KARNATAKA RADIOLOGY EDUCATION PROGRAM

ATTENUATION

Reduction in intensity of X-ray beam as it traverses matter by either absorption or deflection of photons from the beam.

It depends upon quantity as well as quality of radiation. In case of MONOCHROMATIC RADIATION:

Number of photons remaining in the beam decreases by the same percentage with each increment of absorber. This is called as Exponential Attenuation.

Monochromatic radiation: While conventional radiation therapy uses white X-rays that consist of a mixture of X-ray waves with various energy levels, a monochromatic X-ray (monoenergetic X-ray) has a single energy level.

Polychromatic radiation : It is the type of radiation which contains large number of wavelength. It is a light of different wavelength. The term polychromatic gives a whole number of different wavelength that does not describe in sunlight but since two or more wavelength colours can be found in sunlight

ATTENUATION COEFFICIENT

It is measure of quantity of radiation attenuated by absorber thickness.

1.Linear Attenuation Coefficient
2.Mass Attenuation Coefficient

1. **Linear Attenuation Coefficient(μ)**

It is quantitative measurement of attenuation per centimeter of absorber.
Most important in diagnostic radiology.
More practical and useful.
Unit : per cm
Linear Attenuation Coefficient ,
μ = μ coherent +
μ Phptoelectric Effect + μ compton

We can predict total amount of attenuation depending upon percentage of each type of interaction.
Specific for energy of beam and type of absorber.
Does not depend on thickness of absorber.
Energy of beam increases-linear attenuation coefficient decreases.
Half Value Layer thickness (HVL): It is absorber thickness required to reduce the intensity of the original beam by one half.
So unit is cm.
HVL = 0.693/μ

2. **Mass Attenuation Coefficient**

It is used to quantitate attenuation of materials per mass of absorber.
It is independent of physical state of material.
Eg . Same for 1 gm of ice, water, water vapor.
It is obtained by dividing linear attenuation coefficient by the density(ρ)
MAC = μ/ρ
Unit – per g/cm2 or cm2/g

FACTORS AFFECTING ATTENUATION
The factors that affect attenuation are related to the incident X-ray beam and the properties of the material through which the radiation traverses. These factors include the incident beam energy, the thickness, atomic number and density of the material .

Effect of Energy and Atomic Number

As radiation energy increases percentage of photoelectric reaction decreases and compton reaction becomes predominant reaction.
As atomic number increases photoelectric reaction becomes predominant reaction.
Attenuation is always greater when photoelectric effect predominates.
Low energy of radiation
At low kVp.
Increased at wt
Low at wt

As energy increases attenuation decreases.
In case of high atomic number, attenuation may actually increase with increase in energy.
K edge : It is binding energy of K-shell electron.
with radiation energy below K edge fairly large percentage of photons are transmitted, while above K edge transmisssion drops.

Effect Of Density On Attenuation
Increase in density increases attenuation.
Relationship is linear.
Difference in tissue densities is primary reasons why we see an x-ray image.

APPLICATIONS of ATTENUATION :
X-ray image – only transmitted photons reach film.
- Because of differential attenuation between different tissues variable number of photons are transmitted through various tissues.

Differential attenuation may be due to predominance of photoelectric interactions or compton scattering .
Compton predominance – at low energy radiation and low density, no. of electrons per cm3.
Photoelectric predominance – at higher atomic no.

FACTORS AFFECTING SCATTER RADIATION:
Kilovoltage :
Scatter radiation is maximum with high kVp techniques.
Less important as we can't compromise kVp.
Only variable we can control.
Field Size :
Most important .
Scatter radiation increases with increase in field size, then gradually tapers off until finally it reaches plateau or saturation point.
Part Thickness :
Reaches saturation with increase in part thickness.
Some authors (Yochum says use grid to decrease scatter radiation if skeletal part thickness is > 10 cm.)
Collimation, filter decrease scatter radiation.
Air gap technique, grid decrease scatter reaching film.

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