SNS COLLEGE OF ALLIED HEALTH SCIENCES- COIMBATORE 35

DEPARTMENT : RADIOGRAPHY AND IMAGNG TECHNOLOGY

SUBJECT : GENERAL PHYSICS, RADIATION PHYSICS AND PHYSICS OF DIAGNOSTIC RADIOLOGY

PAPER : PAPER II

TOPIC : 3.1 RADIOGRAPHIC IMAGE

IMAGE QUALITY

- The image quality is defined as the ability of the film/detector to record each point in the object as a point on the film.
- It is used to describe the visibility of diagnostically important detail in the radiograph High-quality images are required to make accurate diagnosis.
- The image quality depends on

(i) Contrast,

(ii) Spatial resolution,

(iii) Noise,

(iv) Geometric factors,

(v) Detective quantum efficiency, and

(vi) Sampling and aliasing.

CONTRAST

- Contrast is the difference in brightness between two related areas (the difference in densities).
- Radiographic contrast is the density difference between two adjacent regions on a radiograph.
- If the radiographs have great density differences which are notably distinguished, it is called a high radiographic contrast and if a radiograph has a small density difference between two adjacent regions, it is called a low radiographic contrast.

The contrast may be a subject contrast and film contrast,

- The product of subject contrast and film contrast gives the radiographic contrast.

SUBJECT CONTRAST

- Subject contrast is the difference in X-ray intensities transmitted through different parts of the patient.
- It depends on patient thickness, tissue mass density, effective atomic number, shape of the subject, and photon energy (kVp).
- Thicker and thinner body part attenuates radiation differently, and varies the transmitted X-rays.
- The subject contrast is proportional to the relative number of transmitted X-rays.
- Tissues of equal thickness, having different mass density contribute to subject contrast.
- Shape of the anatomy, which coincides with X-ray beam increases the subject contrast.
- Shapes that have change in thickness for X-ray path may reduce subject contrast.
- High kVp gives lower subject contrast, where as low kVp gives higher subject contrast.

FILM CONTRAST

- The film contrast tells us how the film responds to difference in exposure.
- The film contrast depends on, characteristic curve, film density, screen or non-screen exposure, and film processing.
- High contrast film is made of homogeneous size of silver grains, where as low contrast film is made of heterogeneous grains.
- Double emulsion films produce greater contrast than single emulsion films.
- The fog and scatter will reduce film contrast.
- They produce unwanted film density, which lowers final radiographic contrast.

FILM DENSITY

- The term density refers to the degree of blackening on the film. When the X-ray film is exposed to X-rays, the metallic silver gives the blackness on the film.
- That is why X-ray film is said to be a negative recorder. The degree of blackness is directly related to the intensity of radiation exposure.
- It can be quantified by a term optical density (OD), which is given by the relation:],
- OD = log10 (lo/ lt), where, (lo/ lt) is the inverse of transmittance (T), which is measured by a densitometer.
- If lo is the light intensity measured without film and It, is the light transmitted through the film,
- then T= lo/It.
- The useful range of density in diagnostic radiology is 0.25-2.0.

RESOLUTION

- Resolution is the ability to image two closely placed small objects, as two independent images.

There are three types of resolution, namely,

- **Spatial resolution** - it refers the ability of the imaging system to record the object in the two special dimensions (x, y) of the image. In other words it is the ability to image small objects that have high subject contrast, e.g. bone-soft tissue interface.
- **Contrast resolution** - is the ability to distinguish anatomical structures of similar subject contrast, e.g. liver- spleen. In general, film-screen radiography has excellent spatial resolution.
- **Temporal resolution** - is the ability of the imaging system to localize the object in time, from frame to frame and follow its movement. Temporal resolution is high for fluoroscopy.

SHARPNESS OF RADIOGRAPHIC IMAGE

- The sharpness of the image depends on multiple factors.
- We will consider one variable at a time, keeping the other variables fixed
- The apparent focal spot size: The larger the apparent focal spot, the larger the penumbra, resulting in a less sharp image.

SHARPNESS

UNSHARPNESS
(FOCAL SPOT)

MAGNIFICATION

- Image quality is affected by geometric factors, such as magnification, distortion and focal spot blur.
- All radiographic images are magnified and the magnification (M) is the ratio between the image size and object size.
- If SID is the source to image distance and SOD is the source to object distance,
- Then, M = SID/SOD
- When the object is closer to the source, the magnification is larger.
- When the object moves away from the source, magnification decreases.
- For chest radiography the SOD is about 180 cm, and the magnification is unity.
- Lesser the magnification means image blur is less and higher the resolution.

DISTORTION

- Distortion is the result of unequal magnification of different parts of an object.
- It may be caused by object thickness, object position and object shape.
- Thick objects produce more distortion than thin objects.
- Patient with irregular anatomy may contribute to distortion in a radiograph.
- If the object plane and imaging plane are not parallel then distortion occurs, due to positioning.
- The distortion is minimal for object that is positioned at the centre.
- Object that is positioned lateral to the center may have severe distortion.
- The objects that are lateral may have unequal magnification than that at the centre.
- The angle of inclination of the object also influences the degree of distortion.

FOCUL SPOT BLUR

- The focal spot (F) of an X-ray tube is not a point and have a dimension (0.6-1.8 mm), which produce penumbra at the edge of the field.
- Penumbra is the region at the edges, where the radiation intensity decreases laterally.
- It causes blurred region at the edges of the field in a radiograph, which is called focal spot blur (f).
- $f = F(M-1)$
- The focal spot blur increases with large focal spot size and higher magnification.
- It is small on the anode side and large on the cathode side, due to Heel effect.
- To reduce blur, smaller focal spot size and lesser magnification should be used.
- To have lesser magnification, the patient-film distance is reduced by keeping them close to each other.

NOISE

- The noise (mottle) is the random fluctuation of film density about some mean value following uniform exposure.
- It degrades image quality and limits the ability to visualize low-contrast objects.

Noise is mainly made up of

- **Screen :** The screen noise is caused by non uniformities in screen construction.
- **Film :** Film noise is caused by the grain structure of emulsions.
- **Quantum noise :** Quantum noise is caused by the discrete nature of X-ray photons and it is the most important source of noise in radiography.

BRIGHTNESS

- The brightness is the balance of light and dark shades in a displayed image.
- High brightness (also called density or intensity) settings produce bright images and low settings produce dark images.
- The contrast determines how many gray levels are displayed and the density determines the intensity.

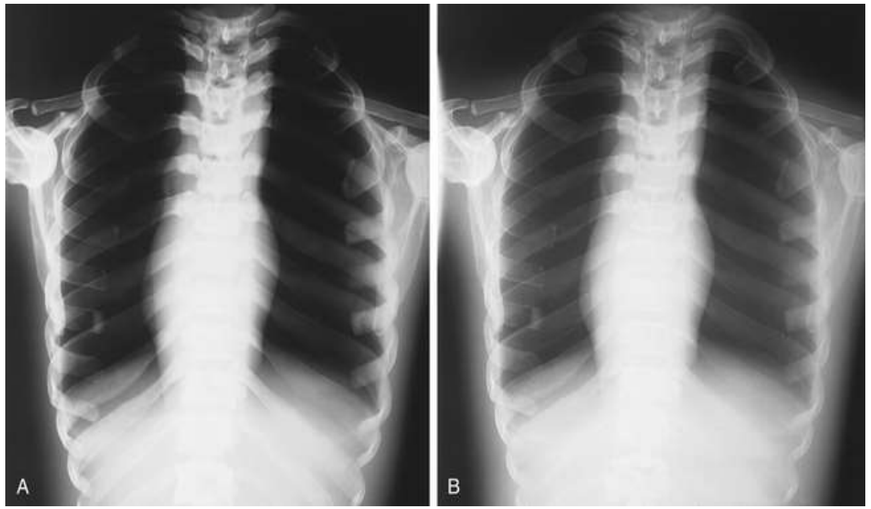
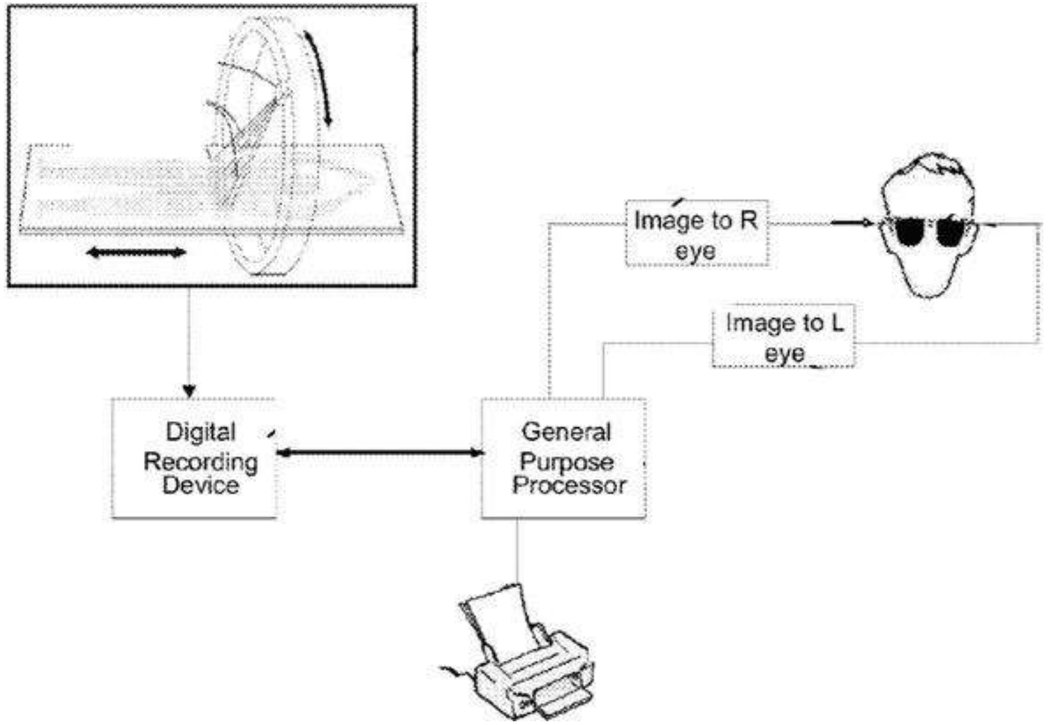


IMAGE RECORDING DEVICES

- image recording plate.
- Part of an electronic detector used in a digital imaging system.
- An x-ray machine produces a small burst of radiation that passes through the body.
- This radiation is recorded on an image recording plate of an electronic detector.



INTERROGATIONS

1. What is optical density ?
2. What is image quality ?
3. What is contrast ?

REFERENCES

1. Radiographic latent image processing – W. E. J McKinney

2.Diagnostic Radiography – A concise practical Manual – Glenda J. Bryan (4th edn),

Churchill Livingstone

THANK YOU