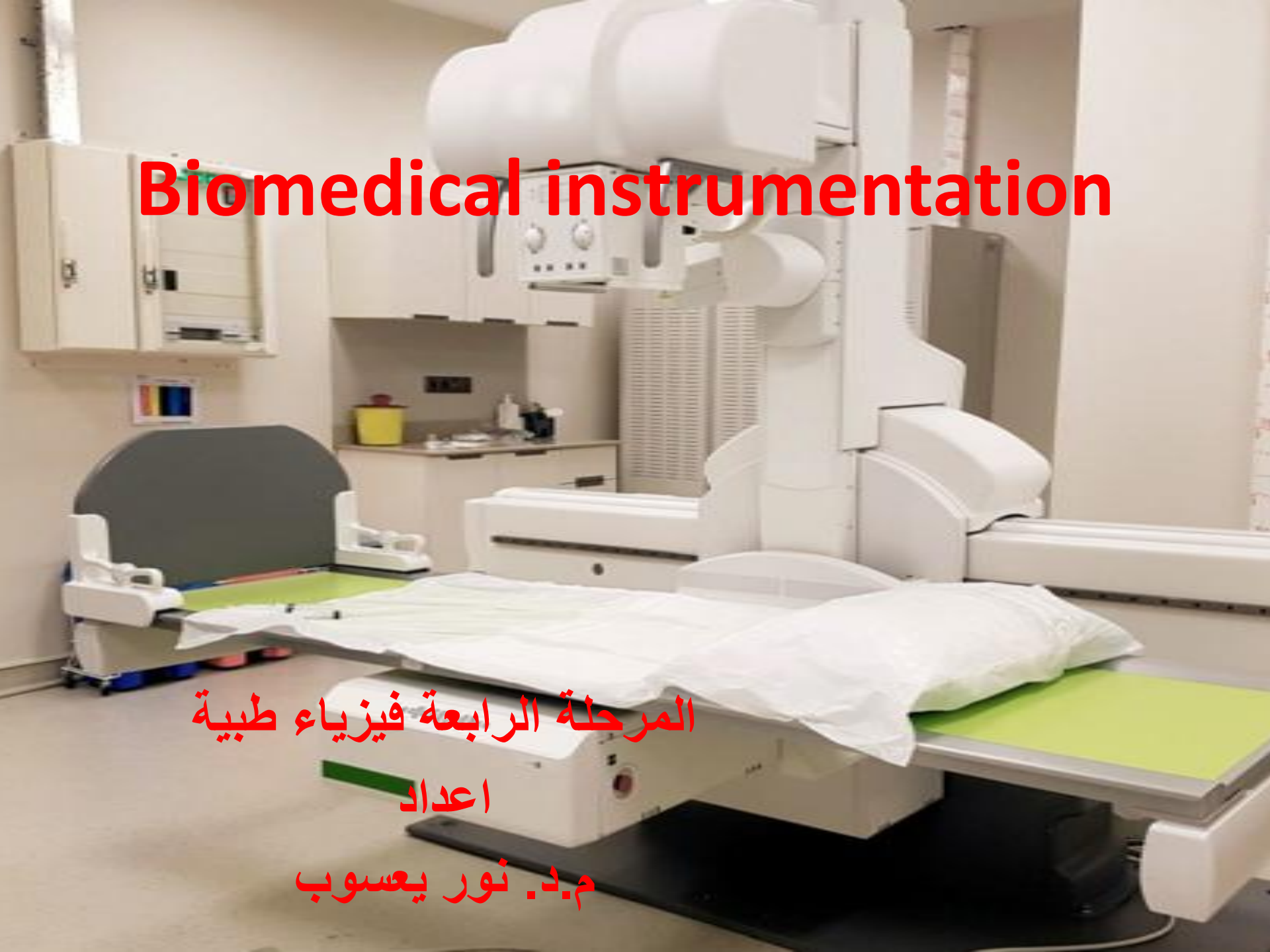


Biomedical instrumentation

المرحلة الرابعة فيزياء طبية

اعداد

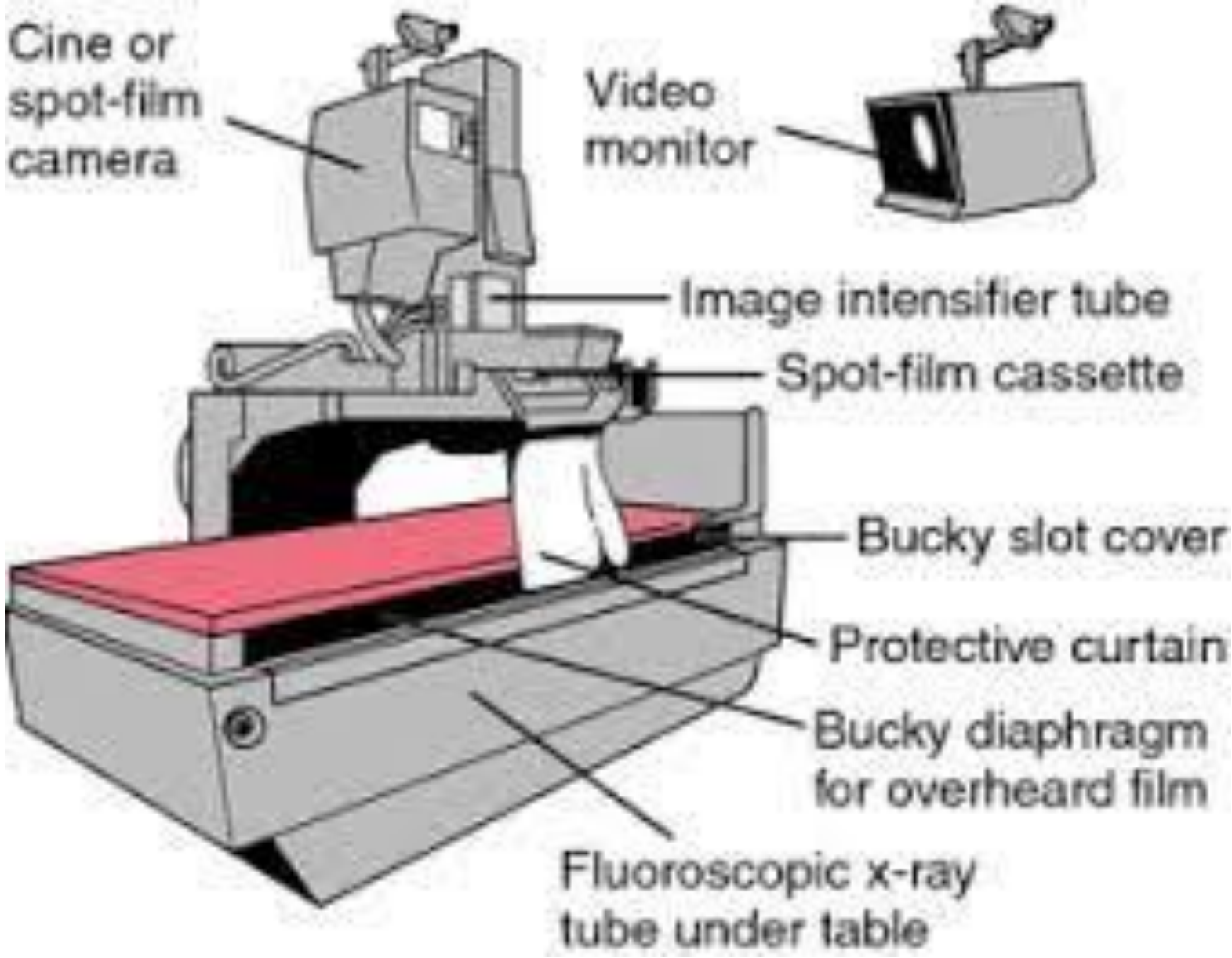
م.د. نور يعسوب

Continuous Picture X-ray Fluoroscopy

- The main function of fluoroscopy imaging is: to obtain a dynamic, moving visual image of what is happening inside the human body, unlike the static imaging that is done by usual radiography.
- As dynamic studies are tests that show the movement of internal organs in the human body, such as the movement of the heart and the process of breathing.

- During a fluoroscopic examination, the radiologist uses a dye to enhance the contrast of the organ to be imaged. And then the radiologist monitors continuous visual images of the internal organs in the human body that result from the patient's exposure to X-rays. If the radiologist notices something strange during the fluoroscopic examination, he can take a picture so that the matter can be examined carefully after the examination is over.
- In fact, fluoroscopy is only a traditional imaging using X-rays, but its use focuses on **angiography**, and this type of imaging is known as angiography, meaning vascular imaging, and this technique **is divided into two parts**: neuroradiology and vascular radiology.

- The figure below shows a diagram of the entire fluoroscopic imaging system. In most systems, the X-ray machine is installed and hidden under the patient's bed. An image intensifier or what is known as the image intensifier and other various monitoring devices are installed above the patient's bed. The image appears on the TV screen. During fluoroscopy, the X-ray machine is operated at a current of less than 5mA, which is a small value compared to the value used to obtain X-ray images, which reaches a few hundred milliamps, and although the value of the current used is relatively low, the radiation dose to which the patient is exposed It is large during fluoroscopy because the patient is constantly exposed to X-rays for a relatively long period of time.


Cine or spot-film camera
Video monitor
Image intensifier tube
Spot-film cassette
Bucky slot cover
Protective curtain
Bucky diaphragm for overheard film
Fluoroscopic x-ray tube under table

Basic Requirements for Fluoroscopic Imaging

- Fluoroscopy is a dynamic process, so the radiologist has to adapt to moving images, which sometimes appear dark. This requires a strong knowledge of image lighting, vision and vision.
- **Illumination**
- **image-intensifier**

- The use of the image-intensifier added many advantages over the traditional fluoroscope types, as this device increased the intensity of the resulting images.
- Light intensity levels are measured in lumens per square meter and denoted by lux. It should be noted here that the eye can see a wide range of lighting levels. The figure shows the levels of illumination for some known objects so that we can imagine the lux unit.

as we know that the optical sensors in the eye depend on two types of sensors: the sticks for night vision and the cones for the daytime vision. Therefore, according to what is shown in figure the eye depends on the sticks sensors in cases of illumination levels less than 100 lux and this range that was formed It contains the images obtained by the radiologist from the traditional fluoroscope,

but after the introduction of the image-intensifier, the images we obtain from the fluoroscope have become at levels that allow them to be seen by the eye based on the cones because the intensity of illumination has become higher than 100 lux, which is the area of day vision.

- During the fluoroscopy examination, it is preferable to obtain the smallest details, and this requires high levels of light intensity, and for this reason, an image-intensifier was introduced to replace the fluorescent screens used in the traditional fluoroscopy, which had to be examined by the radiologist in dark rooms after adapting to night vision. For 15 minutes sitting in a darkened room or wearing special glasses. With the use of the image intensifier, the illumination increased to move to the day-vision area.

Increase image brightness using image-intensifier

- The image intensifier tube is a complex electronic device that receives images consisting of X-rays and converts them into an image in visible light with an increase in the intensity of its illumination.

- The image brightening device consists of an evacuated glass tube, as shown in the figure, and the tube is placed in a metal box to protect it from breakage.

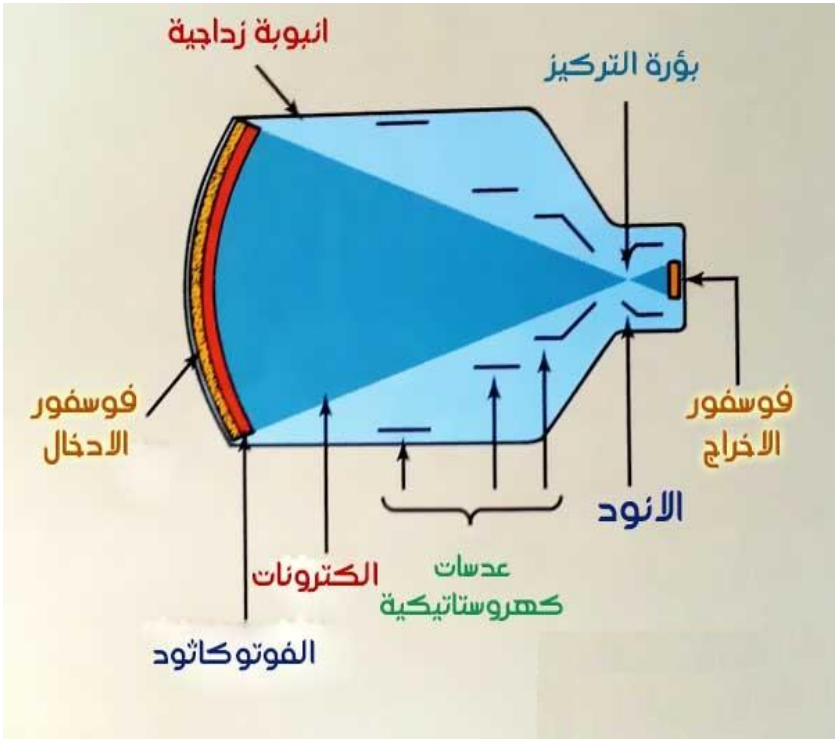
When the X-ray is carried out from the patient's body, it

• falls on the tube to increase the intensity of the image's illumination, specifically on the input phosphor strip, which is a layer of cesium iodide (CsI).

•The cesium iodide layer absorbs x-ray photons and then emits them from the opposite side (inside the tube) into visible light photons.

•The cesium iodide layer is followed by the photocathode layer, which is a thin metal layer containing the two compounds of cesium and antimony, which absorbs the visible light produced by the input phosphorous layer into electrons.

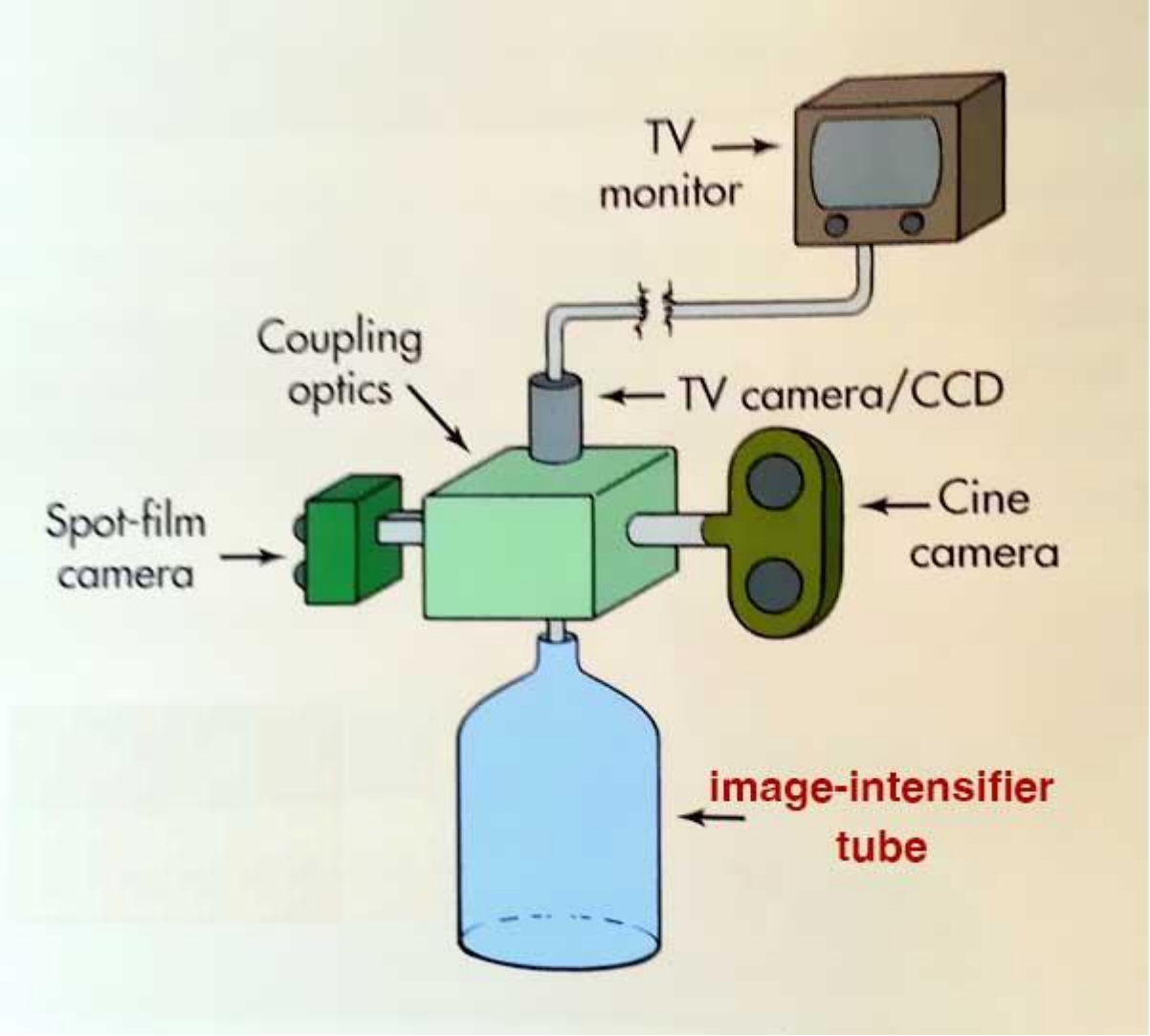
•The number of electrons produced by the photocathode is proportional to the intensity of the X-ray window from the patient's body.



- The length of the image intensifier tube is approximately 50 cm, and it uses a potential difference of up to 25,000 V applied between the photocathode and the anode, and this makes the electrons generated from the photocathode accelerate towards the anode.

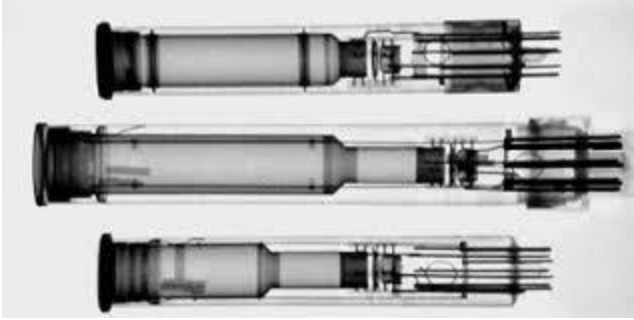
- The anode is a circular disk with a hole in the middle through which electrons pass until they reach the outer phosphor layer. This layer is made of zinc and cadmium sulfide. Here, when the accelerated electrons collide in this layer, visible light is produced.

- The use of electrostatic lenses to focus the accelerated electrons, and these electrostatic lenses are installed along the tube to increase the brightness of the image. These accelerated electrons, collected by the lenses, carry the details of the image formed on the input phosphor, and when they collide with the output phosphor, they give off photons, and each electron that reaches the output phosphor produces approximately 50 to 75 light photons. In the below figure, a diagram shows the stages of the interaction of the X-rays with the tube of increasing the intensity of illumination of the image. The ratio of the number of light photons produced at the output phosphor to the number of X-ray photons at the input phosphor is known as the flux gain.



the stages of the interaction of the X-rays with the tube

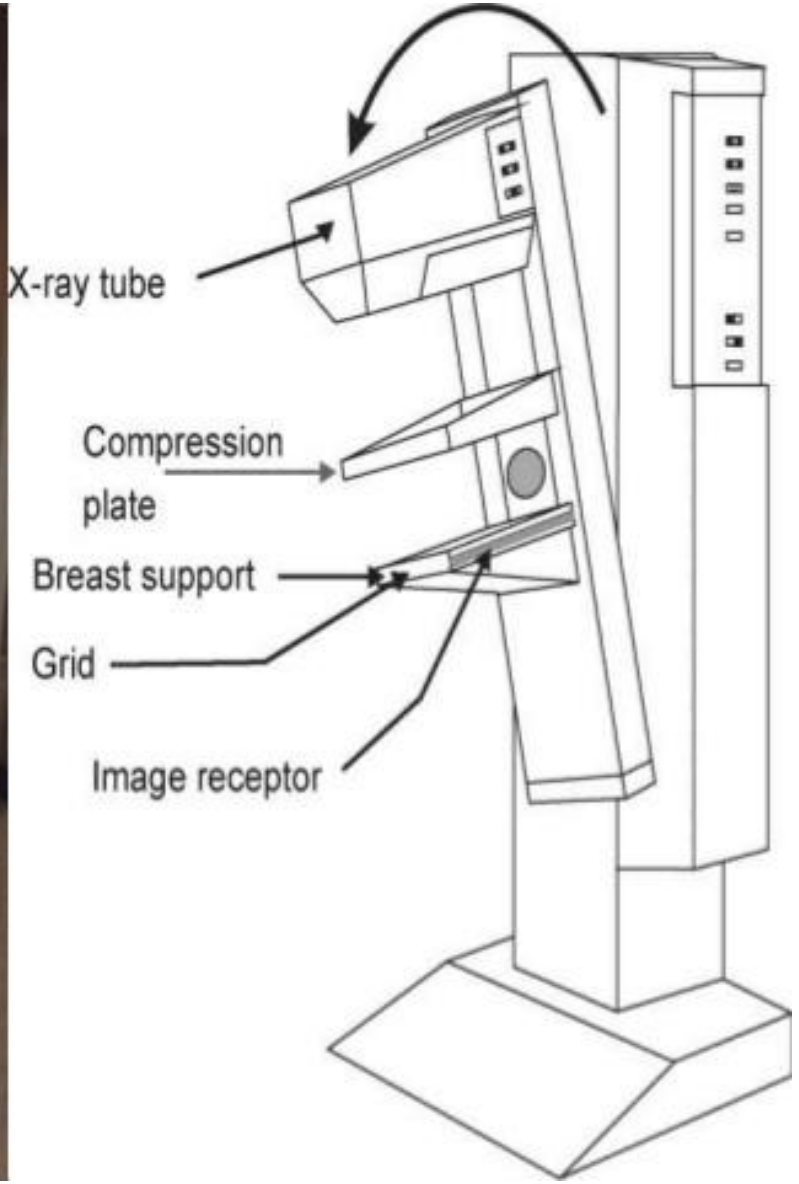
vidicon Camera



- Displaying the dynamic fluoroscopic images on a television screen, using a camera installed at the output phosphor layer. This camera is known as a vidicon camera, and it is shown in figure. This camera has a sensitive surface that has the same diameter as the output phosphor layer for the tube to increase the intensity of the image illumination. The camera converts the optical image from the output phosphorous into an electrical signal that is sent to a fluoroscopic television set. The television surveillance system is an advantage in the fluoroscopic imaging system, as it is possible to control the level of brightness and contrast of the television, as well as more than one doctor can watch what happens during fluoroscopic imaging.

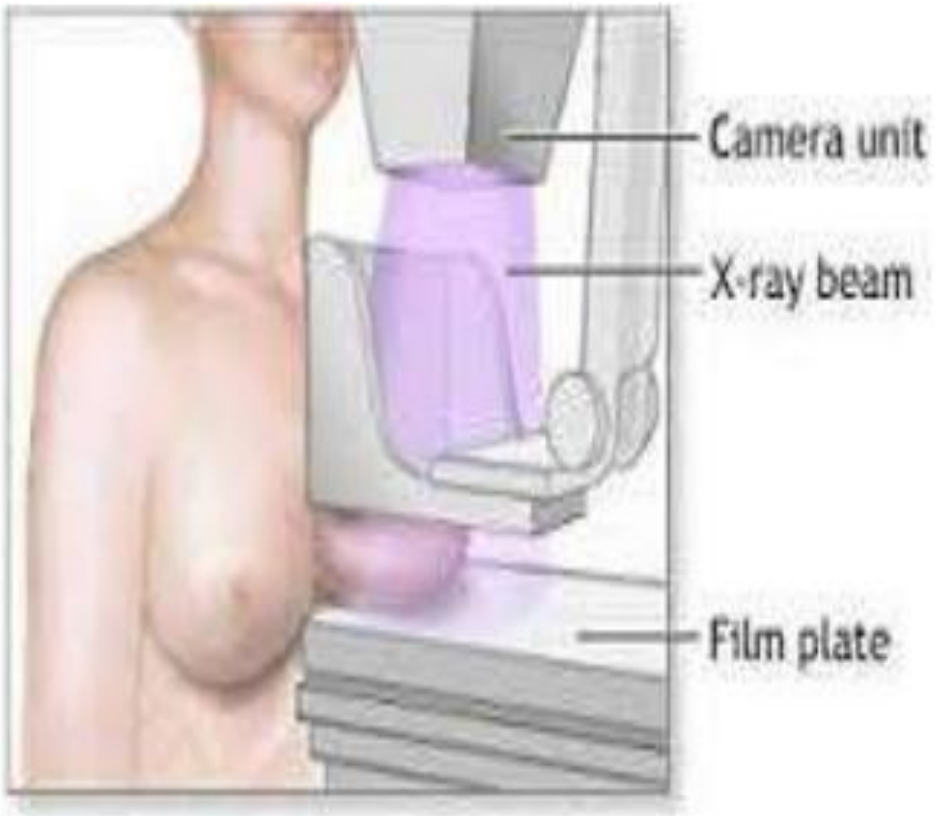
What is mammography?

- A mammography device is a specialized electronic medical device used for radiographic imaging of the breast area, and low-dose x-rays are used to clearly see the breast area and the parts and tissues inside.
- The mammography device helps to detect and diagnose breast diseases early in women. The X-ray used in this device is one of the methods or medical examinations that help doctors diagnose, detect and treat diseases early.

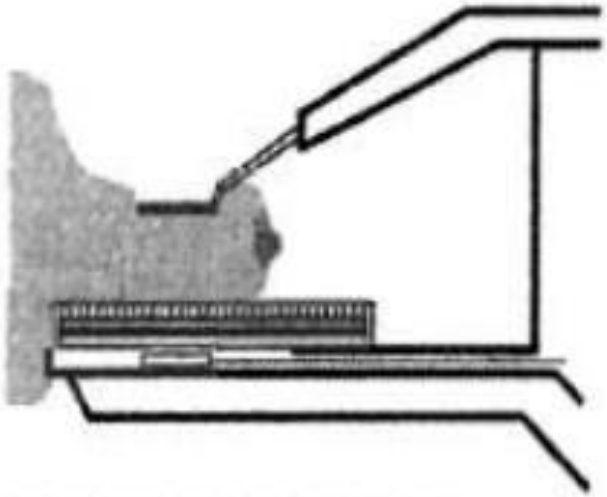

X-ray tube
Compression plate
Breast support
Grid
Image receptor

How does a mammogram work?

- When starting the mammography , the patient's breast is placed on a support plate to raise it and it is also fixed on both sides by two other plates that are often called paddles.
- then the mammography is turned on and works to produce a small amount of X-rays that work It penetrates the breast and is reflected on a detector located on the other side of the breast.
- The detector can be a photographic plate that captures an x-ray image on a film that sends electronic signals to the computer to form a digital image called the mammogram.
- When mammograms, low-density tissues such as fat appear transparently or as darker shades of gray approaching the black background, and in contrast, denser tissues such as connective tissues, glands and tumors, if any, appear whiter on a gray background, and the breast is imaged from all directions, from above and from both sides.



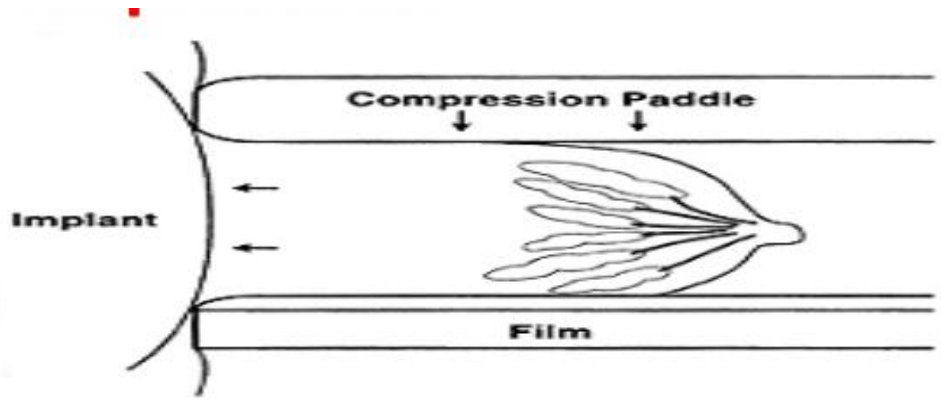
Spot compression



Spot compression paddle:
Better compression over small area

Why the breast compression?

- Get the better spatial resolution.
- The breast is brought closer to the imaging receptor so that magnification and focal spot blurring is reduced.
- Reduced movement blur, even at the relatively long exposure time.



Why the breast compression?

- Less scattered radiation in the image. The beam path length through the breast is shorter, so there is less material to do the

  scattering.
- The reduced path length makes practicable the use of lower energy (less penetrating) X-ray spectra. This gives greater subject contrast.
- Small areas of pathology buried in glandular tissue can be better visualized.

Breast support plates

- It’s the plate that hold the breast , it’s consist of two parts:

- **Upper part** made from carbon fiber (free absorption)
- **Lower part** made from lead (safe the patient abdomen from radiation hazard)

Types of mammography

There are two type of mammogram:

- Screening mammogram.

- Screening mammograms simply look for signs of cancer. A 3D screening mammogram is a woman’s best tool for detecting any changes in breast tissue. This exam is done yearly in women who have no breast symptoms or changes in their breast exam.
- all screening mammograms are read exclusively by breast imaging specialists, not general radiologists.

Diagnostic mammogram

Diagnostic mammogram

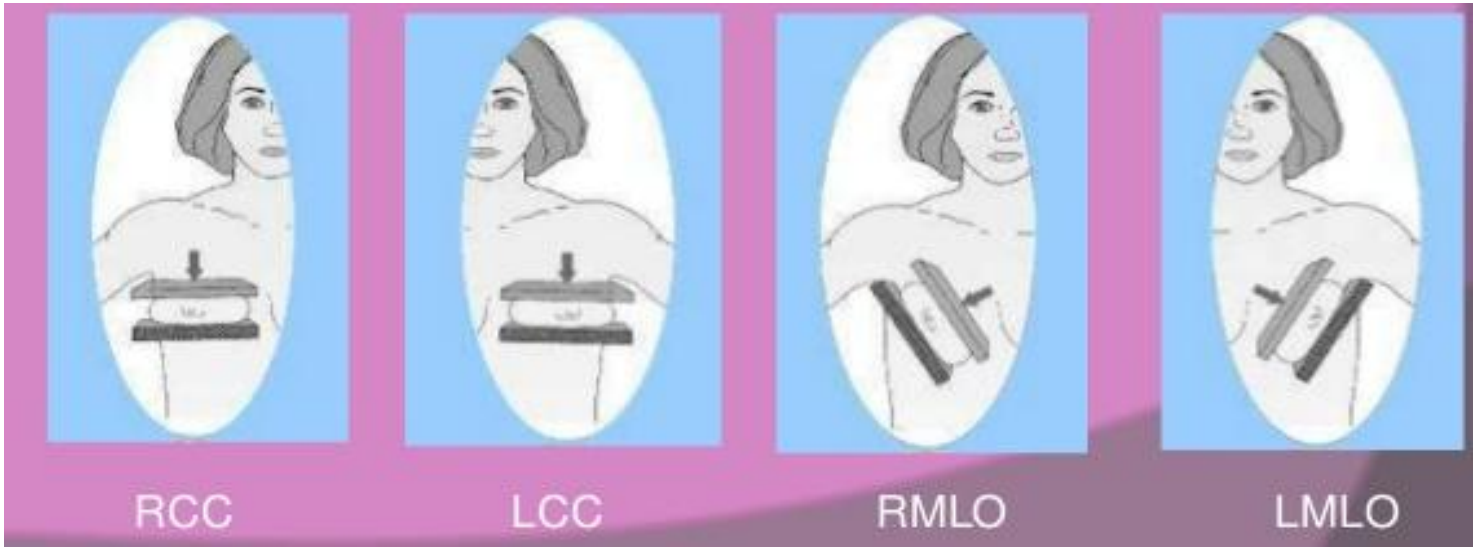
- When something is abnormal or difficult to determine, a woman may be referred for a diagnostic mammogram. For example, a woman with a breast problem, like a lump, breast pain, nipple discharge or an abnormal area found on a routine screening mammogram would get a diagnostic mammogram.
- Diagnostic mammograms are also done in women who need short interval, follow-ups exams as a result of a prior diagnostic exam. Also, women that were previously treated for breast cancer may get a diagnostic mammogram.

A diagnostic mammogram is usually interpreted in one of three ways:

- It may reveal that an area that looked abnormal on a screening mammogram is actually normal. When this happens, the woman may return to having a routine, annual screening mammogram.
- It could show that an area of concern probably is not cancer, but the radiologist may want to watch the area closely. When this happens, it’s common to ask the woman to return for another diagnostic exam in four to six months.
- The results could also suggest that a biopsy is needed to find out if the abnormal area is cancer. This would be to gather more information. If your doctor recommends a biopsy, it does not mean that you have cancer.

Standard view

- craniocaudal view (CC view)
- 45 medio lateral oblique view



Additional Views in Mammography

LAT
Left Axillary Tail

LCV
Left Cleavage

LFB
Left From Below

LLM
Left Lateromedial

LLMO
Left Lateromedial
Oblique

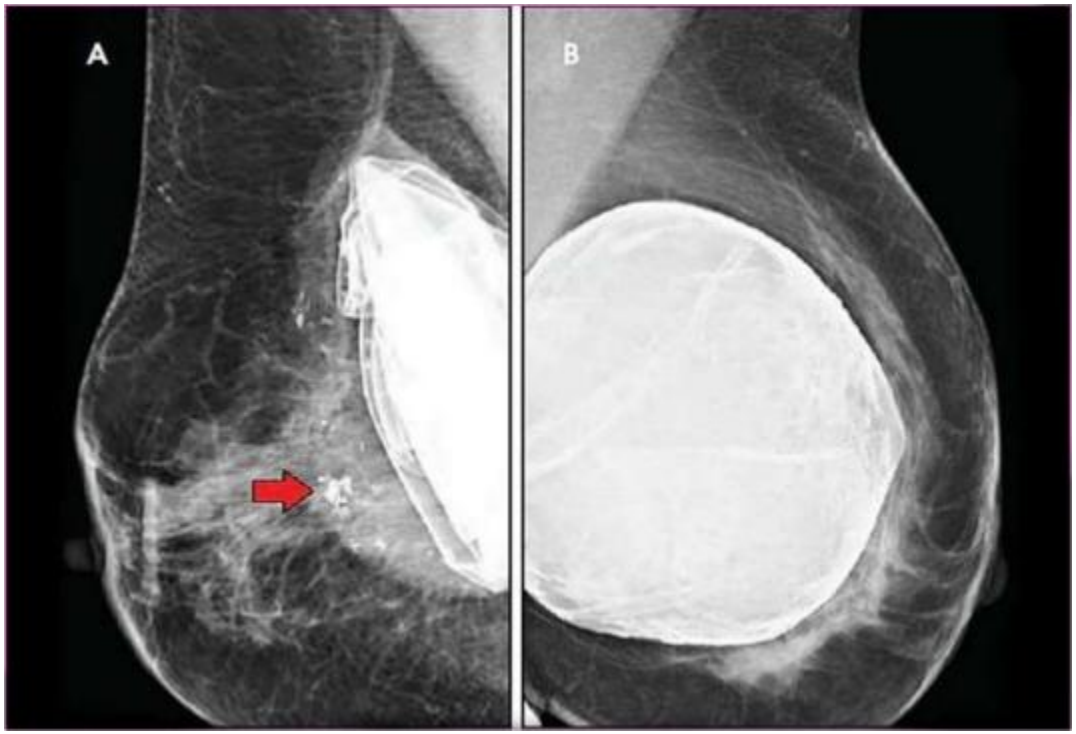
LML
Let Mediolateral

LRL
Left Roll Lateral

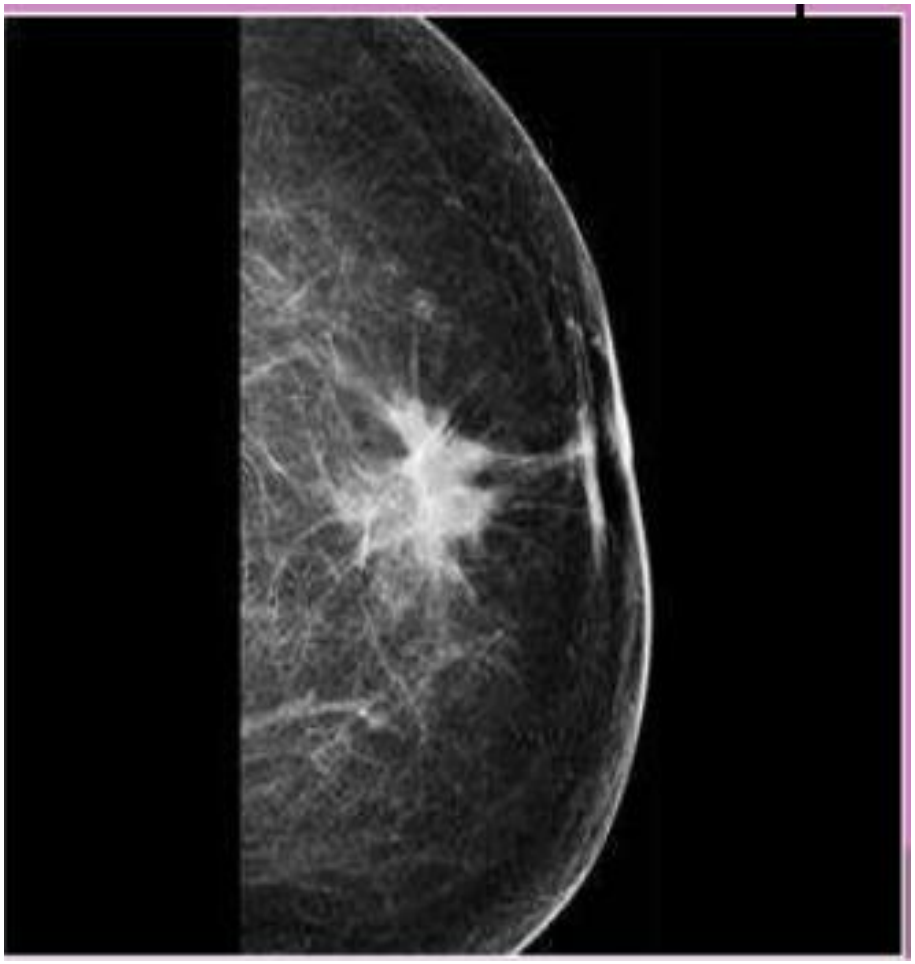
LRM
Left Roll Medial

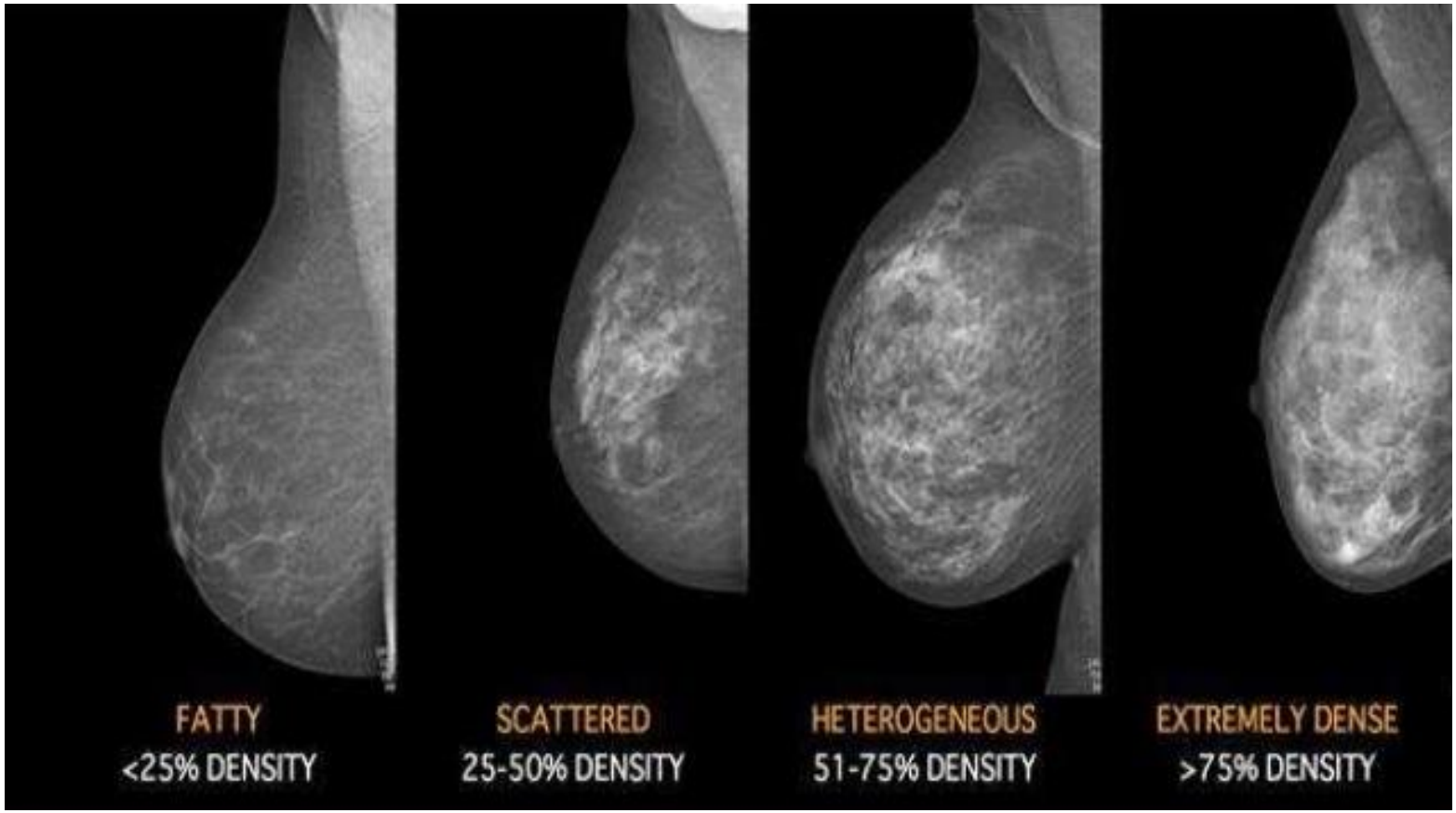
Normal Breast mammogram

Breast implant mammogram



Abnormality mammographic




FATTY
<25% DENSITY
SCATTERED
25-50% DENSITY
HETEROGENEOUS
51-75% DENSITY
EXTREMELY DENSE
>75% DENSITY

What causes high density breast tissue?

- It's not clear why some women develop more dense breast tissue while others don't.
- You may develop dense breast tissue if:
- If you are younger. Breast tissue tends to become less dense as you get older, but some women may develop denser breast tissue at any age.
- If you have a low BMI. Women who have less body fat are more likely to have denser breast tissue than women who are obese.
- Be sure to take hormone therapy for menopause. Women who take combination hormone therapy to relieve the signs and symptoms of menopause are more likely to have denser breast tissue.

How do I prepare for a screening mammography?

- The date of mammogram should be chosen at a time when the breasts are free of pain or discomfort, and the best date for doing a mammogram is in the week after menstruation, because the woman's breasts are likely to be in an uncomfortable or painful position in the week preceding the cycle and the first week of the cycle itself.
- When you make your appointment, please let the radiology facility know if you have breast implants, so they can schedule a longer appointment. This is because it takes more time to obtain clear
- Do not wear any deodorant, perfume, lotion or talcum powder on the day of your appointment, because these substances might show up as shadows on your mammogram. Wear a two-piece outfit, so you only need to undress from the waist up.
-