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Final term Examination
(summer-20)

Subject: Radiology & Diagnostic imaging
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Q. Briefly describe the role of image intensifier in fluoroscopy?

Ans

Fluoroscopy - 3 stages of development

The 2nd stage is the invention of x-ray image intensifiers in the 1950's allowed the image on the screen to be visible under normal lighting conditions, as well as providing the option of recording the images with a conventional camera.

Image intensifiers are utilised to convert low energy x-radiation into visible light images. frequently the detector portion of an x-ray C-arm used in operating ~~theaters~~ theatres, the image intensifiers ~~compared to standard too speed~~ has a low scattered input portion made of low absorption substances such a titanium or aluminium

Image intensifiers are several thousand times more sensitive compared to standard 400 speed screen film Combination, and in practice can produce images using several thousand times less radiation.
The biggest advantage of image intensifiers in medical imaging is ~~that~~ the synergy of high detector efficiency & high Conversion efficient to effectively utilise flouroscopy while adhering to the radiation protection Principle of dose optimisation

Image Intensifier Recieve Remnant x-Ray beam, Convert it to light, Increase the light intensity 50-75 times.

Image Intensification: The photons are amplified & multiplied. The Images are then viewed on Tv screen or monitor.

The Image Intensifier has 3 main Components
1 The input screen (the output window, The input phosphors, The photocathode
2 The electron-optics
3 The output screen.

Beam exits the patient. Hits the input phosphor (cesium iodide CsI tightly packed needles, produce excellent spatial resolution). And Converts x-ray to visible light.

Input phosphor: use a layer of flourescent material laid down on a thin metal layer as the primary x-ray detector. Modern IIs use sodium activated caesium iodide (CsI: Na). Needles like crystals act like fibre optic - minimal scatter & diffusion of light photons. It hits photocathode (cesium & antimony components), & Emits electrons when struck by light (photoemission

Photocathode layer: Converts the pattern of light photons emitted by the input phosphor into electrons. The photocathode layer is disposed on the inside surface of the CsI:Na layer. The photocathode comprises a layer of Caesium Antimonide which is well matched to the blue light emitted by the input phosphor. Number of electrons produced is directly proportional to the intensity of the x-ray photons. The potential difference within the image intensifier tube is a constant 25000 volts. Electrons are accelerated to anode. Anode is a circular plate with hole for electrons to go through. Electrons hit output phosphor which interact with electrons & produce light

The Electron Path: Must be focused for accurate image pattern. Electrostatic ~~lens~~ lenses ~~[illegible]~~ (focusing ~~[illegible]~~ devices). Accelerate & focus electron beam. The engineering aspect of maintaining proper electron travel is called electron optics.

Electrons hit ~~output~~ output phosphor (zinc cadmium sulfide) with high kinetic energy producing an increased amount of light. Each photoelectron at the output phosphor produce 50-75 times as many light photons as were necessary to create it.

Output Phosphor/window

The output phosphor screen is bombarded with high energy electrons. Outer Phosphor is made of Zinc Cadmium Sulphide. Very thin, fine grain phosphor layer is deposited on the inside surface of the II output window. Electrons have a very limited range in Phosphor; minimises spread of light. Is viewed remotely by CCTV or CCD.

- Input screen: Conversion of incident x-Rays into light photons (CsI)
- Photocathode: Conversion of light photons into electrons
- Electrodes: focalization of electrons onto the output screen
- Output screen: Conversion of accelerated electrons into light photons.

Q: Describe the parts of a digital fluoroscopy imaging system & explain their functions.

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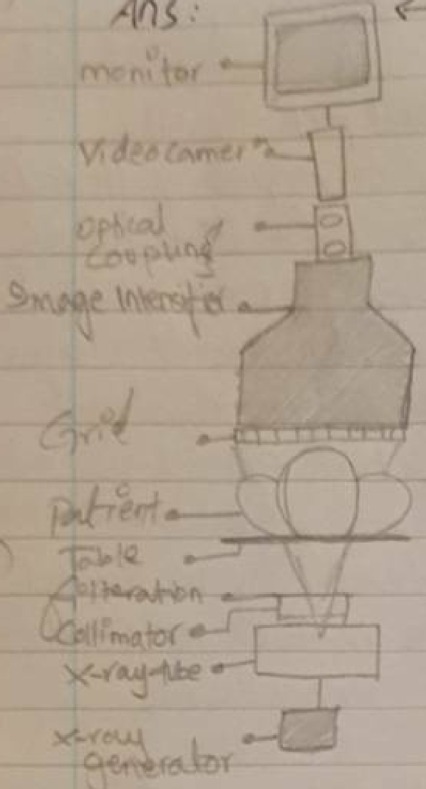
Ans: Image intensified flouroscopy ← system Diagram.



The key components include an x-ray tube, Spectral shaping filters, a field restriction device also known as a collimator, an anti-Scattergrid, an image receptor, an image processing Computer & a display device. Ancillary but necessary Components include a high Voltage generator, a patient support device (table or cauch) and hardware to allow positioning of the x-ray source assembly & the image receptor assembly relative to the patient.

II flouro viewed at same level of brightness as radiographs (100-1000 lux). x-ray tube under table/over table or in C-arm- Image Intensifier above patient in carriage. Carriage also has the power drive control, spot film selection and tube shutters.

Fluoro X-Ray tubes: operate at .5 to 5 mA. They are designed to operate for a longer period of time with higher kVp. kVp dependent on body section. kVp && mA can be controlled to select image brightness - maintaining (automatic) of the brightness is called ABC or ABS or AGC (control, stabilization gain control).

Fluoro x-ray tubes are fixed, may be mounted no closer than 15 inches or 38 cm to patient. Mobile may be brought no closer than 12 inches or 30 cm to patient.

Fluoroscopic x ray tubes operate at mA range: 0.5 - 5.0 mA,

kVp: 70-110

15 minimum SOD in fixed flouroscopic equipment.

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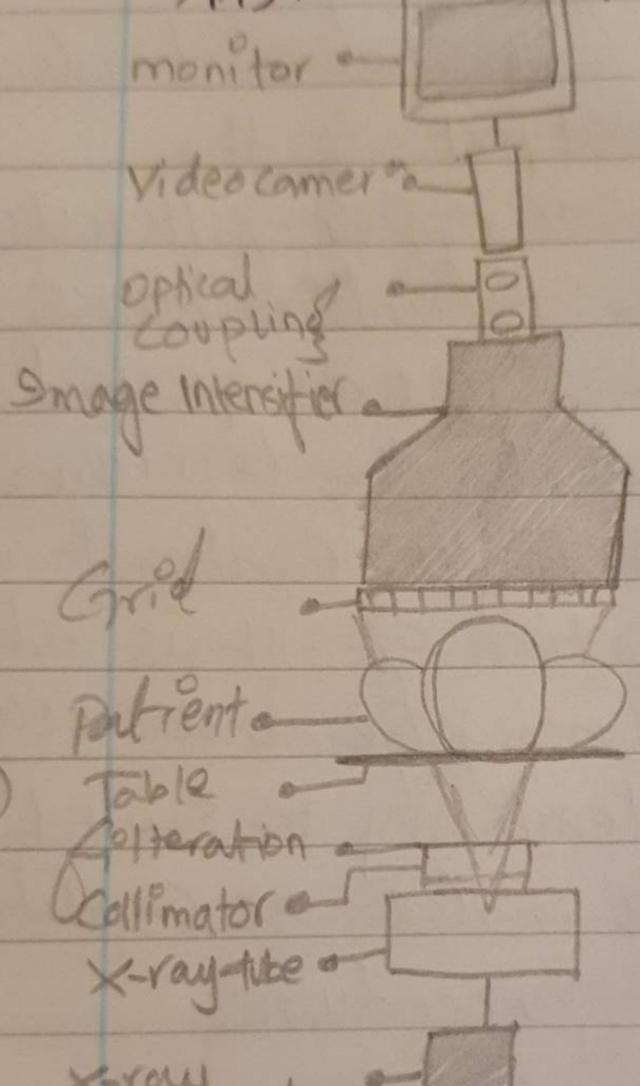
Ans: Image intensified flouroscopy ← System Diagram.



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Fluoro X-Ray tubes: operat

Beam filteration: It is common for flouroscopic imaging systems to be equipped with beam hardening filters between x-ray tube exit port & the collimator. Added aluminium & or copper filteration can reduce skin dose at the patients entrance surface, while a low kVp produces a spectral shape that is well matched to the barium or iodine k edge for high contrast in the anatomy of interest. Insertion of this added filteration in the beam path may be user selectable providing the operator with the flexibility to switch between low dose & higher dose modes as conditions dictate during a flouroscopic procedure.

Collimation: shutters that limit the geometric extent of the x-ray field are present in all x-ray equipment. In flouroscopy, the collimation may be circular or rectangular in shape, matching the shape of the image receptor. when the operator selects a field of view, the collimator blade positions automatically move under motor control to be just a bit larger than the visible field. when the source-to-image Distance (SID) changes, the collimator blades adjust to maintain the field of view & minimize spillover radiation outside of the visible area.

Patient Table & Pad: Patien tables must provide strength to support patients. It is important that the table not absorb much radiation to avoid shadows, loss of signal & loss of contrast in the image. Carbon fiber technology offers a good combination of high strength & minimal radiation absorption, making it an ideal table material. Foam pads may be placed between the table & patient for comfort yet minimal radiation absorption.

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Anti-Scatter Grid: Anti Scatter grids are standard components in fluoroscopic systems, since a large percentage of fluoroscopic examinations are performed in high scatter conditions, such as in the abdominal region. Typical Grid ratios range from 6:1 to 10:1. Grids may be circular or rectangular & are often removable by the operator.

X-Ray Image Intensifier: Components;

1) Input screen Conversion of incident X-Rays into light photons (CsI).

2) Photocathode: Conversion of light photons into electrons.

3) Electrodes: focalization of electrons onto the ouput screen

4) Output screen: Conversion of accelerated electrons into light photons.

Image receptor flat pannel detector (FPD): FPD allows for the replacement of the Image Intensifier in fluoroscopy design. These are more expensive to buy & repair as compared to image intensifiers, so their uptake is primarily in specialties that require high speed imaging e.g vascular imaging & Cardiac catheterization.

Flat panel detectors consist of an array of individual detector elements. The elements are square, 140-200 microns per side & are faricated using amorphous silicon thin-film technology onto glass substrates. Detector arrays used for flouroscopy range from 20x20cm up to 40x30 cm.

Image display: flouroscopy requires a high quality video displays that allow users to appreciate fine details & subtle contrast differences in the anatomy of interest. Modern systems feature high resolution flat panel LCDs with high contrast ratios these displays should be calibrated to a standard luminance response function to ensure that the widest range of grey levels are visible.

Flat Panel Image receptor (FPIR): It is made of cesium iodide/Amorphous silicon pixel detectors ∴ as for DR radiography. Its lighter, smaller than image intensifiers. No cassette needed. Improved contrast & unaffected by exeternal magnetic field. Improvement to image as the spatial resolution is uniform & distortion free. No age degredation.

CCD: CCD mounted on outer phosphor of II & is coupled by fibre optic bundles, lens system. It has unlimited life, maintance free, linear response to light photons, high resolution, no warm up time.

Photospot Camera: Does not require significant interruption of the flouroscopic examination & avoids the additional heat load on the x-ray tube. The photo spot camera uses film sizes of 70 & 105 mm.

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Q: How CT images are aquired?

A CT stands for Computed tomography & is

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a medical imaging procedure that uses Computer processed Combinations of many x-ray measurments taken from different angles to produce cross-sectional images of specific areas of a scanned object, allowing the user to see inside the object without cutting

CT scanner uses a motorized x-ray source that rotates around the circular opening of a donut - shaped structure called a gantry. During a CT scan, the patient lies on a bed that slowly moves through the gantry while the x-ray tube rotates around the patient, shooting narrow beams of x-rays through the body. Instead of film, CT scanners use special digital x-ray detectors, which are located directly opposite the x-ray source. As the x-rays leave the patient, they are picked up by the detectors & transmitted to a Computer. Each time the x-ray source completes one full rotation, the CT Computer uses sophisticated mathematical techniques to construct a 2D image slice of the patient. The thickness of the tissue represented in each image slice can vary depending on the CT machine used, but usually ranges from 1-10 millimeters. when a full slice is completed, the image is stored & the motorized bed is moved forward incrementally into the gantry. The x-ray Scanning process is then repeated to produce another image slice. This process continues until the desired number of slices is collected.

image slices can either be displaye indevidually or stacked together by the computer to generate a 3D image of the patient that shows skeleton, organs, & tissues as well as any abnormalities the physcian is trying to identify. e.g

CT for head/brain:

- A series of 5mm sections parallel to the floor of anterior cranial fossa, from the foramen magnum to the lower third ventricle with 10 mm sections to the vertex
- Intravenous contrast enhancement. Using the equivalent of 15g Iodine, any of the modern non ionic monmeric contrast media is suitable.

CT technique for Pituitary:

- patient is positione for coronal imaging
- Supine-position. Maximum nexk extension is supplemented by gantry angulation, to acheive as near as possible to ~~the~~ a true ~~radiographic~~ coronal image, perpendicular to the radiographic base line. I/V contrast Contiguous 2mm sections through the whole pituatorry angle are obtained, using a 16cm FOV

CT Technique for Neck:

scanning is begun at the level of the thyroid bone & sequential scans of 5mm slices are made in caudal direction

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Ans:

CT Scan is the imaging procedure of Choice to evaluate the interaceberal hemorrhage. Acute hematoma is seen by pre-contrast CT imaging as an area of high density. CT can detect acute intracerebral blood as small as 2 mm due to contranst beween high density of blood & low density of surrounding brain.

infarction or Ischaemic stroke are both names for a stroke caused by a blockage in a blood vessel in the brain

On CT infarct-like lesions are visible usually in the posterior temporal or occipito-temporal regions, often bilaterally & not strictly occupying a typical vascular territory.

Most Ischemic strokes are less dense (darker) than normal brain. where as blood in hemorrhage is denser and looks white on CT scan.