X-ray Image Quality

Daw Kyawt Kyawt Mon Assistant Lecturer Department of Medical Imaging Technology University of Medical Technology, Yangon

What is image quality?

- Refers to how well an x-ray image displays the desired information.
- Is characterized by 'contrast, unsharpness, distortion 'and
- Degraded by the presence of 'noise'

Contrast

- How well a structure of interest is distinct from its surrounding is called 'contrast'.
- Radiographic contrast
- Fluoroscopic contrast
- Radiation contrast

Contrast

Low contrast

High contrast

- Contrast of x-ray image arises from the difference between a structure and its surrounding in atomic number (z), density (Q) and thickness.
- Influenced by the radiation energy, type of receptor and processing condition.
- Where intrinsic contrast is poor, it is enhanced by introducing a contrast medium.

Unsharpness

- No image is perfectly sharp (well defined).
- Some amount of blurring near its edge due to one or more causes.

Types of unsharpness

- Intrinsic unsharpness
- Geometric unsharpness
- Movement unsharpness
- Screen unshrapness
- Parallex unsharpness

Intrinsic unsharpness/ edge unsharpness



Geometric unsharpness







Parallex unsharpness



Unsharpness	Cause	Infuencing Factors	Influence
U _O (object/intrinsic)	gradual decrease in thickness (or) atomic no. near the edge	-	-
U _G (Geometric)	finite size of X-ray source (or) focal spot	focal spot size, SID & OID	 Large focal spot increase unsharpness
			- [†] SID → unsharpness ↓ - OID → unsharpness
U _M (movement)	movement of object, or X-ray source or, image receptor during exposure	rate of movement or length of exposure, SID, and OID	v unsharpness
			t unsharpness
			↑ OID unsharpness
U _S (screen)	use of screen	type of screen, screen-film attachment	fast screen $\longrightarrow U_S$
Up (parallay)	use of double sided film	viewing a wat or	loose attachment $\longrightarrow U_s$
OP (parallex)		dry film	wet $\longrightarrow U_P$
			dry \longrightarrow U _P

The Way to Minimize Radiographic Unsharpness

- (1) Chosen small focal spot
- (2) By applying immobilization device (voluntary)
- (3) Using short exposure time (involuntary)
- (4) Long SID is used
- (5) By keeping structure of interest close to image receptor

- (6) Using non-screen type film
- (7) Using slow screen
- (8) Keeping screen & film firmly incontact
- (9) Using single-sided film

- Note: In practice, the individual unsharpness occur simultaneously, but not independently.
- The total (net) unsharpness is, therefore, less than the total sum, but greater than an individual.
- It is minimum when the individual unsharpness are equal.

Distortion

- Refers to deviation of an image from the object in size/shape/relative position.
- Cause is the divergent of x-ray beam.



Distortion



Noise

• Refers to any information in the image that contributes nothing to diagnosis, but reduces the visibility of diagnostically important features of the image. ""The *structure noise*" refers to the image of structure/anatomy superimposed on that of the structure of interest.

"The *receptor noise*" refers to a non-uniform background of an image due to non-uniform sensitivity of the image receptor to radiation.

It is usually too small to be observed on screen/film.

• "The *quantum noise*" arises when the X-ray intensity is not sufficiently high. It appeared the random variation in background brightness/gray level of the image, as the X-ray intensity vary at random over the image plane. It is disturbing when the image contrast is relatively low.

"The *scattered noise*" is introduced by scattered rays (mainly form patient but not bearing any pattern) that fall everywhere on the image plane. It appears as a patternless background, reducing the image contrast.

Control of Scattered Noise

- Limiting the beam size (just covering the area of interest) and applying compression to the body parts being radiographed minimize the production of scattering.
- Keeping the structure of interest close to the image receptor, keeping an air-gap between the patient and cassette, using an anti-scattered grid, using a cassette provided with lead backing, selecting proper kV minimize the scattered rays reaching the image receptor.

Anti-scattered grid

- Made of a series of thin lead (Pb) strips in parallel and interspaced by aluminium or carbon fibre,
- 80-90% of scattered rays are stopped by the Pb strips (as they are randomly directed)
- About 90% of the (image bearing) primary rays reach the film through the interspaces.



Grid ratio

- Ratio of height of the lead strips (h) to the width of the interspace between the two adjacent lead strips (w)
- Higher the ratio, the more effective is a grid in removing scattered rays.
- And also higher in radiation dose.





- The higher in grid ratio, the greater is the grid factor
- Grid factor is the ratio of exposure when the grid is used to that without grid producing the same film density.
- 8:1, 10:1, 12:1 commonly used in general radiography
- 5:1 typically used in mammography

- Grid frequency the number of lead strips per centimeter
- Grid with high frequency has thin lead strips, reduces the visibility of the shadow on a radiograph.
- Grid with 40 per cm, 60 per cm are available.
- Does not affect the efficiency of scattered clean-up.

Exercises

 A grid is made of 0.045 mm thick Pb strips with 0.12 mm interspacing. If the grid is 1.2 mm thick, find the grid ratio and frequency.

2. A certain grid is made of lead 30 µm thick sandwitched between fibre interspace material 300 µm thick. The height of the strip is 2.4 mm. What is the grid ratio and grid frequency?

Types of grid

- According to grid line construction;
- Parallel grid
- Focused grid
- Crossed grid

- According to grid function
- Stationary grid(parallel/focused/crossed)
- Moving grid(linear/parallel)



Summary

Radiographic factors	Density	Noise	Contrast	Unsharpness	Distortion	Patient Dose	
SID							
OID							
Beam size							
Grid							
Film							
Screen							
Focal Spot							
kV							
mAs							
Exposure Time							
Body Part							
Film Processing							

Note: Consider one factor at a time, keeping other factors constant

•Thank you for your attention!!