Radiological Equipment Techniques (Lec 1)

1. Introduction

X-rays were discovered on November 8, 1895 in Europe in the late nineteenth century by German scientist Dr. Wilhelm Conrad Roentgen after six years later, he won a Nobel prize in 1901 in physics for such discovery.

The first radiograph that demonstrates the bones of the hand of Roentgen's wife, Anna Bertha, with a ring on one finger.

The function of the x-ray imaging system is to provide a controlled flow of electrons intense enough to produce an x-ray beam appropriate for imaging. X-rays are classified as a specific type of energy termed electromagnetic radiation, and like all other types of electromagnetic energy, x-rays act like both waves and particles.

2. Nature of X-ray

X-rays are electromagnetic waves, like all waves, that can be characterized by their specific amplitude, wavelength (λ), frequency (ν) and speed (c). The speed of the wave (c) is equal to the product of the frequency and the wavelength, and its magnitude depends upon and the frequency of the radiation and the nature of the material through which the wave travels.

$$C = \lambda \nu \quad .....(1)$$

In diagnostic radiology, the photon energy is usually expressed in units of keV, where 1 electron-volt (eV) is the energy of the electromagnetic wave.

The energy of electromagnetic radiation is quantized and calculated by Plank's Formula:

$$E = h \nu \quad .....(2)$$

h is Planck's constant = 6.626×10^{-34} J s = 4.1357×10^{-15} eV s (electron volt (symbol eV) = 1.602×10^{-19} joule).

3. Characteristics of X-rays

1. Are invisible
2. Are electrically neutral
3. Have no mass
4. Travel at the speed of light in a vacuum
5. Cannot be optically focused
6. Can be produced in a range of energies.
7. Travel in straight lines.
8. Can cause some substances to fluoresce (shine or glow).
9. Cause chemical changes in radiographic and photographic film.
10. Can penetrate the human body depending on the energy of the x-rays, the compositions and thicknesses of the tissues being exposed.
11. Can be absorbed or scattered in the human body according to the energy of the x-rays.
12. Can cause damage to living tissue.

4. Basic use of X-ray imaging

- X-ray imaging creates pictures of the inside of your body.
- X-ray photon may be absorbed in the body or made to scatter these interactions depend on the energy of an individual x-ray photon.
- The images show the parts of your body in different shades of black and white. This is because different tissues absorb different amounts of radiation.
- Calcium in bones absorbs x-rays the most, so bones look white. Fat and other soft tissues absorb less, and look gray. Air absorbs the least, so lungs look black.
- The most familiar use of x-rays is checking for broken bones, but x-rays are also used in other ways for example;

• chest x-rays can spot pneumonia.

• Mammograms use x-rays to look for breast cancer.

5. Method of image formation

X-ray imaging depends on the partial translucence of biological tissue with respect to X-ray photons.

• High absorption: White.

• No absorption: Black.

• Partial absorption: Range of grey shades.

Appearing of organs as below:

1. Fat. 2. Gas/air 3. Calcified (bone). 4.Tissues.

If a beam of X-rays is directed at the human body, a fraction of the photons will pass through without interaction. The bulk (majority) of the incident photons, on the other hand, will interact with the tissue in the ways.

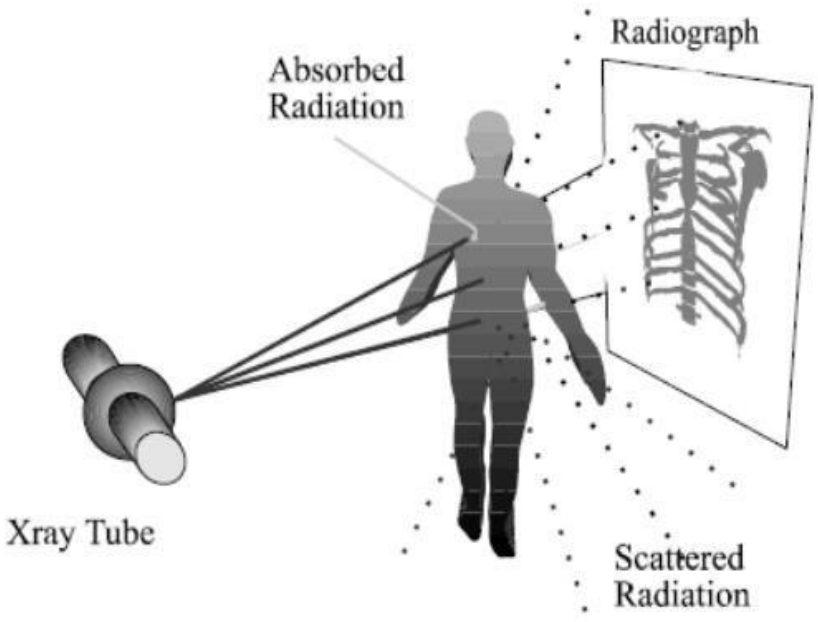

Figure (1): A typical X-ray radiographic geometry. A fraction of the photons pass directly through the body to create a 2-dimensional projection of the exposed anatomy