Subject : sheet no. 3

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The components of X-ray tube are : glass enclosure , cathode and anode

The anode function is to capture the emitted electron from the cathode to be able

To produce the X-ray , by two ways ***Bremsstrahlung***, when electron interact with other atom electrons , negative+ negative will repel each other, friction will occur, the net difference is the energy of X-rays, this rays will go to biological specimen

( human being) interact with the tissues

Factors affecting the quality of the image: Important to be able to diagnose the problem:

1) Tube currant : No. of electrons= milliAmp

2) Time in sec or millisec

3) Tube potential( energy) , indirectly affect the contrast

4) distance

5) filtration

6) collimation

IF you increase the current you will have darker image, cause extra electrons will produce extra photons, and vice versa if we decrease the current you will get lighter image

The relation between milliAmp and the quality of the image is direct and linear, that means if u increase the first to the double the second also will increase to the double, if u decrease the first to the half the seconed also will decrease

The voltage will affect the energy , and the energy will affect the quality directly but not linear, its logarithmic, cause high energy means high penetration, means

The image is darker, the effect will not stop here also it will affect the contrast

Which means the ability to differentiate between two different tissues / materials

That have different density and thickness , so as contrast becomes better , actually the different btw density and thickness is not too much

This is different from special resolution : concentrate on the size and how much these small structure care close to each other, and how much I can differentiate btw them, but contrast resolution deals with contrast and thickness of materials and I Have to differentiate btw them

As you increase the voltage you will increase the peak energy and maximum energy

ALL the above was a quick review for the 2nd lecture

Added filtration :

The curve of energy in ***Bremsstrahlung*** way is continuous from zero all the way to max energy

But is the X-ray energy on the lower end of the curve useful? Or does it penetrate the patient head and reach the film to give the image ?

No , so it exits as it enters , also it has two bad effect 1) it will scatter

2) you deal with a human being , this will increase the dose of radiation and we should avoid this , so to solve this we place material that can band the low energy photons but not the high energy ones, this material is aluminum, not the lead cause it will band the high energy photons, but aluminum density is good for this mission with low thickness, this process is called filtration

There is 2 types

Added and inherent filtration, added because they think about the glass enclosure is not 100% transparent to do filtration alone and they think to use the aluminum to complete the job

We do all this to get rid of the low energy photons cause they increase the harm , and they decrease a little bit the quality of the image

So on the ***Bremsstrahlung*** curve , the part of the curve below zero will be omitted

To remind u :

The effect of time on quality of the image is exactly the same to the current effect

Filtration doesn’t affect the max. energy cause we don’t change the K. voltage , but it will decrease the peak energy, why ?

It’s the same as a class marks if I want to delete lowest marks , it will change the Avg of the class but the highest mark will not change

Scattered radiation: photon should move straight in the middle , when this is not the case its scattered radiation, the important word about this is noise which means : photons that don’t carry informations but it still exist, but the photons that go straight and contribute to make the image and carry informations are called signals

Again the scattered ones are called noise

An image quality called : signal to noise ratio as it increase >> that’s a good image

We can't delete the noise completely cause that is sophisticated , but the signal should be in certain ratio with noise to see what I want

Scatter is one of the major contributor to noise, that we should decrease it as much as possible by the following

Let's assume that we want to take radiograph for abdomen or for a lumber spine , which is better , to take a radiograph for the whole abdomen or just the small area that contain the spine?

We will go with the second choice , cause we will decrease the dose of radiation

Also if we will limit the chance of scatter as the area decrease, and in this case we will need small film instead of the big film is needed to capture the huge scatter that would happen if we go with the first choice

So what we do is : 1) decreasing the scatter

2) the film is focused on what we want to take a radiograph for it only

This process is called collimation ( to decrease the dose and increase the image quality) the procedure will be harder here to focus on smaller area

The signal here will not decrease cause it’s a ratio, it’s the same when you fill the room with water and you will not measure the volume of the room, you will measure the column of water above each Slab

# Scatter doesn't only affect the image quality.. It's also an important concern for the dentist himself ( but there is a specific protocol to deal with that)  
# what affects the contrast?  
1- The voltage  
2- collimation (scatter)  
  
# inverse square law : the intensity of an x-ray beam is inversely proportional to the square of the distance between the source and the point of measure   
 intensity1/intensity2 = (D2)2/(D1)2  
note: it's partially important for the image quality but extremely important for radiation hazard

# there are different types of interactions of x-rays with the patient ( basically the head for dentistry) and all of them affects the image quality :  
1- coherent scattering: it occurs when a photon passes near an outer electron of an atom ( biological atom of a patient) …the photon is resonating in a specific frequency and direction ..then the atom itself begin resonating and this changes the direction of the photon without any change on its length or energy( no exchange of energy.. no system destruction)  
**note:** the percentage of coherent scattering is very small.. so we don't care about it (negligible) in practical life  
  
2- photoelectric absorption: a photon will knock out an inner shell electron then cascading will occur   
**note1:** this is similar to characteristic radiation but:   
a- characteristic radiation happens in the x-ray tube (cathode) while the photoelectric absorption happens in the patient  
b- the incident energy from the photoelectric absorption is a photon while in the characteristic radiation it's an electron

**Note2:** this interaction affects the image quality and the radiation exposure of the patients  
  
3- Compton scattering: an incident photon interacts with an outer shell electron and knock it out … the photon changes it's direction and energy (some energy exchange).. then it continues interacting with other atoms doing the same thing  
**note1:** this interaction affects the radiation exposure of the dental team and the image quality  
**note2:** in this interaction there's a change in the photon length and energy but it's not as big as the change that happens in the photoelectric scattering  
  
# the image we get is the outcome of interactions and how much absorption and scattering happens to the incident beam   
# the incident beam is spatially homogenous while the remnant beam is heterogenous. it's this differential exposure of the detector (film) that allows a radiograph to reveal the morphological features of the enamel,dentin,bone and soft tissue  
  
# beam attenuation: the combined effect of all interactions ( absorption, scattering..etc attenuation(  
  
#factors affecting the interaction of the beam with the matter ( beam attenuation):  
1- thickness and the mass of the absorber : more thickness or more mass will increase the absorption ( metals are the highest in attenuation then it goes down with decreasing mass and density)  
2- energy of the beam: more energy means more penetration and less absorption  
**note:** the idea is like a stepladder: a piece of metal that looks like a ladder and there is a thick and thin part … when increasing the voltage, more shades of grey will appear  
so we can change the image of the same structure by changing the energy of the beam ( some soft tissue lesions can only be recognized at a specific shade)  
  
# there is a specific mA used for children and another one for adults( they have different head sizes … so if I used the same mA of a child for an adult ,the image will be very light because the adult has a bigger head ( more thickness and mass) so more absorption of photons)