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**Paper CT scan (Lab)**

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**Q1: What are the major differences between CT scan and MRI Scan?**

## Ans-CT scans and MRIs are both used to capture images within your body.

The biggest difference is that MRIs (magnetic resonance imaging) use radio waves and CT (computed tomography) scans use X-rays.

While both are relatively low risk, there are differences that may make each one a better option depending on the circumstances.

**What are MRIs?**

Using radio waves and magnets, MRIs are used to view objects inside your body.

They’re frequently used to diagnose issues with you’re:

* joints
* brain
* wrists
* ankles
* breasts
* heart
* blood vessels

A constant magnetic field and radio frequencies bounce off of the fat and water molecules in your body. Radio waves are transmitted to a receiver in the machine which is translated into an image of the body that can be used to diagnose issues.

An MRI is a loud machine. Typically, you’ll be offered earplugs or headphones to make the noise more bearable.

You’ll also be asked to lie still while the MRI is taking place.

**What are CT scans?**

A CT scan is a form of X-raying that involves a large X-ray machine. CT scans are sometimes called CAT scans.

A CT scan is typically used for:

* bone fractures
* tumors
* cancer monitoring
* finding internal bleeding

During a CT scan, you’ll be asked to lie down on a table. The table then moves through the CT scan to take cross-sectional pictures inside your body.

**CT scan vs. MRI**

* CT scans are more widely used than MRIs and are typically less expensive.
* MRI are more expensive
* MRIs, however, are thought to be superior in regards to the detail of the image.
* The most notable difference is that CT scans use X-rays while MRIs do not.MRI usr magnetic field and radio wave.
* In MRI scan bony structures are less seen then a CT scan
* Scan time for a CT scan imaging is 5 to 10 minute and for MRI scan time are about 30 minute ,thus CT scan are less time consuming than MRI
* Patient with metals or certain medical implants are not able to undergo an MRI scan due to metallic field while CT scan can perform with no risk of medicals implants or any metals on body
* CT scan are less noise than MRI scan

**Q2: Which 3D reformation techniques are commonly used in musculoskeletal CT imaging? Explain them.**

**Ans;** The **musculoskeletal system** is composed of two systems – the **muscular** system and the **skeletal** system – but is commonly referred to as 'musculoskeletal' because of the main common functions of the said two systems, which are, movement and support.

The musculoskeletal system is made up of hard and soft tissues. The hard tissue includes bones and cartilages (articular cartilages), while the soft tissues are the muscles, tendons, synovial membranes, joints capsule and ligaments.

Primarily, the roles of the musculoskeletal system are **movement** and **support**, but the system also performs the following functions:

* Protection of vital structures
* Provision of body forms
* Stability
* Storage of salts (e.g., calcium)
* Formation and supply of new blood cells
*

Formusculoskeletalwe use two type of 3D reformation

1. Surface rendering
2. Volume rendering

 **Surface Rendering**

Surface rendering (SR), also known as shaded-surface display (SSD), is similar to taking a photograph of the surface of the structure in that the voxels located on the edge of a structure are used to show the outline or outside shell of the structure In most forms of SR the images are created by comparing the intensity of each voxel in the data set to some predetermined threshold CT value. The software will include or exclude the voxel depending on whether its CT number is above or below the threshold and use this information to create a surface of an object. The remaining voxels in the image are usually invisible. SR is useful for examining tubular structures, such as the inside surfaces of airways, the colon,

And blood vessels. Selecting the appropriate threshold CT values of the voxels that will be displayed is critical. Unfortunately, it is difficult to define clear guidelines for threshold assignment. If the threshold is too narrow, actual protruding structures can be imperceptible. If the threshold is too inclusive, nonissue materials (e.g., fluids) can be displayed as if they were tissue and can obscure protruding structures. Manipulating the predefine need threshold value can dramatically change the appearance of displayed structures. For example, lowering or raising the threshold value can change the included wall thickness of bony structures and hence alter the size and surface appearance.

 **Volume Rendering**

VR is a 3D semitransparent representation of the imaged structure. It has become the favored 3D imaging technique with applications in every type of examination performed with CT. An advantage of VR compared with other 3D techniques is that all voxels contribute to the image. This allows VR images to display multiple tissues and show their relationships to one another.

Like other 3D methods, VR displays are built by collecting and manipulating data along a line from the viewer’s eye through the data set. However, VR techniques sum the contributions of each voxel along the line. Each voxel is assigned an opacity value based on its Hounsfield units. This opacity value determines the degree to which it will contribute, along with other voxels along the same line, to the final image. The process is repeated for the voxels along each line, with each line producing one voxel in the VR image. Unlike other 3D techniques, with VR no

Information is ignored or discarded; every voxel contributes to the final image.

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The pixels in the final VR image can be assigned a color, brightness, and degree of opacity. For example, normal soft tissue can be assigned high transparency, contrasted vessels slight opaqueness, and bone strong opaqueness. In many cases color is used, with the color intensity varied to generate depth information for a traditional 3D impression. VR allows the user a high degree of interactivity. The user can easily change the look of the VR by changing variables such as the color scale, applied lighting, opacity values, and window settings. The image can be rotated and viewed from any angle. By varying opacity and window width and

Level functions, anatomy can be displayed or made invisible. This allows the user to quickly classify structures based on their attenuation. For example, adjusting the window settings can often remove the soft tissue from the VR display so that the contrast-enhanced vascular structures can be seen, without the need for time-consuming data set editing.

**Q3: What is the function of “surestart” in CT imaging?**

**Ans;** The use of state-of-the-art helical CT scanners allows for ultrafast examination of larger regions of the body. Due to the short examination time, optimum utilization of the intravenous contrast medium bolus is of extreme importance. The Sure Start function grants this in a very simple way.

* **Function of the sure start**

In CT system has the option called fast surestart option which allows initiation of the cardiac CT with one second after reaching the predefined threshold in the descending aorta. The sure start protocol and contrast agent injection are started simultaneously, and acquisition of a low dose mentoring scan startafter10s and is presented online. After another 4s the breathing command is given which last 4s.the breathing command is followed by a 2-s delay, which is necessary to allow the heart rate to normalize following the slight increase that may be induced by inspiration. This means that there is a delay os at least 20s after start of contrast injection before the cardiac CT scan can be started.in patient with a normal circulation time ,optimal enhancement of the cardiac chamber will be seen after about 20-25s.the amount of the contrast agent is adjusted to the patient body weight and range from 60 to 80ml(administration at flow rate will be 3.5ml/s) followed by a 40ml saline chaser administrated with a same flow rate ,which serve to accelerate washout from the right ventricle.

The axial contrast agent mentoring slice for the surestart protocols is defined on the basic of a scanogram. The axial slice provide an overview and is presented on the screen for real time mentoring of the inflow of contrast agent into the right atrium and ventricle and its further passage into the left atrium and ventricle and the thoracic aorta.

The optimal time for starting a CT angiogram is when most of the contrast agent has left the right ventricle and aorta.

The two option are available for starting a CT angiogram 1; automatic start after a predefined HU unit has been reached in the descending aorta e.g. 300 HU or 2; manually start based on visual assessment of enchantment in the cardiac chambers and using the surestart option.

**Q4: What are the major differences between single slice CT and Multi slice CT?**

**Ans- Single-slice CT**

Until the 1990s all commercial scanners contained many detector elements aligned in a single row the single-row design was used in both third- and-fourth generation systems. In third generation systems approximately 700 detector elements were arranged in an arc; fourth-generation systems used as many as 4,800 detectors in a single row arranged in a complete ring. In scanners with a single-detector row, each detector element is quite wide in the *z* direction collimator controls the slice thickness by controlling the portion of the detector’s width that is exposed to the incoming x-rays. The width of the detectors (in the *z* axis) in a single-detector array places an upper limit on slice thickness. Opening the collimation beyond this point would do nothing to increase slice thickness, but would increase both the dose to the patient and the amount of scattered radiation

* **Multidetectors CT scan**

Newer CT systems continue to use many detector elements situated in a row. However, they may contain from 4 to 64 parallel rows. In multidetector row (MDCT) scanners a single rotation can produce multiple slices. Therefore, MDCT provides longer and faster *z* axis coverage per gantry rotation. Additionally, many MDCT systems have increased the speed of gantry rotation, which further increases volume coverage per unit time. Slice thickness is determined by a combination of the x-ray beam width (controlled by the collimators) and the detector configuration. The radiation emitted from the collimated x-ray source in these systems is commonly referred to as a cone beam. Multiple detector channels can be used for either axial or helical data acquisitions. Depending on the scanner manufacturer and the number of detector rows, the parallel rows may be of equal size, referred to as a uniform array, or they may be variable, with thinner rows centrally and wider rows peripherally

 **Major difference**

* **Single slice CT**
1. Use a single detector row
2. Low image quality
3. Use low dose
4. More time consuming
5. Low contrast and spatial resolution
6. Less diagnostic according to multidetector CT
* **Multidetector CT**
1. use multiple detector row
2. high image quality
3. use a high dose
4. rapid scan time thus less time consuming
5. high contrast and spatial resolution
6. more diagnostic over single slice CT

This has improved the diagnostic capabilities of CT scanners. Recently new scanners capable of producing 32, 40 and even 64 images have been announced. These scanners will increase the

Diagnostic capabilities of CT scanners even further, result in clearer images and lower doses of radiation.

Multi-slice scanners mean that it takes less time to complete a CT scan. Additionally, the amount of radiation is reduced. The amount of radiation experienced depends on two factors. First, the design of the scanner impacts the amount of radiation required. Secondly, how the scanner is used determines the amount of radiation used.

One of the key differences between single slice scanners and multi-slice scanners is the geometric efficiency of the scan. This is directly proportional to the beam used during the imaging process. If the efficiency decreases from 100 percent down to 50 percent and all other factors remain equal, the dose of radiation must be doubled. Additionally, the amount of radiation used depends on the scan’s parameters- kV, rotation time, mA, scan field of view, focal spot size, pitch and slice width

**Q5: What are general protocols for performing CT contrast studies?**

**Ans-Contrast CT** is X-ray computed tomography (CT) using radio contrast. Radio contrasts for X-ray CT are, in general, iodine-based types. This is useful to highlight structures such as blood vessels that otherwise would be difficult to delineate from their surroundings. Using contrast material can also help to obtain functional information about tissues. Often, images are taken both with and without radio contrast. CT images are called *precontrast* or *native-phase* images before any radio contrast has been administrated, and *post contrast* after radio contrast administration.

**Bolus tracking** is a technique to optimize timing of the imaging. A small bolus of radio-opaque contrast media is injected into a patient via a peripheral intravenous cannula. Depending on the vessel being imaged, the volume of contrast is tracked using a region of interest (abbreviated "R.O.I.") at a certain level and then followed by the CT scanner once it reaches this level. Images are acquired at a rate as fast as the contrast moving through the blood vessels.

* **Washout**

"Washout" is where tissue loads radio contrast during arterial phase, but then returns to a rather hypo dense state in venous or later phases. This is a property of for example hepatocellular carcinoma as compared to the rest of the liver parenchyma.

 **Standard protocols**

* **Phases**

Depending on the purpose of the investigation, there are standardized protocols for time intervals between intravenous radio contrast administration and image acquisition, in order to visualize the dynamics of contrast enhancements in different organs and tissues the main phases thereof are as follows

|  |  |  |  |
| --- | --- | --- | --- |
| **Phase** | **Time from injection** | **Time from bolus tracking** | **Targeted structures and findings** |
| **Non-enhanced CT (NECT)**  | - | -  | * Calcifications
* Fat in tumors such as in adrenocortical adenomas
* Fat-stranding as seen in inflammation such as appendicitis, diverticulitis and omental infarction
 |
| **Pulmonary arterial** **phase**  | 6-13 sec | -  | * Pulmonary embolism (can use bolus tracking in pulmonary trunk + 6 seconds)[7]
 |
| **Pulmonary venous** **phase**  | 17-24 sec | - |  |
| **Early systemic arterial phase**  | 15-20 sec | immediately  | * Arteries, without enhancement of organs and other soft tissues.
 |
| **Late systemic arterial phase*Sometimes also called "arterial phase" or "early venous portal phase"***  | 35-40 sec | 15-20 sec  | * All structures that get their blood supply from the arteries have optimal enhancement.
* Some enhancement of the portal vein
 |
| **Pancreatic** **phase**  | 30 or 40 - 50 sec | 20-30 sec  | * Pancreatic cancers become hypo dense compared to the parenchyma.
 |
| **Hepatic (most accurate) or late portal phase**  | 70-80 sec | 50-60 sec  | * Liver parenchyma enhances through portal vein supply, normally with some enhancement of the hepatic veins.
 |
| **Nephrogenic phase**  | 100 sec | 80 sec  | * All of the renal parenchyma enhances, including the medulla, allowing detection of small renal cell carcinomas
 |
| **Systemic venous phase**  | 180 sec | 160 sec  | * Detect venous thrombosis[*citation needed*]
 |
| **Delayed phase*Sometimes called "wash out phase" or "equilibrium phase"***  | 6-15 minutes | 6-15]minutes  | * Disappearance of contrast in all abdominal structures except for tissue with fibrosis, which appears more radio dense.
 |

## Amount

## Hepatocellular carcinoma without (top) and with (bottom) IV contrast.

### Adults

### The following table shows the preferable volume in normal weight adults. However, dosages may need to be adjusted or even withheld in patients with risks of iodinated contrast, such as hypersensitivity reactions, contrast-induced nephropathy, effects on thyroid function or adverse drug interactions.

|  |
| --- |
| Sufficient volume for normal weight adults  |
| **Exam** | **Iodine concentration** | **Comments**  |
| **300 mg/ml** | **350 mg/ml** | **370 mg/ml**  |
| **CT of brain** | 95m | 80 m | 75 m |  |
| **CT of thorax** | Overall | 70 - 95 ml | 60 - 80 ml | 55 - 75 ml | Parenchymal changes of the lung can often be evaluated adequately without the use of intravenous contrast.  |
| CT pulmonary angiogram | 20 ml | 17 m | 15 ml | Minimal amount when using specific low-contrast protocol |
| **CT of abdomen** | Overall | 70 ml | 60 ml | 55 ml |  |
| Liver | 55 m; | 45 ml | 40-45 ml | Minimal required amount.  |
| **CT angiography** | 25 ml[not | 20 ml | When using specific low-contrast protocol |

The dose should be adjusted in those not having normal body weight, and in such cases the adjustment should be proportional to the lean body mass of the person. In obese patients, the Boer formula is the method of choice (at least in those with body mass index (BMI) between 35 and 40):[12]

For men: Lean body mass = (0.407 × W) + (0.267 × H) − 19.2

For women: Lean body mass = (0.252 × W) + (0.473 × H) − 48.3

### Children

Standard doses in children:

|  |  |
| --- | --- |
| **Exam** | **Concentration of iodine**  |
| **300 mg/ml** | **350 mg/ml**  |
| Generally | 2.0 ml/kg | 1.7 ml/kg  |
| CT of brain, neck or thorax | 1.5 ml/kg | 1.3 ml/kg  |

 **the end**