SNS COLLEGE OF ALLIED HEALTH SCIENCES

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DEPARTMENT OF RADIOGRAPHY AND IMAGING TECHNOLOGY

I YEAR

TOPIC – SCATTERED AND OFF FOCUS RADIATION

FILTERS AND BEAM RESTRICTORS

SCATTERED RADIATION

- There are three types of radiation involved in patient imaging,namely primary,scattered and leakage radiation.
- Leakage radiation does not contribute to image formation.
- However.primary and scattered radiation are responsible not only for image formation but also the degree of image quality.

- Two vital factors of image quality are spatial resolution and contrast resolution.
- Spatial resolution is greatly controlled by focal spot, whereas contrast resolution is controlled by scatter radiation or noise.
- Scatter radiation is produced by Compton interaction, resulting in noise.
- Hence, scatter radiation needs to be reduced to obtain good quality image.
- That is why collimators and grids are used in patient imaging.

- Scattered radiation mainly depends on kVp, field size and patient thickness.
- As the kvp increases, the X-ray energy increases.
- As a result, Compton interaction increases, and photoelectric interaction decreases.
- Hence, increase of kVp, increases the scatter radiation and reduces image quality. Therefore, X-ray imaging should be done with minimum kVp, with lowest scatter. But, at low kVp, the percentage of transmission may be lesser, which can be compensated with increase of mAs. Increase of mAs may account higher patient dose, hence optimal selection of kVp and mAs is required.

- Scattered radiation increases with field size.

- As the field size increases, scatter radiation also increases, which reduces the contrast of the image.

- Smaller the field size, lesser the scatter radiation and lesser the optical density.

- To maintain the optical density, higher exposure techniques are required with smaller field size.

- Scatter radiation increases with patient thickness.
- More scatter radiation is involved with thicker patients or thicker body parts.
- Mainly muscle, fat, bone and fluid filled cavity (pathology) are the sources of scatter radiation.
- Abdomen X-ray produces 3 times higher scatter than that of extremity X-rays. Compression will reduce patient thickness and bring the patient closer to the film.
- It will improve spatial and contrast resolution, with reduced patient dose. Patient thickness cannot be controlled except in mammography, only proper selection of techniques will help to obtain a good quality image.

OFF-FOCUS RADIATION

- Off-focus radiation is produced by an X-ray tube when high speed electron interacts the anode surfaces, other than the focal spot area.
- The main source of off-focus radiation is scattered electrons at the target.
- They are accelerated back to the anode, outside the focal spot. They create a low intensity X-rays over the face of the anode.
- Off-focus radiation increases the patient exposure, geometric blurring and background fog, resulting poor image quality.

- To reduce the off-focus radiation, small lead collimator may be placed very close to the X-ray tube port. Grounded anode X-ray tubes (anode and metal tube envelopes are given same electrical potential) reduce off focus radiation since the scattered electrons are attracted by the metal envelope.
- Tubes that are used in mammography also reduce off-focus radiation.

FILTERS

- A filter is a metallic sheet introduced in the path of X-rays, in order to reduce the patient dose.
- Diagnostic X-rays consist of both low energy and high energy X-rays.
- When X-rays passes through a patient, only high energy X-rays penetrate through the patient and form the radiological image.
- Whereas, the low energy X-rays are absorbed in the first few centimeter of tissue, thereby increasing the radiation dose.

- The introduction of filters absorb these low energy X-rays and reduce the patient dose.
- This process of removing the low energy X-rays, by introducing metallic sheets is called filtration.
- Filtration has two components namely, (i) inherent filtration and (ii) added filtration.
- Filtration resulting from the absorption of X-rays by the X-ray tube and its housing is called inherent filtration. This usually varies between 0.5 mm and 1.0 mm of Al equivalent.

- Added filtration results from absorbers placed in the path of the X-ray beam.
- The sum of the inherent and added filtration gives the total filtration.
- Total filtration = Inherent filtration + Added filtration.
- Al and Cu are the materials usually used in diagnostic radiology. The thickness of added filter varies from 1.0 mm to 1.5 mm of Al.
- Aluminum (Z = 13) is an excellent filter material for low energy X-rays.
- Copper (Z = 29) is a better filter for high energy radiation.
- Copper is always used in combination with aluminum as a compound filter.

BEAM RESTRICTORS OR COLLIMATORS

- An X-ray beam restrictor is a device that is attached to the X-ray tube housing, to regulate the size and shape of an X-ray beam.
- They can be classified into three categories, namely,

(i)aperture diaphragms

(ii)cones and cylinders and

(iii) collimators.

➢Aperture diaphragms consist of a sheet of lead with a hole in the center.

➢ The size of the hole determine the size and shape of the X-ray beam.

➢It is simple and the aperture can be altered to any size and shape.

➢The disadvantage of an aperture diaphragm is that it produces large penumbra

- The use of cones and cylinders will reduce the penumbra considerably.
- Both have extended metal structures that restrict the useful circular beam to the required size

- The collimator is the best X-ray beam restrictor. It defines the size and shape of the X-ray field that emerges from the X-ray tube.


Thank
you!