the intermediate and lateral cuneiforms and the second and the third metatarsal bones. The lateral arch consists of the calcaneus, cuboid and the fourth and the fifth metatarsal bones. The fifth metatarsal and cuboid bones form the fifth ray.

The bones and arches of the foot

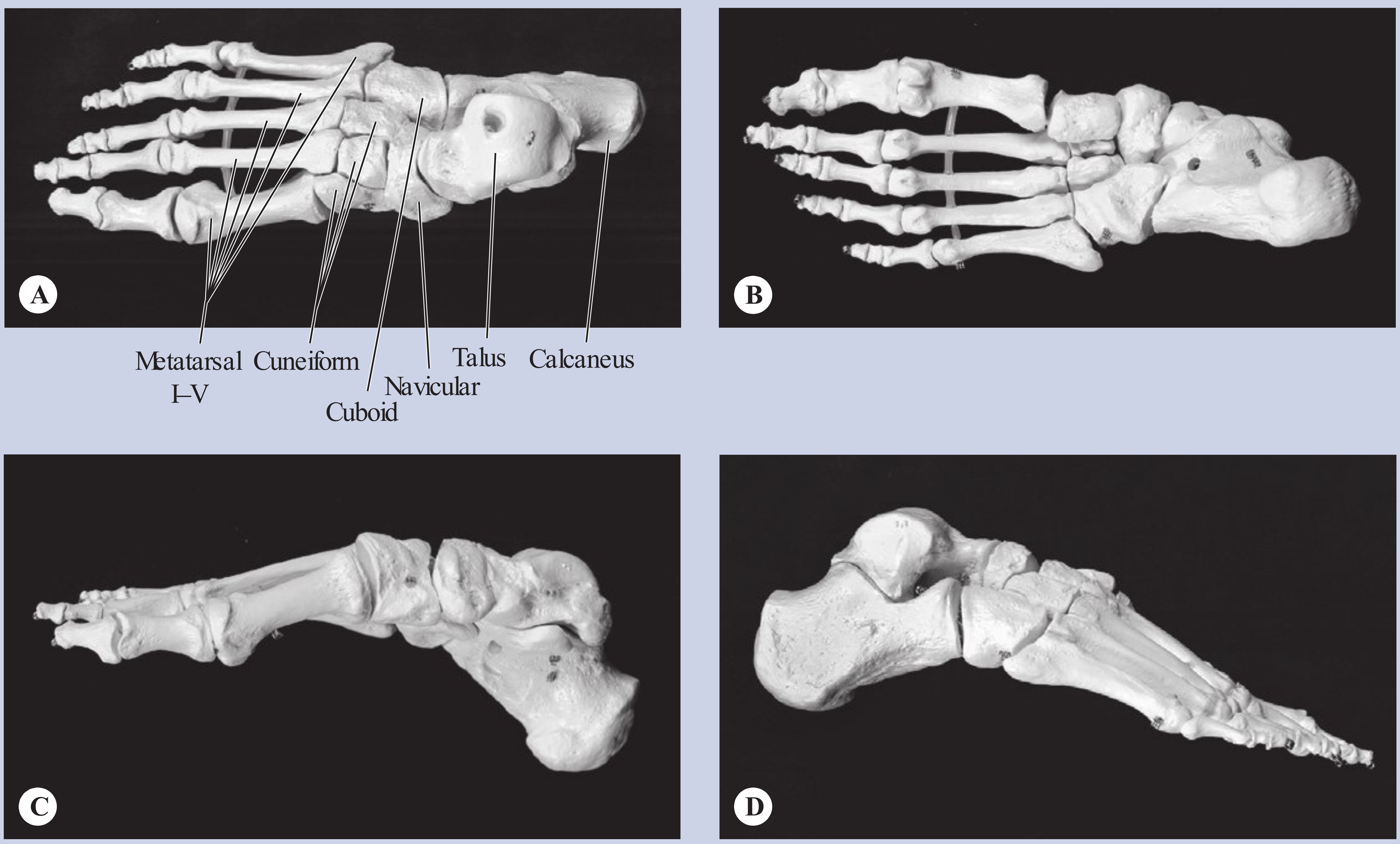

Figure 9.1 • The bones of the foot: A dorsal aspect; B plantar aspect; C lateral aspect with the lateral longitudinal arch; D medial aspect with the medial longitudinal arch.

Figure 9.2 • Medial, central and lateral arches of the foot. The shaded area shows the central arch of the foot.

The medial and lateral arches are more flexible and are actively weight-bearing arches. Whereas, the central arch is more unyielding and passively contributes to the foot and ankle construct.

For manual examination and treatment it is convenient to divide the foot and ankle into the hindfoot and forefoot. The hindfoot consists of the distal tibiofibular joint, talocrural joint (TCJ), subtalar joint (STJ) and surrounding soft tissue structures. The forefoot consists of the midtarsal joint (MTJ), intertarsal joints, tarsometatarsal (TMT) joints, intermetatarsal spaces, metatarsophalangeal (MTP) joints, interphalangeal (IP) joints, and surrounding soft tissue structures.

Movements of the foot and ankle

Optimal function of the foot and ankle is based on the synchronization of the movements of individual joints. Single-joint movements occur in distinctively different directions (Nester et al. 2001, Arndt et al. 2004, Tweed et al. 2008). However, in functional movements of the foot and ankle independent movements of single joints are seldom, if impossible. The actions of the joints are highly inter-related and an action at one single joint will influence the other joints. Moreover, movements are often combined or coupled between the joints. For example, in the ankle one-third of the inversion and eversion occurs in TCJ and two-thirds in STJ (Kleipool & Blankevoort 2010).

Axes and planes of movements

In this text, the terms eversion and inversion (EV and INV, respectively) are used to describe movements around an anteroposterior axis of the foot. These movements take place in the frontal plane. Plantar flexion and dorsiflexion are used to describe movements around a transverse axis of the foot. These movements take place in the sagittal plane. Abduction and adduction are used to describe movements around a vertical axis of the foot. These movements take place in the transverse plane (Arndt et al. 2004). The terms pronation and supination (Pron and Sup) are used to describe the triplanar motions of the subtalar joint (STJ) and midtarsal joint (MTJ). These movements are assumed to occur around an axis of the STJ and MTJ (Nester et al. 2001, Arndt et al. 2004) These definitions are used throughout the text – apart from in the section on techniques. In the section on passive movement techniques, pronation and supination are used to describe the triplanar movement of the whole foot and ankle. The movement of the hindfoot around the vertical axis has been called 'rotation'. This is to make it easier to separate the hindfoot and forefoot movements. Furthermore, the rotations of the hindfoot are so closely related to the rotations of the lower leg, that it is reasonable to maintain the same terminology in clinical practice. In the section on techniques, the movement directions are defined in Figure 9.4.

Movements of the single joints

Distal tibiofibular joint (syndesmosis)

The distal tibiofibular (syndesmosis) joint is formed by two bones and four ligaments. The distal tibia and fibula form the osseous part of the syndesmosis and are linked by the distal anterior tibiofibular ligament, the distal posterior tibiofibular ligament, the transverse ligament and the interosseous ligament (Hermans et al. 2010). The main function of the distal tibiofibular syndesmosis is to provide stability for the ankle (Norkus & Floyd 2001, Hermans et al. 2010). Stability of the distal tibiofibular syndesmosis is necessary for proper functioning of the ankle and lower extremity. Ankle sprain injury may result in widening of the ankle mortise due to increased length of the syndesmotic ligaments (Hermans et al. 2010). This may be felt in passive mobility examination of the distal tibiofibular joint.

During ankle plantar flexion and dorsiflexion, some movement normally occurs at the distal tibiofibular joint. When the foot is moved from a plantar flexed position to a dorsiflexed position, the joint permits approximately 1 to 2 mm of widening at the mortise (Norkus & Floyd 2001). Movement of the fibula occurs at the distal tibiofibular joint. While in the fibular groove of the tibia, the fibula rotates around its vertical axis when the ankle is plantar flexed and dorsiflexed. Lateral fibular rotation is approximately 3° to 5° with dorsiflexion, and medial rotation is 3° to 5° with plantar flexion (Norkus & Floyd 2001).

Talocrural joint

The talocrural joint (TCJ) is formed between the articulation of the distal parts of the tibia and fibula with the talus. The TCJ may be considered to have a single axis of movement. When the TCJ is in a neutral position, the axis of the joint passes through the medial malleolus just below the lateral malleolus. Since the lateral malleolus lies more distally, the axis of the TCJ is angled 20°–30° in the frontal plane. Therefore, the dorsiflexion of the TCJ is coupled with abduction and plantar flexion is coupled with adduction (Hamill et al. 1995). The normal range of motion of the TCJ in dorsiflexion is 20°–30°, and in plantar flexion 40°–50° (Schuenke et al. 2006). However, there are individual variations: a professional ballet dancer would have difficulty managing with only average mobility, whereas another person with different requirements may have below average mobility without any problems.

Subtalar joint

The subtalar joint (STJ) is located between the talus and the calcaneus, and it has three separate articulations. The axis of rotation of the STJ runs obliquely along the line from the plantar posterolateral surface of the talus to the dorsal anteromedial surface of the talus. The movements of the STJ are pronation and supination (Hamill et al. 1995). The normal range of motion of the STJ in pronation is 10°, and in supination 20° (Schuenke et al. 2006).

Movements of the TCJ and STJ are partially combined. The maximal range of motion for inversion–eversion occurs at two-thirds of the level of the STJ and at one-third of the level of the TCJ (Kleipool & Blankevoort 2010).

Midtarsal joint

The midtarsal joint (MTJ) is capable of movement in all three cardinal body planes, either in isolation or in combination (Nester et al. 2001, Tweed et al. 2008). The predominant motion plane of the MTJ varies between subjects; some subjects have a predominance of frontal plane motion, and others have a predominance of transverse plane motion (Nester et al. 2001). In MTJ, eversion and inversion movements can be coupled in a different manner during the stance phase of gait. Between heel strike and forefoot loading, the MTJ can invert, adduct and dorsiflex, but it everts, abducts and plantar flexes after heel-off. This illustrates the complex and variable functional characteristics of the MTJ (Nester et al. 2001). During the stance phase of gait, frontal plane movements of the MTJ occur in the opposite direction of the hindfoot (Tweed et al. 2008).

Rays

The rays are formed in the longitudinal line of the foot. The tarsometatarsal joints are the main articulation of the rays. These joints are gliding planar joints and are numbered one to five (Hamill et al. 1995). The intertarsal joint between the medial cuneiform and navicular bones may be included in the first ray. The axes of the first and fifth rays are oblique. In the first ray dorsiflexion is coupled with inversion and adduction, and conversely, plantar flexion is coupled with eversion and abduction. Whereas, in the fifth ray dorsiflexion is coupled with eversion and abduction, and plantar flexion is coupled with inversion and adduction (Hamill et al. 1995). It is noteworthy, that the first and the fifth rays are the only rays that can be actively supported towards plantar flexion, i.e. on the ground.

The first metatarsophalangeal joint

There are five metatarsophalangeal (MTP) joints. However, the movements of the first MTP joint have a crucial role in the functioning of the foot and ankle. The movements of the first MTP joint are dorsiflexion and plantar flexion. The normal range of motion of the first MTP joint in dorsiflexion is 70°s, and in plantar flexion 45° (Schuenke et al. 2006). During pre-swing of the gait the first MTP joint is dorsiflexed 55° (Perry 1992). The motion of the first MTP joint is coupled with the movements of the first ray. Dorsiflexion of the first MTP joint is diminished as the first ray dorsiflexes (Roukis et al. 1996). This means that the plantar flexion of the first ray is a prerequisite for the dorsiflexion of the first MTP joint in closed kinetic chain. This phenomenon is easy to prove in a clinical setting. Normally in the standing position dorsiflexion of the first MTP joint will result in plantar flexion of the first ray and rising of the longitudinal arch. Whereas if plantar flexion of the first ray does not occur it will limit the dorsiflexion of the first MTP joint.

The dorsiflexion of the MTP joints is related to an important function called the 'windlass' mechanism. This mechanism provides stability of the foot during propulsion and contributes to the efficient transfer of force during propulsion (Herrmann 1995).

Musculoskeletal foot and ankle disorders

Typical medical diagnoses of the foot and ankle

Medical diagnosis aims to identify structural pathology and/or pathophysiological processes responsible for the disorder. Achilles tendinopathy, plantar fasciitis, hallux valgus and chronic ankle instability are typical medical diagnoses of musculoskeletal foot and ankle disorders. However, identifying pathological structures does not explain the mechanism leading to pathology. Plantar fasciitis is used as an example to describe the challenges of making specific structural diagnosis. Chronic ankle instability is used as an example to describe the multifactorial nature of foot and ankle disorders.

Plantar fasciitis

Plantar heel pain is a common disorder which is estimated to affect 10% of the general population at some time during their life (Crawford & Thomson 2003). The exact etiology of plantar fasciitis is unknown in most cases. However, multiple risk factors have been associated with plantar fasciitis, particularly obesity, prolonged weight bearing, and limited ankle dorsiflexion (De Vera Barredo et al. 2007).

Diagnosing plantar heel pain

Plantar fasciitis affects the hindfoot, specifically the insertion of the plantar aponeurosis at the medial calcaneal tubercle (De Vera Barredo et al. 2007). In some cases, pain under the heel is diagnosed as a heel spur syndrome or plantar heel pain syndrome. Heel spur syndrome refers to the existence of plantar calcaneal spur. However, 50–55% of patients with heel pain do not have a calcaneal spur and 15–20% of non-painful heels manifest a spur (Irving et al. 2006, De Vera Barredo et al. 2007). Therefore, the presence of structural pathology (i.e. calcaneal spur) does not correlate necessarily with pain.

Plantar heel pain syndrome is, as indicated by its name, a general definition for the location of pain, but it does not specify the structure of pain origin. Several different structures can be a source of pain under the heel. The plantar surface of the calcaneus serves as an insertion for several structures. Structures connected directly to the medial calcaneal tubercle, lateral calcaneal tubercle or adjacent to these tubercles include: short plantar ligament, long plantar ligament, plantar aponeurosis, m. flexor digitorum brevis (FDB), m. abductor halluces (AbdH), m. quadratus plantae (QP) and m. abductor digiti minimi (AbdDM) (Acland 2010). Therefore, diagnosing plantar heel pain every time as plantar fasciitis is a simplification and can often misdirects the treatment. Identifying the specific source of the pain might be challenging and even in a case where it can be identified it does not explain the mechanism leading to pain. Considering the structures in the heel it is reasonable to argue that very different movement patterns of the foot and ankle may cause overloading and sensitization to one of these structures leading to plantar heel pain. For example, constant flexion of the toes during weight bearing can potentially cause irritation of FDB, QP, and AbdH muscle insertions. Constant loading of the lateral arch during weight bearing can potentially lead to overloading of short and long plantar ligaments and AbdDM muscle. Constant medial loading of the foot during weight bearing collapses the longitudinal arches of the foot potentially leading to overstretching of the plantar aponeurosis. All these loading patterns of the foot may become a mechanism resulting in plantar heel pain. Therefore, identifying the movement patterns of the foot and ankle that can potentially lead to overloading and sensitization of the structures is essential when planning and implementing the intervention. Obviously, all the above mentioned examples require different interventions. In addition to symptomatic structures interventions should target the underlying mechanisms that lead to or maintain the plantar heel pain.

Chronic ankle instability

Ankle ligament injuries are among the most common musculoskeletal injuries (Pijnenburg et al. 2000, Beynnon et al. 2001, Kerkhoffs et al. 2007). Functional treatment has been recommended for the treatment of ankle ligament injuries since the early nineties (Kannus & Renström 1991, Kaikkonen et al. 1996). The elements of functional treatment include: RICE (rest, ice, compression, elevation), protection of the injured ligament, early weight bearing and exercises (Kaikkonen et al. 1996, Konradsen et al. 2002, van Rijn et al. 2010). However, despite functional treatment residual symptoms and disability are very common after inversion sprain (Konradsen et al. 2002, van Rijn et al. 2010). After an acute ankle sprain 10–20% of people develop chronic ankle instability (CAI) (de Vries et al. 2006). Two primary causes for CAI are mechanical ankle instability (MAI) and functional ankle instability (FAI) (Hubbard et al. 2007). MAI is defined as ankle movement beyond the physiological limit of the ankle's range of motion, whereas FAI is defined as the subjective feeling of ankle instability ('giving way') and/or recurrent symptomatic ankle sprains (Tropp 2002). It is noteworthy that MAI means objectively measurable movement of the ankle and FAI is a person's subjective symptoms and disability. MAI and FAI are often seen as dichotomous causes of chronic ankle instability. However, recent research has found relationships between MAI and FAI measures. For example, increased anterior laxity correlated with increased dorsiflexion strength and increased centre-of-pressure excursions (Hubbard et al. 2007).

Chronic ankle instability and mobility of the ankle

Instability as a term refers to increased mobility. By definition, this is true in MAI when the physiological range of movement is tested passively. Objective assessment of mechanical ligamentous laxity is often carried out using the anterior drawer test and talar tilt test (Hubbard et al. 2008). However, increased mechanical laxity in passive movement testing does not correlate with the functional mobility of the ankle. Similarly, in FAI the subjective feeling of instability, i.e. 'giving way', does not mean that functional mobility of the ankle is increased. Based on clinical evidence, patients with CAI often have movement impairments of the ankle. This feature of CAI is often missed. Contrarily to increased mobility, reduced ankle dorsiflexion range is known to predict future lateral ankle sprains (de Noronha et al. 2006), whereas generalized joint hypermobility does not increase risk of injury in the ankle region (Pacey et al. 2010).

Chronic ankle instability and pain

Pain is a common symptom related to ankle instability (Kannus & Renström 1991, Konradsen et al. 2002, de Noronha et al. 2007).

Pain areas vary a lot after initial ankle injury and the pain area may change over time. The different pain areas are often related to the variety of structures that might be involved in inversion sprains, whereas the change of pain area is thought to indicate multi-tissue involvement (Konradsen et al. 2002). The change of pain area over time may also be related to the person's behaviour as caused by the injury. After initial injury people adopt, either consciously or instinctively, movement patterns to avoid pain. These movement patterns can be considered protective, that is, an adaptive mechanism to support healing process. However, if these movement patterns persist beyond normal tissue healing time they may become pain provocative, that is, maladaptive mechanisms, and result in ongoing pain. Depending on the movement pattern the person has adopted, different areas of the foot and ankle are predisposed to abnormal loading. This might be one explanation for the change of pain area over time after an ankle sprain.

Cognitive processes and injury

In acute injury, the escape from a harmful situation and the associated withdrawal behaviour promotes healing. In some individuals immediate withdrawal behaviours do not lead to the anticipated reduction of pain, which may be interpreted as a signal of continuous threat. Negative interpretation may not always reflect the real threat and catastrophic misinterpretations of benign physical sensations may occur. Catastrophic interpretations lead to fear reactions. Pain-related fear is likely to cause a cascade of psychological and physical events including hypervigilance, muscular reactivity, avoidance and guarding behaviours and physical disuse, which in turn are responsible for the persistencee of the pain problem (Vlaeyen & Linton 2002). Pain-related fear of movement, or kinesiophobia, has been shown to contribute to disability in foot and ankle patients (Lentz et al. 2010).

The contribution of physical factors, pain mechanisms and cognitive factors in CAI is individual and it is unlikely that the same functional treatment is beneficial for all patients with CAI. Therefore, identifying the individual group of factors that are maintaining the patient's CAI is crucial to planning and implementing an appropriate intervention.

Chronic musculoskeletal foot and ankle disorders

Many foot and ankle pain disorders do not fit into existing medical diagnosis categories and, in many cases, even where pathoanatomical diagnosis can be made it does not explain the mechanism leading to the disorder. Examples given earlier in this chapter highlight the need to consider the multifactorial nature of musculoskeletal foot and ankle disorders. Chronic musculoskeletal disorders are particularly challenging as specific diagnosis is rarely achieved. The tendency for pain and disability to persist in the absence of obvious, ongoing primary peripheral pathology is challenging (Zusman 2002). Therefore, further classification of chronic foot and ankle disorders is required. A new classification system for chronic musculoskeletal foot and ankle disorders has been proposed (Kangas et al. 2011). This new approach is based on identifying the underlying mechanisms of the disorder. Within a multifactorial bio-psychosocial model, all factors that are maintaining the disorder should be considered. Without the identification of these mechanisms, the optimal intervention for the patient's disorder cannot be determined (Zusman 2002).

Chronic pain disorders may change motor control around the foot and ankle region and appear to result in monotonic movement and loading patterns, with specific parts of the foot and ankle loading unchangingly. Typically, these loading patterns present in a directional manner and are relatively independent of the movement task or activity the patient is performing (Kangas et al. 2011).

Identifying the direction of impairment is the basis for identifying the mechanisms involved in movement and motor control-related disorders of the foot and ankle region and for planning and implementing a specific intervention (Kangas et al. 2011).

Maladaptive motor control and movement impairments are considered underlying mechanisms for chronic foot and ankle disorders. Within these impairments, faulty movement patterns and coping strategies result in chronic abnormal tissue loading, pain, disability and distress. Different underlying pain mechanisms of motor control and movement impairments require further subclassification. These impairments can present with or without pathoanatomical findings (O'Sullivan 2005).

In motor control impairments, lack of motor control results in monotonic loading patterns and pain in the foot and ankle. In movement impairments, movement is lost in the direction of pain provocation. In patients with motor control and/or movement impairments, the patient's maladaptive movement behaviour is the underlying mechanism for the pain. An analysis of all potential factors affecting this movement behaviour should be based on a comprehensive subjective and physical examination and should aim to identify the underlying mechanisms maintaining the chronic foot and ankle disorders. Identifying this underlying mechanism also demands the integration of the proposed classification approach for foot and ankle disorders within a clinical reasoning process (Kangas et al. 2011).

Psychosocial factors of pain and disability

The inclusion of psychosocial factors in the conceptual framework of pain theory helps to explain the limited association between organic pathology and pain severity (Turk & Wilson 2010).

Avoidance behaviour may be reinforcing in the short term through the reduction of distress associated with noxious stimulation. If allowed to persist, it may become a maladaptive response leading to increased fear, limitation of activity, and other physical and psychological consequences that contribute to disability and persistence of pain (Turk & Wilson 2010).

Catastrophic interpretations such as the belief that the presence of, or onset of, pain indicates pathology and therefore harm, are thought to contribute to the development of pain-related fear (Turk & Wilson 2010).

A theoretical approach to the development of chronic pain and disability is the fear–avoidance model. This model is an attempt to highlight the importance of cognitive and behavioural factors in a chain of events linking the experience of pain to disability. The model stresses the role of catastrophic thinking following the pain experience and the consequent fear and hyper-vigilance. Avoidance behaviour features prominently, largely fuelled by the fear that activity will cause harm and will worsen the pain problem (Boersma & Linton 2006).

Fear–avoidance beliefs, catastrophizing, and depression have been identified as important psychological variables in the development of a pain problem (Boersma & Linton 2006).

The relationship between pain, catastrophizing, depression, fear–avoidance beliefs and function at the individual level is an integrated, interacting, and complex process (Boersma & Linton 2006).

Psychological variables might operate differently for different people. Therefore, to understand these processes within individuals, there has been a need to identify distinctive patterns of psychological factors (Boersma & Linton 2006). A study by Boersma & Linton (2006) shows that distinct profiles of psychological functioning can be extracted and that these profiles are related to development of disability. Fear–avoidance, beliefs and catastrophizing were strongly related. These factors can be, but are not necessarily, accompanied with signs of depression. People in the subgroups 'pain-related fear', 'pain-related fear + depressed mood', and 'depressed mood' reported substantially more functional difficulties and pain and sick leave compared to 'medium pain-related fear' and 'low risk' subgroups.

Psychosocial factors and neurophysiological pain mechanisms

Pain processing is regulated by different mechanisms that modulate noxious information at the spinal level. This modulation is based on endogenous descending inhibitory and facilitatory pathways that reach the dorsal horn (Weissman-Fogel et al. 2008). It has been proved that these inhibitory pathways are negatively influenced by catastrophizing (Weissman-Fogel et al. 2008).

Growing evidence is showing that psychological processes have biological effects. For example, cognitive and affective processes within the construct of catastrophizing have been shown to exert an effect on the neuromuscular, cardiovascular, immune and neuroendocrine systems, and the activity in the pain neuromatrix within the brain (Campbell & Edwards 2009). Studies have shown that higher levels of pain catastrophizing correlate with a lower pain threshold, lower pain tolerance, higher pain intensity and greater pain temporal summation (Weissman-Fogel et al. 2008).

Psychosocial factors and musculoskeletal foot and ankle disorders

Pain-related fear of movement has been identified as a strong contributor to disability in the foot and ankle (Lentz et al. 2010).

The treatment generally consists of concurrent patient education and encouragement to perform part of an activity of which they are fearful or an activity that is related to this specific fear. For example, a patient with ankle pain who will not attempt hopping for a distance because of fear of pain in the ankle might be encouraged to begin bouncing on a trampoline or to perform active plantar flexion while in one-leg stance. Once the patient indicates that the fear is reduced, the complexity and difficulty of the task can be progressed in a systematic fashion.

The risk factors and consequences of traumatic and non-traumatic lower limb pain are not the same. Traumatic lower limb pain is associated with practising vigorous exercise and a high level of physical fitness, while non-traumatic pain is correlated more with psychosomatic symptoms (El-Metwally et al. 2006).

Greater numbers of depressive symptoms have been found to associate with greater impairment in lower extremity functioning (McDermott et al. 2003).

Lifestyle factors and musculoskeletal foot and ankle disorders

Lifestyle factors, such as obesity, have been related to foot and ankle pain disorders (Irving et al. 2006, Gaida et al. 2010). There is evidence of an association between increased body mass index and chronic plantar heel pain (Irving et al. 2006). Achilles tendon pathology is associated with central fat distribution among men and with peripheral fat distribution among women (Gaida et al. 2010).

Work-related factors and musculoskeletal foot and ankle disorders

Jobs that necessitate prolonged standing and walking activities are commonly associated with worker's complaints of foot and ankle pain. The foot and ankle area has been identified as the most frequently affected body region among salespersons in department stores (Pensri et al. 2010). Prolonged standing is associated with foot and ankle symptoms among salespersons (Pensri et al. 2010). Furthermore, prolonged standing has been associated with the occurrence of chronic plantar heel pain (Irving et al. 2006). Increased time spent walking is associated with foot and ankle disorders among assembly plant workers (Werner et al. 2010).

Subjective examination

In the assessment of the foot and ankle disorders the physiotherapist needs to consider the multifactorial nature of the musculoskeletal disorders. Subjective examination forms a basis for the clinical reasoning process. Therefore, thorough subjective examination is required to consider all dimensions of the disorder.

The aim of the subjective examination is to gather information about the patient's disorder from the patient's perspective. Therefore, the communication style should reflect empathy, respect and understanding to create a confident atmosphere for the patient. A therapeutic relationship with the patient can be formed through mindful interviewing.

The patient's story may reflect that psychosocial factors are contributing to their foot and ankle disorder. The role of these factors is individual. Therefore, it is reasonable to use standardized questionnaires to screen these factors. For example, the Örebro musculoskeletal pain questionnaire (ÖMPQ) can be used for screening for 'yellow flags'. The Tampa scale of kinesiophobia (TSK) has been used to determine the influence of pain-related fear of movement on foot and ankle disability (Lentz et al. 2010).

The subjective examination can be carried out in a structured manner or more informally. When the subjective examination is carried out in a structured manner it helps the physiotherapist to gather the most relevant information concerning the patient's symptoms. A structured interview is suitable for obvious problems such as acute ankle sprain. Furthermore, some patients may find it easier to talk about their disorder when questioning is well organized. However, if the interview is too strictly organized a lot of information might be lost.

Therefore, the more informal interview has some advantages and it is more suitable, for example, in chronic foot and ankle disorders. It gives freedom to patient to explain their problem and how they experience it. The way patients describe their problem is often very informative because it includes information of factors influencing a patient's pain and movement behaviour. For example, a patient might experience that the symptom itself is not the main problem, but the disability resulting from the symptom is the most disturbing problem. This disability might be maintained with maladaptive thoughts and beliefs. The challenge of an informal interview is to gather the relevant information that the patient possesses, but does not spontaneously reveal. This information can be obtained with reflective and follow-up questioning. The informal interview is best conducted by an experienced physiotherapist and it is not always suitable. As authorities, we have to be aware that our questioning is sometimes directing the patient's attention and providing a structure for the patient to make observations about the problem. Therefore, our questioning should not reinforce the problem, but should be aiming towards recovery from the very beginning. The interview is the beginning of the management.

The following description of the subjective examination of the foot and ankle patient is in a structured format. Clinically, the same information can be gathered in any order. It is the physiotherapist's responsibility to find the most confident way of accomplishing the patient's interview.

Kind of disorder

The first question aims to establish what the patient's main problem is. In other words, what brings the patient to physiotherapy and what is the patient seeking from physiotherapy? The answer to the first question is recorded in the patient's own words on the body chart.

Information from 'Question 1' aids in the establishment of the kind of disorder. Many patients with musculoskeletal foot and ankle disorders will present with pain as the main problem. Other typical symptoms are stiffness, ankle sprains and 'giving way'. However, it is noteworthy that some patients do not experience the symptom as a main problem, but disability, i.e. loss of function resulting in activity limitation. We should not assume that a symptom is the disability or that a symptom alone is causing the disability.

Hypotheses generation begins from the answer to 'Question 1'. For example, a patient may reply to the first question: 'I twisted my left ankle two weeks ago and it's still swollen and painful when I walk'. This information immediately reveals the symptom area and possible local structural source of the symptoms. The answer includes information about the activity that provokes the symptoms. Early hypotheses of the pain mechanisms can be generated from this information. Furthermore, walking is the activity that is affected. The answer is also providing the first information about the injury mechanism and a stage of tissue healing. The physiotherapist may even generate an early hypothesis for treatment and a prognosis based on the answer to 'Question 1'.

Four different clinical profiles are presented in this chapter. The first clinical profile is typical of a somatic source of symptoms. Somatic symptoms arise from a bone, ligament, joint or muscle. The second clinical profile is more related to chronic, local symptoms where the patient's maladaptive behaviour maintains the disorder. In the third clinical profile typical features of radicular pain and neuropathy are represented. The fourth clinical profile represents foot and ankle disorder with central sensitization.

Symptom area(s)

The main question under symptom area is: where are the symptoms? In addition to location of the symptom(s), each symptom area is further defined according to quality, frequency and depth of the symptom(s).

Detailed topographical anatomy knowledge is required to align local symptoms with recognizable structures in the foot and ankle region. In the case of local foot and ankle symptom(s) where a patient can easily pinpoint the area, and describe the type of pain, a specific structural source may be hypothesized. Superficial pain is often related to soft tissue or neural structures, whereas deep pain is often related to articular structures. Symptoms that are consistently related to mechanical stimulus with the sensation most likely linked to stimulus intensity, indicate peripheral nociceptive pain. These local symptoms may be associated with stiffness. The presentation of stiffness is consistently related to movement direction(s) and it can be associated with or without pain.

In some cases local foot and ankle symptom(s) do not correspond with the course of any single anatomical structure and a patient may have difficulty in defining the symptom area exactly. Pain may be associated with other symptoms like a feeling of loss of control or stiffness. Furthermore, the patient may describe symptoms with other than physical qualities, for example, frustration, fear and anxiety. Symptoms are often related to loading of the foot and ankle, but the relationship between stimulus intensity and sensation may be inconsistent. Stiffness is related to pain or anticipation of pain. These local symptoms may indicate peripherally mediated pain associated with factors other than physical factorsrelated to central pain mechanisms.

Foot and ankle symptom(s) may originate from remote structures. A good knowledge of neuroanatomy is needed to differentiate between typical innervation areas of the nerves supplying thefoot and ankle region and somatic structures. For example, the pain around the medial forefoot may arise from the first MTP joint, constant loading of that region without specific structural findings or the L5 nerve root.

However, the neurogenic symptoms vary greatly depending on the local structure involved and the disorder. The symptoms differ depending on the pathophysiology related to the nerves. Radiculopathy, conduction block of the spinal nerve or its root, results in numbness or weakness. Radiculopathy alone does not cause pain. In radicular pain that arises as a result of irritation of the spinal nerve or its roots, pain is shooting and band-like. Radicular pain may occur with or without radiculopathy (Bogduk 1997). In a neuropathy, symptoms related to sensory innervation include sensory loss, dysaesthesia and/or paraesthesia. Dysaesthesia includes symptoms like burning, pricking, tingling, cramping and throbbing. The most typical presentation of paraestheasia is spontaneous tingling that is often described as pins and needles. It is important to realize that numbness and increased sensitivity may be at the same site. The neuropathic process involving motor nerves will result in muscle wasting and weakness (Bennett 2006). Foot and ankle symptoms relating to radicular pain or neuropathy are often spontaneous and/or variable, but independent from foot and ankle loading.

Sometimes a patient presents with widespread pain at the foot and ankle. The patient might describe the main symptom area as migrating and the type of pain as vague, worrying and severe. Pain is constant and variable, but loading makes it worse and most activities increase the symptoms. Pain may be associated with psychosocial factors relating to fear, catastrophizing and depression. These symptoms may indicate a dominant central pain mechanism.

Behaviour of the symptom(s)

The main question in behaviour of the symptom is: what makes the symptoms worse and/or better?

In the case of local foot and ankle symptom(s) with nociceptive pain, symptoms are provoked with activities involving foot and ankle loading and movements. Typical activities are standing, walking, running and jumping. Often pain is closely related to certain activities and the intensity of pain correlates with the amount of mechanical stress and vice versa – pain is often diminished by avoiding the particular activity. Among athletes and dancers foot and ankle pain may be provoked only during strenuous foot and ankle movements or during the great number of repetitions required in sports and dance. However, it is important to realize that mimicking movement patterns may be repeated during normal daily activities. In the acute stage of inflammation pain may be easily provoked, and it may linger after provocation.

In the case of local foot and ankle symptoms with peripherally mediated pain and associated psychosocial factors, symptoms are still provoked with activities of foot and ankle loading and movements. However, the intensity of pain does not necessarily correlate with the amount of mechanical stress. A patient may describe many activities with unequal mechanical stress that provoke the same pain. Analysing the activities the patient is describing may reveal that they all include the same movement direction of the foot and ankle. For example, the patient may say that walking down the stairs, the propulsion phase of walking and squatting are provoking the same pain. All these activities include dorsiflexion of the ankle and this may be the connecting movement component. Furthermore, the patient may discover that avoiding provoking activities does not resolve the disorder. This is often because of the difficulty in recognizing pain triggers or the impossibility of avoiding provoking the movement component during normal daily activities.

In radicular and neuropathic foot and ankle pain symptoms are inconsistently related to foot and ankle loading and movements apart from muscle weakness. Instead, radicular foot and ankle pain is often related to impairments and loading of the low back. In foot and ankle neuropathies symptoms are often spontaneous or the responses to movement stimulation are abnormal. In the 24-hour behaviour of symptoms, patients often complain of night pain. Changing positions or gentle moving like slow walking may diminish the symptoms.

In the case of widespread foot and ankle symptoms and dominant central sensitization, pain may be related to foot and ankle loading and movements, but the stimulus–response relationship is distorted. Response to different stimuli is unpredictable and inconsistent. Similarly, something that diminishes symptoms today may not ease them off tomorrow.

Behaviour of the patient according to the disorder

The main question in this phase of the subjective examination is: how does the patient manage with the problem? The aim of this question is to establish the patient's coping strategies according to the disorder. This question is open and directs the attention to psychological effects of the disorder instead of concentrating only on the symptoms.

The patient may have a belief that pain always indicates pathology and therefore harm. This will often lead to avoidance of activities that provoke or that the patient expects to provoke the symptoms. Note, in particular, if the patient is describing activities which provoke the symptoms and if they is avoiding these activities. This may reflect catastrophic thinking and avoidance behaviour and result in disability and impaired physical performance.

History of the symptoms

The main questions at this stageare: when and how did the symptoms start?

In the case of local somatic foot and ankle symptoms with nociceptive pain, the onset of symptoms is often identifiable. The onset may be related to trauma or an event. In cases of trauma, the progression of symptoms is compared with expected tissue healing time. Multiple symptom areas within the same foot may indicate involvement of more than one structure. For example, after an inversion sprain a variety of structures might be injured.

Recognizable events are often related to so called 'use categories'. 'Use categories' include: over-, mis-, dis-, ab-, new- and non-use. Patients are not always aware of these events and the beginning of the symptoms. Therefore, it is sometimes useful to ask: did you do something unusual when the symptoms started? Among athletes and dancers changes in training and choreography and training environment may play a crucial role in the onset of symptoms.

In the case of local foot and ankle symptoms with peripherally mediated pain and associated psychosocial factors, symptoms persist over the expected tissue healing time or without identified structural pathology. Typically, symptoms start either gradually without an identified event, or after a trauma, but the symptoms and disability do not correlate with the mechanism of injury. Sometimes a patient may recall an old, mild injury after which the foot and ankle has not been symptom free. The main line of thought here is that the relationship between present symptoms and disability cannot be explained by any single factor in the past.

The onset of radicular foot and ankle pain is often associated with the onset of low back pain and related movement impairment. The most common cause of radicular pain is disc herniation (Bogduk 1997). Therefore, the progression of radicular foot and ankle pain often follows the course of low back pathology and associated symptoms.

The history of neuropathic foot and ankle pain is variable. Neuropathic pain can become apparent immediately following injury or be delayed for months or years. Sometimes neuropathic pain is triggered by a second injury at the same area.

Widespread foot and ankle symptoms with dominant central sensitization may develop after a trauma, surgery, immobilization or prolonged over-use.

History of the patient's behaviour according to the disorder

The main question at this stage of the subjective examination is: how has the patient managed with the problem since it started? With this question the therapist aims to identify the strategies the patient has used to cope since the beginning of the disorder. This stage should particularly focus on the psychological process involved in pain perception and behaviour and the attention and attributes the patient gives to noxious stimuli, coping strategies and behaviour (Linton 2002). This information is crucial to understanding the patient's behaviour according to the disorder and for determining if the patient's coping strategies will promote healing and recovery or reinforce the disorder.

Medical screening questions

These questions are for the screening of possible precautions and contraindications relating to physical examination and treatment. Questions concerning the patient's general health, medication, diagnosed diseases and medical screenings should be asked routinely. With the foot and ankle ankle region particular care should be taken, for example, with diabetic patients. Sensorimotor neuropathy and vascular insufficiency may predispose to infections in the diabetic foot (Powlson & Coll 2010).

Planning the physical examination

Planning the physical examination is a critical part of the clinical reasoning process. It is crucial for novice physiotherapists to plan the phases of of the physical examination; however, it is also important for experienced physiotherapists to do this, especially in cases where information from the subjective examination indicates a complex foot and ankle disorder. One phase of planning of the physical examination is expressing hypotheses in different categories. Information within these categories is changing through research. Therefore, it is important for all physiotherapists to update the planning process from time to time. This enables the application of new knowledge into the clinical reasoning process.

Planning the physical examination includes three phases: reflection on the subjective examination, expressing hypotheses and planning physical examination procedures.

Reflection on the subjective examination

In ref ection on the subjective examination the physiotherapist verifies that the subjective examination provides sufficient information to direct the physical examination and the extent of examination. Furthermore, the main findings have to be measurable for reassessment in subsequent sessions.

Expressing hypotheses categories

Expressing hypotheses categories explicitly helps the physiotherapist to identify all the relevant factors related to the disorder. This helps the physiotherapist to direct the physical examination. In the foot and ankle region several hypotheses categories are required to direct the physical examination and the subsequent intervention. Each category has consequences for the examination process and treatment. These hypotheses categories are:

1. Nature of the disorder
2. Source of the symptoms
3. Neurophysiological pain mechanisms
4. Direction of the impairment
5. Contributing factors
6. Intervention
7. Precautions and contraindications
8. Prognosis.

Nature of the disorder

The nature of the musculoskeletal foot and ankle disorder is multifactorial. The term disorder contains the physical and psychosocial factors related to disorder and their effects (Elvey & O'Sullivan 2004). For example, inversion sprain of the ankle may result in the rupture of the anterior talofibular ligament (ATFL). This represents the pathology of the disorder. The physical effect of this is that the patient cannot do plantar flexion of the ankle because of the pain. Injury and resulting pain is always accompanied by psychosocial factors. Pain is psychologically processed and it will influence the patient's behaviour. These effects are considered as psychological effects. Impairments of movement are consequences of physical and psychosocial factors related to the disorder. For an impairment of movement to be relevant it has to be in the context of the nature of the disorder.

Source of the symptoms

In musculoskeletal foot and ankle disorders local sources of the symptoms and impairments include somatic structures, i.e. a bone, a joint and a muscle. Peripheral nerves in the foot and ankle region can also be included in this subcategory. The lumbar spine is the most typical remote source causing radicular symptoms in the foot and ankle region. However, in many cases a specific source of the foot and ankle symptoms cannot be identified. Then the source of the symptoms is 'non-specific'. This does not mean that the impairment or disorder is 'non-specific'.

Neurophysiological pain mechanisms

Pain mechanisms can be divided into peripheral and central mechanisms. This separation is somehow artificial, because different pain mechanisms are always overlapping. However, in a clinical situation it is convenient to think about the mechanism that is dominating in the patient's disorder.

The peripheral pain mechanism can be further divided into the nociceptive pain mechanism and the peripheral neurogenic pain mechanism. These mechanisms are both related to pain states where the source of the symptom and/or pathophysiological processes can be identified. The third peripheral mechanism is peripherally mediated pain where the specific source of the symptoms is not always identified. Disorders with peripherally mediated pain are often associated with psychosocial factors.

The central pain mechanism can be further divided into two central subcategories. In the first subcategory psychosocial factors play a dominant role and a psychiatric disease can be diagnosed. In the other subcategory psychosocial factors do not play a dominant role, but the central nervous system is physiologically sensitized.

All these pain mechanisms require a different approach in the examination and treatment of the disorder. Pain mechanisms are explained in detail in Jones (2014), Blake & Beames (2014).

Direction of the impairment

This hypotheses category aims to clearly define the direction of impaired movement in the disorder. For an impairment of movement to be relevant it should present in the direction of the pain. Movement may be lost or movement or loading increased in a specific direction. The direction of the impairment may be related to physical or psychological effects of the disorder. For example, after an acute inversion sprain the direction of the impairment correlates with structural pathology related to injury, whereas, in more chronic disorders the direction of the impairment is related to loading patterns of the foot and ankle. Both motor control and movement impairments of the foot and ankle present in a directional manner (Kangas et al. 2011).

Contributing factors

Contributing factors of the disorder include biomechanical factors (e.g. structural malalignment of the forefoot), lifestyle factors (e.g. obesity), social factors (e.g. work community) and environmental factors (e.g. training shoes and/or terrain).

Intervention

Intervention is a term used to embrace manual therapy procedures of treatment and strategies of management. Treatment is regarded as specific intervention performed by the clinician. Management is intervention performed by the patient under the direction or by the prescription of the clinician (Elvey & O'Sullivan 2004). Within this hypotheses category, hypotheses are generated relating to the need for treatment procedures and management strategies. For example, in motor control impairments of the foot and ankle, management strategies (i.e. exercise intervention) is the primary approach, whereas with movement impairments restoring normal physiological range of movement of the foot and ankle often requires specific treatment (i.e. mobilization or manipulation) before exercise intervention is initiated.

Precautions and contraindications

Within this hypotheses category, hypotheses are generated in two directions. The first direction considers the possible need for cautious examination and/or a need for immediate referral to medical care in thecase of serious pathology, i.e. a 'Red Flag'. The second direction considers the indication for manual therapy intervention and whether a manual therapy intervention has the ability to favourably influence a disorder towards recovery (Elvey & O'Sullivan 2004). For example, in tibialis posterior tendon insufficiency therapeutic exercise may be helpful if the tendon is not ruptured, but in the case of tendon rupture surgery is warranted.

Prognosis

The prognosis can be thought of as a summary of the previous categories. In each hypotheses category the features that are favourable or not favourable to recovery are compared and contrasted. Obviously, the patient with more features favourable to recovery will have a better prognosis. For example, acute trauma with identified pathology and adaptive response of the patient without contributing factors are features that are favourable to recovery.

Planning physical examination procedures

After expressing hypotheses the physical examination procedure is planned. The physical examination has to consider all dimensions related to the disorder. The physical examination aims to prove or disprove the working hypotheses.

Physical examination

After the subjective examination and the planning of the physical examination the physiotherapist has hypotheses of the various factors related to the disorder. Physical examination of the foot and ankle should be performed in the context of the disorder. During the physical examination the physiotherapist should confirm the generated hypotheses. Furthermore, the physical examination provides information about the physical factors related to the disorder, the behaviour of the symptoms during the examination and the patient's pain and movement behaviour.

The physical examination of the foot and ankle can be divided into phases. These phases are represented in Table 9.1 (Kangas et al. 2011). Each phase of the examination serves a purpose in completing a profile of the patient's foot and ankle disorder.

Observation in non-weight bearing

The physical examination begins with general observation of the foot and ankle. Any signs of injury, inflammation, colour changes of the skin or atrophy/hypertrophy of the muscles are noted. After that, observation of the foot and ankle continues in two different conditions: in non-weight bearing (n-WB) and weight bearing (WB). Observation in n-WB is carried out with the foot and ankle in standard position. The STJ neutral position provides a clinically useful method for mid-positioning of the foot and ankle (Elveru et al. 1988). From this position, the structural morphology of the foot and ankle is examined. Structural malalignments of the foot are measured. For example, malalignments of the forefoot are typical findings and they may be important contributing factors for the pain disorder. Furthermore, changes like asymmetric wearing of the calcaneal fat pad and thickened plantar skin may reflect the loading pattern of the foot and ankle. Palpation of fi

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the plantar surface of the foot may reveal increased sensitivity and reflect the direction of the loading pattern.

Observation in weight bearing

The second phase of the observation is is carried out in WB (Fig. 9.3).

This phase of the examination reflects how the foot and ankle is orientated under WB. This does not necessarily correlate with n-WB position. For example, a patient with a flexible flat foot will have a normal arch under n-WB conditions, but a substantial loss of arch height under WB conditions (Young et al. 2005). Furthermore, structural malalignments of the foot are compensated in WB conditions, but compensatory mechanisms are variable. It is crucial to identify the individual compensatory mechanisms in order to understand the contribution of malalignment to the patient's disorder. The WB position is always compared to the n-WB position. This will reveal whether the WB position of the foot and ankle is influenced by the changes in structural morphology or whether it is related to functional factors and will directly influence the planning and implementing of the intervention. The patient with unusual structural changes may require foot orthoses, whereas the patient with a more functional disorder will benefit from the therapeutic exercise as a primary intervention. Furthermore, the contact areas of the foot provide information about the WB structures and indicate the direction of foot and ankle loading. However, it is crucial to understand that the structural position of the foot and ankle does not correlate directly with the function of the foot and ankle (Kaufman et al. 1999).

Figure 9.3 • Patient in standing position on a podogram.

Functional tests

The next phase of the examination is functional tests. These tests are simple functional movements or activities that will reflect the function of the foot and ankle during movements, the behaviour of the symptoms and the patient's pain and movement behaviour during tested movements. This will provide relevant information concerning the physical and psychological factors related to the disorder and their effects.

One special functional test is functional demonstration. The functional demonstration is a movement that the patient experiences relevant to the disorder. It may be a movement that reproduces the patient's symptoms and patient experiences as 'abnormal' or somehow difficult or challenging. The functional demonstration is often very informative, because it reflects the patient's individual experience of the movement disorder. If the functional demonstration is reproducing the patient's symptoms the test may be used for differentiation between musculoskeletal structures to establish the source of the symptoms. The functional demonstration may be used to identify the functional impairment and the specific direction of the impairment. Furthermore, functional demonstration will direct the intervention. Functional demonstration may be the most relevant movement and/or activity for the patient to normalize. This may mean that part of the intervention is carried out in functional demonstration conditions.

The routine of functional tests begins with one-leg standing. In standing on one leg, the position and loading direction of the foot and ankle, contact areas of the foot, the patient's ability to control the balance and their response to the situation are observed.

During squatting, the ankle range of motion, quality of movement and symptom response to ankle dorsiflexion are examined. Furthermore, the contact areas of the foot and loading direction of the foot and ankle during movement are observed. The same parameters are examined and observed during rising on the forefoot. During movements the patient's pain and movement behaviour are observed. Avoidance of movement may indicate movement impairment. Unawareness of the loading pattern may indicate motor control impairment. Repeating the same tests on one leg will often exaggerate existing impairments and behaviours.

If a directional pattern of functional impairment is emerging other tests may be used to assess the consistency of the movement behaviour. For example, jumping and landing, walking up and down the stairs, walking backwards and sport- or dance-specific movements may be used as functional tests. Furthermore, the patient's ability to activate the forefoot independently, control the neutral position of the hindfoot and dissociate forefoot and hindfoot control may be used to assess the patient's ability to control movement of the foot and ankle.

Observation of gait

Observation of the gait provides one special feature for the physical examination of the foot and ankle. This feature is the timing relationship of the movements during the gait cycle (Perry 1992). This knowledge may be used to observe the patient's movement behaviour and confirm the findings from functional tests. For example, a patient with a lateral loading pattern of the foot will be missing normal pronation during loading response and contact of the medial forefoot during terminal stance and preswing.

In another example, a patient with movement impairment of the ankle in dorsiflexion will have difficulties during late mid-stance and early terminal stance. The compensations for the missing dorsiflexion are most likely to be seen during these phases of the cycle.

Active movements

The next phase of the examination is active movements of the foot and ankle. In this phase active movements are examined either in supine or prone lying. In supine lying active movements may be used for isometric muscle tests and tendon tests. These tests may provide information concerning the source of the symptoms and the effects of the disorder. Furthermore, active movements may be used to examine the patient's ability to dissociate movements between hindfoot and forefoot and between forefoot and toes. This may confirm the hypotheses concerning the direction of the impairment. In prone lying active movements may be used to examine the active range of motion, quality of active movement and symptom response to active movement. The patient's pain and movement behaviour are observed during active movements. This precedes passive movement testing.

Passive movements

Passive movement testing of the foot and ankle is performed in a sequential manner. This sequence is presented in Figure 9.4. Passive movement testing may be used for provocation testing of the foot and ankle joints. Furthermore, passive movement testing aims to identify movement impairments and the direction of the impairment. It may provide further information of the mechanisms underlying the impairment.

Provocation tests

The last phase of physical examination contains provocation tests for other structures in the foot and ankle region, screening tests for other body regions and neurological and vascular screening tests. Other musculoskeletal structures are, for example, neural tissue. The examination of neural tissue is explained in detail in other sources (Butler 2000). Screening tests for other body regions may include the knee, hip, lumbar spine and thoracic spine. Neurological screening is warranted if the patient has any signs indicating changes in the conduction property of the nerves. Vascular screening tests should be performed routinely with diabetic patients.

Treatment techniques

Examination of passive foot and ankle movements follows the sequence presented in Figure 9.4. In the examination sequence movements begin from the physiological movements of the whole foot and ankle. After that physiological movements are carried out separately for the forefoot or hindfoot. Forefoot and hindfoot movements are further divided into single-joint movements with accessory

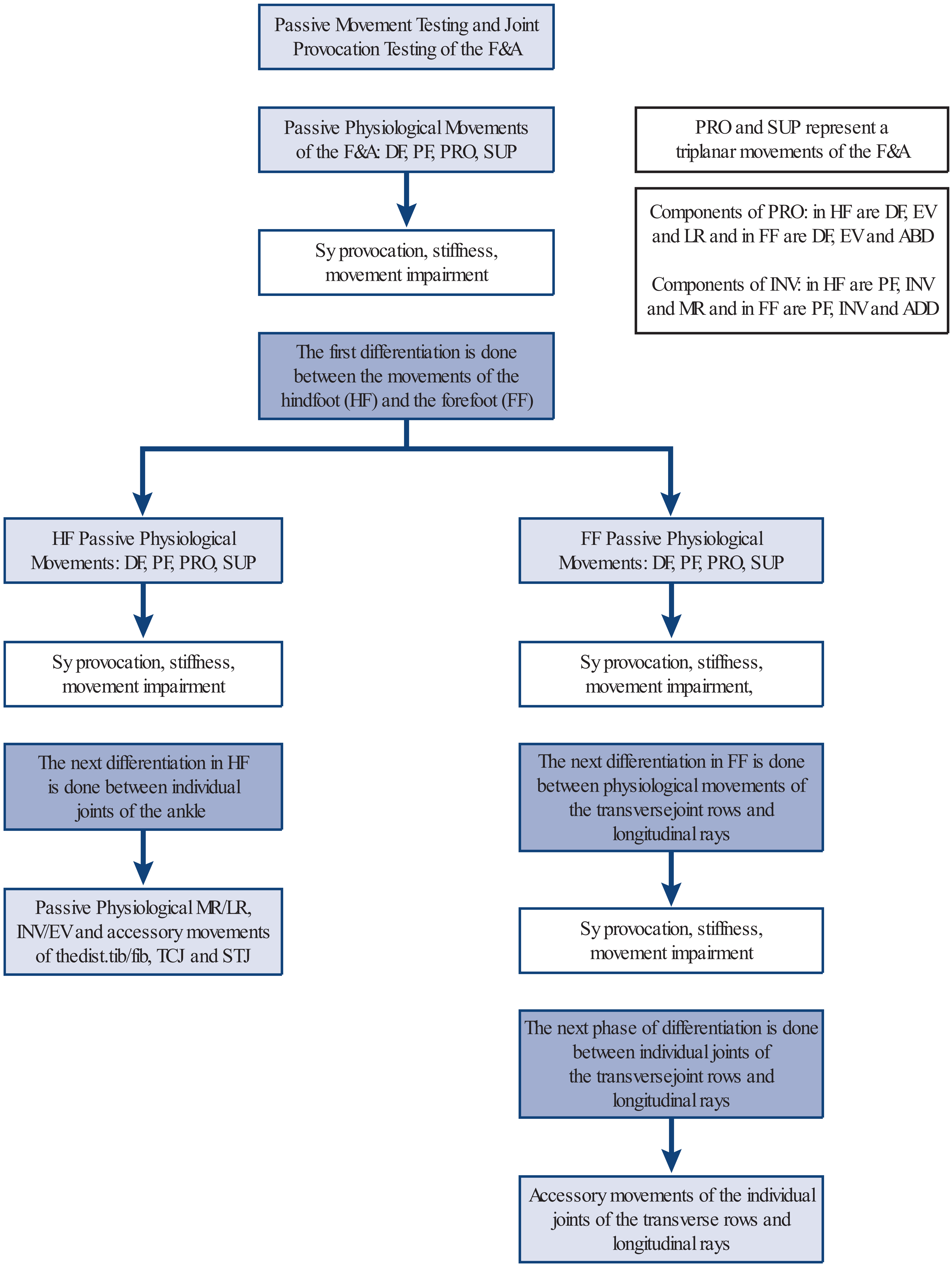

Figure 9.4 • Sequential passive movement testing.

movements. This sequence enables the therapist to identify the impaired physiological movement direction and localize the impairment to a specific joint and specify the direction of the most relevantly impaired accessory movement within the impaired physiological range of movement. This process will provide the information required to determine the direction and intensity of the passive treatment technique. All passive movements used for examination can be applied as treatment techniques either independently or as combined physiological and accessory movements. Therefore, the possible combinations are numerous. In text that follows, the treatment techniques most frequently used by the author in daily clinical practice are described.

Passive physiological movements of the foot and ankle

The first phase of passive movement examination is the physiological movements of the whole foot and ankle. The physiological movements are plantar flexion (PF), dorsiflexion (DF), supination (Sup) and pronation (Pron).

Plantar flexion (Fig. 9.5)

- *Direction*: Plantar flexion of the foot and ankle.
- *Symbol*: PF.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel: the thumb around the lateral surface, the fingers around the medial surface.
- The right hand is placed over the dorsal surface of the metatarsals, the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- The movement is produced by simultaneous and equal action of both arms. The left arm moves downwards and the right arm upwards.

Dorsiflexion (Fig. 9.6)

- *Direction*: Dorsiflexion of the foot and ankle.
- *Symbol*: DF.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel from behind, with the thumb along the lateral surface and the fingers along the medial surface of the heel.
- The right hand is placed over the plantar surface of the metatarsals, the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- The movement is produced by simultaneous and equal action of both arms. The left arm moves upwards and right arm downwards.

Supination (Fig. 9.7)

- *Direction*: Supination of the foot and ankle.
- *Symbol*: Sup.

Figure 9.5 • Plantar flexion.

Figure 9.6 • Dorsiflexion.

Figure 9.7 • Supination.

- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- For the plantar flexion component, the left hand holds the heel with the thumb around the lateral surface and the fingers around the medial surface.
- The right hand is placed over the dorsal surface of the metatarsals, the thumb over the lateral surface and the fingers over the medial surface of the forefoot.
- After plantar flexion, the left hand moves behind the heel simultaneously maintaining the plantar flexed position of the hindfoot. Changing the grip is a prerequisite for introducing inversion and medial rotation movements.

Application of forces by therapist (method)

- The Sup movement begins with plantar flexion (i.e. sagittal plane movement). Both arms move simultaneously and equally to produce the plantar flexion movement. While maintaining the plantar flexed position the grip is changed. After that the foot and ankle are moved into inversion (i.e. frontal plane movement), with both hands working simultaneously and equally. The last components of the supination movement are the medial rotation of the hindfoot and adduction of the forefoot (i.e. transverse plane movement). While doing the transverse plane movements the previous components are maintained.

Pronation (Fig. 9.8)

- *Direction*: Pronation of the foot and ankle.
- *Symbol*: Pron.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel from behind with the thumb along the lateral surface and the fingers along the medial surface of the heel.
- The right hand is placed over the plantar surface of the metatarsals, the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- The pronation movement begins with dorsiflexion (i.e. sagittal plane movement). Both arms move simultaneously and equally to produce the dorsiflexion movement. While maintaining dorsiflexed position, the foot and ankle is moved into eversion (i.e. frontal plane movement). The last components of pronation are the lateral rotation of the hindfoot and abduction of the forefoot (i.e. transverse plane movement). While doing the transverse plane movements the previous components are maintained.

Figure 9.8 • Pronation.

- In general, supination and pronation movements are stressing the foot and ankle in all three planes of the movement. The order of movement components described above represents the routine examination sequence. However, the order of movements may be changed if it is relevant for the patient's disorder. For example, the patient may present with a pain-provoking movement pattern where the dominant movement component of the hindfoot appears in eversion (i.e. in frontal plane) and in the forefoot in abduction (i.e. in transverse plane). In such a case, it may be useful to combine simultaneously these movement components in passive movement examination.
- If physiological movements of the whole foot and ankle reproduce the patient's symptoms or reveal impaired movements, examination is continued. The next phase of examination is passive physiological movements of the hindfoot and forefoot separately. If the hypothesis is that the movements of the hindfoot are relevant to the patient's disorder, it is reasonable to begin from the physiological movements of the hindfoot. However, it is equally important to examine the forefoot to prove that the passive physiological movements of the forefoot are not relevant to the patient's disorder.

Passive physiological movements of the hindfoot

The movements of the hindfoot involve three joints: the distal tibiofibular joint, TCJ and STJ. The movements of the forefoot involve the MTJ, intertarsal joints, tarsometatarsal joints and intermetatarsal joints.

Plantar flexion of the hindfoot (Fig. 9.9)

Plantar flexion of the hindfoot is basically the same movement as the plantar flexion of the whole foot and ankle. The only difference is that the movement is localized to the hindfoot. Therefore, the distal right hand is placed on the dorsal side of the head and neck of the talus adjacent to the ankle. The forefoot will follow the movement, but there is no stress on forefoot structures.

- *Direction*: Plantar flexion of the hindfoot.
- *Symbol*: Hindfoot PF.

Figure 9.9 • Plantar flexion of the hindfoot.

- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel: the thumb is around the lateral surface and the fingers around the medial surface.
- The right hand is placed over the dorsal side of the head and neck of the talus, the thumb over the lateral surface and the index finger over the medial surface of the neck of the talus.

Application of forces by therapist (method)

- The movement is produced by simultaneous and equal action of both arms. The left arm moves downwards and the right arm upwards.

Dorsiflexion of the hindfoot (Fig. 9.10)

- For the dorsiflexion of the hindfoot, the distal right hand is placed over the plantar surface of the distal calcaneus.
- *Direction*: Dorsiflexion of the hindfoot.
- *Symbol*: Hindfoot DF.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Figure 9.10 • Dorsiflexion of the hindfoot.

Localization of forces (position of therapist's hands)

- The left hand holds the heel from behind with the thumb along the lateral surface and the fingers along the medial surface of the heel.
- The right hand is placed over the plantar surface of the distal calcaneus, the thumb over the lateral surface and the index finger over the medial surface of the heel and talus.

Application of forces by therapist (method)

- The movement is produced by simultaneous and equal action of both arms. The left arm moves upwards and the right arm downwards.

Supination of the hindfoot (Fig. 9.11)

For the supination of the hindfoot, the distal right hand is placed on the dorsal side of the head and neck of the talus adjacent to the ankle.

Figure 9.11 • Supination of the hindfoot.

- *Direction*: Supination of the hindfoot.
- *Symbol*: Hindfoot Sup.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel: the thumb is around the lateral surface and the fingers around the medial surface.
- The distal right hand is placed on the dorsal side of the head and neck of the talus adjacent to the ankle.
- After plantar flexion, the left hand moves behind the heel simultaneously maintaining the plantar flexed position of the hindfoot. Changing the grip is a prerequisite for introducing inversion and medial rotation movements. The right hand turns towards the left hand. The thumb of the right hand holds the talus laterally and the index finger holds the talus medially.

Application of forces by therapist (method)

- The supination movement begins with plantar flexion (i.e. sagittal plane movement). Both arms move simultaneously and equally to produce the plantar flexion movement. While maintaining the plantar flexed position the grip is changed. After that the hindfoot is moved into inversion (i.e. frontal plane movement) with both hands working simultaneously and equally. The last component of the supination movement is the medial rotation of the hindfoot (i.e. transverse plane movement). While doing the transverse plane movements the previous components are maintained.

Pronation of the hindfoot (Fig. 9.12)

For the pronation of the hindfoot, the distal right hand is placed over the plantar surface of the distal calcaneus.

- *Direction*: Pronation of the hindfoot.
- *Symbol*: Hindfoot Pron.
- *Patient starting position*: Prone, 90° knee flexion.

Figure 9.12 • Pronation of the hindfoot.

- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the heel from behind with the thumb along the lateral surface and the fingers along the medial surface of the heel.
- The right hand is placed over the plantar surface of the distal calcaneus.

Application of forces by therapist (method)

- The pronation movement begins with dorsiflexion (i.e. sagittal plane movement). Both arms move simultaneously and equally to produce the dorsiflexion movement. While maintaining the dorsiflexed position, the hindfoot is moved into eversion (i.e. frontal plane movement). The last component of the pronation movement is the lateral rotation of the hindfoot (i.e. transverse plane movement). While doing the transverse plane movements the previous components are maintained.

Passive physiological movements of the forefoot

For the examination of the independent forefoot movements, the hindfoot is maintained in neutral position. Therefore, the proximal hand is used to fixate the hindfoot while the distal hand produces the physiological movement for the forefoot.

Plantar flexion of the forefoot (Fig. 9.13)

For the plantar flexion of the forefoot the proximal left hand is placed over the plantar surface of the calcaneus.

- *Direction*: Plantar flexion of the forefoot.
- *Symbol*: Forefoot PF.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the hindfoot in neutral position. The distal right hand is placed over the dorsal surface of the metatarsals with the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- Movement is produced with the right arm moving upwards. The left arm is producing a counterforce downwards to maintain the position of the hindfoot.

Figure 9.13 • Plantar flexion of the forefoot.

Dorsiflexion of the forefoot (Fig. 9.14)

For the dorsifexion of the forefoot the proximal left hand can be placed either over the dorsal side of the head and neck of the talus (Fig. 9.14A) or over the plantar surface of the calcaneus (Fig. 9.14B).

- *Direction*: Dorsifexion of the forefoot.
- *Symbol*: Forefoot DF.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee, the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the hindfoot in neutral position. The right hand is placed over the plantar surface of the metatarsals with the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- Movement is produced with the right hand and arm moving downwards. The left hand and arm produces a counterforce to maintain the position of the hindfoot. If the left hand is placed over the dorsal side of the head and neck of the talus, the counterforce is produced and directed upwards, whereas if the left hand is placed over the plantar surface of the calcaneus the counterforce is produced and directed downwards.

Figure 9.14 • Dorsiflexion of the forefoot.

Supination of the forefoot (Fig. 9.15)

- *Direction*: Supination of the forefoot.
- *Symbol*: Forefoot Sup.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the hindfoot in neutral position. The distal right hand is placed over the dorsal surface of the metatarsals with the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- The supination movement begins with plantar flexion (i.e. sagittal plane movement). The left hand maintains the hindfoot in neutral position and the right hand produces the plantar flexion movement. While maintaining the plantar flexed position the forefoot is moved into inversion (i.e. frontal plane movement). The last component of the forefoot supination is the

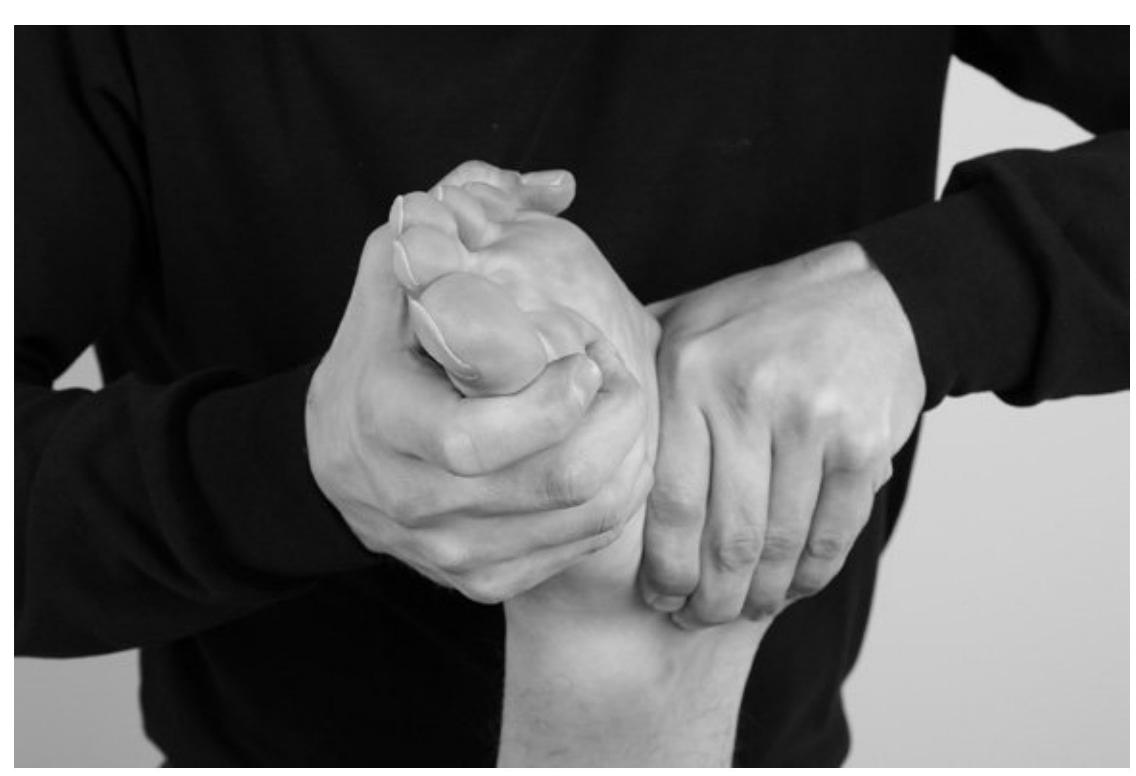

Figure 9.15 • Supination of the forefoot.

adduction (i.e. transverse plane movement). While doing the transverse plane movement the previous components are maintained.

Pronation of the forefoot (Fig. 9.16)

- *Direction*: Pronation of the forefoot.
- *Symbol*: Forefoot Pro.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand holds the hindfoot in neutral position. The distal right hand is placed over the plantar surface of the metatarsals with the thumb over the lateral surface and the fingers over the medial surface of the forefoot.

Application of forces by therapist (method)

- The pronation movement begins with dorsiflexion (i.e. sagittal plane movement). The left hand maintains the hindfoot in neutral position and the right hand produces the dorsiflexion movement. While maintaining the dorsiflexed position the forefoot is moved into eversion (i.e. frontal plane movement). The last component of the forefoot pronation movement is the abduction (i.e. transverse plane movement). While doing the transverse plane movements the previous components are maintained.
- If passive physiological movements of the hindfoot or forefoot reproduce patient's symptoms or reveal impaired movements, differentiation testing of the individual joints continues. In the hindfoot differentiation of the distal tibiofibular joint, TCJ and STJ is carried out. In the forefoot differentiation begins between transverse joint rows. MTJ, intertarsal joints and tarsometatarsal joints form the three transverse rows in the forefoot.Differentiation of the longitudinal rays, i.e. intermetatarsal spaces, should also be performed.

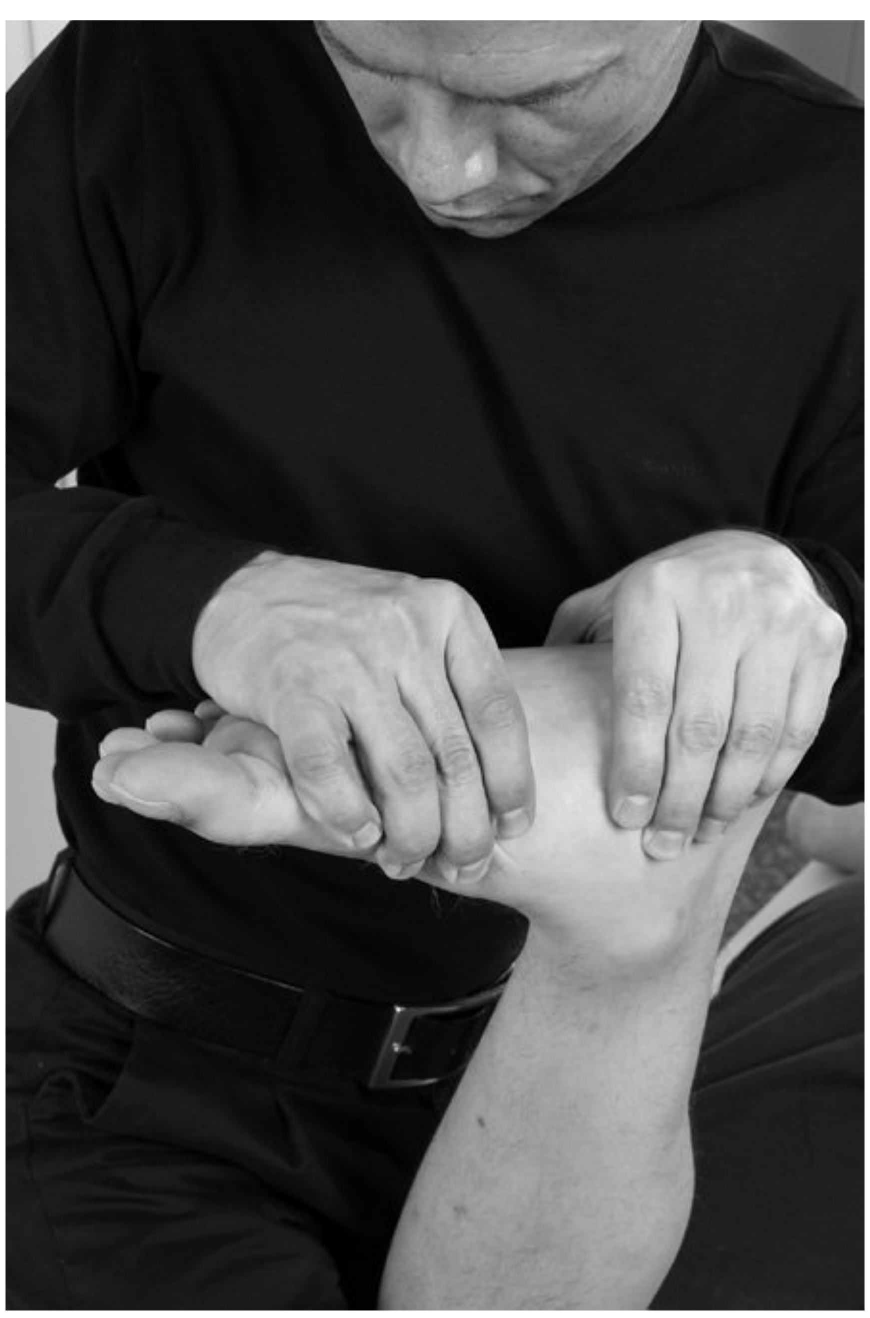

Figure 9.16 • Pronation of the forefoot.

Passive physiological rotation and inversion/eversion movements of the hindfoot

In the hindfoot differentiation tests between the joints are carried out with physiological MR/LR, INV/EV and accessory movements. Physiological movements of the hindfoot in transverse and frontal planes should be examined independently to screen these movements within different angles of dorsiflexion and plantar flexion.

Medial rotation and lateral rotation (Fig. 9.17)

- *Direction*: Medial/lateral rotation of the talus and calcaneus.
- *Symbols*: MR and LR ⤾ and ⤿
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand grasps around the calcaneus posteriorly with the thumb positioned laterally and the other fingers medially. The right hand

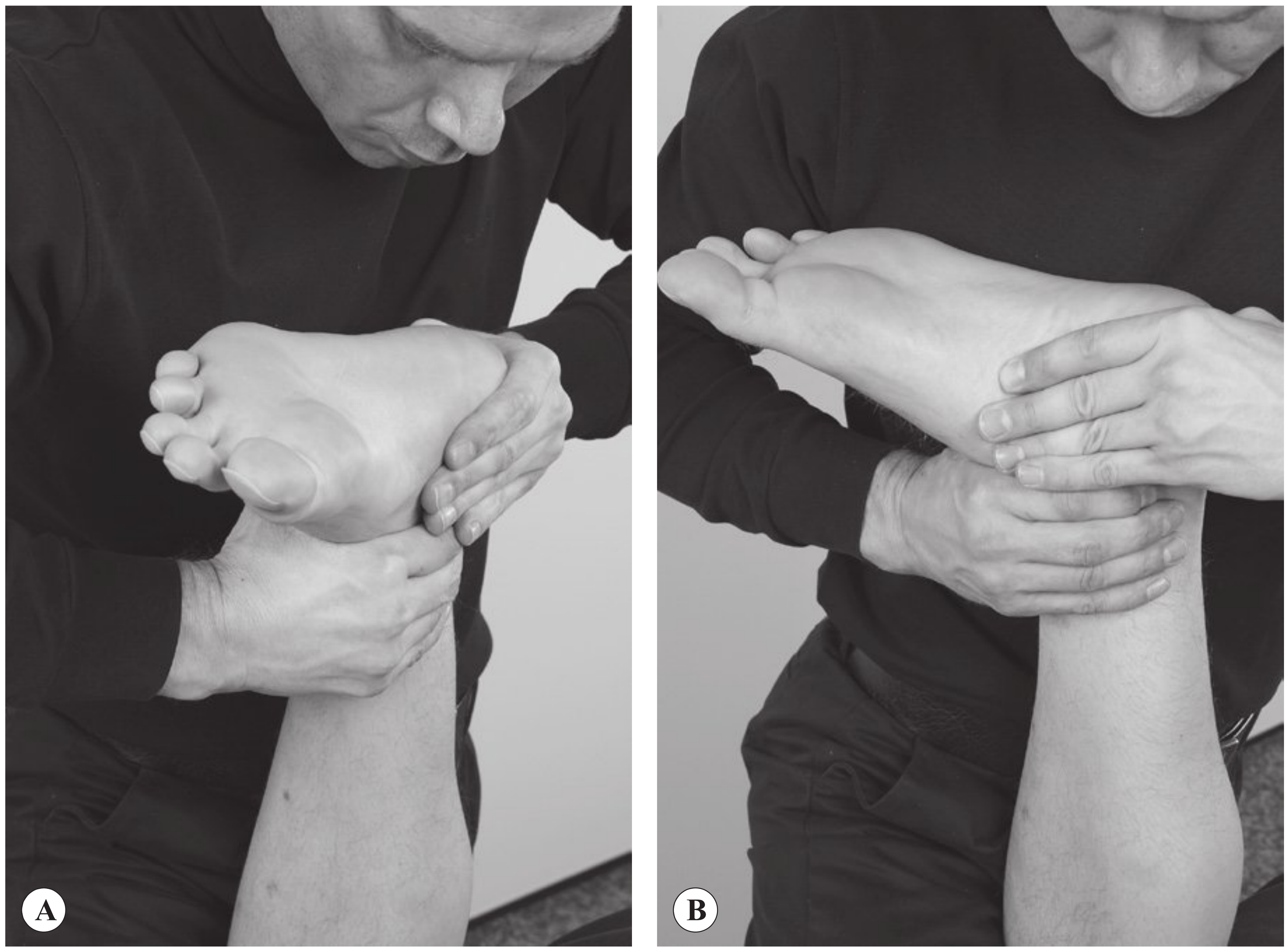

Figure 9.17 • A Medial rotation and B lateral rotation of the talus and calcaneus.

grasps around the talus anteriorly with the thumb positioned laterally and the index finger medially.

Application of forces by therapist (method)

- Both arms rotate simultaneously and equally in the same direction, for example, medial rotation (Fig. 9.17A). This will applymedial rotation to both the STJ and TCJ and test the range, quality and symptom response of the movement. In the case of symptom reproduction, differentiation between STJ and TCJ can be carried out using the rotation–derotation principle. The same test is repeated towards lateral rotation (Fig. 9.17B).

Inversion and eversion (Fig. 9.18)

- *Direction*: Inversion/eversion.
- *Symbols*: INV/EV.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand grasps around the calcaneus posteriorly with the thumb positioned laterally and the other fingers medially. The right hand grasps around the talus anteriorly with the thumb positioned laterally and the index finger medially.

Application of forces by therapist (method)

- Both arms turn simultaneously and equally in the same direction, for example, inversion (Fig. 9.18A). This will apply inversion to both the STJ and TCJ and test the range, quality and symptom response of the movement. In the case of symptom reproduction, differentiation between the STJ and TCJ can be performed with the same principle as rotation. The same test is repeated towards eversion (Fig. 9.18B).

Passive accessory movements of the hindfoot

Accessory movements of the hindfoot are longitudinal caudad (distraction) and cephalad (compression), transverse movement medially and laterally and anteroposterior (AP) and posteroanterior (PA) movements. In the examination and differentiation process it is useful to examine the accessory movements with the hindfoot in the position where the physiological movement restrictions occur.

Figure 9.18 • Inversion and eversion.

Distal tibiofibular joint

The accessory movements of the distal tibiofibular joint are PA, AP and compression. Hypothetically the distal tibiofibular joint can also be moved longitudinally. However, the movement must be performed with leverage from the hindfoot. The techniques of PA, AP and compression for the distal tibiofibular joint are described below.

Posteroanterior movement (Fig. 9.19)

- *Direction*: Movement of the fibula in relation to the tibia in a posteroanterior direction.
- *Symbols*: PA ↕
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The heel or thenar eminence of the left hand is placed against the posterior border of the lateral malleolus with the thumb pointing downwards and other fingers pointing towards the toes.

Figure 9.19 • Movement of the fibula in relation to the tibia in a posteroanterior direction.

The heel of the right hand is placed against the anterior border of the medial malleolus with the fingers pointing towards the heel.

Application of forces by therapist (method)

- The forearms are directed opposite each other and movement is produced with the left arm. The right arm maintains the position of the tibia.

Anteroposterior movement (Fig. 9.20)

- *Direction*: Movement of the fibula in relation to the tibia in an anteroposterior direction.
- *Symbols*: AP ↕
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The heel of the right hand is placed against the anterior surface of the lateral malleolus with the thumb pointing downwards and other fingers spreading posteriorly around the ankle. The heel of the left hand is placed against the posterior surface of the medial malleolus with the fingers spreading anteriorly around the ankle.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the right arm. The left arm maintains the position of the tibia.

Compression (Fig. 9.21)

- *Direction*: Movement of the fibula towards the tibia.
- *Symbol*: >•<
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing at the end of the treatment table, facing along the patient's leg.

Localization of forces (position of therapist's hands)

- The heel of the left hand is placed on the lateral malleolus and the heel of the right hand

Figure 9.20 • Movement of the fibula in relation to the tibia in anteroposterior direction.

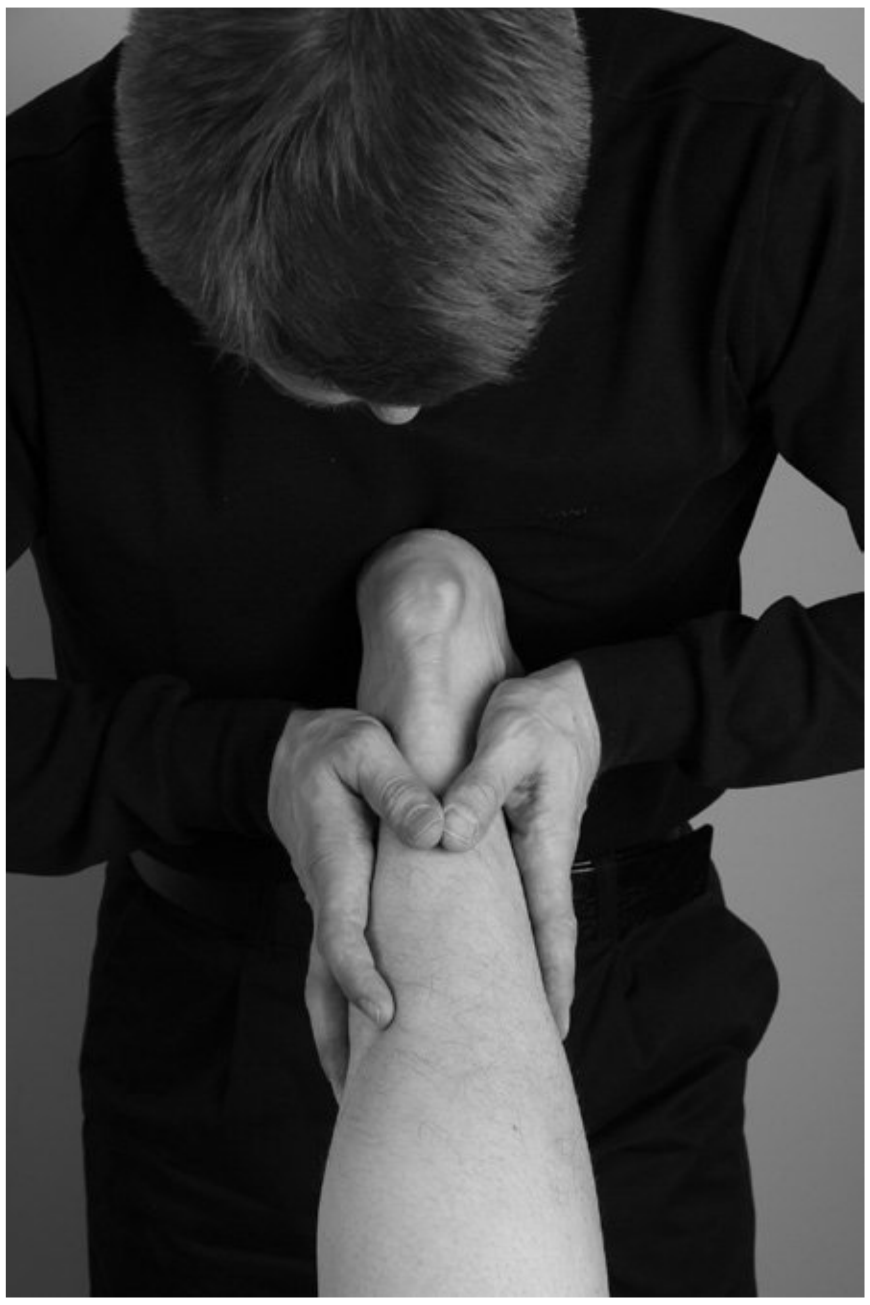

Figure 9.21 • Compression: movement of the fibula towards the tibia.

on the medial malleolus. The fingers are spread along the line of the lower leg pointing towards the knee.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced by simultaneous and equal action of both arms along the line of the forearms.

Talocrural joint

The accessory movements of the talocrural joint are PA, AP, distraction and compression. Hypothetically TCJ can also be moved in a transverse direction, but the movement is very small because the distal tibiofibular syndesmosis encloses the talus medially and laterally. Therefore, in this text the techniques of PA, AP, compression and distraction are described for TCJ.

Posteroanterior movement (Fig. 9.22)

- *Direction*: Posteroanterior movement of the talus in relation to the tibia and fibula.
- *Symbols*: PA ↓
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The right hand is placed against the anterior surface of the tibia and fibula with the thumb positioned laterally over the lateral malleolus and the other fingers positioned medially over the distal part of the tibia. The left hand is placed behind the talus with the thumb positioned laterally and the index and middle fingers medially, just distal of the malleoli.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the left arm while the right hand maintains the position of the tibia and fibula.

Anteroposterior movement (Fig. 9.23)

- *Direction*: Anteroposterior movement of the talus in relation to the tibia and fibula.
- *Symbols*: AP ↑
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand is placed against the posterior surface of the tibia and fibula with the thumb positioned laterally over the lateral malleolus and the other fingers positioned medially over the distal part of the tibia. The right hand is placed in the front of the talus with the thumb positioned laterally and the index and middle fingers medially, just distal of the malleoli.

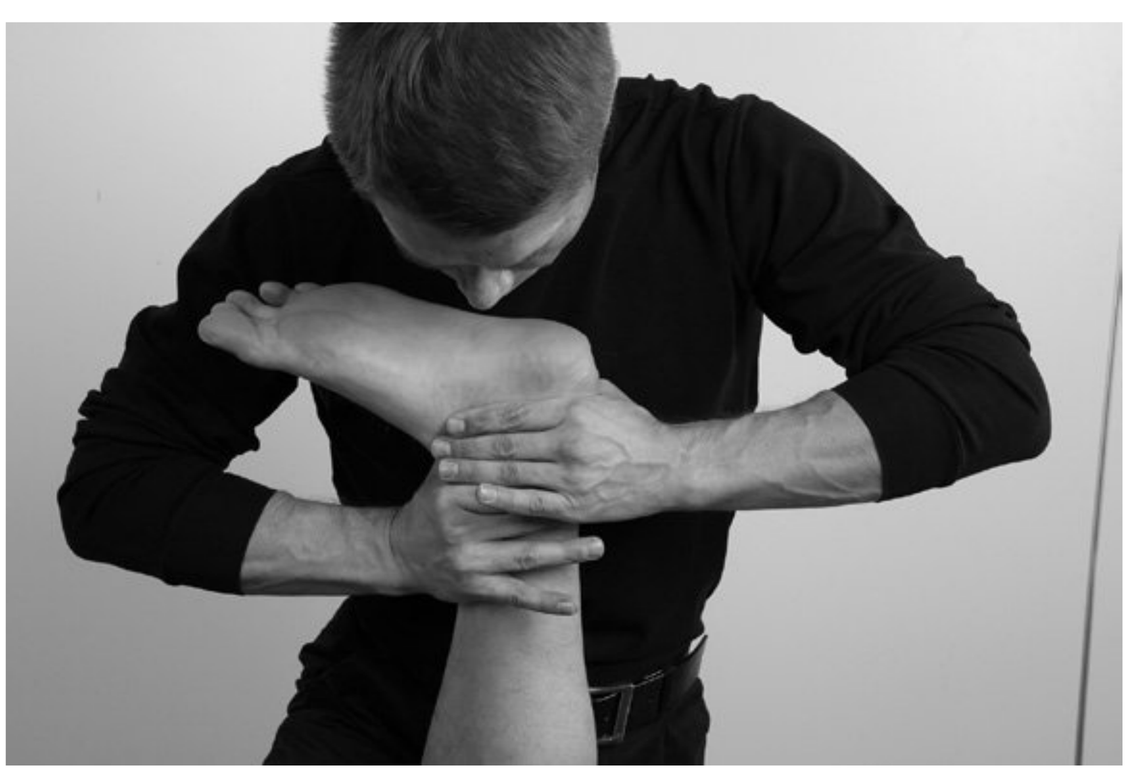

Figure 9.22 • Posteroanterior movement of the talus in relation to the tibia and fibula.

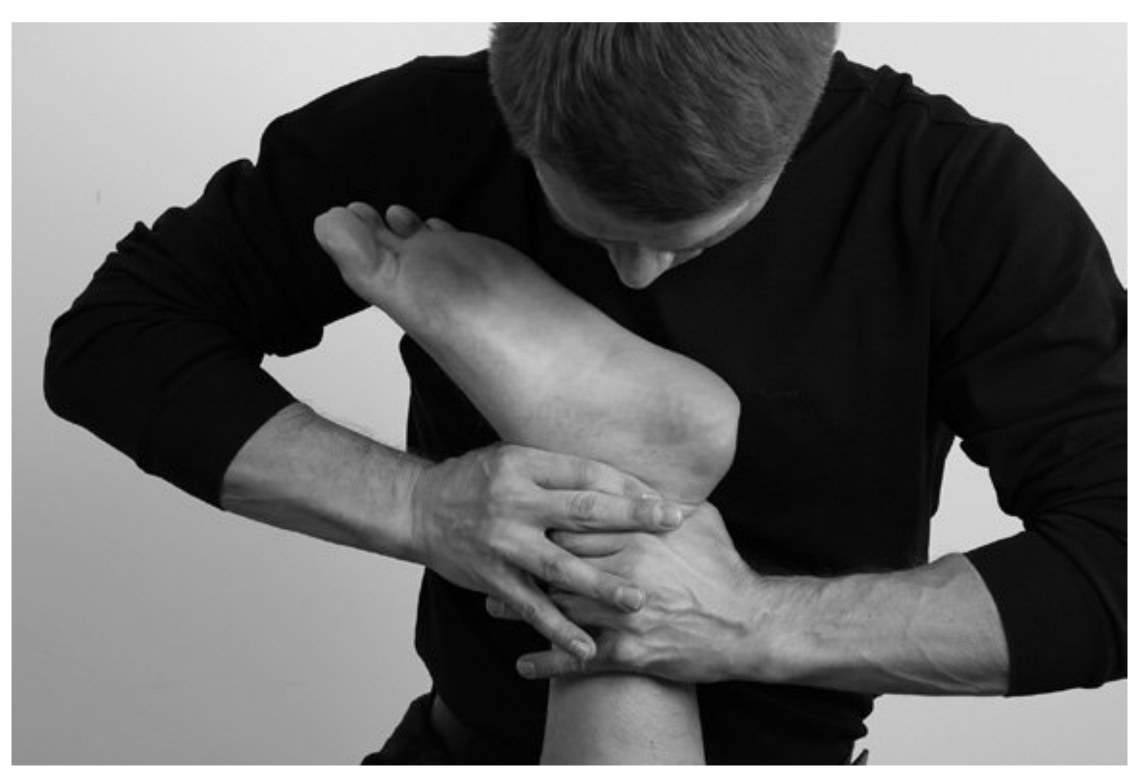

Figure 9.23 • Anteroposterior movement of the talus in relation to the tibia and fibula.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the right arm while the left hand maintains the position of the tibia and fibula.

Distraction (Fig. 9.24)

- *Direction*: Movement of the talus in a caudad direction along the line of the tibia.
- *Symbols*: ↔
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the left knee supporting the posterior aspect of the patient's left thigh.

Localization of forces (position of therapist's hands)

- The right hand is placed on the front of the talus and the left hand is placed behind the talus. The webs of the first interosseus space are brought into contact with the talus. The thumbs are positioned laterally and the other fingers medially over the hindfoot.

Application of forces by therapist (method)

- The forearms are directed as vertically as possible and both arms equally lift the talus towards the ceiling while the left knee maintains the position of the patient's thigh.

Compression (Fig. 9.25)

Compression of the TCJ always includes the compression of the STJ. Therefore, the technique is described as a compression of the hindfoot. However, compression may be combined with other movements of the hindfoot.

Figure 9.24 • Distraction: movement of the talus in a caudad direction along the line of the tibia.

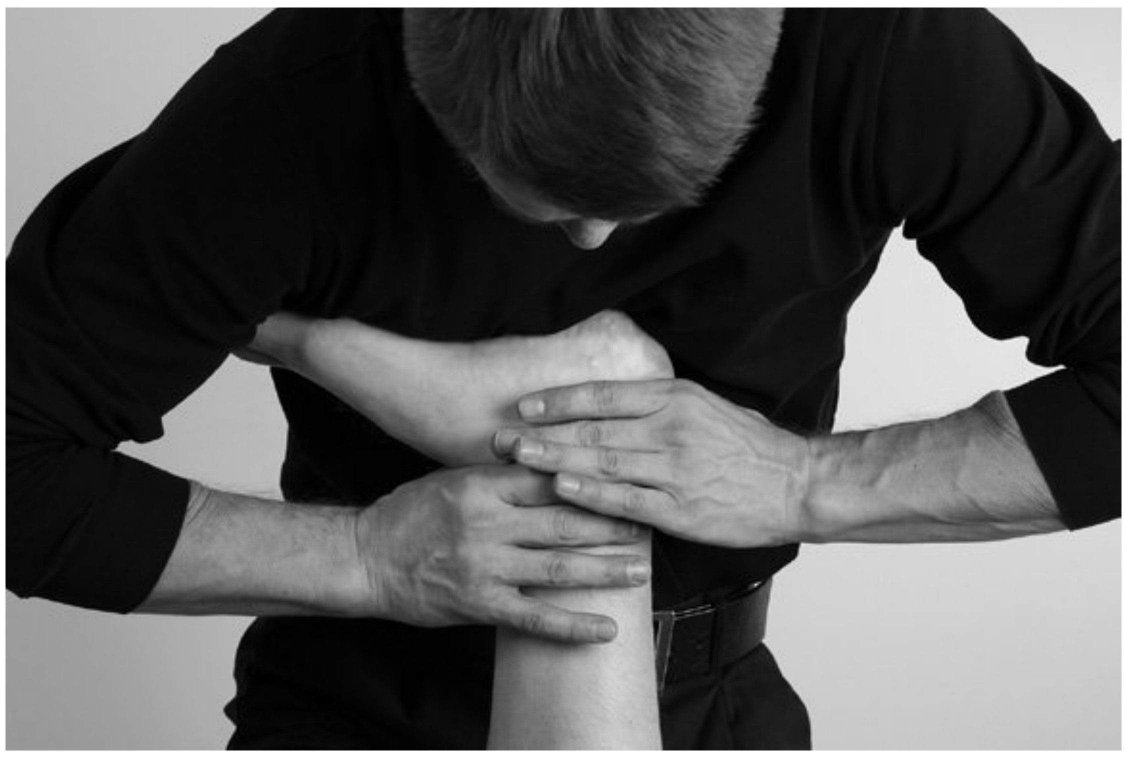

Figure 9.25 • Compression of the hindfoot.

- *Direction*: Movement of the hindfoot in a cephalad direction along the line of the tibia.
- *Symbol*: ↔
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee.

Localization of forces (position of therapist's hands)

- The hands are supporting the ankle in neutral position.

Application of forces by therapist (method)

- The therapist places the sternum over the patient's hindfoot. The compression is produced with the weight of the therapist's upper body.

Movements under compression

- Compression of the hindfoot may be combined with physiological or accessory movements. Localization of forces is provided with the same grip that is used for movements without compression and compression is produced with the weight of the therapist's upper body.

Subtalar joint

- In STJ all accessory movements are available. Compression has already been described above. Other accessory movements of the STJ are PA, AP, distraction and transverse movements medially and laterally.

Figure 9.26 • Posteroanterior movement of the calcaneus in relation to the talus.

Figure 9.27 • Anteroposterior movement of the calcaneus in relation to the talus.

Posteroanterior movement (Fig. 9.26)

- *Direction*: Posteroanterior movement of the calcaneus in relation to the talus.
- *Symbols*: PA ↕
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The right hand is placed against the anterior surface of the talus with the thumb positioned laterally and the other fingers medially. The left hand cups around the posterior surface of the calcaneus with the thumb and fingers spreading over and around the calcaneus.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the left arm while the right hand maintains the position of the talus.

Anteroposterior movement (Fig. 9.27)

- *Direction*: Anteroposterior movement of the calcaneus in relation to the talus.
- *Symbols*: AP ↕
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Figure 9.28 • Distraction: Movement of the calcaneus in a caudad direction along the line of the tibia.

Localization of forces (position of therapist's hands)

- The left hand is placed against the posterior surface of the talus with the thumb positioned laterally under the lateral malleolus and the index and middle finger positioned medially under the medial malleolus. The right hand cups around the calcaneus anteriorly and from the plantar side of the heel.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the right arm while the left hand maintains the position of the talus.

Distraction (Fig. 9.28)

- *Direction*: Movement of the calcaneus in a caudad direction along the line of the tibia.

- *Symbol*: ←•→
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The right hand is placed in the front of the talus. The first web space of the left hand is placed on the posterosuperior corner of the calcaneus.

Application of forces by therapist (method)

- The left forearm is directed as vertically as possible and the right arm horizontally. The left arm lifts the calcaneus towards the ceiling while the right hand maintains the position of the talus.

Transverse movement medially (Fig. 9.29)

- *Direction*: Transverse movement medially of the calcaneus in relation to the talus.
- *Symbols*: –•→, ←•–
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing at the end of the treatment table, facing along the patient's leg.

Localization of forces (position of therapist's hands)

- The right hand is placed over the talus and distal tibia medially with the fingers pointing towards the knee. The left hand cups around the calcaneus from the lateral side with the fingers spreading over the calcaneus.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the left arm while the right hand maintains the position of the talus.

Transverse movement laterally (Fig. 9.30)

- *Direction*: Transverse movement laterally of the calcaneus in relation to the talus.
- *Symbols*: –•→, ←•–
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing at the end of the treatment table, facing along the patient's leg.

Localization of forces (position of therapist's hands)

- The left hand is placed over the talus and the distal fibula laterally with the fingers pointing towards the knee. The right hand cups around the calcaneus from the medial side fingers spreading over the calcaneus.

Figure 9.29 • Transverse movement medially of the calcaneus in relation to the talus.

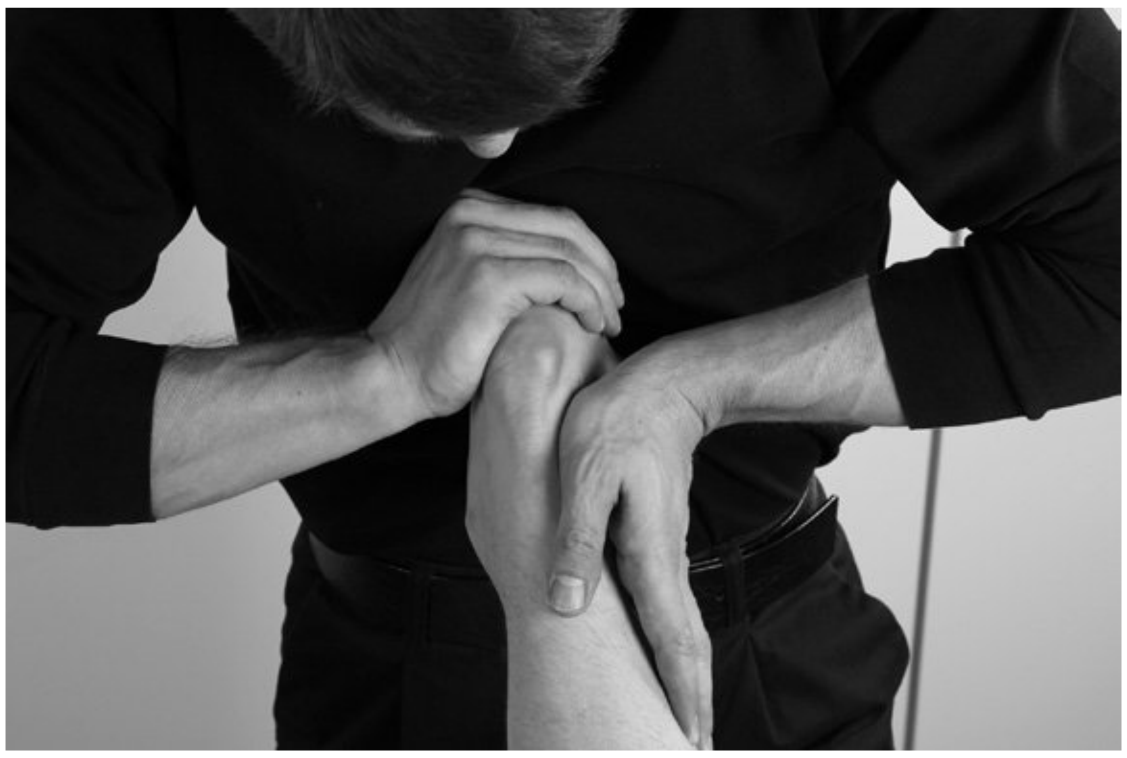

Figure 9.30 • Transverse movement laterally of the calcaneus in relation to the talus.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the right arm while the left hand maintains the position of the talus.

Passive accessory movements of the forefoot

If passive physiological movements of the forefoot reproduce the patient's symptoms or reveal impaired movements further differentiation between joints is established with accessory movements. Differentiation should beginwith the transverse joint rows – the MTJ, intertarsal joints and tarsometatarsal joints form the three transverse rows in the forefoot. Differentiation between longitudinal rays, i.e. intermetatarsal spaces should also be carried out.

Two examples of accessory movements between transverse joint rows are described below: AP of the MTJ and transverse movement medially of the MTJ.

Anteroposterior movement of the MTJ (Fig. 9.31)

- *Direction*: Anteroposterior movement of the navicular and cuboid in relation to the talus and calcaneus.
- *Symbols*: AP ↕
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand is placed on the plantar and anterior surface of the calcaneus proximally adjacent to the MTJ. The left hand holds the hindfoot in neutral position.The distal right hand is placed over the dorsal surface of the navicular and cuboid.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the right arm moving upwards while the left hand maintains the position of the calcaneus and the talus.

Transverse movement medially of the MTJ (Fig. 9.32)

- *Direction*: Transverse movement medially of the cuboid and navicular in relation to the calcaneus and the talus.
- *Symbols*: →•→, ←•←
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing at the end of the treatment table, facing along the patient's leg.

Localization of forces (position of therapist's hands)

- The right hand cups the calcaneus and talus medially, with the fingers spreading on the lateral side of the calcaneus. The right hand is

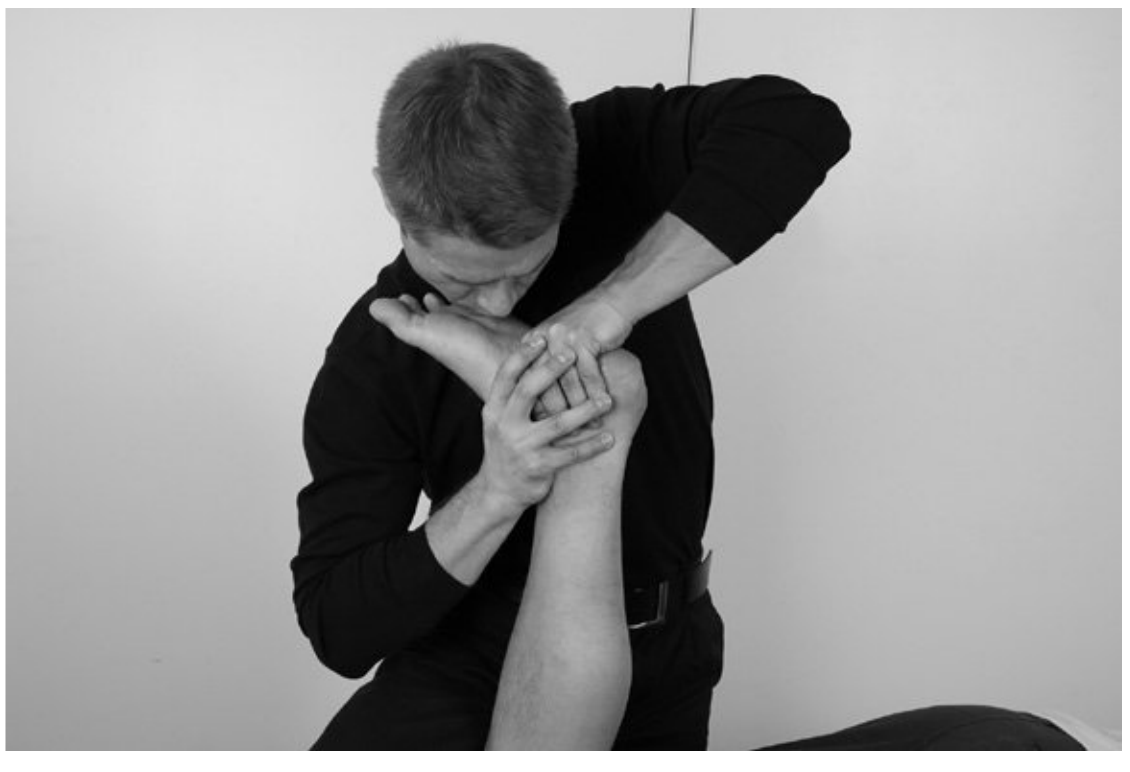

Figure 9.31 • Anteroposterior movement of the MTJ.

Figure 9.32 • Transverse movement medially of the MTJ.

placed proximally adjacent to the MTJ. The left hand is placed over the cuboideum and navicular from the lateral side of the foot. The index finger is placed over the dorsal side of the cuboideum and navicular distally adjacent to the MTJ. The thumb is over the plantar side of the cuboid and navicular.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the movement is produced with the left arm while the right hand maintains the position of the calcaneus and the talus.
- If an accessory movement of the transverse joint row reproduces the patient's symptoms or reveals impaired movement then further differentiation may be performed by repeating the accessory movement with a single joint. An example of this is described below.

Anteroposterior movement of the medial cuneiform (Fig. 9.33)

- *Direction*: Anteroposterior movement of the medial cuneiform in relation to the navicular.
- *Symbols*: AP ⇞
- *Patient starting position*: Supine, the heel over the end of treatment table.
- *Therapist starting position*: Standing by the patient's foot.

Localization of forces (position of therapist's hands)

- The thumb of the right hand is placed over the dorsal side of the navicular and the index and middle fingers hold the navicular from the plantar side. The thumb of the left hand is placed over the dorsal side of the medial cuneiform and the index and middle fingers hold the medial cuneiform from the plantar side.

Application of forces by therapist (method)

- The left hand moves the medial cuneiform while the right hand maintains the position of the navicular.
- Differentiation between intermetatarsal spaces, i.e. rays may be done with accessory movements. For example, AP movement as described below.

Anteroposterior movement of the IV-ray (Fig. 9.34)

- *Direction*: Anteroposterior movement of the fourth ray in relation to the third ray.
- *Symbols*: AP ⇞
- *Patient starting position*: Supine, the heel over the end of the treatment table.
- *Therapist starting position*: Standing at the end of the treatment table, facing patient's leg.

Localization of forces (position of therapist's hands)

- The left thumb is placed on the dorsal side of the three medial rays and the index and middle finger are on the plantar side of the same rays. The left hand is perpendicular in relation to the metatarsals. The thumb of the right hand is placed on the dorsal side of the fourth ray parallel with the metatarsal. The index and

Figure 9.33 • Anteroposterior movement of the medial cuneiform .

Figure 9.34 • Anteroposterior movement of the IV-ray.

middle fingers are on the plantar side of the fourth ray.

Application of forces by therapist (method)

- The right hand moves the fourth ray while the left hand maintains the position of the three medial rays.

Combined movement techniques

Combined movement techniques may be required in the treatment of movement impairments of the foot and ankle. The use of these techniques is justified when passive movement examination reveals impairments in directions, which can be combined (with other movements) or used in the progression of treatment.

Dorsiflexion and posteroanterior movement of the STJ (Fig. 9.35)

- *Direction*: Combined dorsiflexion of the hindfoot and posteroanterior movement of the calcaneus in relation to the talus.
- *Symbols*: Hindfoot DF + STJ PA.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The right hand is placed against the anterior surface of the talus with the thumb positioned laterally and the other fingers medially. The left hand is placed behind the calcaneus with the thumb positioned laterally and other fingers medially around the calcaneus.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the posteroanterior movement is produced with the left arm while both arms direct the hindfoot towards dorsiflexion simultaneously. Dorsiflexion of the hindfoot may be enhanced through flexion of the knee.

Dorsiflexion and anteroposterior movement of the TCJ (Fig. 9.36)

- *Direction*: Combined dorsiflexion of the hindfoot and anteroposterior movement of the talus in relation to the tibia and fibula.
- *Symbols*: Hindfoot DF + TCJ AP.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand is placed against the posterior surface of the tibia and fibula with the thumb positioned laterally over lateral malleolus and the other fingers positioned medially over the distal part of the tibia. The right hand is placed in the front of the talus with the thumb positioned laterally and the index and middle

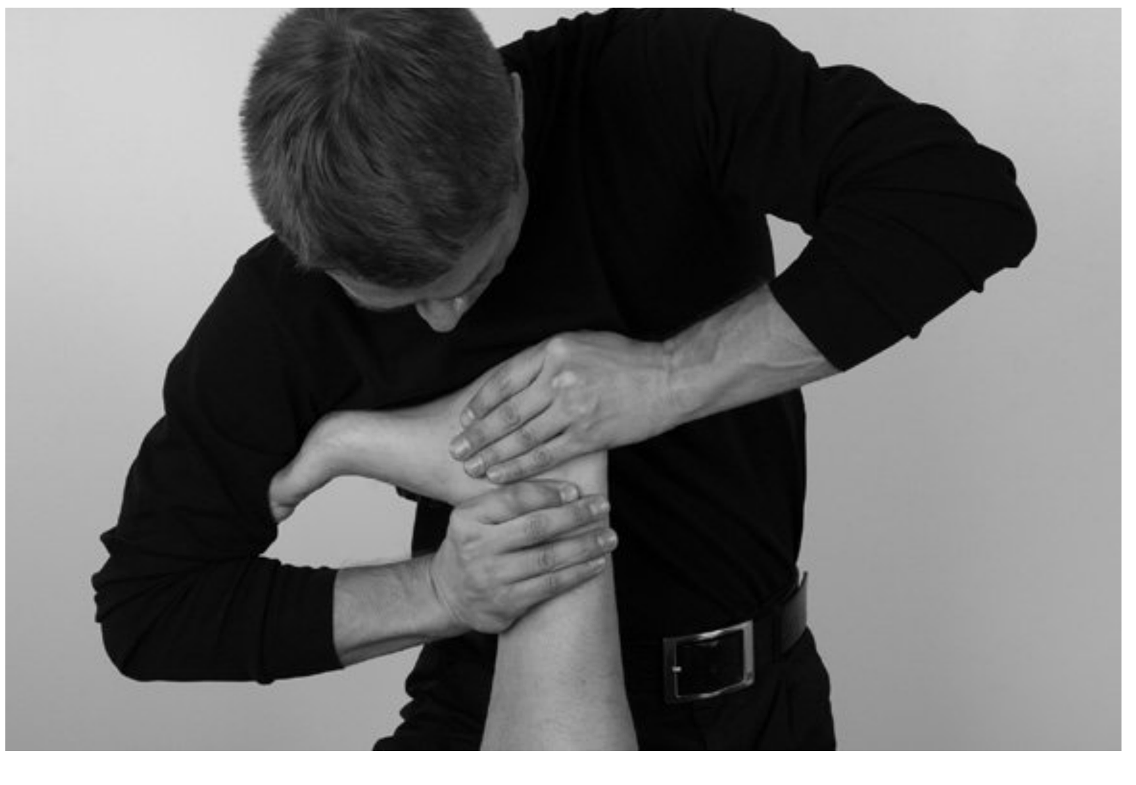

Figure 9.35 • Dorsiflexion and posteroanterior movement of the STJ .

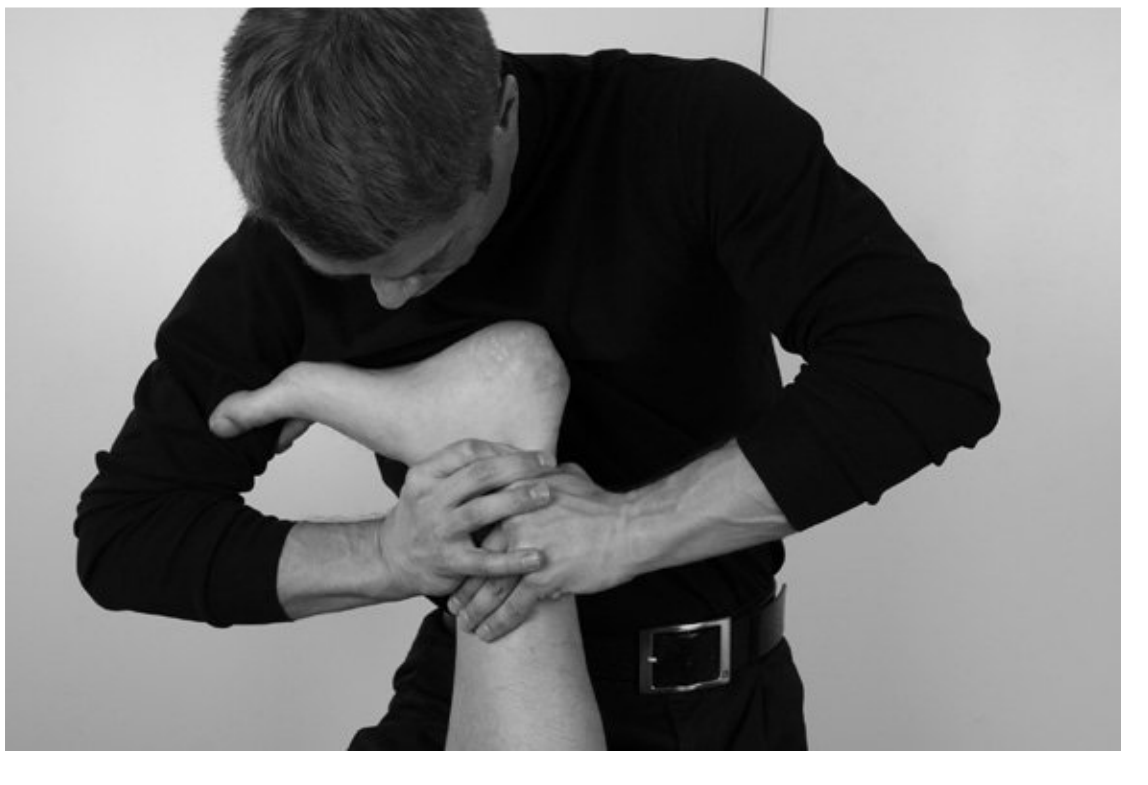

Figure 9.36 • Dorsiflexion and anteroposterior movement of the TCJ.

fingers medially, just distal of the malleoli. The forefoot is supported underneath the right axilla.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the anteroposterior movement is produced with the right arm while the dorsiflexion movement is produced through side bending of the therapist's body to the right.

Dorsiflexion and compression of the hindfoot (Fig. 9.37)

- *Direction*: Combined dorsiflexion and compression of the hindfoot.
- *Symbol*: >•<
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee.

Localization of forces (position of therapist's hands)

- The right hand is placed against the anterior surface of the talus with the thumb positioned laterally and the other fingers medially. The left hand holds the heel from behind, thumb along the lateral surface and fingers along the medial surface of the heel.

Application of forces by therapist (method)

- The therapist places the sternum over the patient's hindfoot. The compression is produced with the weight of the therapist's upper body while both hands and arms are simultaneously and equally producing the dorsiflexion of the hindfoot.

Dorsiflexion and lateral rotation of the hindfoot (Fig. 9.38)

- *Direction*: Combined dorsiflexion and lateral rotation of the hindfoot.
- *Symbols*: Hindfoot DF + LR.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand grasps around the calcaneus posteriorly with the thumb positioned laterally and the other fingers medially. The right hand grasps around the talus anteriorly with the thumb positioned laterally and the index finger medially.

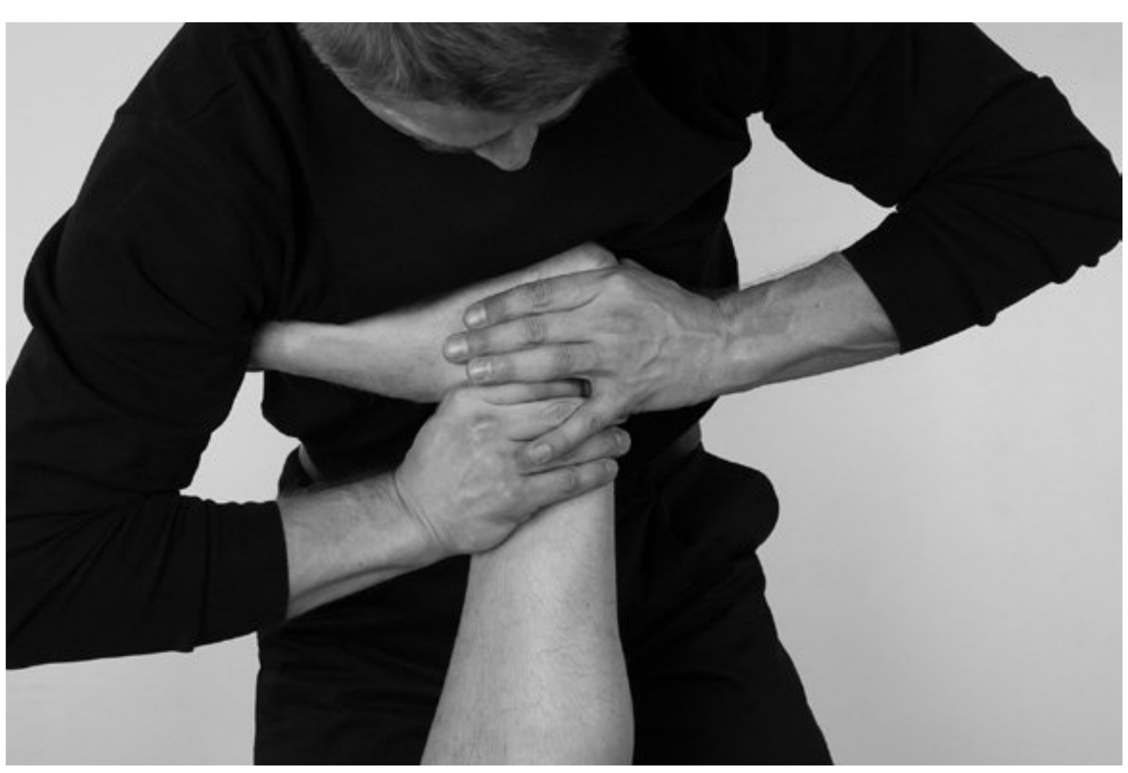

Figure 9.37 • Dorsiflexion and compression of the hindfoot.

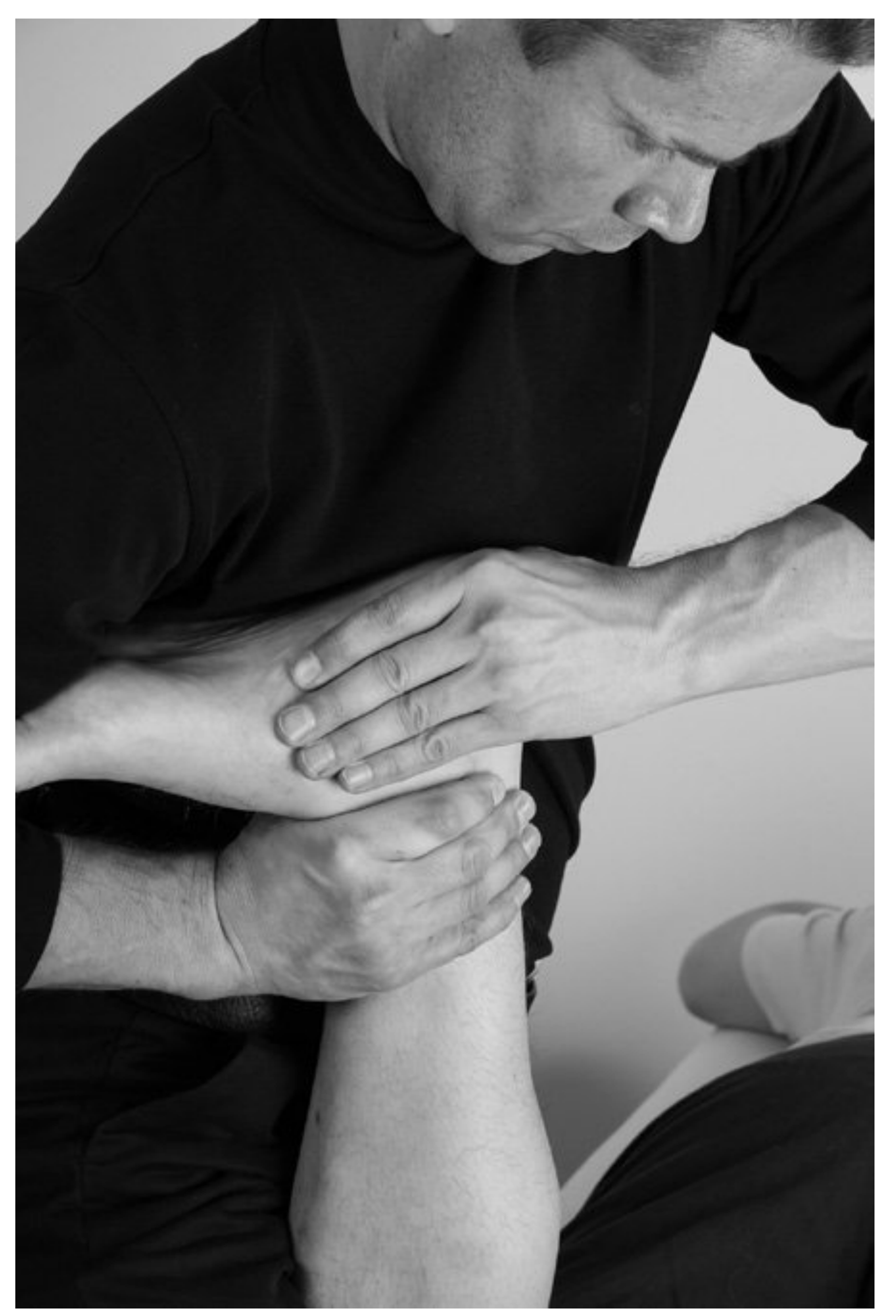

Figure 9.38 • Dorsiflexion and lateral rotation of the hindfoot.

Application of forces by therapist (method)

- Both arms rotate equally in lateral rotation while simultaneously producing dorsiflexion of the hindfoot.

Dorsiflexion and anteroposterior movement of the talocrural joint and distraction (Fig. 9.39)

- *Direction*: Combined dorsiflexion of the hindfoot and anteroposterior movement of the talus in relation to the tibia and fibula and distraction of the hindfoot.
- *Symbols*: Hindfoot DF + TCJ AP.
- *Patient starting position*: Supine, the heel over the end of the treatment table and with the medial and lateral malleolus supported on the treatment table.
- *Therapist starting position*: Standing by the patient's foot.

Localization of forces (position of therapist's hands)

- The right hand is placed against the anterior surface of the talus with the thumb positioned laterally and the other fingers medially. The left hand cups the heel from behind and the forefoot is placed against the left forearm.

Application of forces by therapist (method)

- The left hand is pulling the heel into the caudal direction along the line of the tibia while the right hand is producing anteroposterior movement of the talus. The left forearm is simultaneously leaning against the forefoot and producing the dorsiflexion movement.

Plantar flexion and anteroposterior movement of the subtalar joint (Fig. 9.40)

- *Direction*: Combined plantar flexion of the hindfoot and anteroposterior movement of the calcaneus in relation to the talus.
- *Symbols*: Hindfoot PF + STJ AP.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand is placed against the posterior surface of the talus with the thumb positioned laterally under the lateral malleolus and the index and middle finger positioned medially under the medial malleolus. The right hand cups around the calcaneus anteriorly and from the plantar side of the heel.

Application of forces by therapist (method)

- The forearms are directed opposite each other and the anteroposterior movement is produced with the right arm while the plantar flexion movement is produced through side bending of the therapist's body to the left.

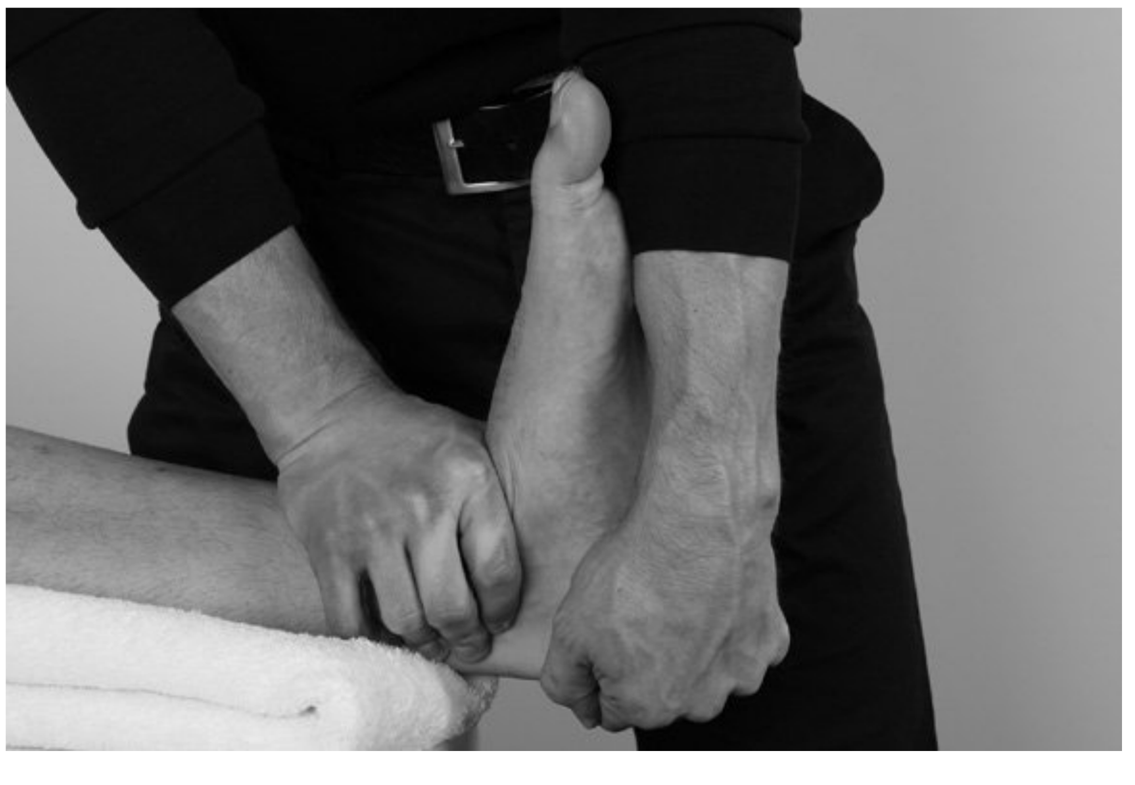

Figure 9.39 • Dorsiflexion and anteroposterior movement of the talocrural joint and distraction.

Figure 9.40 • Plantar flexion and anteroposterior movement of the subtalar joint.

Plantar flexion and inversion (Fig. 9.41)

- *Direction*: Inversion.
- *Symbol*: INV.
- *Patient starting position*: Prone, 90° knee flexion.
- *Therapist starting position*: Standing by the patient's knee with the right knee on the couch to support the patient's left shin.

Localization of forces (position of therapist's hands)

- The left hand grasps around the calcaneus posteriorly with the thumb positioned laterally and the other fingers medially. The right hand grasps around the talus anteriorly with the thumb positioned laterally and the index finger medially.

Application of forces by therapist (method)

- Both arms turn simultaneously and equally towards inversion while the plantar flexion movement is produced through side bending of the therapist's body to the left.

Figure 9.41 • Plantar flexion and inversion.

Therapeutic exercises of the foot and ankle

Therapeutic exercises of the foot and ankle are a cornerstone of the movement intervention in musculoskeletal foot and ankle disorders. Exercises are required to restore the patient's active movement capacity and performance. Therapeutic exercises may be the primary intervention for the foot and ankle disorder or they may follow the passive manual treatment to normalize the motor control of the foot and ankle.

The physiotherapist should consider all factors contributing to the patient's foot and ankle disorder when exercises are planned and implemented. For example, a patient with hindfoot dorsiflexion movement impairment may need exercises to mobilize ankle joints to maintain mobility after passive mobilization, stretch calf muscles, mobilize neural tissue, regain the normal relaxed movement pattern and get rid of the withdrawal activity or to regain trust of movement through graded exposure into the dorsiflexion.

The selection of exercises is based on identifying the direction of the impairment. In the following descriptions exercises are explained based on the functioning of the foot and ankle.

Mobility exercises

Mobilization of the ankle into dorsiflexion (Fig. 9.42)

- *Direction*: Dorsiflexion.
- *Patient starting position*: Standing with the left foot on the floor and the right foot on a chair. The right foot is in neutral position and the lower leg is vertical or mildly leaning backwards. The upper body is leaning against the right thigh. (Fig. 9.42A)
- With the right hand, the patient grasps around the toes to dorsiflex the toes and plantar flex the rays, i.e. to lift the arches of the foot. This will lock the movement of the MTJ and forefoot and direct the movement to the ankle. The best way to accomplish a proper position is to support the toes against the base of the palm and place the fingers underneath the heads of the metatarsals. With the left hand the patient may support the hindfoot directly downwards to hold the heel on the chair. With the left hand the patient can monitor the position of the hindfoot. (Fig. 9.42B)
- *Aim of the exercise*: To mobilize the ankle towards dorsiflexion. The desired effect of the mobilization is dependent on the factors limiting the physiological range of movement. The limiting factors may be physical (i.e. tightness of the tissues or overactive

Mobilization of the ankle into dorsiflexion

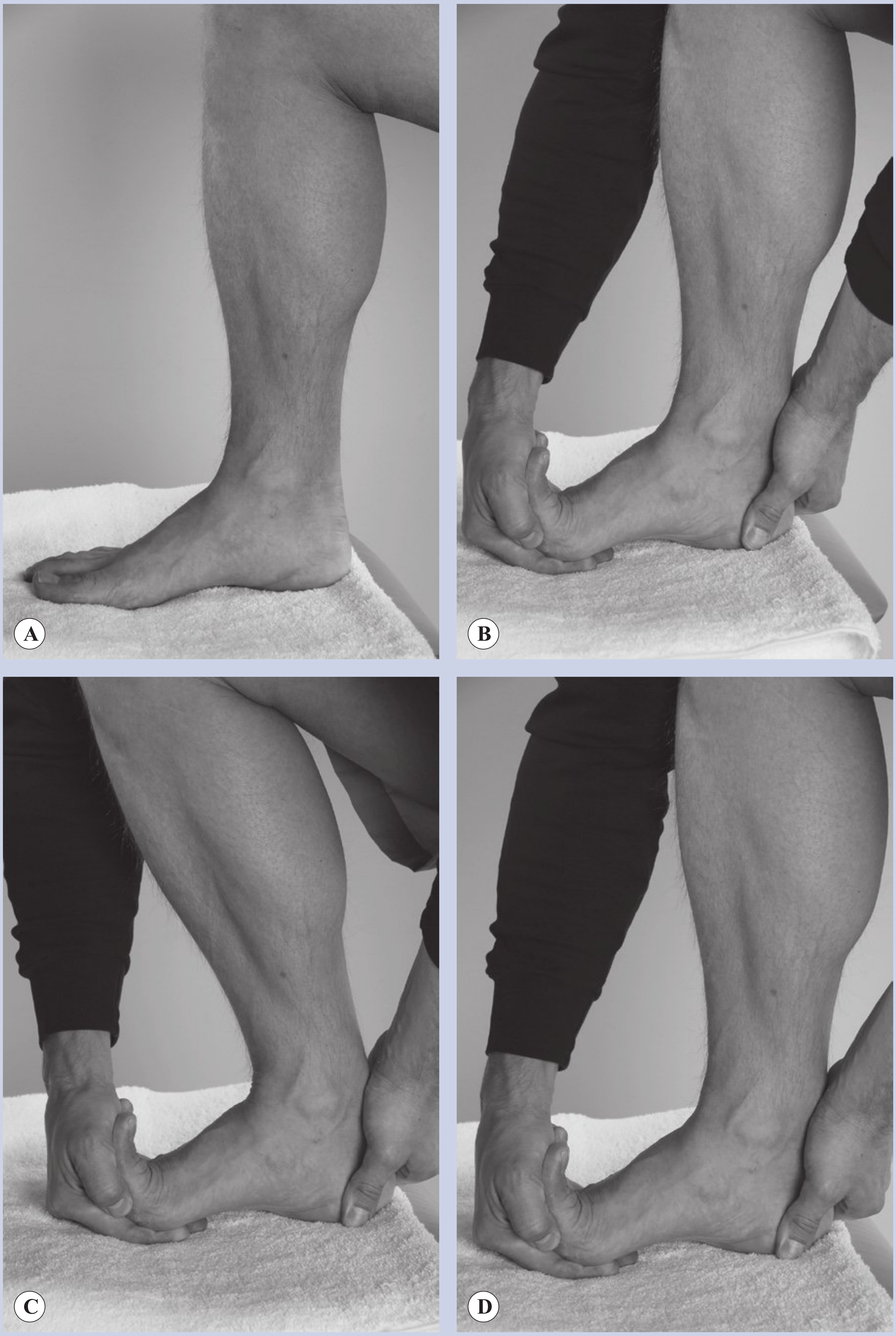

Figure 9.42 • A Starting position. B With the right hand, the patient grasps around the toes to dorsiflex the toes and plantar flex the rays, i.e. to lift the arches of the foot. C The position of the foot is maintained throughout the movement with the hands. The only part moving is the right lower leg. D Lower leg leans forwards and this is accomplished by transferring the centre of gravity. Transference is controlled with the activity of the left lower extremity and with the movement of the body leaning against the right thigh.

Figure 9.43 • Mobilization of the ankle in different directions with balance board.

withdrawal reflex creating compression and stiffness of the ankle joints) or psychological (i.e. fear of movement-related pain). Depending on the mechanism leading to impairment the patient's focus during movement may vary a lot. Some patients may have to feel a stretch of tissues whereas others may have to concentrate on keeping the ankle relaxed during movement.

- *Performing the exercise*: The right foot on the chair is mobilized. The position of the foot is maintained throughout the movement with the hands. The only part moving is the right lower leg. The lower leg leans forward and this is accomplished by transferring the centre of gravity. Transference is controlled with the activity of the left lower extremity and with the movement of the body leaning against the right thigh. It is crucial that the right ankle is relaxed during the mobilization. Through relaxed movement the full potential of the physiological range of movement in dorsiflexion is accomplished. Movement is done in rhythm without a pause between the available range of dorsiflexion and the starting position. Usually the movement is repeated 15–20 times (Figs. 9.42C and 9.42D).

Mobilization of the ankle in different directions with a balance board (Fig. 9.43)

- *Direction*: Any direction of the foot and ankle or combination of movements.
- *Patient starting position*: Sitting with the right foot on the balance board. The foot is positioned in the middle of the balance board.
- *Aim of the exercise*: This exercise is mainly used for patients with movement impairments where pain-related fear of movement contributes to the foot and ankle pain and disability. The aim of this exercise is to gradually expose the foot and ankle into the impaired movement direction, regain trust of movement in the impaired direction and restore normal physiological range of movement.
- *Performing the exercise*: The patient is encouraged to move gradually into the direction of impairment. The rim of the board is used to limit the movement. The patient is made aware that the movement cannot go beyond the normal physiological range of movement. Forefoot activation may be used to encourage the independent movement control between forefoot and hindfoot. Forefoot activation will increase the sense of control and allow the hindfoot to move more freely.

Motor control: exercises in a sitting position

Usually motor control exercise intervention is initiated in a sitting position where most patients can start to activate the foot and ankle without the need to avoid pain. Therefore, ideal coordination of movement can be achieved from the very beginning of the exercise intervention. Patients can also regain an awareness of motor control of the different regions of the foot and ankle before progressing into the weight-bearing situation.

Activation of the forefoot (Fig. 9.44)

- The first activation strategy is described in detail and variations are shown in photographs.
- *Patient starting position*: Sitting with the foot on the ground. The lower leg is vertical and the foot is in a relaxed position (Fig. 9.44A).

- *Aim of the exercise*: To activate the heads of the first and fifth metatarsals against the ground.
- *Performing the exercise*: In the first phase the patient dorsiflexes the big toe (first MTP) approximately 20°. After this the first ray should start to plantar flex resulting in a reinforced support on the ground under the head of the first metatarsal. The patient continues to dorsiflex the big toe and maintains the contact under the heads of the first and fifth metatarsals. The vertical alignment of the lower leg is maintained. Dorsiflexion of the big toe continues until the longitudinal arches of the foot are raised. Because the active forefoot contact is maintained the foot shortens (Fig. 9.44B).
- In the second phase of the exercise the active support of the first and fifth metatarsals is maintained against the ground while the big toe is brought down and all toes are relaxed (Fig. 9.44C). After the relaxation of the toes the longitudinal arches should be raised, the foot shortened and the pretibial muscles relaxed.
- In the third phase of the exercise the forefoot is relaxed and that will result in lowering of the arches and lengthening of the foot, i.e. returning to the starting position of the exercise (Fig. 9.44D).
- Briefly, the phases of this exercise are: activation of the forefoot, maintaining the activation while relaxing the toes and relaxing the forefoot.

Activation of the forefoot

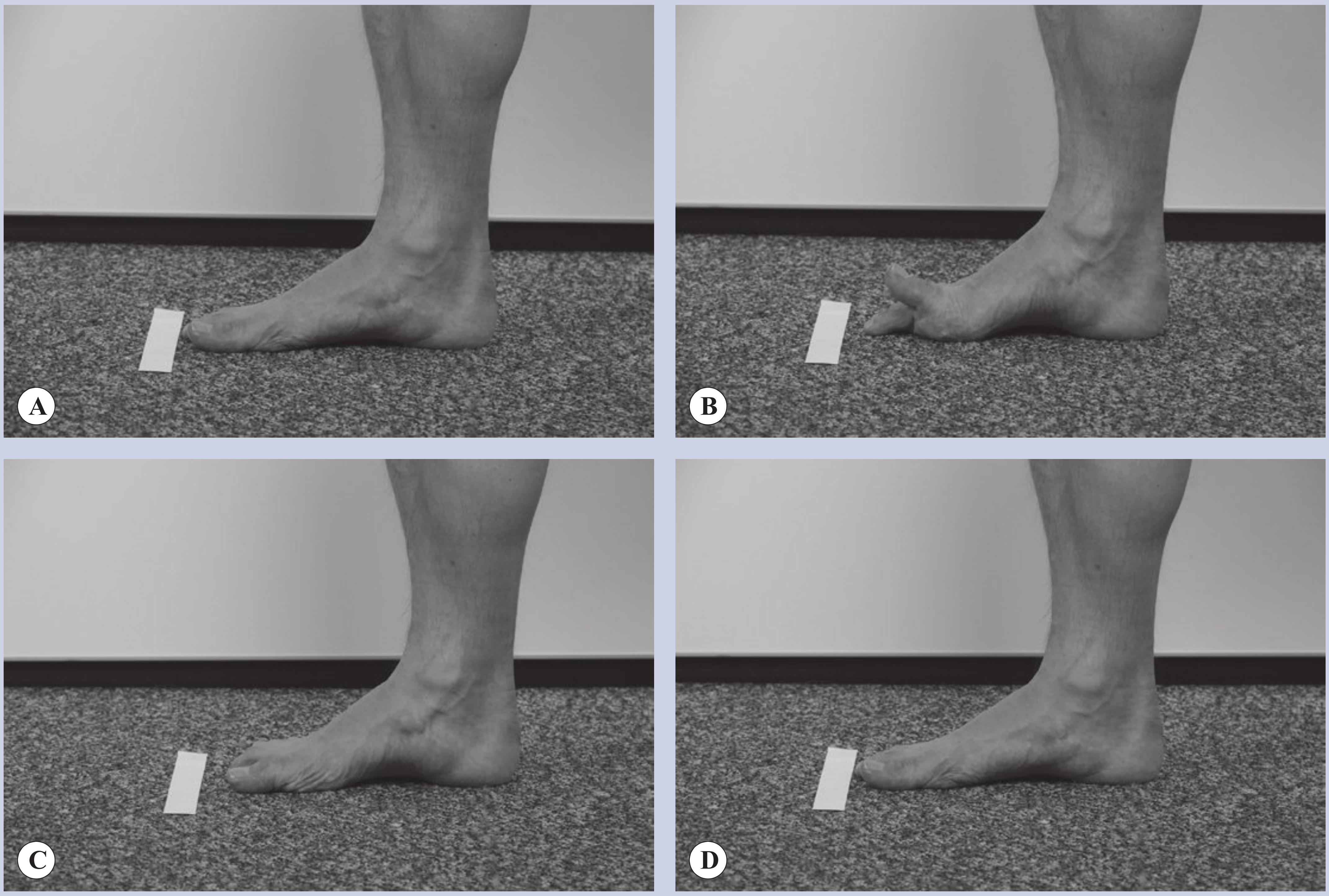

Figure 9.44 • A Starting position of the patient. B The patient continues to dorsiflex the big toe and maintains the contact under the heads of the first and fifth metatarsals until the longitudinal arches of the foot are raised; because the active forefoot contact is maintained the foot shortens. C The active support of the first and fifth metatarsals is maintained against the ground while the big toe is brought down and all toes are relaxed. D The forefoot is relaxed that will result in lowering of the arches and lengthening of the foot, i.e. returning to the starting position of the exercise.

Activation of the forefoot—cont'd

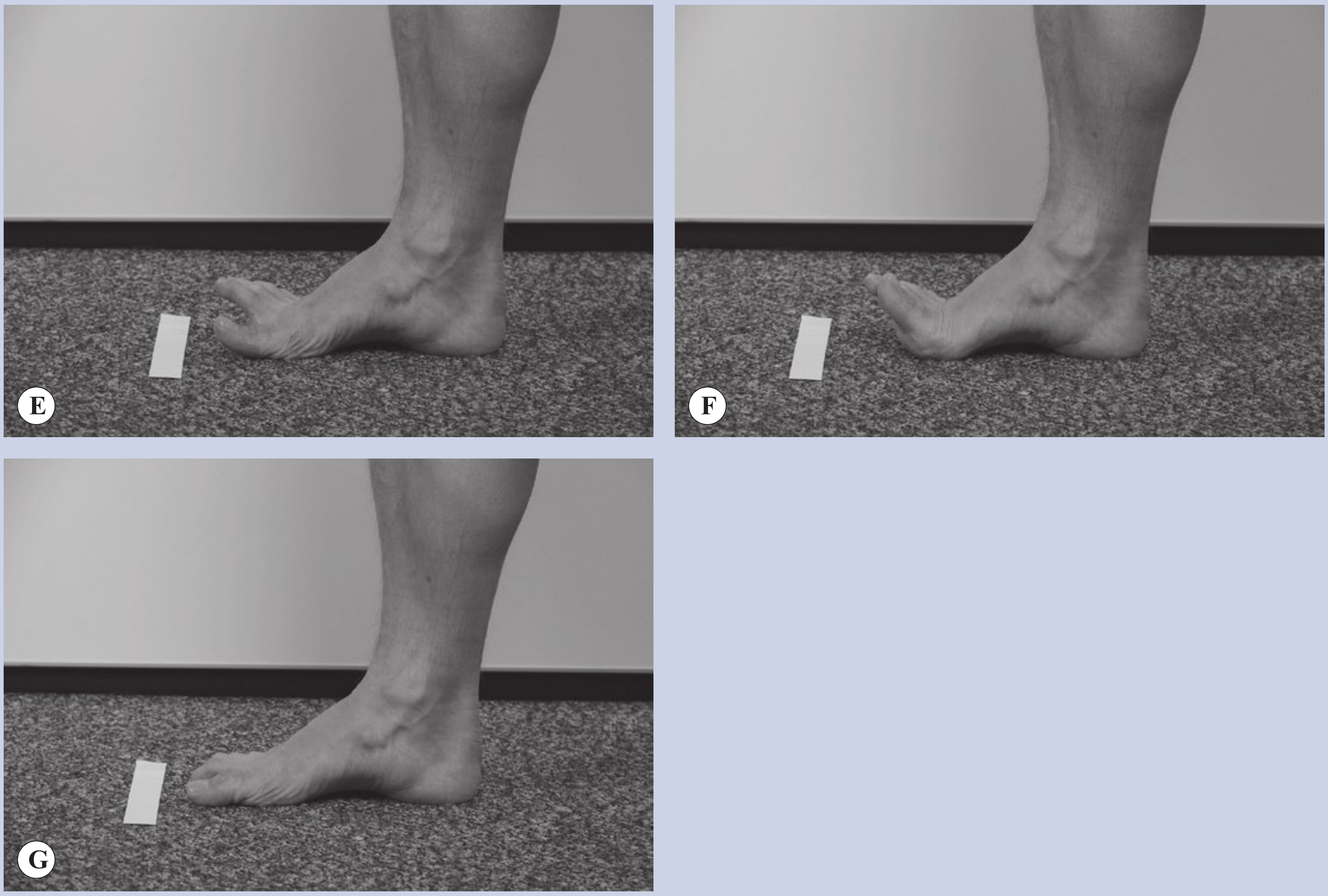

Figure 9.44A • cont'd E The same exercise and phases may be carried out through dorsiflexion of the second to fifth toes. F Alternatively, the same exercise and phases may be carried out through dorsiflexion of all toes. G At advanced level the patient may be able to activate the heads of the first and fifth metatarsals directly against the ground without dorsiflexion of the toes.

- The same exercise and phases may be carried out through dorsiflexion of the second to fifth toes (Fig. 9.44E) or with all toes (Fig. 9.44F). At advanced level the patient may be able to activate the heads of the first and fifth metatarsals directly against the ground without dorsiflexion of the toes (Fig. 9.44G).

Dissociative hindfoot supination (Fig. 9.45)

- *Patient starting position*: Sitting with the foot on the ground. The lower leg is vertical and the foot is in a relaxed position.
- *Aim of the exercise*: To restore and reinforce the independent movement control between the hindfoot and the forefoot. This exercise can be used when the medial loading of the hindfoot is increased, lateral loading of the hindfoot has been restricted or the counter-rotation between forefoot and hindfoot has been impaired in this direction.
- *Performing the exercise*: The forefoot is activated through dorsiflexion of the second to fifth toes.

Figure 9.45 • Dissociative hindfoot supination.

Active support of the first and fifth metatarsals is maintained against the ground. The hindfoot is moved towards supination. Under the heel weight is transferred onto the outer part of the heel pad. Simultaneously, in the forefoot the active support under the first metatarsal should increase. This will result in lifting and shortening of the medial longitudinal arch.

Dissociative hindfoot pronation (Fig. 9.46)

- *Patient starting position*: Sitting with the foot on the ground. The lower leg is vertical and the foot is in a relaxed position.
- *Aim of the exercise*: To restore and reinforce the independent movement control between the hindfoot and forefoot. This exercise can be used when the lateral loading of the hindfoot is increased, the medial loading of the hindfoot has been restricted or the counter-rotation between the forefoot and the hindfoot has been impaired in this direction.
- *Performing the exercise*: The forefoot is activated through dorsiflexion of the first toe. Active support of the first and fifth metatarsals is maintained against the ground. The hindfoot is moved towards pronation. Under the heel weight is transferred onto the inner part of the heel pad. Simultaneously, in the forefoot the active support under the first and fifth metatarsals should increase. It is crucial that the active support under the fifth metarsal in maintained. This will result in lifting and shortening of the lateral longitudinal arch.

Figure 9.46 • Dissociative hindfoot pronation.

Integrative hindfoot plantar flexion (Fig. 9.47)

- *Patient starting position*: Sitting, with the foot on the ground. The lower leg is vertical and the foot is in a relaxed position.
- *Aim of the exercise*: To integrate the heel lift in the active and independent support of the forefoot. This will reinforce the independent movement control between the forefoot and hindfoot.
- *Performing the exercise*: The forefoot is activated and the active support of the first and fifth metatarsals is maintained against the ground. The movement is performed by lifting the heel towards the ceiling and activating the forefoot on the ground. An equal amount of force is produced in both directions. At the beginning, the movement is performed within the range in which the forefoot activity against the ground can be maintained. It is important to direct the movements vertically, in the forefoot towards the ground and in the hindfoot towards the ceiling. Within the middle range of this movement the fifth metatarsal is detached from the ground. After this the control of movement is maintained through active support of the first metatarsal. The most challenging part of this exercise is to start the return and maintain the forefoot activity on the ground

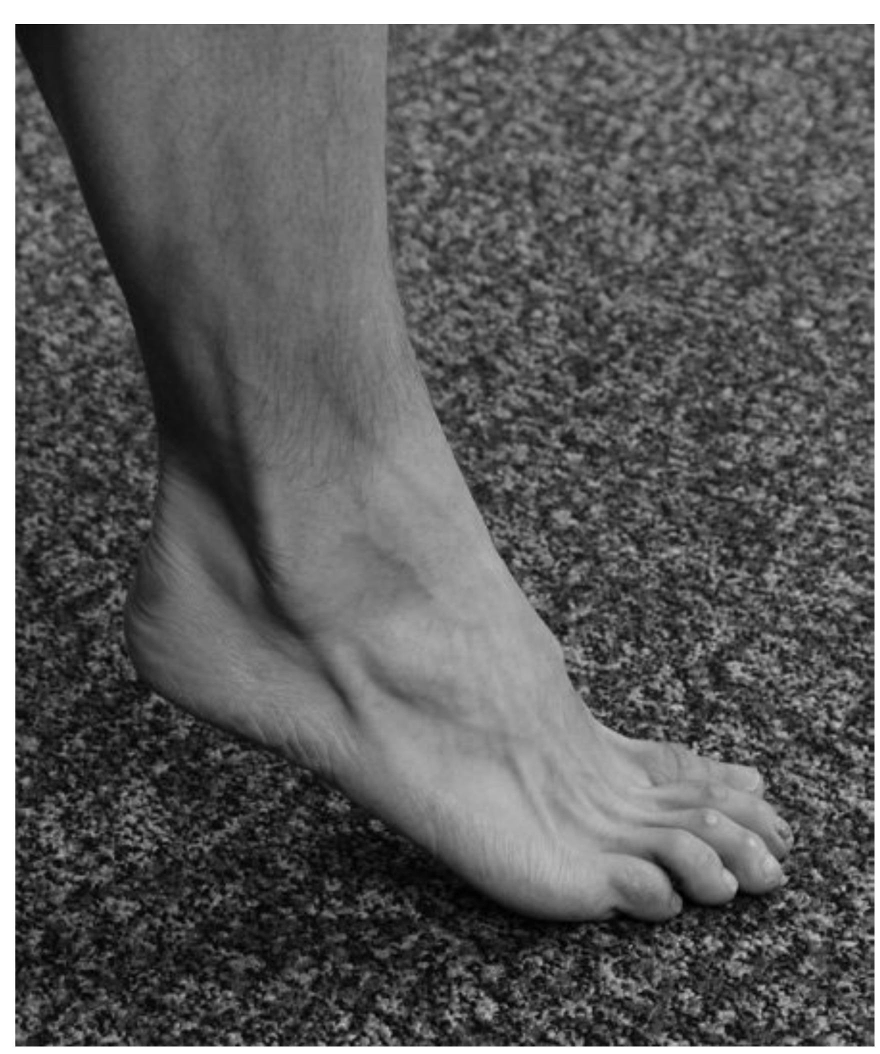

Figure 9.47 • Integrative hindfoot plantar flexion.

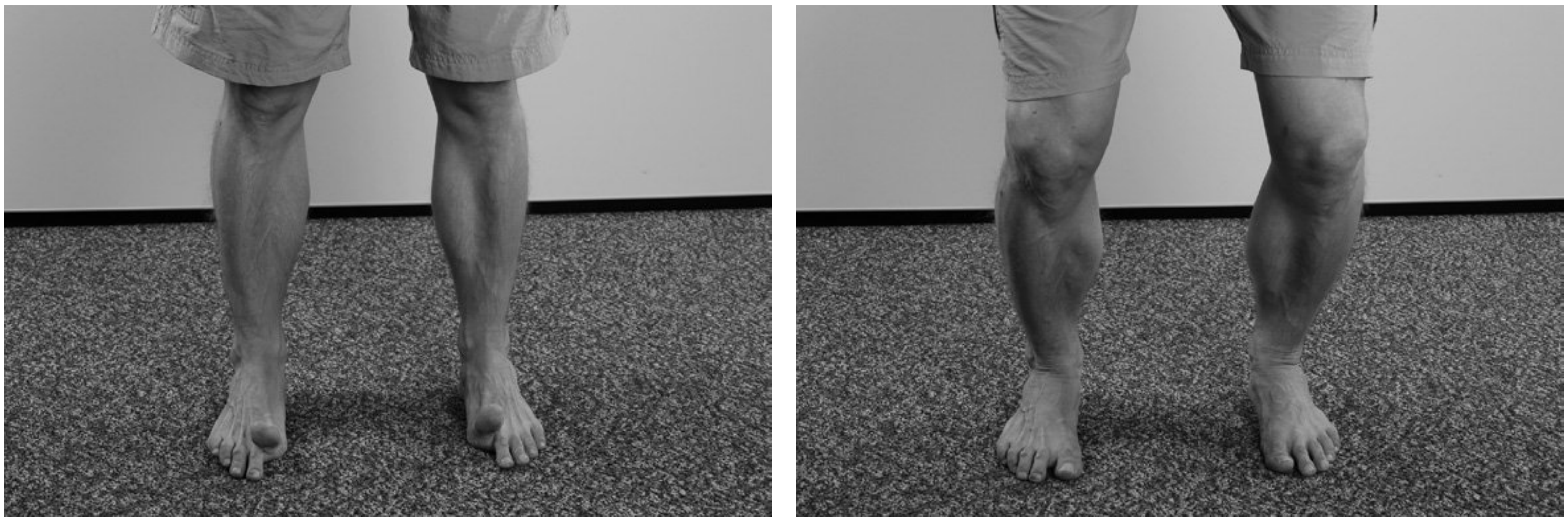

Figure 9.48 • Squat (emphasis on foot and ankle control).

when the movement direction of the ankle changes towards dorsiflexion. The active forefoot control is maintained until the heel is on the ground. During the ankle movement toes and pretibial muscles should be relaxed.

Motor control: exercises in a standing position

All exercises that are described in a sitting position can be repeated in a standing position. Exercises in standing are a progression from exercises in a sitting position. The patient can then progress further to exercises in single-leg standing. In the standing position it is crucial for the patient to identify the difference between forefoot loading and active forefoot support against the ground. Active support of the forefoot is a prerequisite for the foot and ankle to maintain the arches of the foot, direct the loading to bony structures designed for weight bearing, provide a stable base for ankle movements and to enable counter-rotation between the forefoot and hindfoot.

An important exercise in the standing position is squatting. Impaired dorsiflexion of the ankle is probably the most typical finding in foot and ankle disorders.

Squatting (emphasis on foot and ankle control) (Fig. 9.48)

- *Patient starting position*: Standing in relaxed position with the feet approximately a shoulderwidth apart.
- *Aim of the exercise*: To promote active forefoot control during squatting and achieve full range of ankle movement into dorsiflexion.
- *Performing the exercise*: The forefeet are activated and the active support of the first and fifth metatarsals is maintained against the ground (Fig. 9.48A). Forefoot activity is necessary to achieve independent movement control between the forefoot and the hindfoot and to achieve full dorsiflexion of the ankle. The patient squats and controls the movement of the lower legs with the calf muscles. The patient is directed to allow free ankle movement. Activity of the pretibial muscles is avoided during ankle movement (Fig. 9.48B). Simultaneous activity of the calf and pretibial muscles would create compression and stiffness into the ankle joints. At the beginning the movement is performed within the range at which the patient can maintain forefoot control. Gradually movement is progressed into the full range of ankle dorsiflexion.

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The Maitland Concept as a clinical practice framework for neuromusculoskeletal disorders

1

1. The culture within which the Maitland Concept operates is to encourage clinicians to:
   - a] Improve adopt adapt
   - b] Adapt adopt improve
   - c] Adopt improve adapt
   - d] None of the above
2. Which of these are included as the main pillars of manipulative physiotherapy clinical practice?
   - a] Clinical reasoning
   - b] Patient centred practice
   - c] Assessment examination and treatment
   - d] All of the above
3. Complete this title. The International Classification of Functioning, Disability and …:
   - a] Disease
   - b] Impairment
   - c] Health
   - d] Handicap
4. Healthy life expectancy means:
   - a] Adding life to years
   - b] Adding years to life
   - c] a and b
   - d] Living to 100 years old
5. According to the IFOMPT, competency should include:
   - a] Knowledge
   - b] Skill
   - c] Attributes
   - d] a, b and c
6. In the domain of outcome measures, PROMS stands for:
   - a] Patient reported outcome measures
   - b] Patient related objective markers
   - c] Problems with range of movement
   - d] Passive range of muscle spasm
7. Which of the following is not a feature of the patient's body's capacity to inform?
   - a] The effects of treatment on symptoms and signs
   - b] The therapist's skills in manual therapy
   - c] The patient's responses to painful movement
   - d] The patient's overall satisfaction with the outcome of treatment
8. Collaborative reasoning is not:
   - a] Therapist centred
   - b] Patient centred
   - c] Semi-structured interviewing
   - d] Planning physical examination with the patient
9. Metacognition is best described as:
   - a] Thinking about what you are thinking
   - b] Evidence based practice
   - c] The treatment technique
   - d] Reasoning in action

10. Which of these features belongs to the clinical side of the brick wall model of clinical reasoning?
- **a]** Painful knee extension
- **b]** Nociception
- **c]** Inflammatory soup
- **d]** Femoral roll spin and slide

11. Manual examination should not be designed around:
- **a]** The source of the patient's symptoms
- **b]** X-ray changes
- **c]** Contributing factors
- **d]** Movement impairments

12. The movement continuum theory of physiotherapy practice demands that Physiotherapists think about movement in relation to
- **a]** Tissues
- **b]** Cells
- **c]** The person in society
- **d]** All of the above

13. Which of the following is not an asterisk?
- **a]** Volume of medication
- **b]** Severity of pain with daily activity
- **c]** The number of past episodes
- **d]** Active range of movement

14. Planning of physical examination should be carried out:
- **a]** Before the subjective examination
- **b]** After reading the referral letter
- **c]** After completion of the subjective
- **d]** After observing the patient's movements

15. Reassessment of each treatment technique is best carried out:
- **a]** During the treatment
- **b]** After the treatment
- **c]** Before during and after the technique is performed
- **d]** At the start of the next session only

16. Which of the following features may act to inhibit responses to manipulative physiotherapy?
- **a]** Symptoms of a mechanical behaviour
- **b]** Previous good response to manipulative physiotherapy treatment
- **c]** Signs of impairment related to movement
- **d]** Maladaptive thoughts and behaviours

17. Which of the following is not one of the IFOMPT educational standards dimensions
- **a]** Knowledge of alternative medicines
- **b]** Advanced levels of clinical reasoning skills
- **c]** Comprehensive knowledge of behavioural sciences
- **d]** Appreciation of the process of research

18. Autonomous practice is characterised by which two of the following?
- **a]** Working under the supervision of orthopaedic practitioners or consultants
- **b]** Independent self-determined professional judgement and action
- **c]** Carrying out treatments under prescription from the referring doctor
- **d]** **Exercising professional judgement within a clearly def ned scope of practice**

19. Movement diagrams were developed solely as:
- **a]** Outcome measures
- **b]** A measure of movement impairment
- **c]** A teaching and communication aid
- **d]** A legal requirement for documentation

20. Which of the following statements is most appropriate description of the paradigm within which manipulative physiotherapists operate?
- **a]** The biopsychosocial model of health care is the only model physiotherapists should use
- **b]** Physiotherapists think about the biomedical model primarily
- **c]** Both the biomedical and biopsychosocial models are important to physiotherapists
- **d]** The use of the biomedical model is much more important for physiotherapists

The Maitland Concept: evidence-based practice and movement sciences

2

One or more of the answers maybe correct.

1. The science of physiotherapy is established in:
   a] Biomedical sciences
   b] Biomechanical science
   c] Movement science
   d] Rehabilitation science
2. Cott et al.'s movement continuum theory (1995):
   a] Builds up upon Hislop's cybernetic model of movement (1975)
   b] Focuses on movement capacity and potential of different levels of movement
   c] These levels of movement are not interrelated
   d] These levels of movement are only influenced by internal factors
3. The International Classification of Functioning, Disability and Health (ICF) and physiotherapy diagnosis:
   a] Are not related
   b] Physiotherapy diagnosis is expressed in terms of movement functions and dysfunctions
   c] The categories of impairments, activities and participation of the ICF are very suitable to express physiotherapy diagnosis
   d] Particularly manipulative physiotherapy has developed its strength in the diagnosis and treatment of movement disorders at impairment levels of ICF
4. The application of evidence-based practice:
   a] And clinical reasoning are strongly related
   b] Is related to making decisions for patients based on the best available evidence
   c] Only randomised clinical trials and reviews/meta-analyses should be considered as best evidence
   d] Qualitative research and evidence based practice are not related
5. The practice guidelines:
   a] Need to be applied as in the guideline, otherwise the clinician may be held liable
   b] May serve as an essential aid in clinical decision making, but the clinician needs to assess if the guidelines are fully applicable to the individual case
   c] Carry an inherent risk that decisions about norms and values are shifted from the clinician's consultation room to the conference room of the professional association
   d] If a patient's problem may be related to different practice guidelines, the clinician selects the most suitable one as a guideline for decisions

6. In paradigms to movement:
- **a]** Physiotherapist employs various paradigms to movement simultaneously
- **b]** Only biomechanics are relevant to physiotherapy science and practice
- **c]** Only neurophysiology is relevant to physiotherapy science and practice
- **d]** Only those paradigms from those areas where lots of research is done, need to be employed

7. Physiotherapy diagnosis
- **a]** Is expressed in terms of functions, disability and health
- **b]** Is directly related to biomedical, structural diagnosis
- **c]** Is based on subjective and physical examination procedures
- **d]** Is based on treatment procedures and subsequent reassessment procedures

8. The biomedical paradigms in physiotherapy practice:
- **a]** Establish precautions, contraindication to treatment
- **b]** Are an outdated paradigm
- **c]** Serve in medical and/or orthopaedic diagnosis
- **d]** Are a part of clinical patterns recognition for physiotherapist, as long as these patterns are linked to decisions regarding examination and/or treatment

9. Biopsychosocial paradigms in physiotherapy:
- **a]** Enhance a client-centred attitude
- **b]** Encompass salutogenic perspectives to practice
- **c]** Focus on the individual illness experience and behaviour
- **d]** Should not neglect the ‘bio’ parts of a problem, since the psychosocial aspects has received so much more attention in the past decade

10. Salutogenesis as a contrast to pathogenesis has been developed as a concept by Antonowsky (1979). Which of the following statements is correct?
- **a]** Physiotherapists often intrinsically employ an salutogenic attitude in daily practice
- **b]** Sense of coherence is an essential aspect of the salutogenic concept
- **c]** Health is just the other side of the coin of being ill
- **d]** In a salutogenic approach to treatment no special attention needs to be given to communication and the selection of words

11. Neurophysiological models in physiotherapy practice:
- **a]** Serve to develop a broader understanding of the pain experience
- **b]** Should not be used in educational sessions with patients, as it will only lead to confusion
- **c]** Only nociceptive and peripheral neurogenic pain mechanisms are of relevance.
- **d]** Central nervous system mechanism belong in the care of psychologist

12. Cognitive behavioural approaches to practice:
- **a]** Define the different roles a clinician may take during treatment to enhance change in a patient
- **b]** Should consider the various phases of change through which individuals may go before a change in behaviour is established
- **c]** Compliance enhancement is an important aspect of a cognitive behavioural approach
- **d]** Can be employed during any phase of examination and treatment

13. Theoretical biomechanical models as, for example, theories on coupling movements of the spine or convex–concave rule of movements of peripheral joints:
- **a]** Are contradictory, therefor they should not be employed in clinical practice
- **b]** Serve as the only means to make decisions regarding treatment with passive movement
- **c]** The models need to be considered in the context of pathological changes and structural differences and may enhance initial decision making with regards to the selection of treatment
- **d]** The models need to be linked to clinical information as for example changes in perceived resistance and pain. They have to be monitored by reassessment procedures.

Management of craniomandibular disorders

3

1. Intra-articular ligaments of the temporomandibular joint are:

A. Lig. temporomandibulare laterale
B. Lig. disco-temporale
C. Lig. disco-condylare
D. Lig. spheno-mandibulare

- **a]** A and B are correct
- **b]** B and C are correct
- **c]** A and D are correct
- **d]** all are correct

2. As masticatory (chewing) muscles are considered:

A. M. masseter, pars profundus and pars superficialis
B. M. temporalis, pars anterior and pars posterior
C. M. pterygoideus medialis, pars anterior and pars posterior
D. M. pterygoideus lateralis, pars inferior, pars intermedius and pars superior

- **a]** All are correct
- **b]** Only A and B are correct
- **c]** Only A and C are correct
- **d]** Only A, C and D are correct

3. The anterior temporomandibular joint capsule shows attachments with:

A. Discus articularis
B. Os temporale, anterior of the tuberculum or eminentia articulare
C. Condylus mandibulare
D. M. pterygoideus lateralis, pars superior

- **a]** All are correct
- **b]** Only A and C are correct
- **c]** Only B, C and D are correct
- **d]** Only A and B are correct

4. Typical physiological characteristics of the discus articularis of the temporomandibular joint are:

A. Three-dimensional biconcave hat shaped
B. The posterior border is in the vertical line on top of the head of the mandible or slightly anterior (11 or 12 o'clock position) and shows two ligamentous attachments
C. Designed for equilibration and suspension between the fossa of the temporal bone and mandibular head in all positions of the mandible
D. Can move over the mandibular head passively; muscular activity is not required

- **a]** Only A and C are correct
- **b]** Only B and D are correct
- **c]** Only A, B and C are correct
- **d]** All are correct

5. Excursive movements of the temporomandibular joint are:

A. Depression
B. Elevation
C. Protraction
D. Lateral movements

- **a]** All are correct
- **b]** Only A and B are correct
- **c]** Only A, C and D are correct
- **d]** Only B and D are correct

6. Physiological characteristics of depression (mouth opening) are:

A. Average range of motion measured between the incisives is 36–50 mm, including overbite

B. Average range of motion measured between the incisives is equal with the width of two fingers of the same person

C. Condylar rotation along a frontal axis during initial depression (arthrokinematics of the lower joint compartment)

D. Limited mouth opening is related with the occurrence of mental depression

- **a]** Only A and C are correct
- **b]** Only B and D are correct
- **c]** Only A, B and D are correct
- **d]** All are correct

7. The temporomandibular joint differs from most other synovial peripheral joints in the human body by:

A. The temporomandibular joint never develops degenerative changes

B. The head of the mandible has fibrous cartilage

C. The left and right joints have one common distal joint partner

D. Teeth contribute to movement behaviour, movement guidance and resting position of the joint

- **a]** All are correct
- **b]** Only B and C are correct
- **c]** Only B and D are correct
- **d]** Only B, C and D are correct

8. Functions of the various fascicles of the lateral pterygoid muscle are:

A. Stabilizing the disc-condyle complex

B. Eccentric activity on incursive movements such as mouth closing

C. Concentric activity on lateral movement

D. Swallowing

- **a]** All are correct
- **b]** Only A and C are correct
- **c]** Only B and D are correct
- **d]** Only A, B and C are correct

9. Stomatognathic muscles regularly showing tender or trigger points are:

A. M. pterygoideus medialis, M. masseter and M. temporalis

B. M. digastricus

C. M. buccinator

D. M. orbicularis oris, Mm. levator and depressor anguli ori

- **a]** All are correct
- **b]** Only A and B are correct
- **c]** Only B and D are correct
- **d]** Only A and C are correct

10. Which suprahyoidal muscle receives its motor innervation from the cervical spine?

- **a]** M. digastricus, venter posterior
- **b]** M. mylohyoideus
- **c]** M. geniohyoideus
- **d]** M. stylohyoideus

11. Which infrahyoidal muscle receive motor innervation from the cervical spine?

A. M. sternohyoideus

B. M. thyrohyoideus

C. M. sternothyroideus

D. M. omohyoideus

- **a]** All are correct
- **b]** Only A and C are correct
- **c]** Only B and D are correct
- **d]** Only A, B and C are correct

12. Main aims of myofunctional therapy are:

A. lip closing

B. gain control over tongue movements and position e.g. at swallowing

C. support orthodontic management

D. having fun at children's birthdays

- **a]** All are correct
- **b]** Only A and C are correct
- **c]** Only B and D are correct
- **d]** Only A, B and C are correct

13. Peripheral somatic nerves that contribute to the sensory innervation of the head are:

A. N. trigeminus including its main branches N. opthalmicus, N. maxillaris and N. mandibularis

B. N. facialis

C. N. accessorius and N. hypoglossus

D. N. spinales C1–3

- **a]** Only A and C are correct
- **b]** Only B and D are correct
- **c]** Only A, B and D are correct
- **d]** All are correct

14. The caudad part of the spinal nuclei of the trigeminal nerve (Nucleus trigemino-cervicalis, pars caudalis)…

A. Receives sensory input of the mandibular, temporal and frontal region of the head
B. Stretches out caudally to at least the myelum segment C3
C. Shares the dorsal horns with incoming afferents from the upper cervical segments
D. Differs in its organizational pattern from the three main peripheral end branches of the N. trigeminus that innervate the skull

a] Only A and C are correct
b] Only B and D are correct
c] Only A, B and D are correct
d] All are correct

15. Functions of the emotional motor system (EMS), descending efferent loops from the limbic system to motor nuclei, are considered:

A. Vocalization
B. Licking, chewing and swallowing
C. Mimic expression
D. Lordosis behaviour, including hormonal components

a] Only A and C are correct
b] Only B and D are correct
c] Only A, B and D are correct
d] All are correct

16. Antero-posterior accessory movement of the mandible is considered to:

A. Load the retrodiscal bilaminar zone and the posterior joint capsule of the temporomandibular joint
B. Indicate an intra-articular dysfunction if painful or definitely limited
C. Being one component of the retruding grinding movement (in bruxism)
D. Promote non-physiological posterior translation in the lower compartment

a] All are correct
b] Only A and C are correct
c] Only B and D are correct
d] Only A, B and C are correct

17. Accessory movements that can be considered useful contributing treatment directions in intra- or peri-articular temporomandibular joint disorders are:

A. longitudinal cephalad
B. longitudinal caudad
C. transverse medially
D. anteroposterior

a] All are correct
b] Only A and D are correct
c] Only B and C are correct
d] Only A, B and D are correct

18. Overlapping characteristics of the upper cervical spine and the stomatognathic tract include:

A. Both can show similar areas of pain and complaints
B. Both may be the source of facial pain at daily activities such as eating
C. Arthrokinematic interrelationship: upper cervical movements affect mandibular resting position and mandibular movements may demand cervical movement or stability
D. Nociceptive input from trigeminal and upper cervical innervated areas share common dorsal horns of the myelum

a] Only A and C are correct
b] Only B and D are correct
c] Only A, B and D are correct
d] All are correct

19. The role of the physical therapist in the overall management of craniomandibular dysfunction may include:

A. Providing passive movement techniques, e.g. for the mandible and hyoid bone
B. Instructing active training of masticatory, hyoidal, cervical and or mimic muscles
C. Providing other interventions such as myofeedback, electromassage, taping (elastic), trigger point treatment, relaxation
D. Contributing to clinical diagnosis and formulation of the management plan

a] Only A and C are correct
b] Only B and D are correct
c] Only A, B and D are correct
d] All are correct

20. Apart from physical therapy modalities, the overall management of cranio-mandibular dysfunction may include:

A. splint therapy

B. anti-inflammatory medication

C. orthodontic management with braces and or occlusal correction (abrading) / teeth restoration

D. change of anti-concepive medication

a] Only A and C are correct

b] Only B and D are correct

c] Only A, B and D are correct

d] All are correct

Management of shoulder and shoulder girdle disorders

4

One or more of the answers maybe correct.

1. What benefts does the extended scope physiotherapist role bring to the physiotherapy profession?
   a] Increased breadth of medical knowledge
   b] Increased profle of physiotherapy
   c] Extended clinical career ladder
   d] All of the above
2. Which of the below options best demonstrates how a physiotherapy diagnosis *differs* from a medical diagnosis?
   a] A physiotherapy diagnosis relates to both the management and prognosis of an individual.
   b] Physiotherapy diagnosis is concerned with classifying the consequences of a patient's disease, injury or disorder
   c] Physiotherapy diagnosis is concerned with the determination of the cause of a patient's illness or suffering
   d] All of the above
3. As a physiotherapist what are the limitations one should be aware of when considering the medical diagnostic titles associated with shoulder conditions? Tick all which apply.
   a] There is a lack of uniformity in the way shoulder conditions are labelled
   b] The manner in which diagnostic labels are defned is inconsistent
   c] A variety of shoulder classifcation systems have been shown to have poor inter-rater reliability
   d] There are diffculties associated with establishing links between pathology and symptomology
4. Which of these orthopaedic special tests are considered to be diagnostically discriminatory?
   a] External rotation lag sign
   b] Hawkins-Kennedy test
   c] Biceps load II test
   d] None of the above
5. Which issues have been reported in the literature which may help to explain the disappointing diagnostic accuracy and reliability of the shoulder orthopaedic special tests? Tick all which apply.
   a] Pain inhibition
   b] Anatomical validity
   c] Inconsistent operational defnitions
   d] Widespread research methodological shortcomings
6. Physiotherapy treatment should primarily be based upon which of the following?
   a] The referring practitioner's diagnosis
   b] The patient's functional impairments
   c] The results of any medical investigations
   d] The theoretical impression of the disorder

7. With regards to imaging and rotator cuff pathology, which of the following statements is true?
   a] On balance both ultrasound and MRI are accurate in the detection of full thickness rotator cuff tears
   b] On balance both ultrasound and MRI are accurate in the detection of partial thickness rotator cuff tears
   c] There is a high correlation between increasing age and rotator cuff tears
   d] The detection of a rotator cuff tear signifies the cause of the patient's shoulder pain or functional loss

8. Which of the following have been proposed as theoretical aetiological mechanisms for rotator cuff tendinopathy/subacromial impingement?
   a] Movement disorders of the scapula
   b] Excessive superior humeral head migration
   c] Intrinsic tendon mechanical overload
   d] All of the above

9. Which of the following should be considered as red flags during the shoulder examination?
   a] Previous history of cancer
   b] Progressive well localised pain, often night predominant
   c] Unexplained wasting, significant sensory or motor deficit
   d] Local shoulder redness and systemically unwell

10. Which of the following situations should be considered to require early medical intervention?
   a] A young adult with acute traumatic primary anterior shoulder dislocation
   b] Severe, irritable movement related shoulder pain
   c] Recent trauma with acute disabling pain and significant weakness
   d] A young adult with symptoms suggestive of atraumatic instability who shows no response to three sessions of treatment

11. When examining the shoulder the screening process of the cervical spine should include:
   a] Active cervical movements
   b] Cervical quadrants and compression tests
   c] Cervical passive accessory intervertebral movements
   d] Meticulous reassessment of the subjective and physical asterisks post cervical examination

12. From the following list of nerves identify the one which is not capable of producing pain in the deltoid region of the upper arm.
   a] The suprascapular nerve
   b] The axillary nerve
   c] The long thoracic nerve
   d] C5 nerve root

13. Which of the following impairments have been associated with the medical diagnostic term of subacromial impingement?
   a] Minor glenohumeral instability
   b] Glenohumeral joint stiffness
   c] Sterno-clavicular joint stiffness
   d] Scapular dyskinesis

14. Which of the below patients is most likely to have sustained a full thickness rotator cuff tear?
   a] A sedentary male of 30 years with severe shoulder pain of an insidious onset
   b] A 21-year-old professional tennis player with severe shoulder pain whilst serving
   c] A 65-year-old gentleman with severe shoulder pain following a FOOSH
   d] A 40-year-old gentleman with severe shoulder pain following a lifting incident

15. A 40-year-old lady with type II diabetes presents with a 6 week history of an insidious onset of severe shoulder pain disturbing her sleep. Which of the following medical diagnostic terms would you consider to be **most** likely?
   a] Glenohumeral osteoarthritis
   b] Calcific tendonitis
   c] Frozen shoulder
   d] Subacromial impingement

16. A 70-year-old lady presents with a medical diagnosis of glenohumeral OA. You have established that her main disability is a difficulty fastening her bra behind her back. Which one of these physical impairments is most likely to be relevant?
   a] Reduced upward elevation and outward rotation of the scapula
   b] A weakness in resisted lateral rotation
   c] Reduced thoracic extension
   d] Stiff glenohumeral joint medial rotation

17. A weight lifter presents with an inability to perform a bench press. You have identif ed that the movement impairment is a painful restriction to horizontal extension in 90° abduction. Which components need to be assessed to determine the cause of this movement impairment?

a] The intra-articular and peri-articular glenohumeral joint structures

b] The upper limb neural provocation test 1

c] The f rst and second ribs

d] The cervical spine

18. A patient is referred to Physiotherapy post subacromial decompression with a painful restriction to forward elevation. Which of the points below should be considered in the patient's management?

a] A knowledge of the healing times and surgical intervention undertaken

b] The surgeon's post-operative protocol

c] The patient's functional loss and aims for treatment

d] Identif cation of all possible components contributing to movement impairments

19. Which of the following statements and requirements are considered as essential to the Maitland concept?

a] An open-minded attitude to treatment techniques, being able to innovate freely, unhindered by theory and to relate the techniques to functional disturbances.

b] Flawless analytical assessment. Validation-proving each step in the clinical situation.

c] Not allowing theoretical knowledge, or the lack of it to obstruct seeing or f nding clinical facts.

d] Making use of the patient's functional movements, with which he/she can demonstrate his/her disability or disorder.

20. What clinical information can be gleaned from a positive Hawkins–Kennedy test?

a] Internal rotation of the arm in 90° scapular elevation is painful

b] Subacromial impingement is present

c] The underlying pathology is a supraspinatus tendinopathy

d] Subacromial bursitis is the likely cause of symptoms

Management of elbow disorders

5

1. The articular surfaces of the humeroulnar joint and the type of joint formed are best described as:
   a] Concave/convex and biaxial
   b] Saddle-shaped and uniaxial
   c] Saddle shaped and biaxial
   d] None of the above
2. Peripheral sensitization of the median nerve inducing elbow pain would be identified by?
   a] Symptom reproduction on active median nerve neurodynamic tests
   b] Symptom reproduction on passive median nerve neurodynamic tests
   c] Local pain on palpation of the median nerve at the elbow
   d] All of the above
3. What are the approximate normal ranges of forearm pronation and supination in women:
   a] 110° and 90°
   b] 90° and 80°
   c] 80° and 90°
   d] 60°and 70°
4. Possible entrapment sites for the median nerve at the elbow include:
   a] Ligament of Struthers, carpal tunnel, and pronator teres
   b] Cubital tunnel, carpal tunnel, and pronator teres
   c] Ligament of Struthers, bicipital aponeurosis, and pronator teres
   d] None of the above
5. Name possible entrapment sites for the branches of the radial nerve at the elbow:
   a] Triceps tunnel
   b] Supinator tunnel
   c] Radial tunnel
   d] b and c
6. Name possible consequences of ulnar nerve compression at the elbow:
   a] Sensory loss in the C7 dermatome
   b] Weakness of the abductor digiti minimi and sensory loss at the tip of the fifth finger
   c] Positive reverse Phalens test
   d] Positive ulnar nerve neurodynamic test
7. The most common cause of elbow pain in children under 10 years is:
   a] Rheumatoid arthritis
   b] Panner disease (osteochondrosis)
   c] Osgood schlatters disease
   d] Lateral epicondylalgia
8. A baseball pitcher reports posterior elbow pain associated with end-range elbow extension movement. Treatment could include:
   a] Olecranon rotational mobilization with movement
   b] Ultrasound
   c] Rest and splinting
   d] None of the above

9. You suspect a compressive neuropathy of the posterior interosseous nerve. Describe the area of sensory examination to support this:
   a] Lateral elbow
   b] Dorsum of the wrist
   c] C7 dermatome
   d] None of the above
10. Contraindication to extension/adduction grade IV at the elbow should include:
   a] Pain
   b] Joint stiffness on elbow flexion
   c] Difficulty to relax
   d] Laxity of the lateral ligament complex
11. Manual examination of the elbow should include:
   a] All potential contributing factors
   b] Articular structures
   c] The humeroulnar joint, radiohumeral and radioulnar joints
   d] Movement impairments
12. Barriers to recovery from elbow pain include:
   a] Psychological status
   b] Job stress
   c] Pain coping styles
   d] All of the above
13. Chronic lateral epicondylalgia is:
   a] A lost cause
   b] A multisystem problem
   c] Rarely helped by manual therapy
   d] Always musculotendinous in origin
14. Name the tests to 'prove' the elbow unaffected in a low grade elbow pain condition:
   a] Extension/abduction and extension/adduction
   b] Supination and pronation overpressure
   c] a and b
   d] Flexion and extension overpressure
15. Mobilization with movement involves:
   a] Pain-free accessory glide with active or passive movement
   b] Pain-free accessory glide followed by muscle contraction
   c] Painful accessory glide followed by active movement
   d] Painful accessory glide followed by muscle contraction
16. Symptom from a remote source are likely to be:
   a] Localized, defined, precise
   b] Vague, spreading medially
   c] Associated with specific elbow movements
   d] None of the above
17. The risk of myositis ossificans is:
   a] Reduced by judicious, thoughtful and controlled techniques
   b] Reduced by high velocity thrust techniques
   c] Reduced if pain-free, gentle techniques are employed
   d] a and c
18. Examination of the local articular structures in the composite elbow includes the:
   a] Radioulnar joint
   b] Radiohumeral joint
   c] Humeroulnar joint
   d] All the above
19. Strengthening exercise for lateral epicondylalgia are:
   a] Contraindicated
   b] Focused on the pronator muscles
   c] Aimed to minimize a deconditioning response to pain
   d] None of the above
20. A patient presents with diffuse lateral elbow pain, without local signs of dysfunction. Describe the structures you should examine in this case?
   a] Remote structures
   b] The radiohumeral joint
   c] The lateral ligament complex
   d] None of the above

Management of wrist and hand disorders

6

One or more of the answers maybe correct.

1. The tactile-kinaesthetic system is concerned primarily with:
   a] Movement
   b] Co-ordination
   c] Feeling
   d] Body image
2. According to Moseley (2008), in patients with chronic pain, a relationship exists between:
   a] Pain intensity, loss of movement and fear avoidance
   b] Cortical re-organization, proprioception and loss of feeling
   c] Pain description, muscle strength and pain inhibition
   d] Pain intensity, tactile acuity and cortical reorganization
3. Which 'joints' can be differentiated during painful wrist pronation?
   a] Inferior radioulnar and radiocarpal
   b] Inferior radioulnar, radiocarpal, mid carpal [intercarpal] and carpometacarpal
   c] The movement only involves the radioulnar joints
   d] Inferior radioulnar, radiocarpal, mid carpal, carpometacarpal, metacarpophalangeal
4. Painful and debilitating musculoskeletal conditions are a combination of which of the following mechanisms?
   a] Inflammation, nerve injury, fear
   b] Ischemia, complex regional pain, yellow flags
   c] Input, processing, output
   d] Phantom pain, sympathetic pain, mechanical pain
5. Which two of the following features best corresponds to nociception?
   a] A strong relationship between symptoms and mechanical stimuli
   b] Associated tissue changes such as swelling and soft tissue thickening
   c] Spontaneous pain
   d] Numbness and night pain
6. Dequervain's disease is tenosynovitis of the tendon sheaths of:
   a] EPL and ECR
   b] ABD PL and EPB
   c] EPL and ABPL
   d] EPL and EPB
7. Wartenberg's disease or Cheiralgia parasthetica is a sensitive neuropathy of:
   a] The musculocutaneous nerve
   b] The ulnar nerve in Guyon's canal
   c] The superficial branch of the radial nerve
   d] The C5 Nerve root
8. Volkmann's ischaemic contracture results in:
   a] Thoracic outlet syndrome
   b] Gangrene of the hand
   c] Avascular necrosis of scaphoid
   d] Retraction of the forearm flexor muscles

9. According to source, the ideal ranges of movement at the wrist are:
- **a]** flexion 80 degrees, extension 70 degrees, ulnar deviation 35 degrees, radial deviation 20 degrees pronation 85 degrees supination 90 degrees
- **b]** flexion 90 degrees, extension 90 degrees, ulnar deviation 35 degrees, radial deviation 20 degrees pronation 90 degrees supination 90 degrees
- **c]** flexion 85 degrees, extension 80 degrees, ulnar deviation 35 degrees, radial deviation 20 degrees pronation 90 degrees supination 90 degrees
- **d]** flexion 85 degrees, extension 85 degrees, ulnar deviation 20 degrees, radial deviation 10 degrees pronation 90 degrees supination 90 degrees

10. The cutaneous supply of the median nerve include:
- **a]** The ball of the thumb
- **b]** The palmar aspect of thumb, index, middle and half the ring finger
- **c]** The dorsal aspects of the distal phalanx of the thumb, index, middle and half the ring finger
- **d]** The anterior aspect of the forearm

11. Which of the following are features of tendinopathy of the wrist?
- **a]** Crepitus with movement of the fingers
- **b]** Swollen inflamed sheath
- **c]** Pain with gripping
- **d]** History of overuse

12. Examples of prehensile function are:
- **a]** Press ups
- **b]** Opening a bottle
- **c]** Waving
- **d]** Threading a needle

13. To differentiate De Quervain's tendinopathy from radial nerve sensitivity with the elbow in extension, the thumbs in flexion and adduction and with the wrist in ulnar deviation add and release:
- **a]** Forearm pronation
- **b]** Wrist flexion
- **c]** Shoulder girdle depression
- **d]** Cervical contra lateral lateral flexion

14. The superficial radial nerve at the wrist and hand can be palpated:
- **a]** Over the scaphoid tubercle
- **b]** Over the dorsum of the index finger
- **c]** In the 'anatomical snuff box'
- **d]** At the lateral border of the radius just proximal to the radial styloid

15. Mobilize the mid carpal 'joint' into extension by placing:
- **a]** Thumbs against the dorsal aspect of the proximal row of carpal bones and index fingers against the palmar aspect of the distal row of the carpal bones
- **b]** Thumbs and index fingers on the distal row of the carpal bones
- **c]** Thumbs and fingers on the proximal row of the carpal bones
- **d]** Thumbs against the palmar aspect of the distal row of carpal bones and index fingers against the dorsal aspect of the proximal row of the carpal bones

16. Intercarpal horizontal extension is produced by:
- **a]** Adducting the carpal bone
- **b]** Spreading the palm
- **c]** Pulling on the hand
- **d]** Flexing the wrist

17. According to Roston & Wheeler-Haines (1947) to produce cavitation of the MCP joint requires, on average a distraction load of:
- **a]** 0.5 kg
- **b]** 90 kg
- **c]** 8.3 kg
- **d]** 10 kg

18. Stabilization of wrist and hand function should include dissociation of:
- **a]** ECRB/ECRL from FCR
- **b]** Lumbricals and interossei from long flexors and extensors
- **c]** Carpal mobility from wrist mobility
- **d]** Elbow movement from wrist movement

19. Manual therapy has a role to play in peripheral neuropathy and should include which of the possibilities as treatment options:
- **a]** Accessory movements on entrapment sites in neural tension
- **b]** Nerve sliders in the functional position
- **c]** Cervical gliders in specific ULNT
- **d]** Thoracic mobilization in slump position

20. It is possible to modulate nociceptive antalgic activity by:

a] Staring at the hand
b] Wearing pressure gloves
c] Crossing the arms
d] Neglecting the hand

Management of hip disorders

7

One or more of the answers maybe correct.

1. Which of the following structures are likely to refer pain into the groin?
   a] Lateral femoral cutaneous nerve
   b] L5 S1 disc
   c] Patellofemoral joint
   d] Pubic symphysis
2. Structural femoroacetabular impingement is associated with:
   a] Groin pain
   b] Lack of decelerating force in the superficial gluteus maximus
   c] Boney exostosies on the acetabulum or femoral neck
   d] Hypermobility in flexion
3. Iliotibial tractitis may be associated with:
   a] Lateral hip pain
   b] Repeated extension / rotation activities such as jogging
   c] Overactive tensor fascia lata
   d] Inhibited piriformis
4. A patient with degenerative osteoarthritis may be expected to complain of:
   a] Generalized groin pain
   b] Pain relief on weight-bearing
   c] Restriction in multiple movement directions
   d] Most flexible first thing in the morning
5. Meralgia paraesthetica:
   a] Is caused by entrapment of the inguinal nerve
   b] Produces burning pain on the inside of the thigh
   c] Produces symptoms with longer periods of sitting, squatting, increased walking, standing
   d] Is often associated with obesity
6. The segmental stabilizers are:
   a] One-joint muscles
   b] Short
   c] Direction specific
   d] Aligned in the direction of primary joint movement
7. A maximal contraction recruiting only tonic muscle fibres:
   a] Will best be achieved by asking the patient to contract the muscle slowly
   b] Will best be achieved by asking the patient to contract the muscle with at least 40% of maximal voluntary contraction
   c] Will show signs of fatigue by approximately 30 seconds
   d] May be facilitated by increasing proprioceptive input
8. Patients with the following disorders may complain of pain during flexion and flexion/adduction activities:
   a] Structural Femoro-acetabular Impingement (Pincer or Cam)
   b] Excessive Anterior Gliding Dysfunction
   c] Excessive Posterior Gliding Dysfunction
   d] Piriformis syndrome

9. The following parameters are helpful in assessing ideal alignment:
   a] The patella is aligned over the second metatarsal
   b] A line joining the ASIS and PSIS is horizontal or tilted 5° posteriorly
   c] The foot is externally rotated 15°–20°
   d] The knee fold is horizontal (or not more than 10° higher laterally)

10. Apparent hip lateral rotation with toeing-out may be related to which one of the following structural disorders:
   a] Coxa valgus
   b] Femoroacetabular impingement
   c] Femoral retroversion
   d] Tibial torsion

11. Which of the following parameters would be acceptable for active range of hip movement:
   a] Flexion 110°–125°
   b] Extension 10°–15°
   c] Medial rotation (measured in 90° flexion) 30°–45°
   d] Lateral rotation (measured in 90° flexion) 40°–60°

12. When testing the posterior gluteus medius for optimal length change:
   a] Active range of movement should approximately equal passive range
   b] The heel should reach a level approximately 2.5 cms above the plinth (women) or should reach the plinth (men)
   c] The contraction should be held without fatigue for 30 seconds
   d] The waiste should remain in contact with the plinth

13. For ideal performance of the modified Thomas' test:
   a] The patient's lumbar spine should lie flat on the plinth
   b] During hip extension on the test side the hip should remain in neutral abduction/adduction
   c] The thigh should come to rest on the plinth with the knee flexed and the hip in 15° adduction
   d] The thigh should come to rest on the plinth with the knee extended and the hip in abduction

14. During the flexion/adduction examination test:
   a] Groin pain should not be elicited in the normal hip
   b] Increased pain caused by tilting the ilium posteriorly in a symptomatic position implicates the sacroiliac joint
   c] Increased pain caused by tilting the ilium anteriorly in a symptomatic position implicates the lumbar spine
   d] Pain from a structural femoroacetabular impingement but not from a functional anteromedial impingement may be expected

15. Restricted posterior and lateral gliding:
   a] May be responsible for gross restriction of physiological flexion
   b] May be implicated if a SLR performed with simultaneous anteroposterior pressure on the femoral head goes further than the classical SLR procedure
   c] May be due to overactivity in the posterior hip joint muscles
   d] May be associated with excessive anterior gliding

16. The test for excessive anterior gliding in prone:
   a] Requires the patient to extend the externally rotated hip 10°–15°
   b] Is positive if the trochanter moves towards the plinth
   c] Requires good fixation of the ilium on the test side
   d] Is positive if the patient internally rotates the hip

17. Strong lateral accessory movement as a passive mobilising technique may be ideal for the treatment of:
   a] Medial migratory presentations of osteoarthritis
   b] 'Up and out' migratory presentations of osteoarthritis
   c] Excessive posterior gliding dysfunction
   d] Restricted hip flexion

18. Which of the following statements are accurate?
   a] The segmental stabilizers should be tonically recruited to stabilize excessive gliding movements

b] As a multi-joint global mobilizer psoas is often overactive or short and requires inhibition and lengthening techniques

c] Recruiting/shortening the global stabilizers and inhibiting/lengthening the global mobilizers may help painful hypermobility disorders

d] Recruiting the global stabilizer is much more important than correcting posture or correcting movement patterns

19. When physiological movement is restricted and non-irritable, treatment may be directed at:

a] Lengthening the fascia

b] Inhibiting/lengthening the global Stabilizers

c] Mobilizing the joint

d] Recruiting the segmental stabilizers

20. Which of the following techniques may be important in the treatment of athlete's groin:

a] Recruitment of transversus abdominis

b] Stretching of the painful adductors

c] Surgical techniques to suture and stabilize the abdominal fascia

d] Avoidance of forceful rotatory and 'stop and go' activities in early rehabilitation

Management of knee disorders

8

One or more of the answers maybe correct.

1. The 'Bone and Joint Decade' is raising awareness to:
   a] The necessity of an active lifestyle to prevent non communicable diseases as osteoarthritis of the knee
   b] Sedentary life styles are of consequence with regards to non communicable diseases only to the elderly population
   c] Poor habits in diet and activity levels in adolescent ages have no impact on an individual's health in future
   d] Physiotherapy is already sufficiently used in the treatment of osteoarthritis of the hip or knee in the UK
2. In order to improve fitness levels physiotherapists should consider:
   a] Aerobic capacity
   b] Muscle functions as strength, endurance, power
   c] Balance
   d] Agility and flexibility
3. To maintain its stability the knee joint is mainly dependent upon the following structure:
   a] Menisci
   b] Ligaments
   c] Muscle functions
   d] Gliding and rolling mechanisms of the knee joint
   e] All of above interacting together
4. The main functions of the popliteus muscle are:
   a] Internal rotation of the tibia in relation to the femur
   b] Monitoring subtle movement in the transverse and frontal plane of the knee
   c] Controlling anterio-posterior movement of the lateral meniscus
   d] None of above
5. Alignment of the trunk/pelvis/hip area and foot/ankle complex are:
   a] Not relevant in motor patterns of the knee
   b] Influenced by abductors and lateral rotators of the hip
   c] Influenced by intrinsic muscles of the foot
   d] Influenced by quadriceps, hamstrings, gastrocnemius and popliteus muscles
6. Osteoarthritis of the knee:
   a] Will only be diagnosed by x-ray changes
   b] Clinical symptoms do not play a role in diagnosis
   c] A direct correlation between X-ray changes and symptoms and disability is not demonstrated
   d] Needs to be treated with rest

7. Treatment guidelines for osteoarthritis of the knee include:
   a] Optimising movement functions as mobility, motor control, coordination
   b] Restoring overall functional capacity and performance
   c] Enhancement of fitness and wellbeing
   d] Prevention of recurrences of pain and disability

8. OA related research has demonstrated that:
   a] Active exercises may have beneficial effects on treatment outcomes
   b] A combination of active and passive movement show better therapeutic outcomes than either form of treatment alone
   c] No movement has any effect
   d] Anterior thigh pain may be a clinical prediction rule for treatment of the hip in cases of knee osteoarthritis

9. Anterior knee pain as an expression of a patello femoral pain syndrome:
   a] May need to be treated with corrective tapes alone
   b] Corrective tapes are an option to train the VMO : VL relationships in a painfree condition
   c] Passive mobilizations of the patella and soft tissue techniques may be considered as a treatment option in acute and subacute phases of the syndrome
   d] Studies demonstrate a correlation between improvement of the EMG timing of the vasti medialis and lateralis the quadriceps muscles and pain reduction

10. Subjective examination of the knee should encompass:
   a] Questions about the areas of symptoms
   b] Questions related to levels of disability
   c] Questions related to onset of the disorder, being traumatic or of spontaneous onset
   d] Screening questions related to medical disease and health

11. Physical examination – observation of alignment:
   a] Is not important
   b] Is relevant to monitor possible risk factors for knee injury
   c] Should only include the Q-angle (quadriceps-angle)
   d] Should include six measurements/ observations

12. Active tests of the knee:
   a] Are only performed in supine
   b] Include only flexion, extension and rotation movements
   c] Should be adapted to the current levels of activity of the patient
   d] May include movement combinations as for example F/Ab, F/Ad, F/MR, F/LR, E/AB, E/AD

13. Muscles tests may be performed with the following objectives:
   a] Symptom reproduction
   b] Muscle strength, endurance, coordination and recruitment patterns
   c] Muscle length tests
   d] All of above

14. Screening of other movement components in the examination of knee disorders may include:
   a] Examination of the hip
   b] Examination of the lumbar spine
   c] Examination of neurodynamic functions
   d] Examination of the sacroiliac joint

15. Neurodynamic tests for the knee area may include:
   a] Only tests for the sciatic nerve
   b] Only tests for the femoral nerve and its branches
   c] Sciatic nerve with emphasis on the tibial nerve and communal peroneal nerve
   d] Femoral nerve, saphenous nerve, infrapatellar branches

16. Movement diagrams of passive movement tests:
   a] Give inconsistent results and should not be used anymore
   b] Are confusing
   c] Are a means of communication
   d] Are a means of learning the skills of palpation

17. Orthopaedic testing of menisci and ligaments:

a] Are a standard procedure of examination

b] Are only performed if indication of trauma to the structures is present

c] Will frequently be incorporated in the standard movement examination as outlined in the Maitland Concept of Manipulative physiotherapy

d] Many tests have an acceptable sensitivity

18. Treatment of knee disorders:

a] Is related to the restoration of functional capacity

b] Should encompass guiding patients to a health living and life-style

c] Passive mobilization may play a core role in acute and subacute phases of pain

d] Motor control enhancement strategies are often a part of treatment planning

19. Passive mobilizations are being selected

a] Based on the behaviour of pain, tissue resistance and motor reactions of physiological movements

b] Based on the behaviour of pain, tissue resistance and motor reactions of accessory movements

c] Based on current levels of pain and mobility

d] Only in cases of stiffness, not in cases of hypermobility or instability

20. Compression may be added to the joint surfaces while treating with passive movement:

a] This is a novel contribution of Maitland to the world of manipulative physiotherapy

b] In cases of a pain occurring 'through the range of movement', pain occurring mainly when loading the structures concerned and the pain increases under compression

c] In cases in cases of acute inflammation of the joint

d] In early postsurgical phases

Management of foot and ankle disorders

9

One or more of the answers maybe correct.

1. How many bones do the foot and ankle contains?
   a] 42
   b] 52
   c] 28
   d] 25
2. What is the main function of the distal tibiof bular syndesmosis?
   a] Provide stability for the ankle
   b] Prevent movement of the ankle
   c] Restrict movement of the STJ
   d] Provide stability for the knee
3. What is the normal range of motion of the subtalar joint?
   a] 100 degrees
   b] 20 degrees
   c] 10 degrees
   d] 30 degrees
4. What is the predominant motion plane of the midtarsal joint?
   a] Frontal plane
   b] Variable between subjects
   c] Sagittal plane
   d] Transverse plane
5. How many degrees the f rst metatarsophalangeal joint dorsiflex during the pre-swing of the gait cycle?
   a] 70
   b] 45
   c] 55
   d] 110
6. What is the estimated prevalence of the plantar heel pain in general population?
   a] 10%
   b] 50%
   c] 2%
   d] 15%
7. How many people develop chronic ankle instability after an acute ankle sprain?
   a] 80–90%
   b] 2–4%
   c] 10–20%
   d] 50%
8. What is the role of the subjective examination?
   a] It is not necessary.
   b] It forms a basis for the clinical reasoning process.
   c] It completes the information gathered during the physical examination.
   d] It is important for legal purposes.
9. Which alternatives of the following suggestions belong to the subjective examination?
   a] Symptom area
   b] Movement testing
   c] Behaviour of the patient according to the disorder
   d] History of the symptoms

10. Which of the following phases are included in planning of the physical examination?
    a] Functional demonstration
    b] Expressing hypotheses
    c] Reflection on the subjective examination
    d] Planning physical examiantion procedures
11. Which of the following alternatives represent hypotheses categories?
    a] Prognosis
    b] Direction of impairment
    c] Source of the symptoms
    d] Mobilization
12. How many phases are there in physical examination of the foot and ankle?
    a] 10
    b] 7
    c] 3
    d] 5
13. How is the position of the foot and ankle standardized during observation in non-weight bearing?
    a] Patient is standing with the feet facing forwards
    b] Patient is in relaxed prone lying position
    c] Talocrural joint is in neutral dorsiflexion
    d] Subtalar joint is positioned in a neutral position
14. What special feature observation of the gait provides physical examination of the foot and ankle?
    a] Timing relationship of the movements during gait cycle
    b] Mobility of the joints
    c] Provocation test
    d] Passive mobility of the joints
15. What is the aim of the passive movement testing?
    a] Provoke symptoms
    b] Identify movement impairments
    c] Identify direction of impairment
    d] Identify motor control impairment
16. Which physiological movement directions of the following alternatives are related to passive movement testing of the foot and ankle?
    a] Longitudinal caudad
    b] Anteroposterior movement of the talus
    c] Plantarflexion
    d] Supination
17. Which movement components of the following alternatives are related to hindfoot supination?
    a] Plantarflexion
    b] Inversion
    c] Lateral rotation
    d] Medial rotation
18. What is the primary intervention in movement impairments?
    a] Motor control exercises
    b] Medical treatment
    c] Restoring physiological movement with mobilization and/or exercises
    d] Foot orthoses
19. What is the primary intervention in motor control impairments?
    a] Medical treatment
    b] Foot orthoses
    c] Therapeutic exercises
    d] Mobilization and manipulation
20. What is basis of the selection of the exercises in motor control impairment?
    a] Strength
    b] Endurance
    c] Direction of the impairment
    d] Mobility

Vertebral manipulation

Question	Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 7	Chapter 8	Chapter 9
1	b	c,d	b	d	b	c	b,d	a	c
2	d	a,b	a	b	d	d	a,c	a,b,c,d	a
3	c	b,d	a	a,b,c,d	c	b	a,b,c	e	c
4	c	a,b	d	d	c	c	a,c	a,b,c	b
5	d	b,c	c	a,b,c,d	d	a,b	c,d	b,c,d	c
6	a	a	a	b	b	b	a,b	c	a
7	b	a,c,d	d	a,c	b	c	a,d	a,b,c,d	c
8	a	a,c,d	d	d	a	d	a,b,c	a,b,d	b
9	a	a,b,c,d	b	a,b,c,d	d	a	a,d	b,c,d	a,c,d
10	a	a,b	c	a,c	d	a,b,c	c	a,b,c,d	b,c,d
11	b	a	a	a,b,c,d	a	a,b,c,d	a,b,c,d	b,d	a,b,c
12	d	a,b,c,d	d	c	d	b,d	a,c	c,d	b
13	c	c,d	c	ab	b	c,d	c	d	d
14	c		c	a,b,c,d	c	c,d	b	a,b,c,d	a
15	c		d	c	a	a	a,b,c,d	c,d	a,b,c
16	d		a	d	d	b	b,c	c,d	c,d
17	a		c	a,b,c,d	d	c	a,d	b,c,d	a,b,d
18	b		d	a,b,c,d	d	b	a,c	a,b,c,d	c
19	c		d	a,b,c,d	c	a,b,c,d	a,c	a,b,c	c
20	c		d	a	a	c	a,c,d	a,b	c

Self-management strategies: Compliance and behavioural change

Appendix 1

Elly Hengeveld

CHAPTER CONTENTS

As stated at various times in this book, in many clinical presentations passive mobilization can be considered as a kick-start to active movement. Therefore manipulative physiotherapists will often suggest self-management strategies complementary to the passive mobilizations, once they have established the sources of the movement dysfunctions and the mechanisms of the nociceptive processes.

Self-management strategies should refect the clinical stages and syndromes as outlined in Chapter 1 and may follow different purposes:

- Self-help strategies to control pain and promote a sense of wellbeing
- Prevention of new episodes of symptoms
- Increase general physical fitness and normalize activity levels
- Increase bodily awareness and relaxation
- Rehabilitation of movement impairments such as joint mobility, neurodynamics and muscle function.

The provided instructions, suggestions and exercises are especially relevant in the process of secondary prevention of disability due to pain. Currently this concept receives much attention in the treatment of spinal disorders as, over a period of two decades until the end of the 1990s, the prevalence of chronic disability due to low back pain increased substantially in industrialized countries (Waddell 2004). It is suggested that psychosocial factors (e.g. fear avoidance behaviour, beliefs) as well as confusing information by clinicians are contributing elements in this development (Kendall et al. 1997).

In particular, a sense of helplessness, which easily evolves into hopelessness, may be an important contributing factor which should be prevented in any acute pain state (Harding et al. 1998). Therefore it may be concluded that it is essential in an early stage of treatment to guide patients to a *sense of control* over their wellbeing with self-management strategies (Roberts et al. 2002).

An increasing number of studies incorporating variables with locus of control (Rotter 1966) or self-efficacy beliefs (Bandura 1989) are being integrated in physiotherapy research (Crook et al. 1998, Frost et al. 2000, Roberts et al. 2002).

It is important to realize that the sense of control may change over the period of time in which a patient suffers from pain and restricted functioning. It is possible that a sense of helplessness increases with ongoing states of pain and disability. It is crucial that the physiotherapist discovers in an early stage of examination whether or not patients (still) have a sense of control over their pain and perceived limitations of daily life and which strategies they employ to achieve this.

Physiotherapists with their specific professional expertise have numerous possibilities to guide patients towards a sense of control over their pain or wellbeing, as for example:

- repeated movements
- automobilizations
- relaxation strategies
- body and proprioceptive awareness
- muscle recruitment exercises
- other pain-management strategies (e.g. hot packs, cold packs).

Compliance

In the process in which the physiotherapist provides the patient with self-management strategies, the concept of compliance enhancement plays an important role.

Compliance is described as the degree to which the behaviour of a client coincides with the recommendations of the clinician (Schneiders et al. 1998). At times the word 'adherence' is used as well. However, both terms are somewhat awkward, as they indicate too strongly an authoritarian one-dimensional clinician–patient relationship in which the patient has to follow the orders of the clinician in a passive role (Kleinmann 1997). Within this context a focus on the change of unfavourable (movement) behaviours in daily life is recommended, hence taking a cognitive– behavioural perspective in which the term 'compliance' is associated with a more active role for the patient.

Barriers to compliance

It seems that compliance to medical or physiotherapy interventions ranges from 15 to 94%, depending on the way the studies were performed (Sluys & Hermans 1990, Ferri et al. 1998). There appear to be different opinions as to why patients would not follow the advice, recommendations or exercises of a physiotherapist. It appears that many physiotherapists contribute this to patients' lack of motivation or discipline (Kok & Bouter 1990).

However, a profound study indicates several categories of barriers perceived by *patients* to the suggested behaviours (Sluys 1991):

- Barriers to incorporating the suggestions and exercises into daily life (e.g. exercises in supine cannot be performed in a work setting; lack of time to exercise every day for 30 minutes; directive goal setting such as '*you should take more time off for yourself*'; too many instructions and suggestions in one treatment session).
- Lack of positive feedback (insecurity as to whether the exercises are performed in the correct manner; no experience if the exercises truly are helpful).
- Sense of helplessness (the patient does not *experience* an ability to influence the situation positively).

Cognitive–behavioural approach

Based on these perceived barriers it is suggested that the therapist follows a cognitive–behavioural approach to the education of a patient, with an information plan incorporated in the overall treatment plan (Sluys 2000). In this approach, focussing on the *change of unhelpful habits* in movement behaviour is recommended (Harding & Williams 1995).

However, frequently physiotherapists seem to choose a somewhat one-dimensional approach to treatment (Fig. A1.1) in which no specific behavioural or communication strategies are pursued. In a one-dimensional approach it is assumed that trust to move as well as the levels of activity and participation normalize as a consequence of interventions with objectives such as pain reduction and normalization of movement impairments. Furthermore, it appears that it is expected that a single instruction of an exercise leads to a lasting change in behaviour, in which the suggested interventions are employed at all the moments in which this seems necessary (Hengeveld 2000). Within this context there is the criticism that physiotherapists seem to prefer to *tell* a patient how to move in daily life, rather than

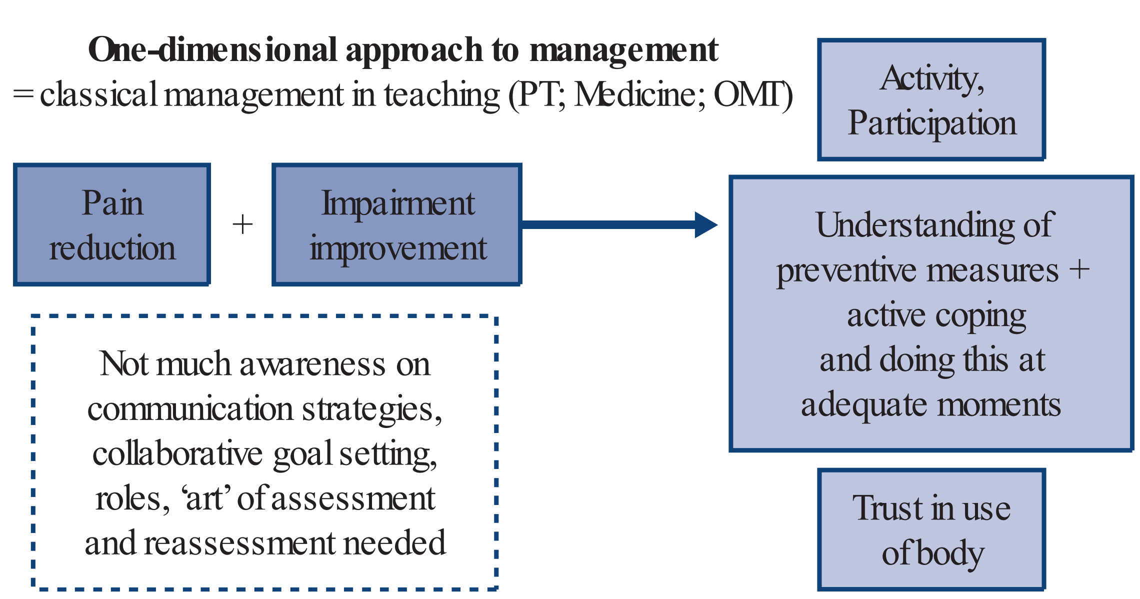

Figure A1.1 • One-dimensional approach to treatment. Reproduced by kind permission from Hengeveld (2000).

guiding them to *experience* this (Treves 1998). This may hinder some patients in regaining trust in daily life activities.

Habits don't change overnight – phases of change

Habits rarely change overnight and people will go through phases in which the *intention* may exist to change the behaviour, but distractions and tasks in daily life, as well as other habits, may hinder the patient from automatically and consequently incorporating the suggested behaviour immediately.

It has been postulated that people go through various stages of motivation in a behavioural change (Prochaska & DiClemente 1994, Van der Burgt & Verhulst 1997, Dijkstra 2002) (Table A1.1). It can be summarized from these models that a person goes through various phases before being able to successfully implement the suggested behaviours in daily life routines:

- Motivation development
- Short-term compliance: the behaviour is performed as long as the contact between the physiotherapist and patient exists
- Long-term compliance: the patient maintains the behaviour after the completion of treatment.

Motivational phase

- In this phase the patient often needs educational strategies with regard to, for example, the positive effects of movements on osteoarthritic processes or discal problems. Education with regard to neurophysiological pain mechanisms may also be necessary in this phase.

Table A1.1 Models of stages of change in behaviour and suggested interventions by physiotherapist

Prochaska & DiClemente (1994) – Stages of change model	Van der Burgt & Verhulst (1997)	Dijkstra (2002)
1 Precontemplation: in this phase changing behaviour is not considered 2 Contemplation: change of behaviour is considered; however no concrete plan exists 3 Preparation: plans are developed actively to change the behaviour in the short term 4 Action: phase in which the desired behaviour is performed 5 Consolidation: the desired behaviour is maintained and fallbacks in behaviours are prevented	1 Openness: (PT interventions: Investigation of beliefs and expectations. Information on usefulness of movement with e.g. discal problems or osteoarthritis) 2 Understanding and comprehension of the information: (often neglected inphysiotherapy: have the patientsunderstood and do they consider the given information useful?) 3 Intention (development of plans) 4 Capability (having the capacity) The exercises should be simple and if possible give a sense of success 5 Action: change of behaviour with respect to incorporation of exercises and suggestions into DLA 6 Maintaining behaviour: continuation with the behaviour after completion of therapy	1 Non-motivated: (in this phase a patient needs information and education with regard to the use of exercises to enhance wellbeing. Patients need to experience directly that the exercises contribute to wellbeing. Attention to the quality of the educational processes and reassessment of cognitive objectives is necessary – i.e. has the patient understood what the PT wanted to explain?) 2 Consideration if suggested behaviour is useful (allow time for the patient to ask questions concerning the information given in previous sessions) 3 Preparation (development of plan and clear intentions) Clear instructions needed, when to do the exercises in daily life, asking when it was possible to do the exercises and when difficulties existed, monitoring if the suggested interventions brought the desired results 4 Experimenting with the actions in various daily life situations 5 Action: change of behaviour with respect to incorporation of exercises and suggestions into DLA

Adapted from Prochaska & DiClemente (1994), Van der Burgt & Verhulst (1997), Dijkstra (2002).

- In order to be able to provide the educational strategies successfully, the therapist first needs to determine the patient's beliefs with regard to movement and to ascertain if the patient is receptive to new information.
- Further, it is suggested that the therapist follows an initial process of collaborative goal setting before starting off with explanations and educational strategies (Brioschi 1998).
- After the educational strategies the therapist should evaluate if the patient has understood and can make sense of the information.
- Next, over a period of several sessions, it is essential to give the patient sufficient time to ask questions and seek clarifications.
- In this phase it is essential that the patient can *experience* that movement and relaxation may contribute to wellbeing. Perceived success and a sense of achievement appear to be relevant factors in compliance to exercises (Courneya et al. 2004).
- Reassessment of subjective findings and physical examination tests will contribute to a sense of success.

Short-term compliance

- The phase of short-term compliance begins once the patient starts to experiment with a few simple exercises in daily life.
- It should not be expected that the desired effect is immediately experienced or that the patient performs the exercises at all the appropriate moments in daily life.
- Often it is better to start off with one or two exercises and to check if they are helpful before other exercises are integrated into the self-management programme.
- Regular contact between the physiotherapist and patient is essential, in which the patient can ask questions and the physiotherapist may give corrections or suggestions.
- The physiotherapist may need to motivate the patient to 'hang in' with the exercises, even if no results are experienced yet.

During the subjective reassessment in follow-up sessions, the physiotherapist needs to find out if the patient has been able to perform the exercises and done them at appropriate moments. Patients may do the exercises at fixed times of the day; however, at those moments where pain increases they often stay in the habituated behaviour of resting or taking medication, rather than trying out the suggested interventions. It is essential that the physiotherapist does not consider this as a lack of motivation but as a help-seeking behaviour which has not yet been habituated. The style of communication may influence this process of learning and experimenting with exercises in various daily life situations substantially.

Long-term compliance

- The patient maintains the behaviour after the completion of therapy (long-term compliance).
- This phase needs to be well prepared.
- It usually takes place towards the end of the treatment series and is completed with the final analytical assessment.
- Collaboratively with the physiotherapist, the patient needs to anticipate future situations in which pain is likely to recur.
- The physiotherapist and patient discuss and repeat the behaviours which may be useful to influence the discomfort if the pain situation recurs.
- A repetition of prophylactic measures is often helpful in this phase as well.

Compliance enhancement strategies

In order to develop meaningful exercises for a patient, the physiotherapist may follow an algorithm of actions and decisions:

- Find the sources of the movement dysfunction in examination and reassessment procedures.
- Make a decision regarding treatment goals and interventions colaboratively with the patient.
- In the selection of interventions, make a decision as to which physiotherapist-directed interventions (e.g. passive mobilizations) and

which self-management strategies are to be employed.
- In the selection of self-management strategies the physiotherapist should consider the objectives of the strategies if the patient has to do the exercises for a definite or indefinite period of time.
- To those patients whose main complaint is pain, it is essential to teach coping strategies prior to the employment of interventions which should influence contributing factors (e.g. posture, general fitness).
- With these coping strategies patients may perceive a sense of success and control over their wellbeing, and hence may develop trust to perform exercises which they initially believed to be harmful.

Selection of coping strategies to control pain and wellbeing

- The selection of coping strategies is normally based on the difficulties in daily life activities as perceived by the patient.
- In this case information from the subjective examination is frequently a more decisive factor in decision making than data from inspection or active movement testing.
- In particular, data from the '24-hour behaviour' of symptoms and at times the precipitating factors of the history may be very informative (Chapter 1). It is important to know in which ways the patient is capable of influencing painful daily life activities.
- In order to be able to make a decision with regard to meaningful coping strategies, it is essential that the physiotherapist deliberately seeks information in the above-mentioned phases of subjective examination.

Example

A woman who works in a factory at a sewing-machine develops pain in the thoracic area after 6 hours of work. Although in the physical examination she is shown to have a flattened thoracic kyphosis, her self-management strategies to influence the pain are variations of repeated extension and rotation movements.

Integration of the exercises into daily life situations

- In situations in which the patient needs to develop a new behaviour which influences wellbeing, it may be that the patient will need to employ this behaviour for a long period of time, sometimes for life.
- Therefore it is essential to provide simple, achievable exercises which are easy to incorporate in daily life situations in order for them to become part of the habitual movement behaviour.
- Unfortunately, patients are often taught to perform certain exercises lying supine, although the difficulties they have with pain occur during working situations in, for example, sitting positions. In such cases it is possible that a sense of helplessness gradually develops, as the patient does not perceive a sense of success directly in the given working situation (*'I have tried physiotherapy, but nothing really helped'*).
- It is essential not to teach a single intervention, but to work collaboratively with the patient on modifications of the exercise, according to the demands of the various daily life situations. The patient needs to know that the adaptations are not different exercises but are 'variations on the same theme'.
- Notwithstanding cases such as postoperative management, in which it is anticipated that the exercises only need to be employed for a limited period, the patient may be provided with a 'home programme' to which time is allocated in the patient's daily routine. However, if the patient starts to resume daily routines or returns to work, often it is useful to seek collaboratively with the patient variations of the 'home programme' exercises which can be integrated into the busy schedules of daily life.

Based on a literature study, the following aspects of compliance enhancement are recommended to support the patient optimally to a lasting change in movement behaviour (Hengeveld 2003):

- Follow a cognitive–behavioural perspective, in which it is acknowledged that habits in behaviour do not change overnight with one intervention. Respect the various phases of behavioural change.

- Beliefs with regard to the necessity of activities and movements in the treatment of pain need to be investigated.
- Follow an instruction and education plan, in which an awareness of all the instructions given during one session is necessary. Repeat the given information over various sessions; give pieces of information, rather than everything at once.
- Collaborative goal setting and conscious communication procedures are essential.
- One of the most essential goals of self-management strategies is guiding patients to a sense of control over their wellbeing (Harding et al. 1998).
- If a patient believes that moving may be harmful when activities and work situations provoke pain, the physiotherapist may guide the patient with educational strategies complementary to passive mobilizations and other self-management interventions. At times the physiotherapist may use the following axioms in the educational process:
  - 'It's not *what* you move, but *how* you move' (Sahrmann 1999).
  - 'It's not necessarily the work task, but the working *style* which provokes symptoms' (Watson 1999).
- Take time to teach the exercises, rather than telling the patient what to do in the last few minutes of a session. Allocate time for the patient to ask questions.
- Enhance positive feedback by performing a reassessment after the exercise (sometimes only seeking information about the sense of pain or wellbeing – 'present pain').
- In follow-up sessions ask the patients during the subjective reassessment phase if they have been able to perform the exercises and what the effect was. Pose the questions in such a way that patients feel free to say if they have forgotten the exercises. If this happens, it should not directly be attributed to lack of motivation or discipline.
- Written information as a mnemonic may enhance understanding. At times patients may do this by themselves. A 'pain, activities and exercise diary' may be incorporated.
- Ensure that the exercises can be implemented in daily life situations. Patients frequently need to be provided with variations of the same exercises and should understand them as such. This is particularly important in those situations where a patient needs to develop a new behaviour, which may last for a long time, sometimes for life.
- Anticipation of difficulties: after the selection and instruction of an exercise, the physiotherapist needs to discuss with the patient if and where difficulties are anticipated. Certain exercises may be very useful, but not during a given work situation. Collaborative problem solving for such a situation is essential and modifications of the exercise need to be worked out.
- At the completion of a treatment series, in order to enhance long-term compliance, further anticipation of possible future recurrences and their solutions needs to take place.

Conclusion

Before teaching an exercise the physiotherapist should go through the following steps and questions:

- What are the goals of the exercises?
- When should the exercises be employed in daily life?
- Have I explained the objectives of the exercises to the patient?
- Have I checked if the patient has understood?
- Were the exercises reassessed immediately after being performed? Did they contribute to a sense of success?
- Did I anticipate collaboratively with the patient if and when to perform the exercises should difficulties recur?

This appendix is adapted from Hengeveld, E. 2003. Compliance und Verhaltensänderung in Manueller Therapie. *Manuelle Therapie*, **7**(3), 122–132, with permission.

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Appendix 2

Recording

Elly Hengeveld

CHAPTER CONTENTS

Key words

Recording, reassessment, SOAP notes

Introduction

Assessment and treatment require an in-depth written record of the findings and results at each session. Ideally, documentation which is systematic, consequent and easy to (re-)read in a short time provides the physiotherapist with a framework that should lead the therapist throughout the overall therapeutic process. Systematic records serve as a mnemonic and a means of communication to other professionals. They support the physiotherapist in various ways:

- To reflect upon the decisions made
- To control the actions taken
- If necessary, to quickly adapt the therapy to a changing situation.

Hence, written records are essential in the process of ongoing quality management.

It is argued that many physiotherapists consider documentation of sessions as a necessary evil. As a consequence many records frequently seem superficial and incomplete (Cohen 1997). Although probably recording will not be encountered with a lot of positive expectations in learning the ‘art of physiotherapy’, there are various reasons why physiotherapists should consider the recording of the sessions they shape:

- Records serve as a mnemonic for the physiotherapist of what has been done, thought and planned
- Systematic recording serves clinical reasoning and learning processes: committing thoughts to paper forces therapists to think more precisely and accurately and to become aware of their own reasoning processes. It enhances reflection and monitoring decisions made and actions taken

- Committing the essence of examination and treatment findings to paper is a valuable learning experience in itself. It forces one to identify the things that are essential, and record them, and leave out the less important information
- Committing thoughts to paper, with systematic recording, helps to clear the mind as the information and impressions gained throughout are organized
- Recording of patient information, actions and planning steps support the development of clinical patterns in memory. Therefore recording may be an essential process in the development of experiential knowledge (Higgs & Titchen 1995, Nonaka & Takeuchi 1995)
- Ideally, the records should document the trail along which assessment and treatment are moving
- Comprehensive, systematic patient records may serve as a basis for clinical case studies
- Records may be a mnemonic for the patient as well. In some cases, the patient may have forgotten how the disorder has been improved immediately following a treatment. If for other reasons a few days later the symptoms recur, the patient may easily interpret the condition as unchanged. Examination of the record made immediately following the treatment may guide the physiotherapist as well as the patient in the reassessment of the patient's condition over the whole period directly after the last session until the moment that symptoms increased again
- Records aid communication in team collaboration. If a colleague is absent from work, the physiotherapist may be able to continue with the initialized course of treatment, provided the records are such that they are understandable
- Recording for legal reasons – in many countries physiotherapists are enforced by law to store their patient records for a certain period of time. Furthermore, physiotherapy records may be used in litigation
- An increasing number of professional associations declare documentation as an integral part of the physiotherapy process (ÖPV 1998, WCPT 1999, Heerkens et al. 2003).

SOAP notes

Recording of therapy sessions must include detailed information, yet must be brief and provide a simple overview. Within this concept use has been made of the so-called 'SOAP' notes (Weed 1964, Kirk 1988). The acronym SOAP refers to the various parts of the assessment process:

1. Collection of **s**ubjective information
2. Collection of **o**bjective information
3. Performing an **a**ssessment
4. Develop and formulate a **p**lan.

It is not mandatory to follow the guidelines and abbreviations as set out in this book; however, some method must be determined to suit the patient's comments and the therapist's pattern of thinking. The basic elements of the SOAP mnemonic may serve as a useful format to follow all the steps of the therapeutic process in a brief and comprehensive way.

It has been argued that the term 'objective' in the SOAP notes is somewhat awkward, due to the fact that the physiotherapist values the *subjective* experience of the patient while performing the test movements. Furthermore, it is argued that the physiotherapist as the 'measuring instrument' will give attention to those aspects of a test which seem most relevant at the time, and thus true objectivity in test procedures may not exist (Grieve 1988). It has therefore been decided to replace the term 'objective examination' with 'physical examination' (P/E).

There has been criticism that SOAP notes within problem oriented medical records (POMR) would confine the physiotherapist to focusing merely on biomedical data (French 1991); however, if the physiotherapist pays attention to key words and specific key phrases of the patient which are indicative of the individual illness experience, they may be recorded in parentheses and integrated in the documentation, thereby incorporating elements of the individual illness experience into the records.

At all times patient records should include the findings as well as the steps in planning –a trail is laid of what is done *and* what is thought. Recording encompasses ideally:

- Information on examination and assessment procedures
- Treatment interventions and results (reassessments)

- Planning steps and hypotheses formulated
- Important key words or phrases of the patient.

Asterisks

During the subjective examination the patient may state certain facts related to the disability which may prove to be valuable parameters for reassessment procedures. These should be highlighted in the records *immediately*, and an 'asterisk' sign may be used.

Although the use of asterisks is not mandatory, it may speed up the whole process. They are time savers, reminders and indicators of highly important facts for the particular person. Identifying these main assessment markers with a large, obvious asterisk not only enforces a commitment but also makes reassessment procedures quicker, easier, more complete and therefore more valuable.

Using asterisks is just as valuable for the physical examination parameters as it is for the subjective examination. Similarly, making use of the asterisks progressively *during* the physical examination rather than *after* is recommended. The same applies to each subsequent session.

At times it seems that the term 'asterisk' has become jargon; however, it is not meant in such a way. People teaching and working with this concept may frequently use the term 'subjective and physical examination asterisks'. Mostly this refers to information of subjective and physical examination parameters which will be reassessed at regular intervals over the whole therapeutic process in order to monitor progress in rehabilitation and the effects of treatment (Box. A2.1).

Conditions

Some people may prefer other ways of recording. However, regardless the method of recording, some conditions need to be fulfilled. Patient records need to be:

- Organized
- Clear
- Comprehensive
- Simple to (re)read
- Written concisely, in telegraphese
- Homogenous, consequent.

Box A2.1

Use of asterisks

Asterisks are an invaluable aid in assessment procedures. The use of an asterisk in recording highlights the following aspects:

- Primary symptoms or activity limitations
- Signs that reproduce a patient's symptoms
- Other important comparable signs that will be followed up in reassessment procedures
- Other information that is important
- Key issues that need to be followed up
- 'Asterisk as you go along' indicates that it is important to immediately highlight relevant findings once they have been obtained rather than in retrospect. If the findings have been recorded straight away it will influence the physiotherapist in the further procedures of examination and assessment.

Some remarks with regards to recording

It is important to record related information even when the findings indicate normality. By their having been recorded, reference at a later date shows that the particular questions have been asked or physical examination tests have been carried out.

Recording normal findings on a 'record sheet' is a quick and simple procedure. For example, if a patient has pain in the shoulder area and the therapist has examined the acromioclavicular joint *comprehensively* and found it to have normal painless movements, all that might be recorded is:

AC ✓✓

The point is, *it must be recorded.*

There is much more to be recorded from an initial consultation than for subsequent sessions. However, the same detail is required and so the same details and abbreviations can be used. People have likes and dislikes about these symbols – this does not matter, provided the criteria for comprehensive recording are met.

Questionnaires as well as 'cheat sheets' as they are often termed, have advantages and disadvantages. The primary considerations are that they should not be regimented and they should not be detailed. A cheat sheet that has a list of questions requiring ticks and crosses, should not be used. They are inflexible and destroy independent thinking on the part of the examiner, and they completely obliterate any chance of following the patient's line of thought or the pursuit of hypotheses in greater detail.

Recording of subjective examination findings

With each patient there are many questions and answers that need to be entered in the recording, even if it is only to show that the question, which was important, has in fact been posed and answered.

It is a safe procedure to utilize the *patient's words* during the recording of subjective examination findings. For example, if a patient complains of a pulling in the arm while lifting the arm above the head, this needs to be recorded as the patient said it, rather than the physiotherapist's language of 'symptoms or pain with flexion', as this may immediately narrow down the physiotherapist's thinking.

Key words and phrases indicative of the personal illness experience may be put in quotation marks. It has been emphasized that such key words and phrases may be essential information to the shaping of the therapeutic process, hence they have to be recorded accordingly.

Organization of the information in the main categories of the subjective examination is essential to keep an overview over the process of subjective examination. While asking questions regarding the 'main problem', it is possible that the patient gives information on history mingled with, for example, bits of symptomatic behaviour. In such cases it is relevant to leave sufficient space on the paper to organize and record the information under sections 'history' or 'behaviour' rather than writing down every bit of information in a chronological manner. This will help the physiotherapist to keep an overview over the whole process of subjective examination, even if the communication technique of 'paralleling' has been chosen.

Body chart

- Frequently, after establishment of the patient's main problem and receiving a more general statement about the perceived disability, the area, depth and nature, behaviour and chronology of the symptoms are clarified and recorded on a 'body chart' (Fig. A2.1).
- Reference to such a body chart provides a quick and clear reminder of the patient's symptoms and main problem.
- A well-drawn body chart helps to generate hypotheses on the sources of the movement dysfunction or symptoms as well as on the neurophysiological pain mechanisms. Additionally, first hypotheses with regard to precautions and contraindications may be made.
- In principle, the body chart is drawn by the physiotherapist to facilitate recording and memory.
- Occasionally, in patients with chronic pain states, the body chart may be drawn by the patient. If different colours are used, as a metaphor for the pain experience they may become a guide in reassessment procedures.
- If the information on a body chart is recorded consistently at the same place all the time, self-monitoring mechanisms are more easily activated. If the physiotherapist forgets to ask certain questions, this may be noticed more easily when re-reading the information.
- The use of Arabic numerals in circles for the different symptom areas simplifies later recording: if there is a need to refer to the symptom areas, the numerals can be used rather than lengthy descriptions of the symptom areas.

Clinical tip

Always record the same information on the same spot of the body chart. This enhances self-monitoring – on re-reading the information it will be easier to discern if certain details are missing.

Behaviour of symptoms and activities

The information on the 'behaviour of symptoms' is essential to the expression of many hypotheses. Furthermore, the information usually serves in reassessment procedures of subsequent sessions. Therefore the information needs to be recorded in sufficient detail.

If activities or positions are found which aggravate the patient's symptoms, this has to be recorded

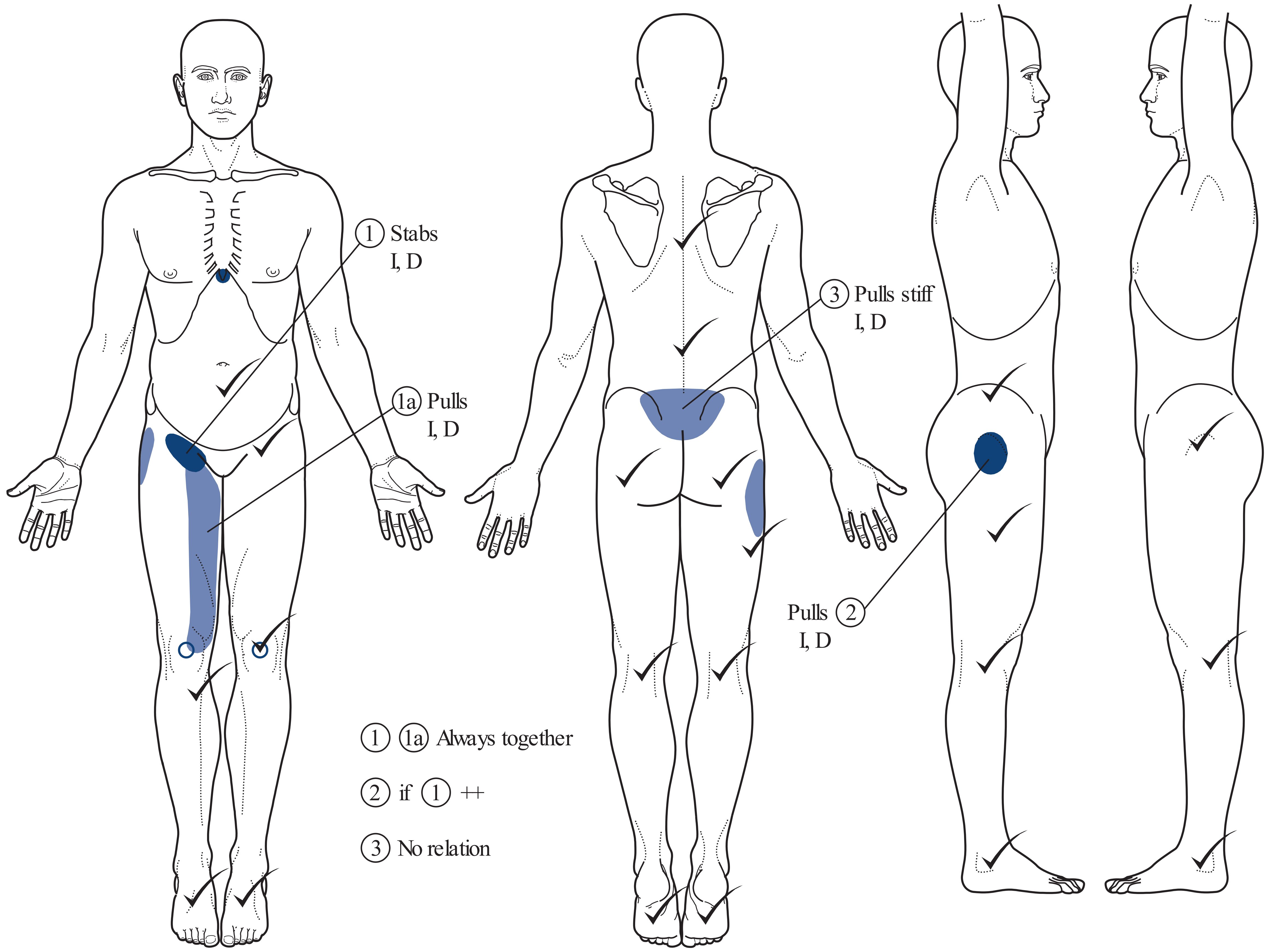

Figure A2.1 • Example of a body chart.

meticulously. However, any easing factors also need to be written down straight away, on the same line as the activity which provokes the symptoms. This may sound pedantic to some; however, it will give the physiotherapist an immediate overview as to which activities and positions the patient has developed as useful coping strategies and with which ones the patient may need some help.

Some examples are:

* ① ↑ Gardening, pulling weeds, in squat position; after 10′ P_1 ①, after 20′ ①^1
  ↓ Gets up, walks around (few steps, shuttles leg):
  ① ↓ 100% immed. May continue gardening.
* ① ↑ Putting on socks, in standing – activity possible as usual
  ↓ ① ↓ 100% immed. as soon as leg is put down.
* ① ↑ Lying in bed – prone, right leg pulled up. Wakes up c. 03:00 ①^1
  ↓ Does not know how to ease. Gets up, walks c. 20′ ① 'acceptable'

History

At times it may be difficult to keep an overview of all the information regarding the history of a patient's problem and to monitor if all the relevant data have been obtained. This may happen particularly in those circumstances where there have been more episodes and the problem has been recurrent for many years.

Although not mandatory, the physiotherapist may draw a line indicative of the course of time to keep an overview of both the current and previous history (Figs A2.2, A2.3).

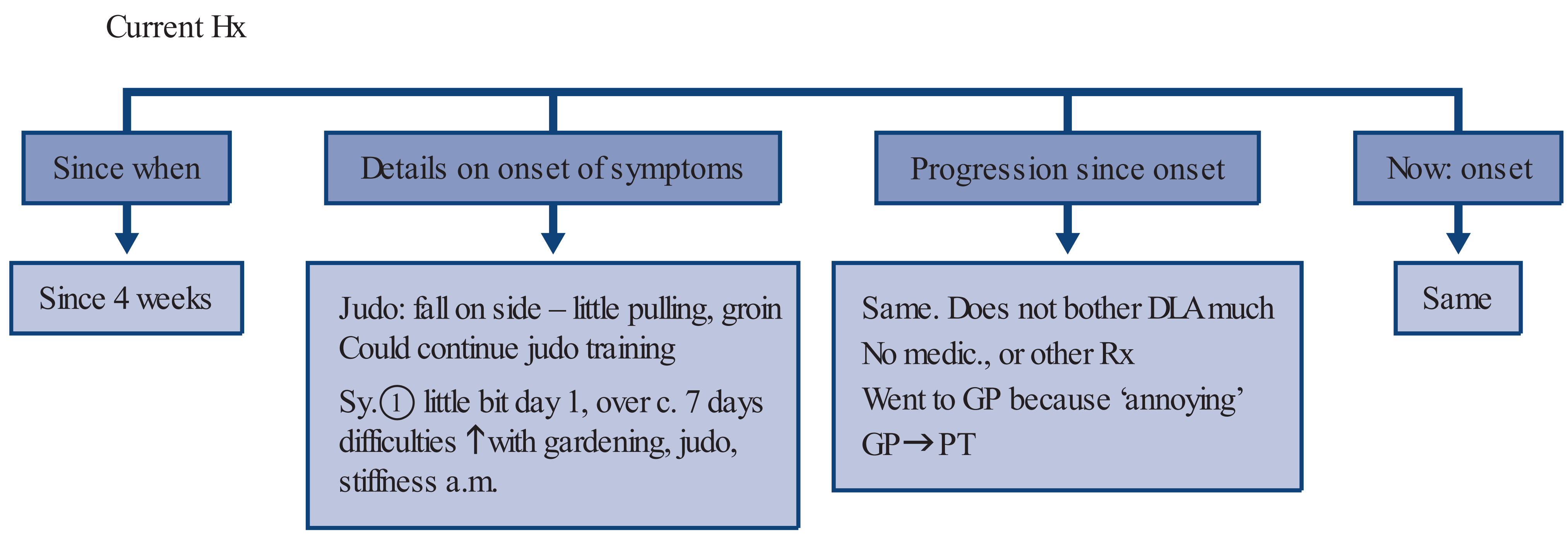

Figure A2.2 • Time line: current history.

Recording of physical examination findings

Physical examination findings need to be recorded in sufficient detail and systematically in order to allow for quick referencing during subsequent reassessment procedures.

Making use of symbols helps speed up the process and enhances quick referencing (Table A2.1).

Active movements

When recording the range and quality of movement and the symptomatic response to that movement, one should develop a pattern of recording and stick to it. By doing so, more facts can be remembered, while at the same time leaving the therapist's mental processes more time to take in other details. Active movement findings can be recorded as follows:

Sup ✓, ✓$_{IV++}$

This example means supination (sup) has a normal range and quality of movement (the first tick, □) and has no abnormal pain response when overpressure is applied (the second tick, □).

It is suggested relating the first tick (□) to movement responses such as range and quality of movement and the second tick (□) to symptom responses which occur during the test movement. It may be indicated with a grading of IV−, IV++ or IV+ how firm the overpressure has been. This is particularly relevant in those cases where the physiotherapist wants to test the movements with a certain amount of overpressure; however, factors in the 'nature of the disorder' may limit the physiotherapist in applying maximum overpressure.

A movement cannot be classed (or recorded) as normal unless the range is pain free both actively and passively. Further overpressure applied at the limit of the available range should not cause pain other than normal responses.

Abnormal findings may be recorded as follows:

*Ab 170°, Dev. Ventr. 120–170°, ①$_{act. EOR}$
Corr. Dev. 130°, ①11

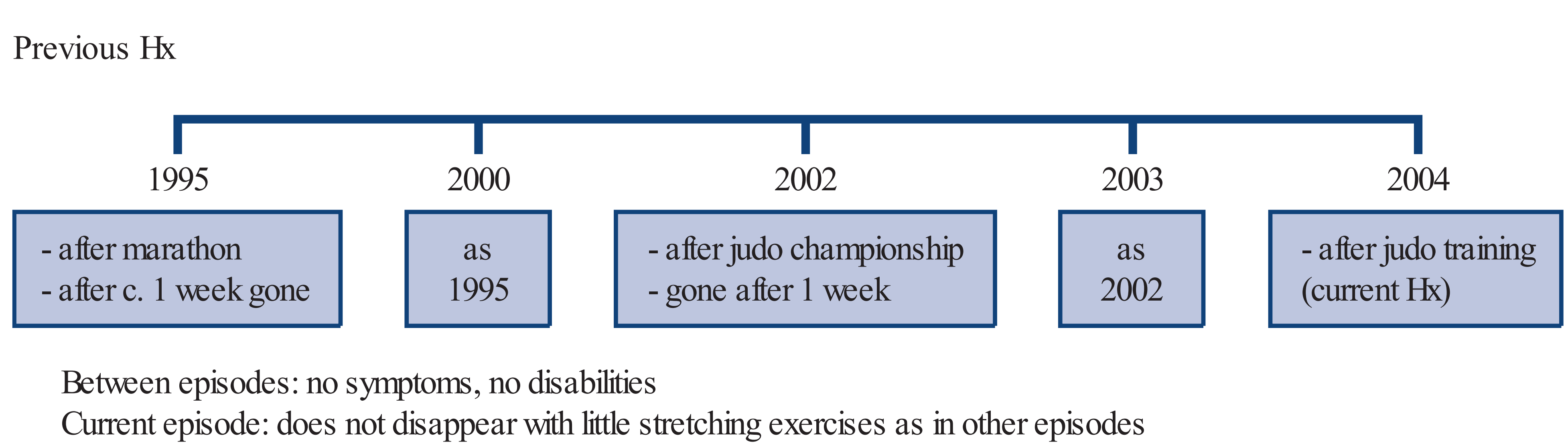

Figure A2.3 • Time line: previous history.

Table A2.1 Recording symbols

Peripheral joints		Spine	
F E	Flexion Extension	↓	Central posteroanterior pressure (PAs) ↙ with a Ⓛ inclination
Ab Ad	Abduction Adduction	↑	Central anteroposterior pressures (APs)
↺	Medial rotation	⌐↓	Unilateral PAs on Ⓛ < with a medial inclination
↻	Lateral rotation	↑⌐	Unilateral APs on the Ⓛ
HF HE	Horizontal fexion Horizontal extension	←•	Transverse movement towards Ⓛ
HBB	Hand-behind-back	↺	Rotation towards Ⓛ
Inv	Inversion	↖	Lateral fexion towards Ⓛ
Ev DF	Eversion Dorsifexion	←•→	Longitudinal movement (state cephalad or caudad)
PF	Plantarfexion	⌐↓	Unilateral PAs at angle of Ⓡ 2nd rib
Sup Pron	Supination Pronation	•——↓	Further laterally on Ⓡ on 2nd rib
El	Elevation	•⌐↑	Unilateral APs on Ⓡ
De	Depression	CT & ↗	Cervical traction in fexion
Protr	Protraction	CT & ↑	Cervical traction in neutral (sitting)
Retr	Retraction	IVCT & ↑	Sitting
Med Lat	Medial Lateral	IVCT & ↗	Lying
OP	Overpressure		
PPIVM	Passive physiological intervertebral movements	IVCT & ↗ 10 3/0 15	Intermittent variable cervical traction in some degree of neck fexion, the strength of pull being 10 kg with a 3-second hold period, no rest period, for a treatment time lasting 15 minutes
PAIVM	Passive accessory intervertebral movements		
ULNT	Upper limb neural tests		
LLNT	Lower limb neural tests	LT	Lumbar traction
Q	Quadrant	LT 30/15	Lumbar traction, the strength of pull being 30 kg for a treatment time of 15 minutes
Lock	Locking position		

Table A2.1 Recording symbols—cont'd

Peripheral joints		Spine	
F/Ab F/Ad	Flexion abduction Flexion adduction	LT crk 15/5	Lumbar traction with hips and knees fexed: 15 kg for 5 minutes
E/Ab	Extension abduction	IVLT 50 0/0 10	Intermittent variable lumbar traction, the strength of pull being 50 kg, with no hold period and no rest period, for a treatment time lasting 10 minutes
E/Ad	Extension adduction		
Distr	Distraction		
↓	Posteroranterior movement		
↑	Anteroposterior movement		
→	Transverse movement in the direction indicated		
↕	Gliding adjacent joint surfaces		
>•<	Compression		
	Longitudinal movement:		
Ceph	Cephalad		
Caud	Caudad		
Longitudinal movement is the direction of movement of a joint in line with the longitudinal axis of the body in its anatomical position. When that same movement is performed in any other position than the anatomical position, that movement of the joint is still called longitudinal movement even though it is not now in line with the longitudinal axis of the body			

Spinal data reproduced by kind permission from Maitland, G. D., Hengeveld, E., Banks, K & English, K 2001. Maitland's Vertebral Manipulation, 6th edn. Oxford: Butterworth-Heinemann

This indicates that the range of abduction has been 170°, with a deviation of the movement between 120° and 170° of abduction; symptom reproduction occurred at the active end of range without application of overpressure. With correction of the deviation in the movement, the range decreased until 130° of abduction and the pain was clearly increased.

*Hip F 130°, loc P groin$_{IV-}$, ①$_{IV+}$

This example shows that the overall range of hip flexion was 130°, without any deviations in the quality of the movement; local symptoms were produced with a light overpressure ('IV−'), symptom reproduction occurred with stronger overpressure ('IV+').

Passive movements

With passive movement the behaviour of pain, resistance and motor responses (spasm) is monitored. The physiotherapist is particularly interested in how these components behave and relate to each other. This is a very detailed examination procedure and may be considered as a part of the 'art of manipulative physiotherapy'. Most simply, but

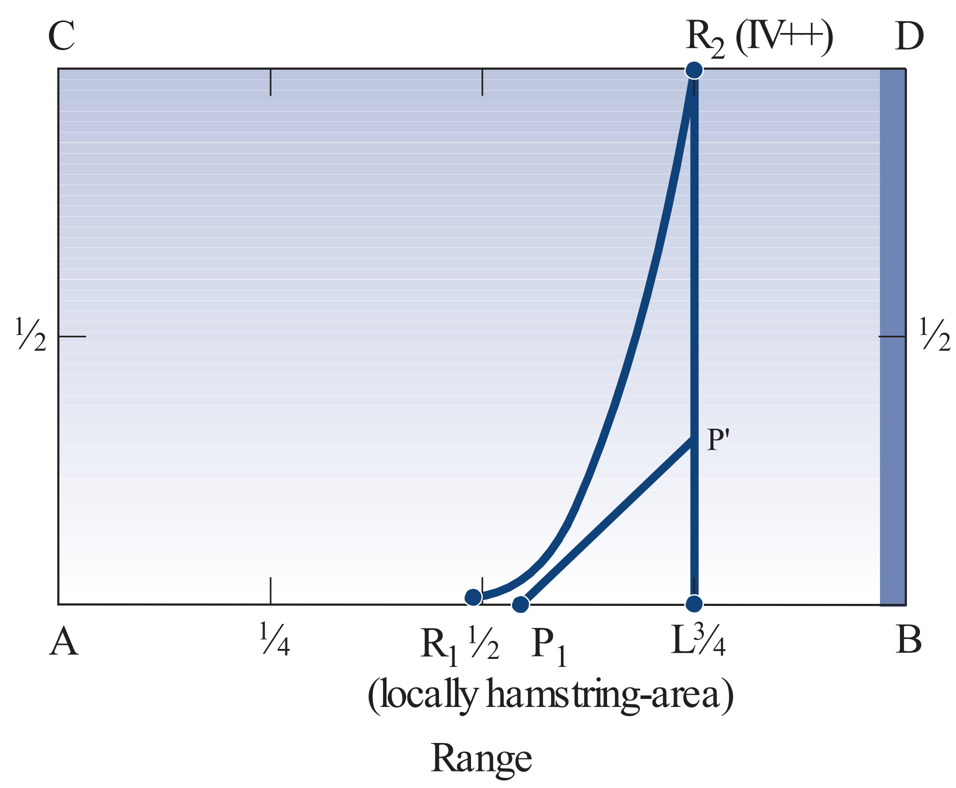

Figure A2.4 • Movement diagram.

not mandatory, would be the drawing of a movement diagram, as delineated in Appendices 1–3 of Volume 1. Otherwise abnormal findings regarding the behaviour of P_1 and P', R_1 and R_2, including their relationship, may be recorded verbally.

If certain passive movements are classed as normal, the same method (□), □)) as with active movements may be used. However, if relevant abnormal findings are present, this method is not sufficiently comprehensive.

Example:

SLR®: R_1: 50°, L 5 R_2 70°; P_1 pulling hamstr. c. 55°, P′ only little (3/10).

This example indicates that the physiotherapist first felt an increase in resistance with c. 50° of SLR, the movement was limited by resistance at c. 70° of SLR, only a little pulling sensation was provoked in the hamstrings area. Figure A2.4 illustrates the associated movement diagram.

Recording of treatment interventions

Before performing a treatment technique, the planning and the reasoning for its selection should be recorded. Next, the treatment and its effect should be written down. This needs to include sufficient details in order to be able to refer back at later stages when making retrospective assessments.

The treatment record for a passive mobilization technique should contain:

- The position of the patient
- The position of the joint
- Selected treatment technique(s), including inclinations of the movements
- Grade(s) of the technique
- Rhythm in which the technique was performed
- Duration (in number of repetitions or time units)
- Symptomatic responses and the patient's reactions while the intervention is being performed ('assessment during treatment' – see Chapter 1)
- Reassessment immediately following the technique (it is usually helpful to make comparisons or statements as to which parameters have improved and which ones have stayed unchanged).

It is essential not only to record the treatment by passive movement in detail but also active procedures, exercises or physical applications (e.g. ultrasound requires the same depth of recording).

Treatment is followed by a reassessment in which patients are asked to make a comparison of any changes of symptoms or in their sense of wellbeing resulting from the technique. This is then followed by a reassessment of the affected physical examination tests. Ideally, the records of the physical examination findings include a brief appraisal of the results in comparison with the assessment just before the application of the treatment technique.

Finally, at the end of a treatment session, the clinician should commit to paper thoughts on how treatment needs to be modified at the next session. Such an analysis not only forces the clinician to reflect on clinical reasoning processes, but also stimulates memory of the last treatment session.

Examples:

- **Passive movement:**

Rx G/H, Supine In: 150°F (before P1) Do: ↙, ↻ IV− to IV Smooth rhythm, rel. quick Totally c. 6′ 'Comfortable'; after 4′ R1 to L, especially with ↙ After c. 6′ no further changes in P or R	C/O: 'same' P/E: F 160°, ① IV++ ☺ ('feels much freer, I can move higher') HBB: range & P ISQ Plan: repeat same Rx; if HBB remains ISQ, do acc. mvt in EOR HBB

Other forms of treatment:

• **Exercises**	C/O: 'lighter than before to stand'
In sitting: do F/Ad hip R and L 5×, c. 10″, until slight pulling buttock 'Comfortable'	P/E: Lx F: 2 cm, □, act EOR ☺ Hip F: 130°, ① IV+ ☺ Plan: do ex. at/work; at least 3×/day A P buttock starts. 1–2 series; 5×/30″ each leg
• **Ultrasound**	C/O: 'not tender now'
Sitting, knee extended	P/E: Squat: full range, □ ☺
Rx: US 3 MHz, large head; 1 : 2 int. 1.0 W/cm^2; 3′; on tender spot, medially knee No pain	E/AB: □, ①, IV+ ☺ (*It is frequently useful to compare the results and to mark which elements may have improved following the intervention*)

Information, instructions, exercises, warning at the end of a session

Any information or instruction given during the treatment, any exercise that the patient should perform as a self-management strategy needs to be recorded as well.

At the beginning of a treatment series it is often important to warn the patient diplomatically for possible exacerbations. This also needs to be recorded.

Example

- Warned about possible increase; however, if spot gets smaller, may be a good sign.
- Should observe *and* compare:
  - mornings getting out of bed – changes in stiffness?
  - working in garden – anything different from before?
  - nights – anything changing in sleep pattern?
  - effect of exercise, if pain occurs?
- Instruction (e.g. remembers anything particular about fall during judo?).

Recording of follow-up sessions

When recording follow-up sessions, the first words must include a quotation of the patient's opinion of the effect of the previous treatment. This quotation must be worded in such a way that it is a 'comparison' rather than just a 'statement of fact'. The subjective reassessment is then completed in which the physiotherapist clarifies those activities that serve as parameters and have been highlighted with an asterisk in the records of previous sessions.

Following the subjective reassessment the record includes the physical examination tests which are being reassessed. These too are recorded as comparisons with the previous findings.

Changes in the physical examination findings will hopefully agree with the findings of the subjective assessment, so reinforcing each other. This will then make the total assessment more reliable.

Also during reassessment of physical examination tests it may be necessary to record key words and phrases; in the rehabilitation of, for example, shoulder problems it may be a good sign if the patient makes the spontaneous remark: '*the arm is mine again*'.

The following pattern may be used in recording follow-up sessions:

- Date, time of the day, R× 3, D8 (indicating third session on eighth day since the initial consultation)
- C/O spontaneous information: 'better', 'felt lighter than before'
- C/O follow-up of subjective parameter: putting on socks today cf. yesterday: no pain (5 unusual! First time in 3 weeks!)
- PP
- P/E: reassessment of physical examination parameter (including statements of comparison with after/before the previous treatment)
- P/E: additional tests as planned
- Plan: e.g. stick to plan as stated after R× 2
- R× 3a (as above) …
- R× 3b (as above) …
- Plan

Retrospective assessment

The record of retrospective assessment has to stand out from other parts of the treatment so that the information can be easily traced on reviewing progress in later sessions. This is particularly important when a patient has an extensive disorder and considerable treatment. To be practical, time must be a consideration, but not at the expense of detail and accuracy.

Especially within retrospective assessment, in the written record three requirements should be respected:

1. To stand out from other data (to be highlighted so that it is readily seen on checking back through the record).
2. To state with what time frame the comparison is made (e.g. R × 5 cf. R × 1).
3. To emphasize spontaneous information.

Retrospective assessments should include the following information and comparisons:

- General wellbeing compared with, for example, four sessions ago
- Symptoms compared with, for example, four sessions ago (know indicators of change – see Chapter 5)
- Level of activities compared
- Effect of interventions so far (P/E and passive movements)
- Effect of instructions, recommendations and exercises so far
- What has the patient learned so far – what was particularly relevant to the patient?
- Comparison of all the relevant physical examination parameters compared with, for example, four sessions ago
- Which interventions brought which results? (certain physical examination findings may improve more with some interventions than with others)
- Goals for the following phases of treatment (process of collaborative goal setting: redefinition or confirmation of agreed goals to treatment, interventions and the parameters to measure if the objectives are being achieved).

Written records by the patient

There are times when it is necessary for a patient to write a running commentary of the behaviour of the symptoms. For example, a patient may be a poor historian in which case he may be asked to write down how he feels immediately following treatment, how he feels that night and how he feels on first getting out of bed the next morning. Some people may feel this is encouraging a patient to become overly focussed on his symptoms. However, if the patient is asked not only to record how he feels, but also the level of activities, medication intake and possible self-management interventions, such a record may become a highly valuable teaching instrument which aids both the patient and the physiotherapist.

There are many different types of pre-printed form that can be used. However, it is essential that the forms leave space for information regarding:

- Symptoms
- Activities before and during the increase of symptoms
- Activities throughout the day/week
- Employment of self-management strategies to influence wellbeing, including the effects of the interventions.

When a written record by the patient is used, it should be handled by the manipulative physiotherapist in a particular sequence:

1. On receiving it from the patient, it should be laid down.
2. The patient should be asked to give a general impression of the effect of the last treatment.
3. The subjective assessment of the effect of the last treatment should be taken through to its conclusion.
4. The written record can then be assessed and any discrepancies clarified.

Conclusion

Although recording of examination findings, treatment interventions and results, and regular planning, may not be the most interesting part of learning, it is an essential element of the quality of the overall therapeutic process. It monitors the physiotherapist throughout the process and allows quick adaptation of interventions, if needed. When recording is accurate and succinct, and can be correctly interpreted by another person reading it, it is an invaluable self-teacher and may support physiotherapists on their path to expertise and maintaining this.

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