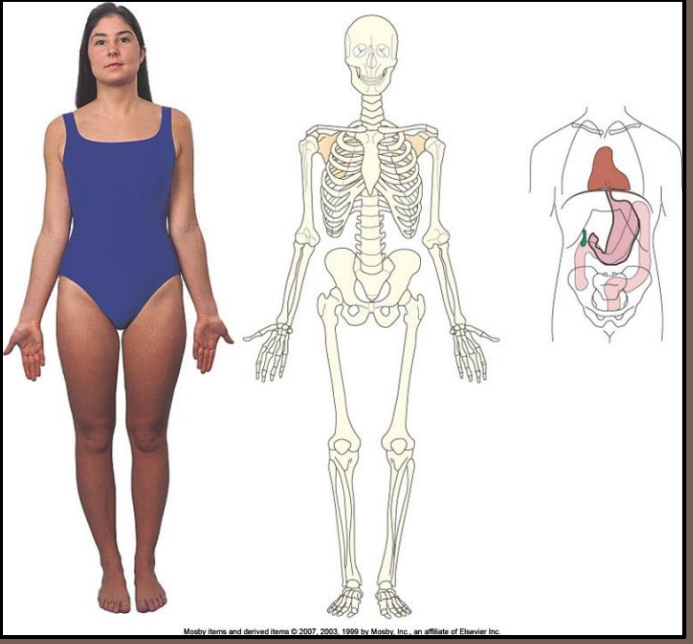


Chapter-1

GENERAL PRINCIPLE OF RADIOGRAPHIC POSITIONING

Prepared by; SAMUEL.B(MRT, Assistant lecturer)

Objectives:-

At the end of this session you will able to:-

- Explain the importance of radiographic positioning course
- Define the anatomic position, the imaginary planes and body sections
- Describe standard positioning terms
- Distinguish between the radiographic projection and position
- List and identify the meaning of specific terms related to movement.

Contents:-

- ***General Terms***
- ***Introduction to radiographic examination***
- ***General radiological Terminology:-***
  I. Anatomical terminology
  II. Positioning terminology
  III. Projection terminology

cont'd…

- ***Imaging principles:-***
  - ✓ Exposure factors
  - ✓ Radiographic image
  - ✓ Image evaluation
- ***Anatomical Land marks***

General Terms

- ***Radiography:-*** ***is the process and procedures*** of producing a radiograph.
- ***Radiograph:-*** is ***an image of a patient's anatomic part(s),*** as produced by the action of x-rays on an image receptor.
- ***X-ray film:-*** specifically refers to the physical piece of material on which a latent image is stored.

Cont'd…

- ***Image receptor (IR):-*** ***The device that captures the radiographic image*** that exits the patient.
- ***Central ray (CR):-*** Refers to ***the center-most portion of the x-ray beam*** emitted from the x-ray tube.

Introduction

- ***A radiographic examination involves five general functions:-***

1. ***Positioning of the body part***
2. Application of radiation protection measure
3. Selection of exposure factor
4. Instruction to the patient related to the respiration
5. Processing of the image receptor. Fig

General Radiological Terminology

- The human body is a complicated structure, and errors in radiographic positioning or diagnosis can easily occur; unless practitioners have a ***common set of rules*** that are ***used to describe the body and its movement.***
- ***Knowledge of specific terminology is required to understand instruction of patient positioning.***

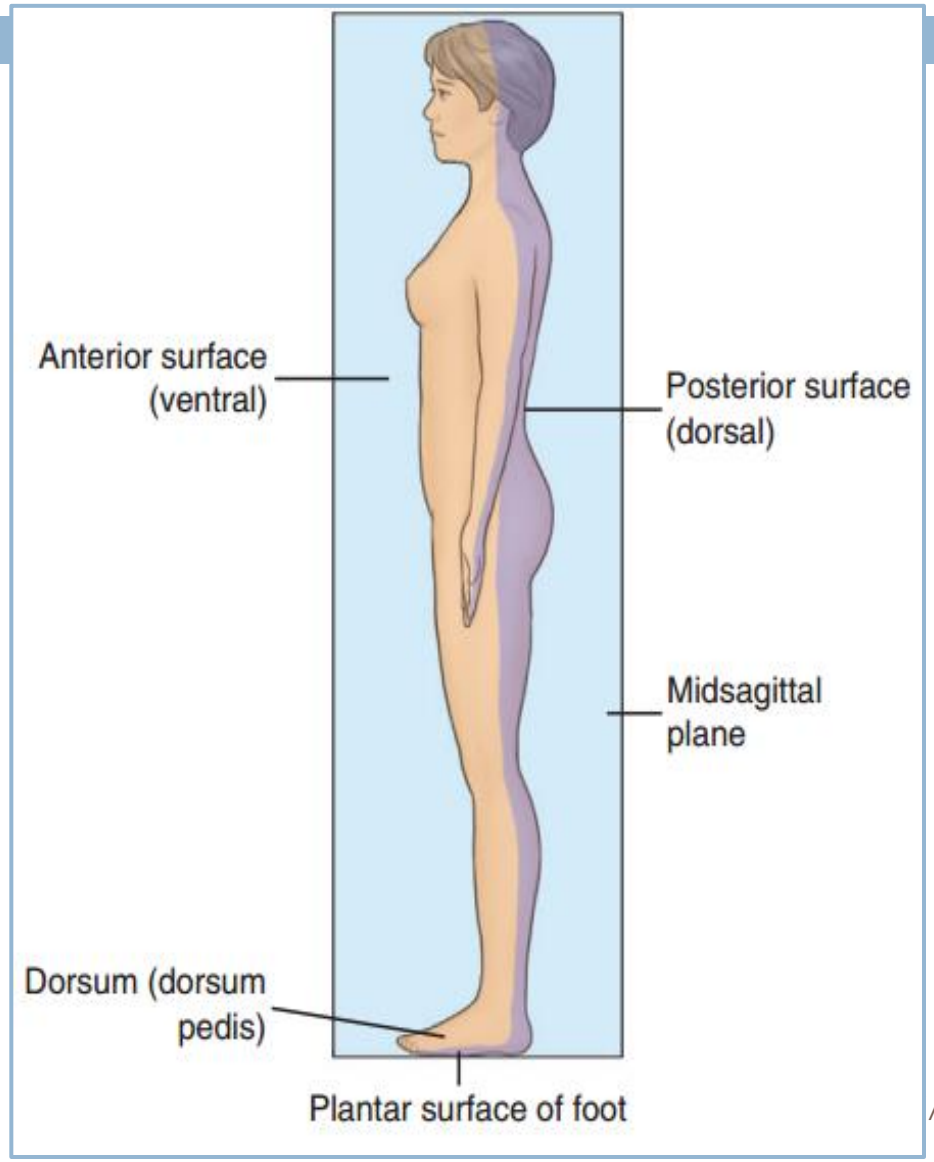
I. Anatomical Terminology

- ***Anatomical position:-***
  - is a standardized method of observing or imaging the body that allows precise and consistent anatomical references.
  - ***Its an upright position with arms abducted slightly (down), palms forward, and head and feet directed straight ahead.***

❖ *Patient aspect:-*

- ***Anterior(ventral) aspect:*** that seen when viewing the patient from the front.
- ***Posterior (dorsal) aspect:*** that seen when viewing the patient from the back.
- ***Lateral aspect:*** refers to any view of the patient from the side.
- ***Medial aspect:*** refers to the side of a body part closest to the midline,
  - **E.g:-** the inner side of a limb is the medial aspect of that limb.

Fig, Patient aspect



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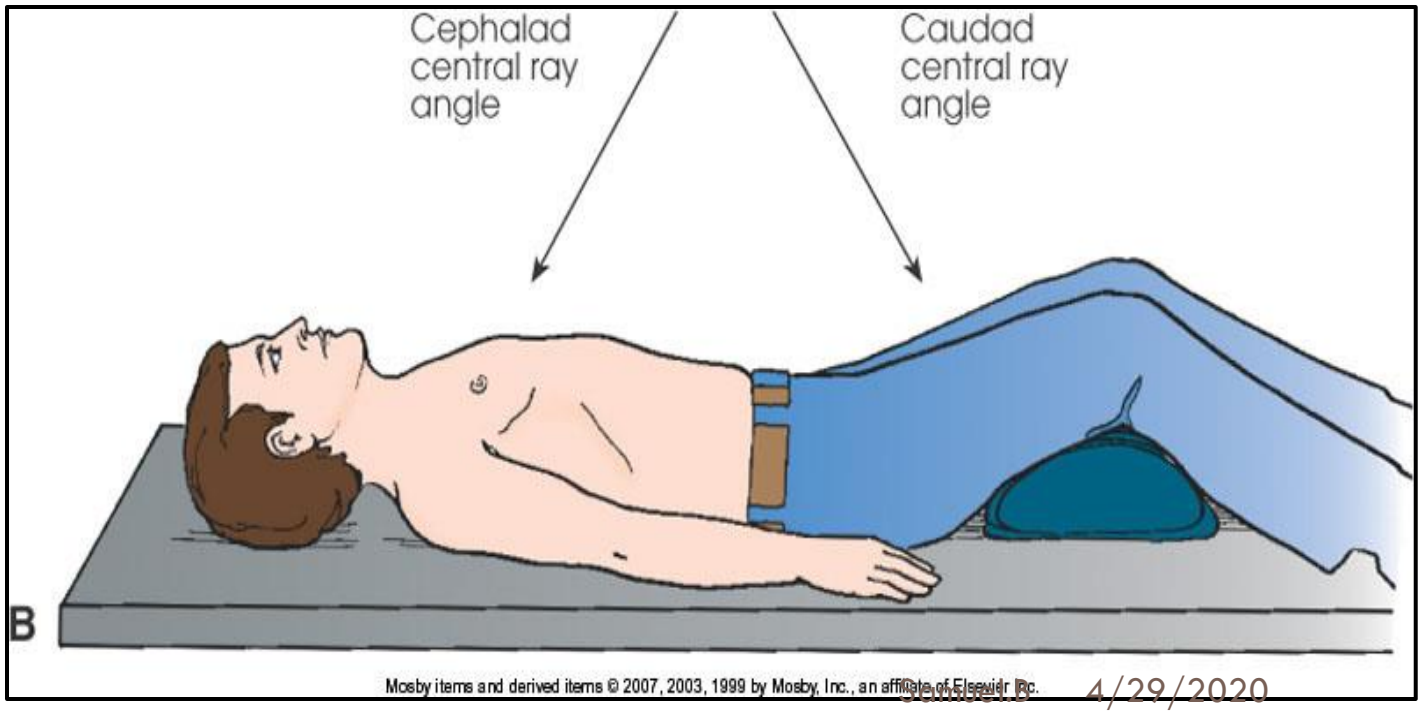
❖ *Anatomically related terms:*

- ✓ ***Caudal:-*** parts away from the head.
- ✓ ***Cephalic:-*** parts toward the head.



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- ***Superior:-*** part nearer to the head**.**
- ***Inferior:-*** nearer to the feet.
- ***Central:-*** mid area.
- ***Peripheral:-*** at or near the surface, edge, or another body part.
- ***Medial:-*** toward the mid.
- ***Lateral:-*** away from the mid-line.

Cont'd…

- ***Superficial:-*** near the skin(surface).
- ***Deep:-*** far from the surface.
- ***External:*** outside the body.
- ***Internal:*** inside the body.
- ***Parietal:*** the wall or lining of a body cavity
- ***Visceral:*** the covering of an organ

Cont'd…

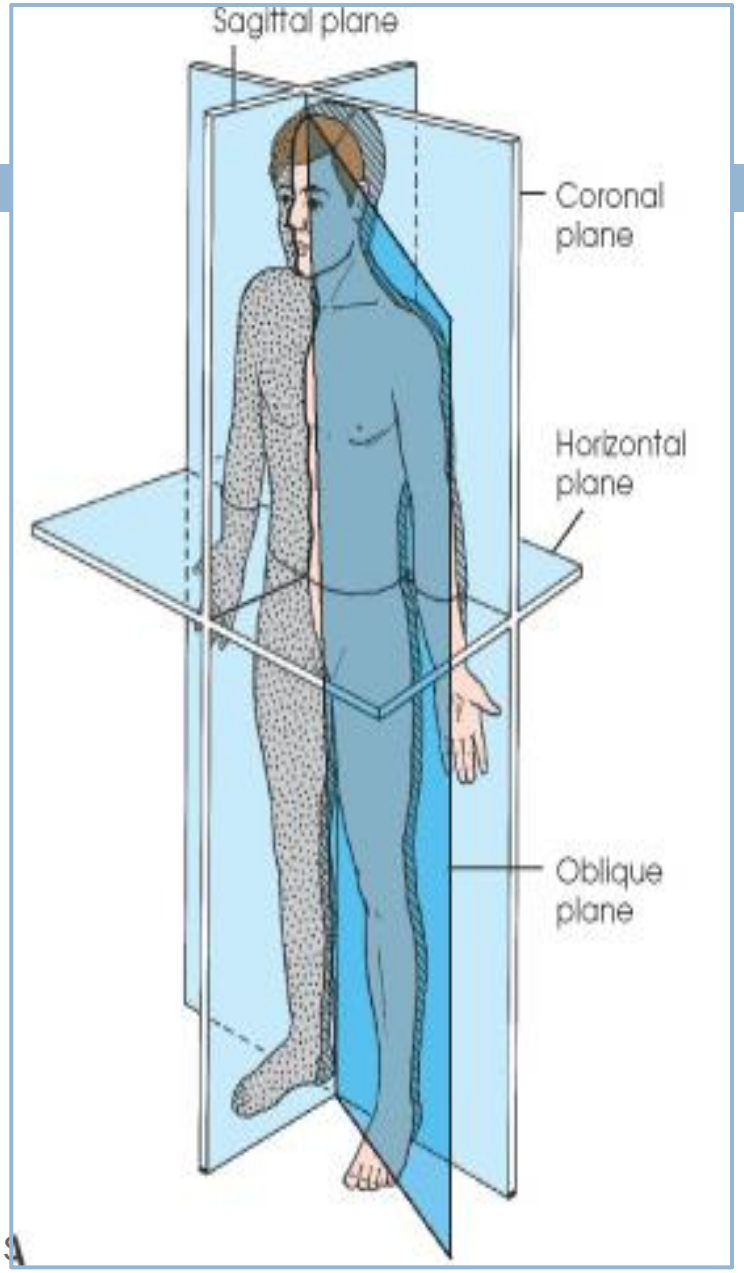
- ***Ipsilateral:-*** parts on the same side of the body
- ***Contralateral:-*** Parts on the opposite side of the body
- ***Palmar:-*** palm of the hand
- ***Plantar:-*** sole of the foot
- ***Dorsum:-*** Anterior or top of the foot or the back of the hand.

II. Positioning Terminology

- ***Positioning*** ***is the act of placing the patient in the desired position***
- ***Body Planes:-***
  - Are ***imaginary planes*** that subdivide the body in reference to anatomic position
  - Four common planes are:
    A. ***Sagittal,***
    B. ***Coronal,***
    C. ***Horizontal &***
    D. ***Oblique***.

❑ *Body Planes:-*

Fig, Body planes



- **N.B:** the first three planes are mutually at right-angle to each other.

Cont'd…

A. Sagittal plane:- is any longitudinal plane that divides the body into right and left parts

- ***Midsagittal (median) plane*:-** is specific sagittal plane that divides the body into **equal** right and left halves

Cont'd…

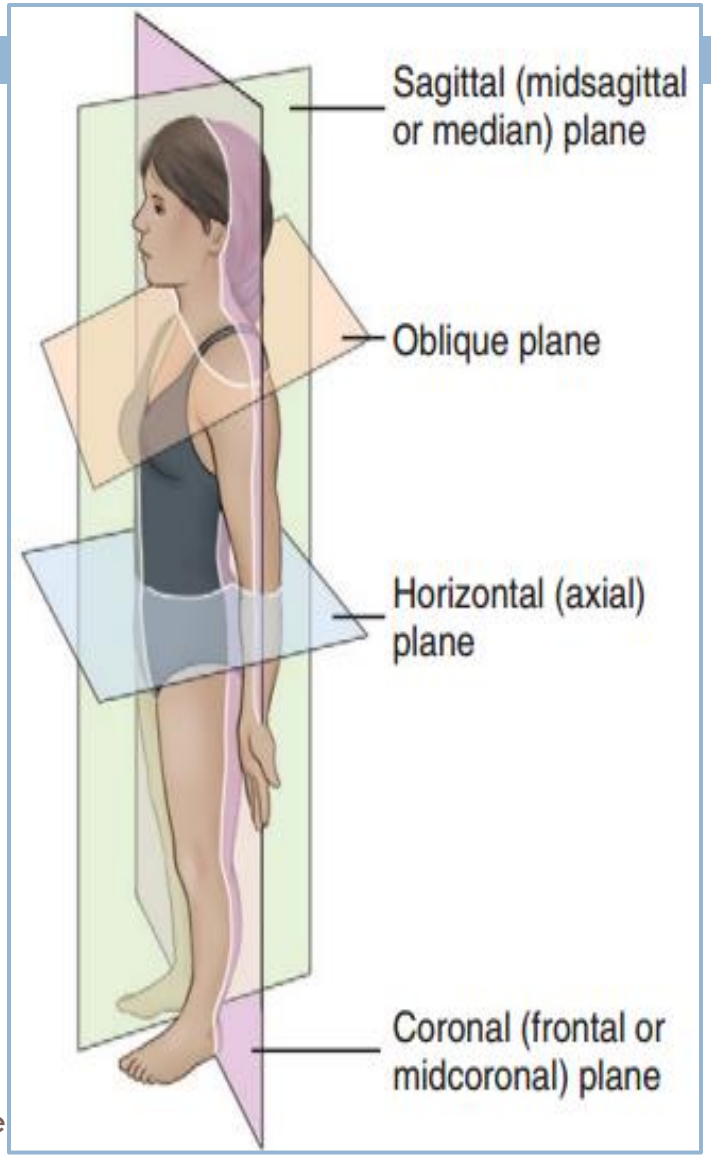
B. Coronal plane:- is any longitudinal plane that divides the body into anterior and posterior parts

- ***Midcoronal plane*:-** is the specific plane that passes through midline and divides the body into **equal** anterior and posterior halves

Cont'd…

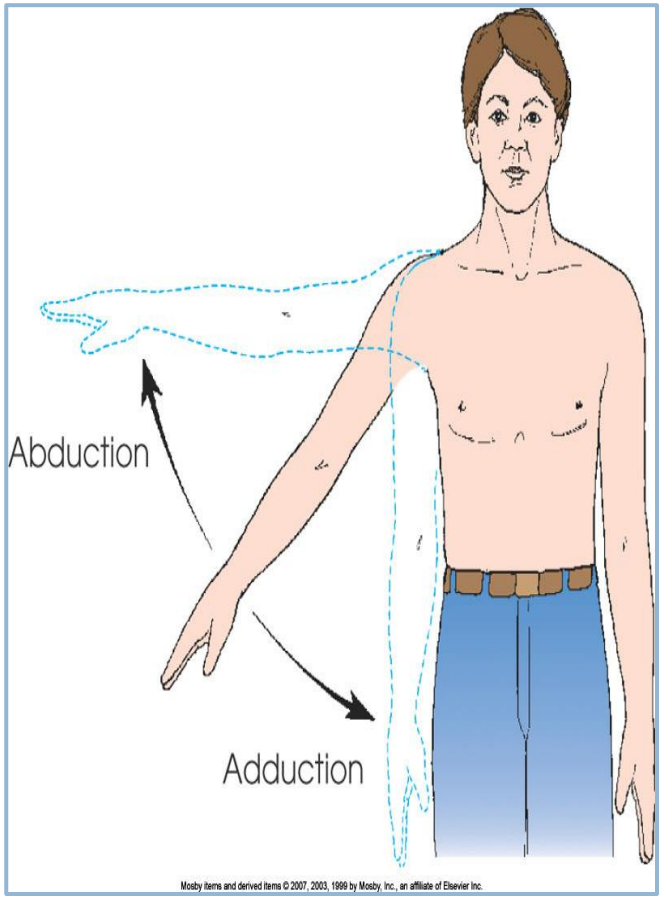
C. ***Horizontal(axial) plane:*** is any transverse plane that passes through the body dividing the body into superior and inferior portions.

D. ***Oblique plane:-*** is a longitudinal or transverse plane that is at an angle and is ***not parallel*** to the sagittal, coronal, or horizontal plane.



❑ *Body mov't terminology:*

- ***Abduction*:-**
  - refers to a movement away from the midline.
- ***Adduction*:-**
  - refers to a movement towards the midline



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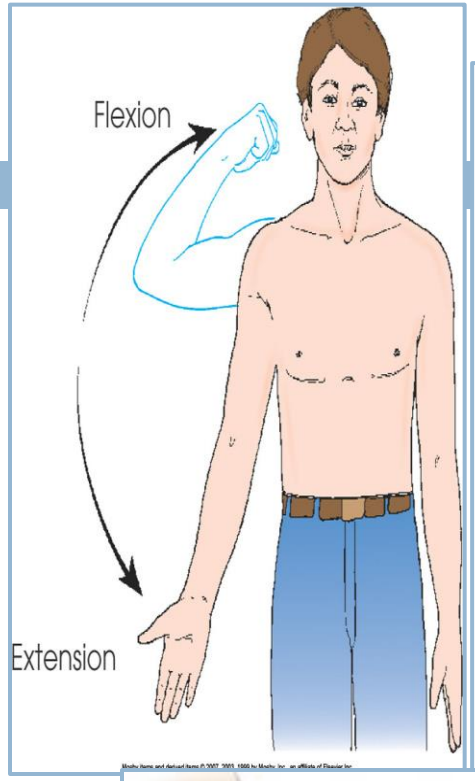
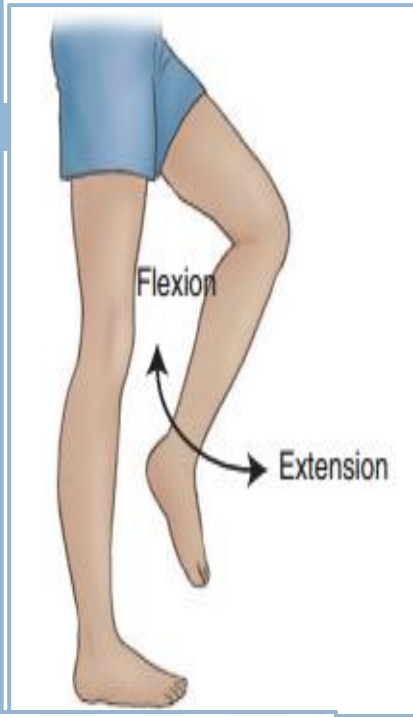
- ***Extension*:-**
  - Straightening of a joint
  - When joint angle increase
- ***Flexion*:-**
  - Bending of a joint
  - When joint angle decrease
- ***Hyperextension* & *hyperflexion*.**





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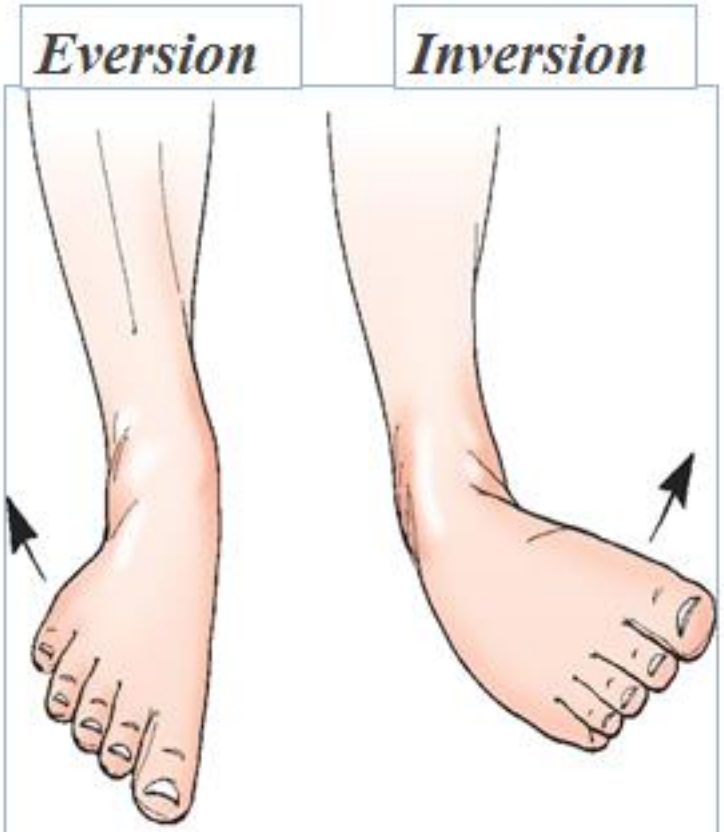
- ***Evert/eversion*:-**
  - Outward turning of the foot at the ankle
- ***Invert/inversion*:-**
  - Inward turning of the foot at the ankle



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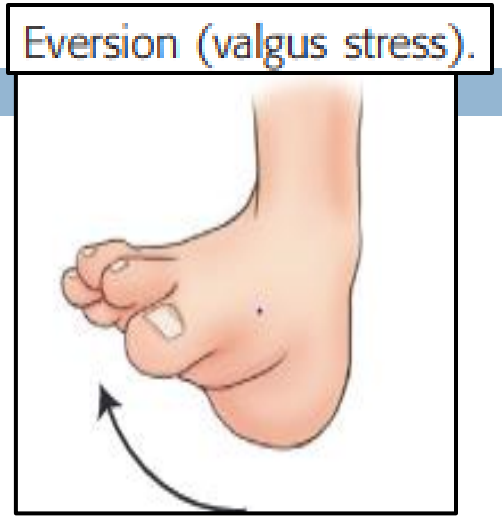
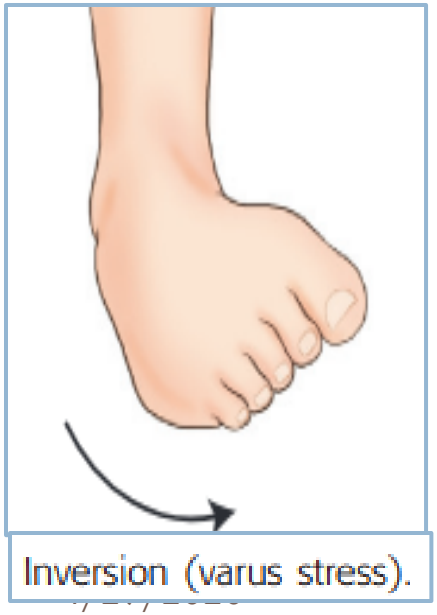
- ***Valgus*:-**
  - Is used to described as ***stressed eversion*** of ankle joint.
- ***Varus(knock-kneed)*:-**
  - Is used to describe ***stressed inversion*** of ankle joint.





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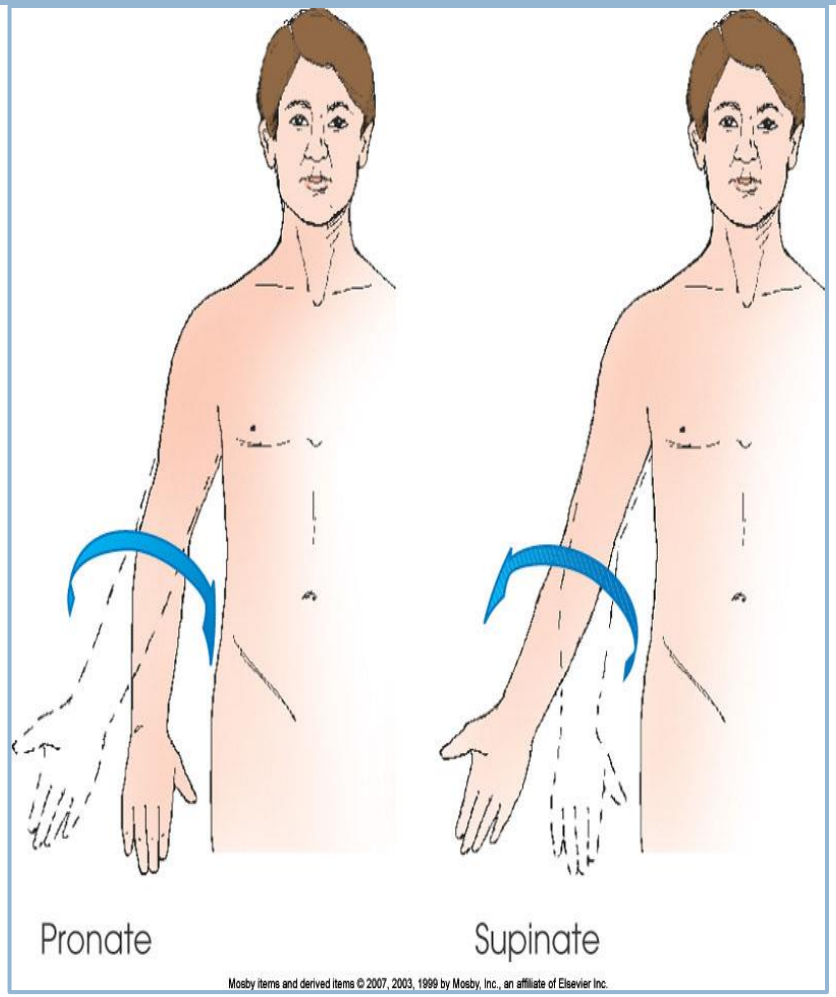
- ***Pronation*:-**
  - Rotation of forearm so that the palm is down
- ***Supination*:-**
  - Rotation of forearm so that the palm is up



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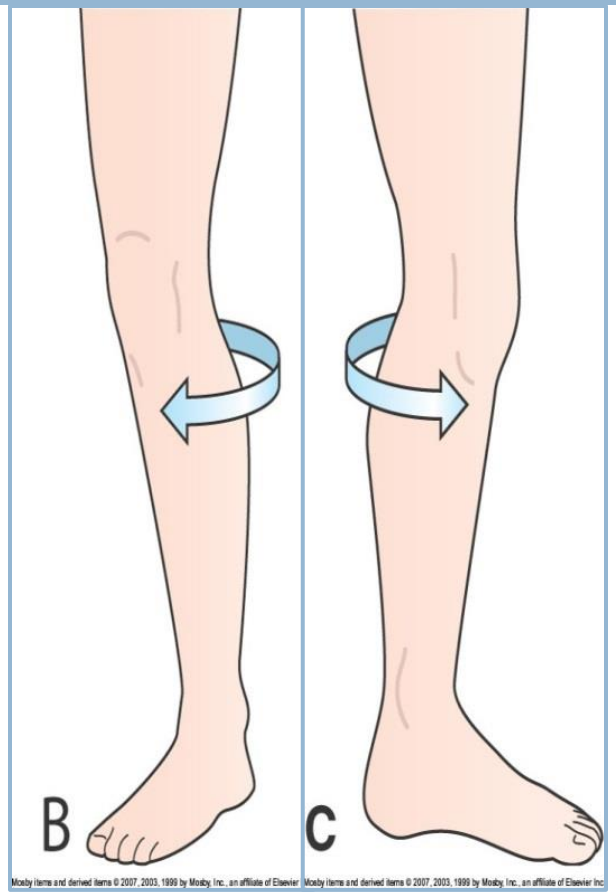
- ***Rotation***:- movement of the body part around its own axis.

Fig. ***(B)medial(internal)*** rotation towards the midline &, ***(C)lateral (external)*** rotation away from the midline.



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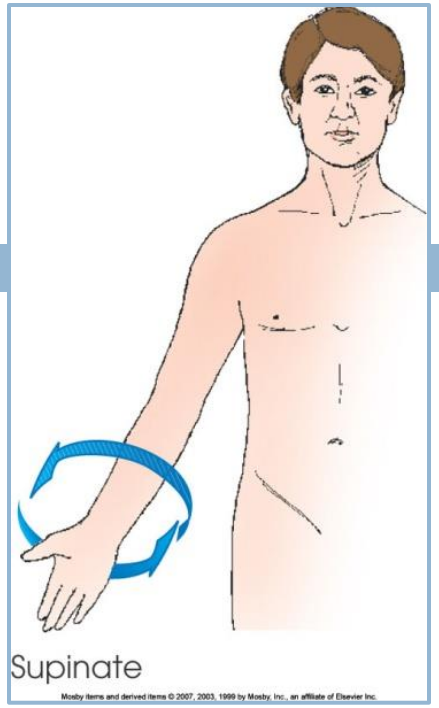
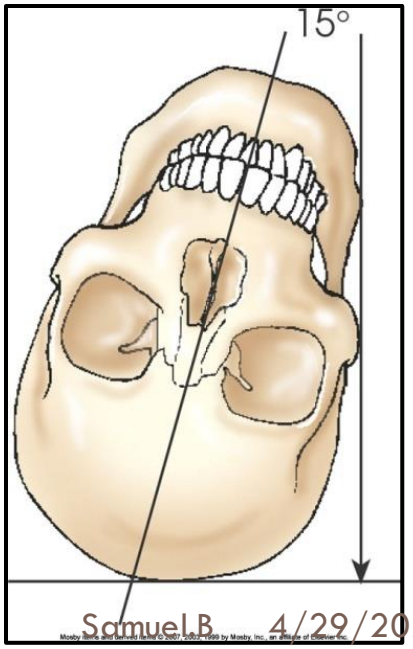
- ***Circumduction*:-**
  - Circular movement of a limb
- ***Tilt*:-**
  - Tipping or slanting a body part slightly





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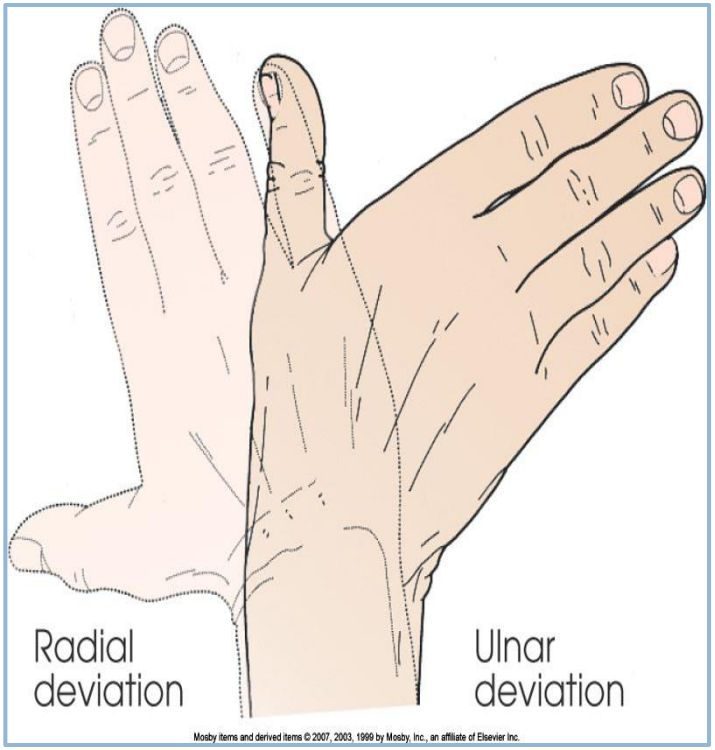
- ***Deviation*:-**
  - A turning away from the regular or standard course



❑ *General body position:-*

- ***Erect*:-** an upright position, to **stand** or **sit**.
- ***Recumbent:*** lying down on any position,
  - ✓ ***Dorsal recumbent(supine):-*** lying on the back
  - ✓ ***Ventral recumbent(prone):-*** lying face down
  - ✓ ***lateral recumbent:-*** Lying on side (right or left lateral).

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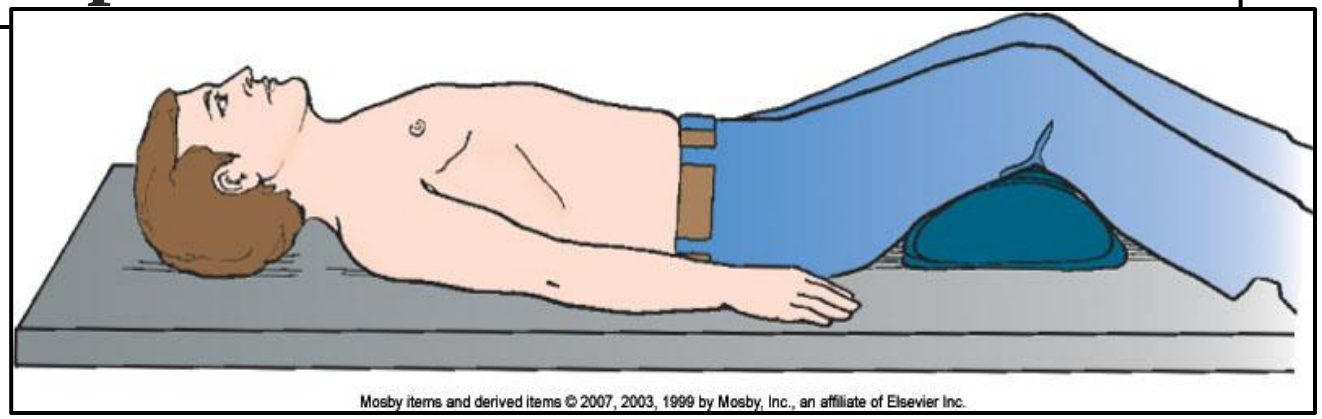
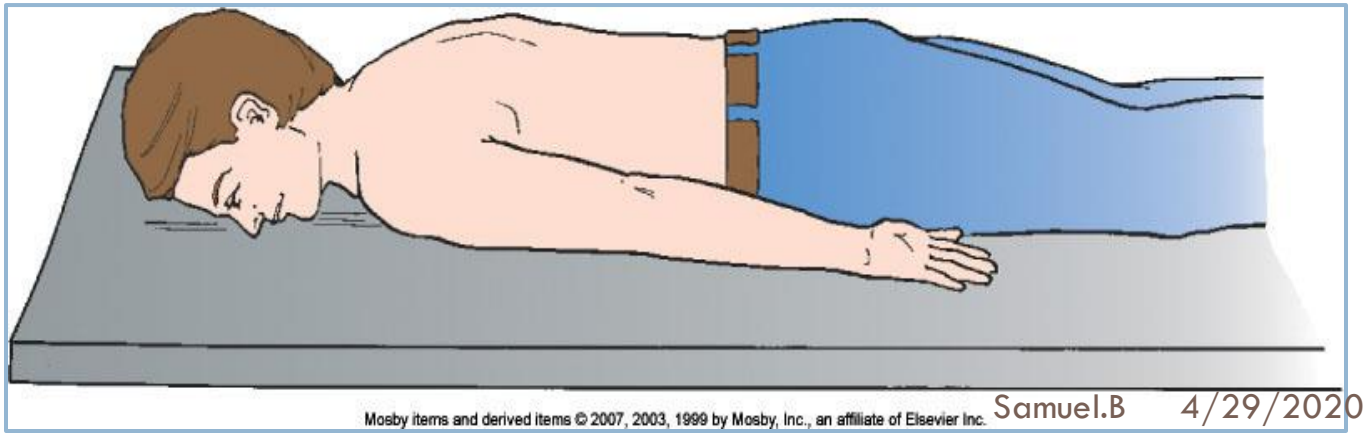
Supine:-



Prone:-



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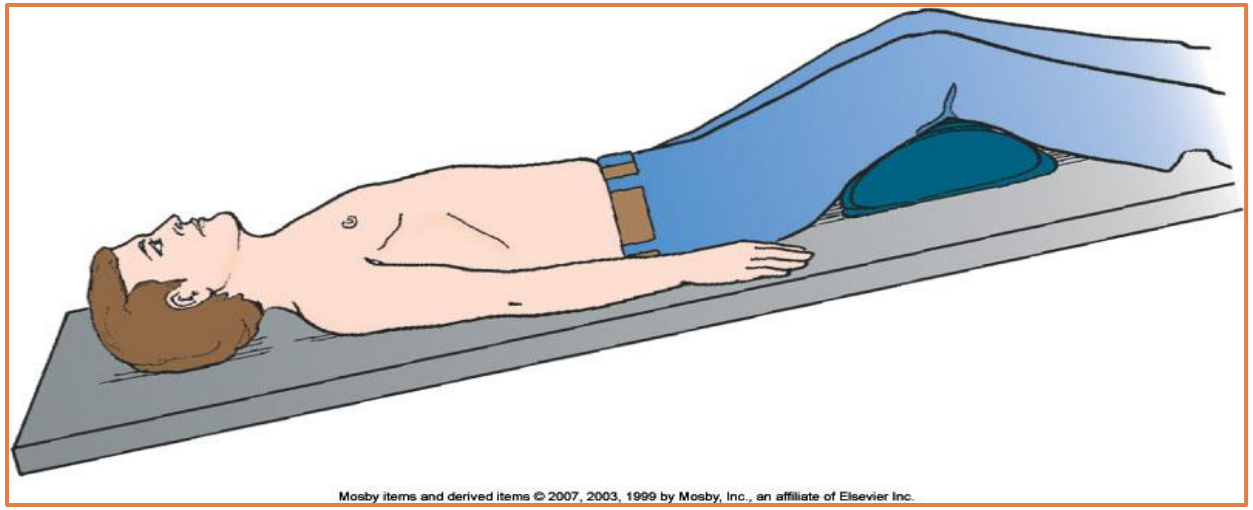
- ***Trendelenburg*:-**
  - A supine position with the body tilted with the ***head lower than the feet***.



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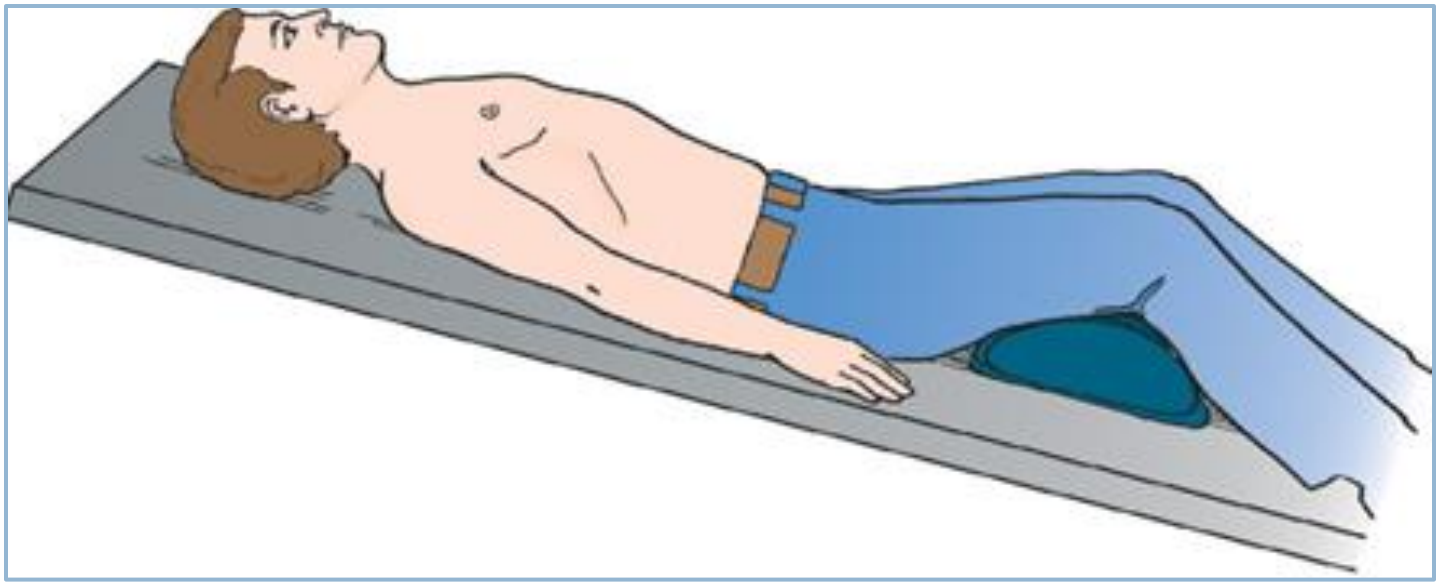
- ***Fowler's position*:-**
  - Supine with the ***head elevated***



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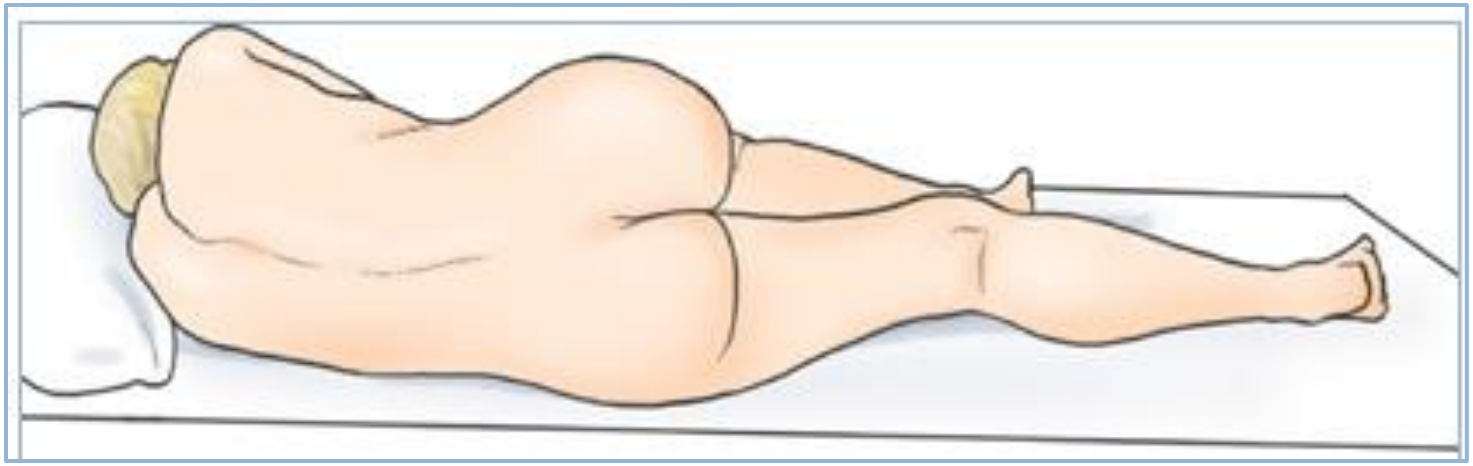
- ***Sims' (semi-prone) position:-***
  - Recumbent with patient lying on left anterior side, with left leg extended and right knee and thigh partially flexed.



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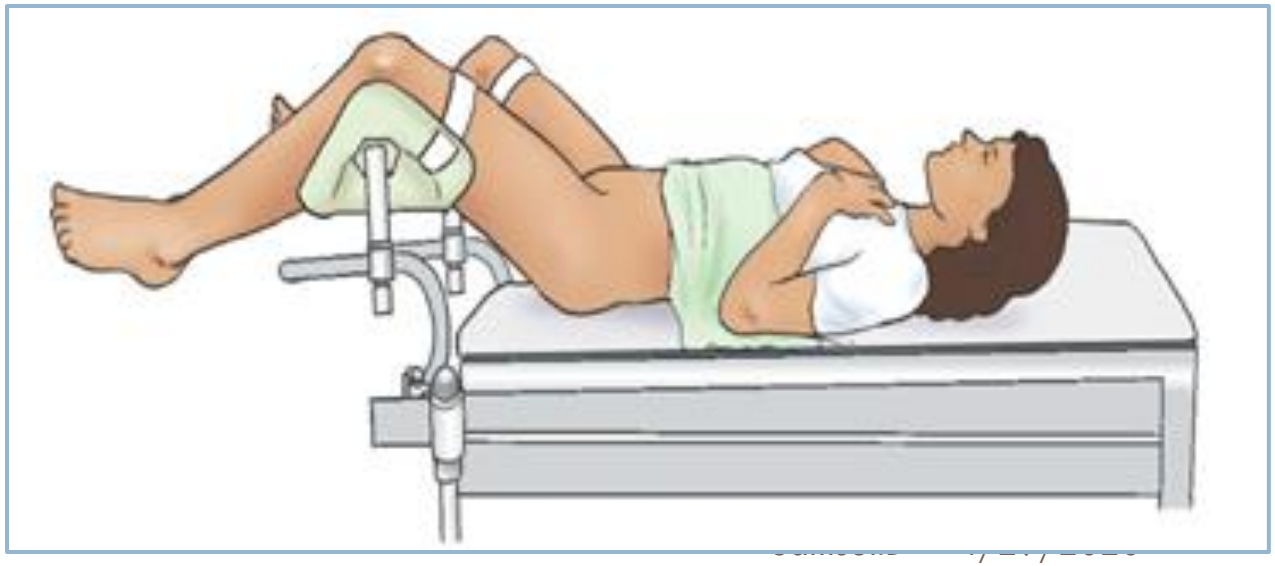
- ***Lithotomy position:-***
  - Supine position of the body;
    - with knees and hips flexed, &
    - thighs abducted and rotated externally, supported by ankle supports

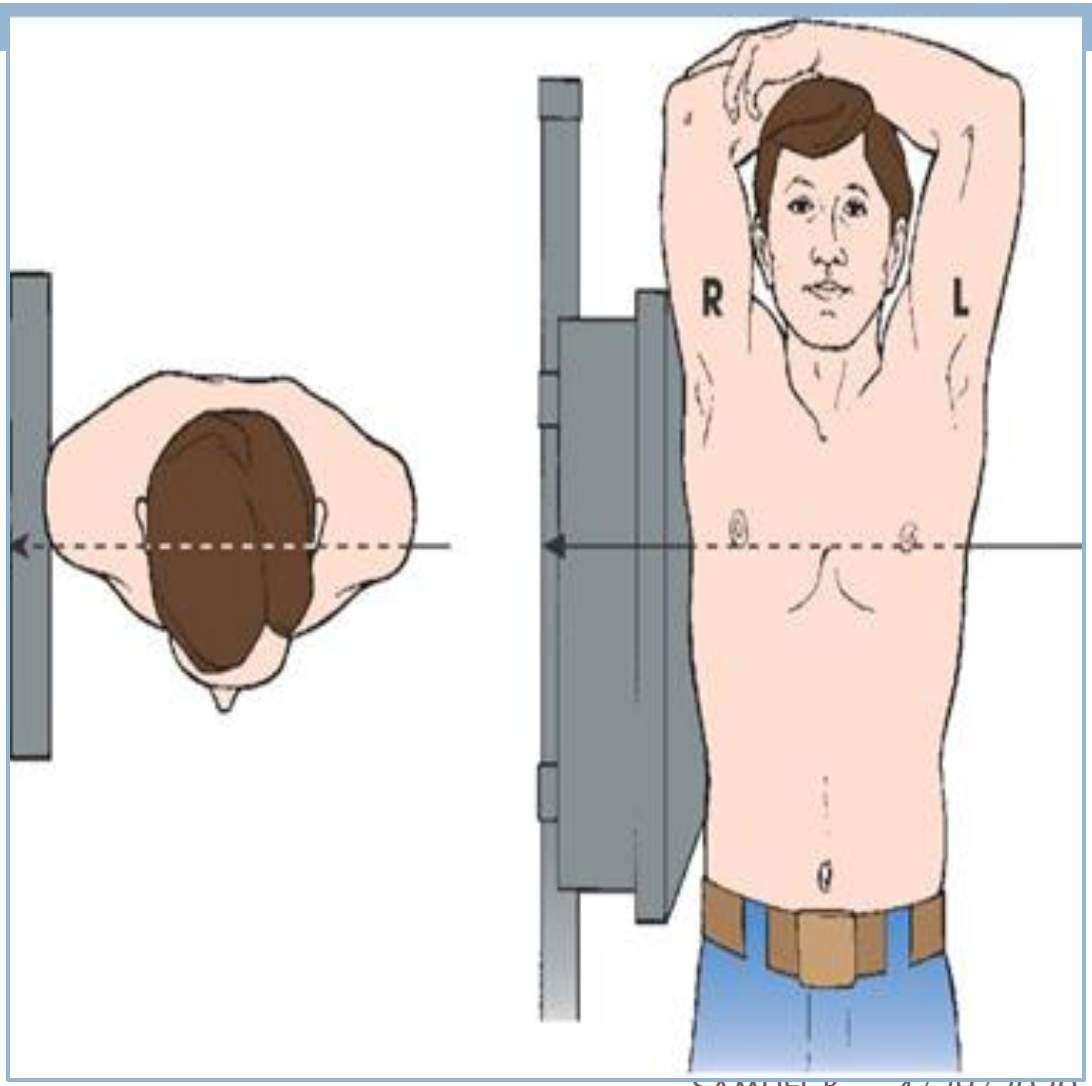


❑ *Specific body position:*

➢ ***Lateral position:-***

- described by the ***part closest to the IR*** *or the* ***body part from which the CR exits.***
- Right lateral & left lateral.
- ➢ ***A true lateral position*** is always 90°, or perpendicular to a ***true AP or PA projection***.

Fig. lateral position



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- ***Oblique position*:-**
  - angled position in which ***neither*** the sagittal nor the coronal body plane is perpendicular to the IR.
  - Named according to side and surface of body closer to table or IR.
  - **RAO & LAO and RPO & LPO** positions.

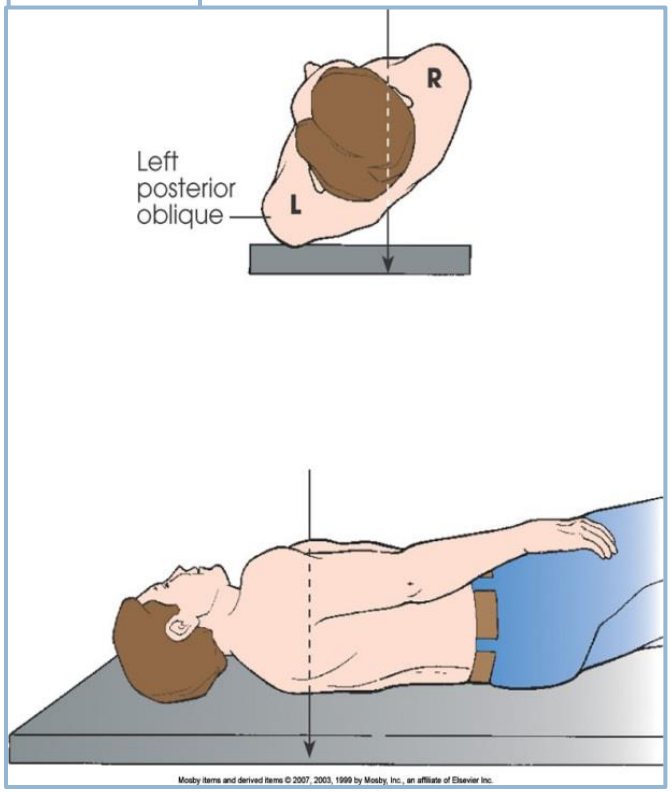
Cont'd…

1. ***Left and right Posterior oblique (LPO & RPO):-***

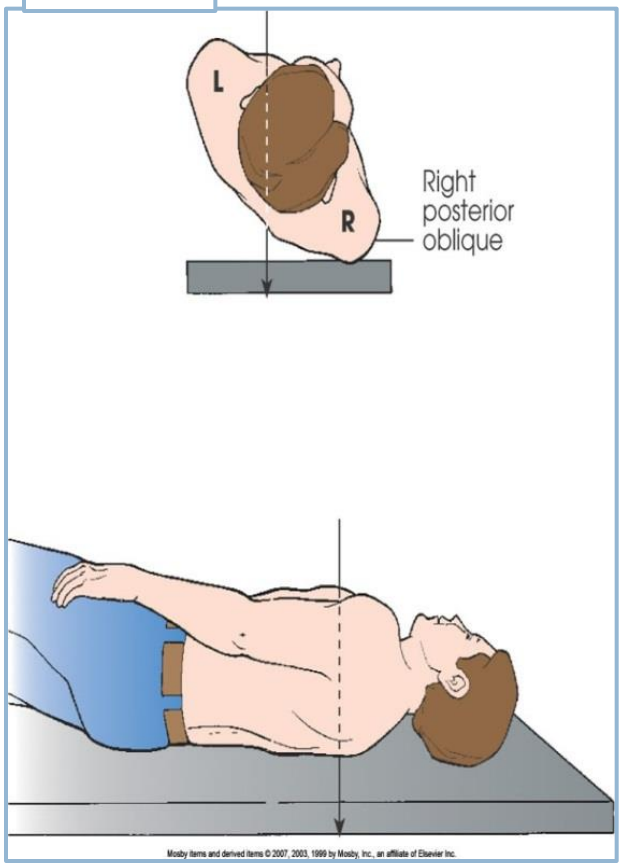
   - Specific oblique positions in which the **left** or **right** ***posterior aspect*** of the body is closest to the IR.
   - Angle of rotation is specific for anatomy of interest.

Fig, LPO(A) & RPO(B).

A)



B)



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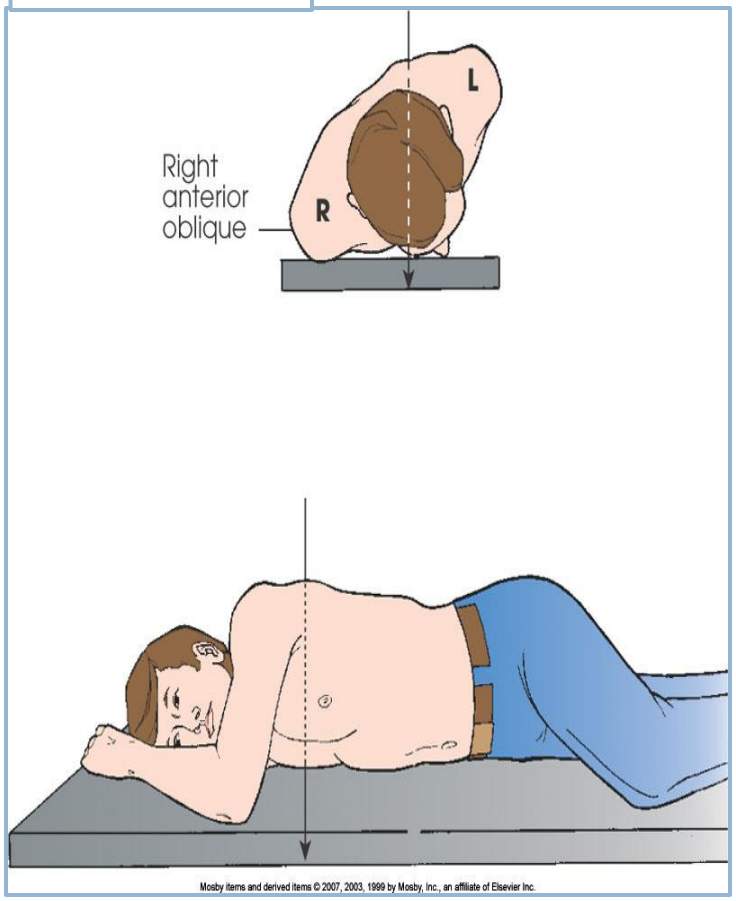
2. Right and left anterior oblique (RAO & LAO):-

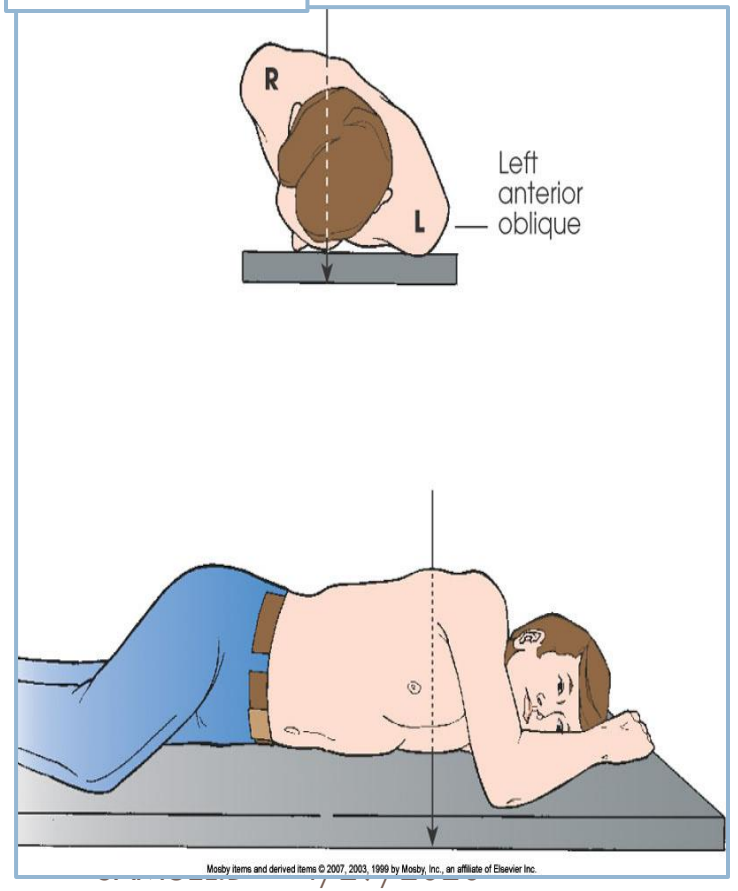
- Specific oblique positions in which the **right** or **left** ***anterior aspect*** of the body is closest to the IR.

Fig, Right and left anterior oblique

A) RAO



B) LAO



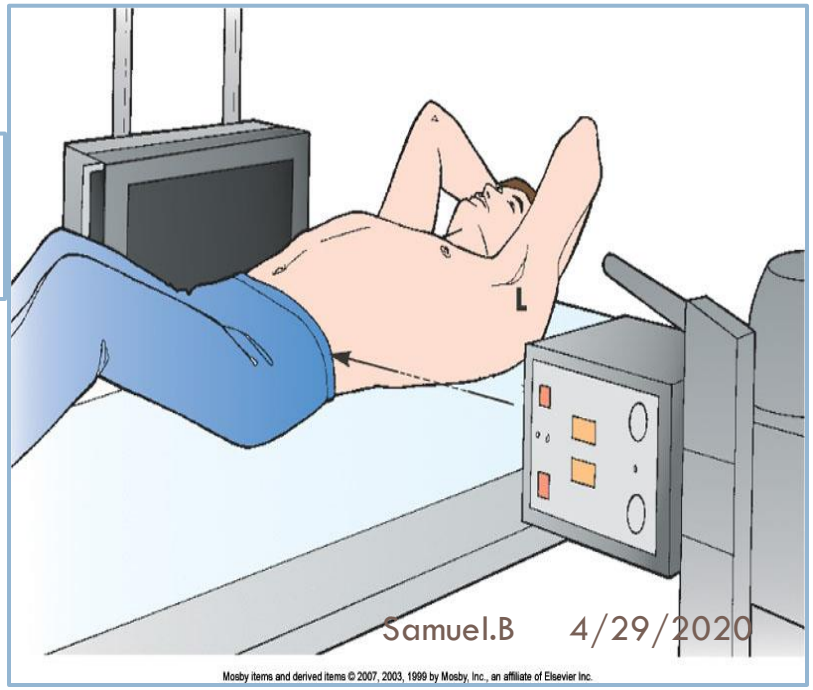
➢ ***Decubitus Position:-***

- To lie on horizontal surface
- Described according to the surface on which the body is resting;-
  - ➢***Back(dorsal)***,
  - ➢ ***Front(ventral)*** *or*
  - ➢ ***Side****(right/left* ***lateral****).*
- ***Always performed with horizontal CR.***

a) ***Dorsal decubitus*:-**

- The patient is lying on the ***posterior surface*** with the ***x-ray beam directed horizontally***.
- ***Supine recumbent position.***

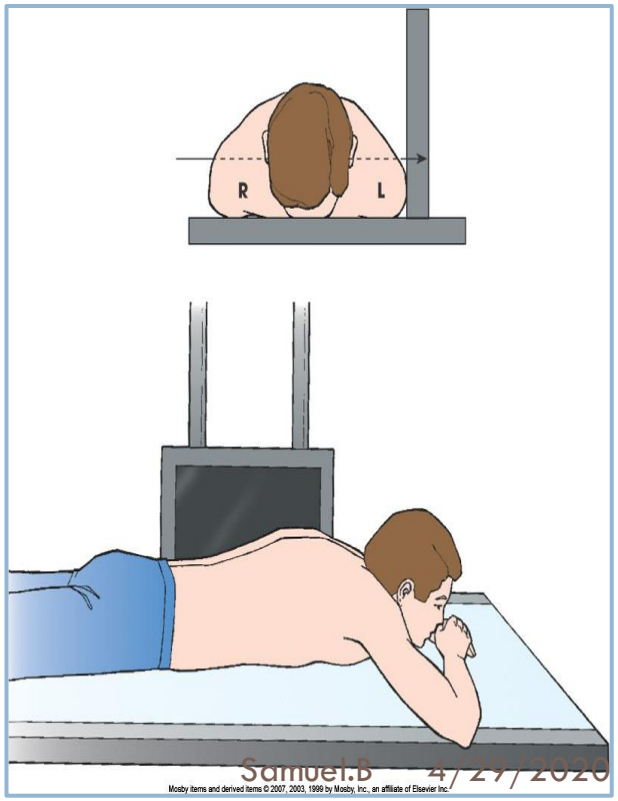
Fig, RDD



b) Ventral decubitus:-

- The patient is lying on the ***anterior surface***.
- ***Prone Recumbent position with a horizontal CR.***

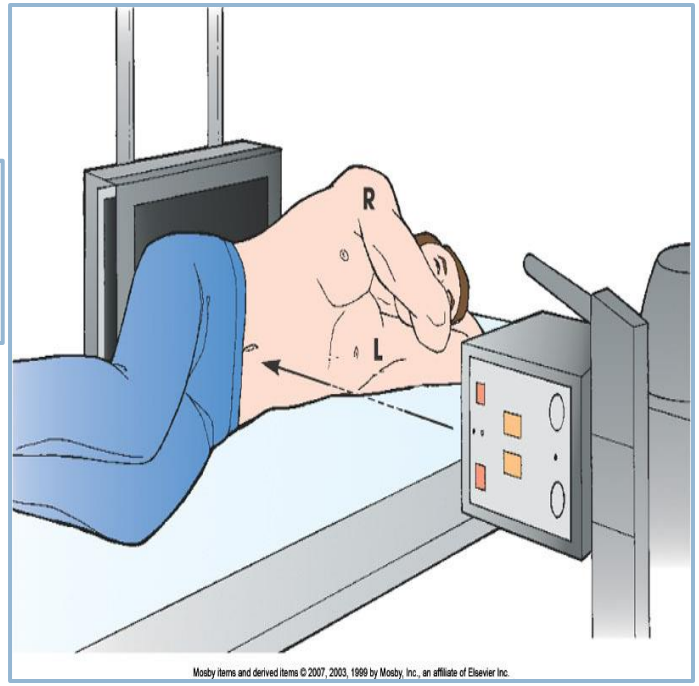
Fig., LVD



c) ***Lateral decubitus(Right/left):-***

- The ***patient lies on the side***, and the x-ray beam is directed ***horizontally***.
- On **AP** or **PA projection.**

Fig., LLD



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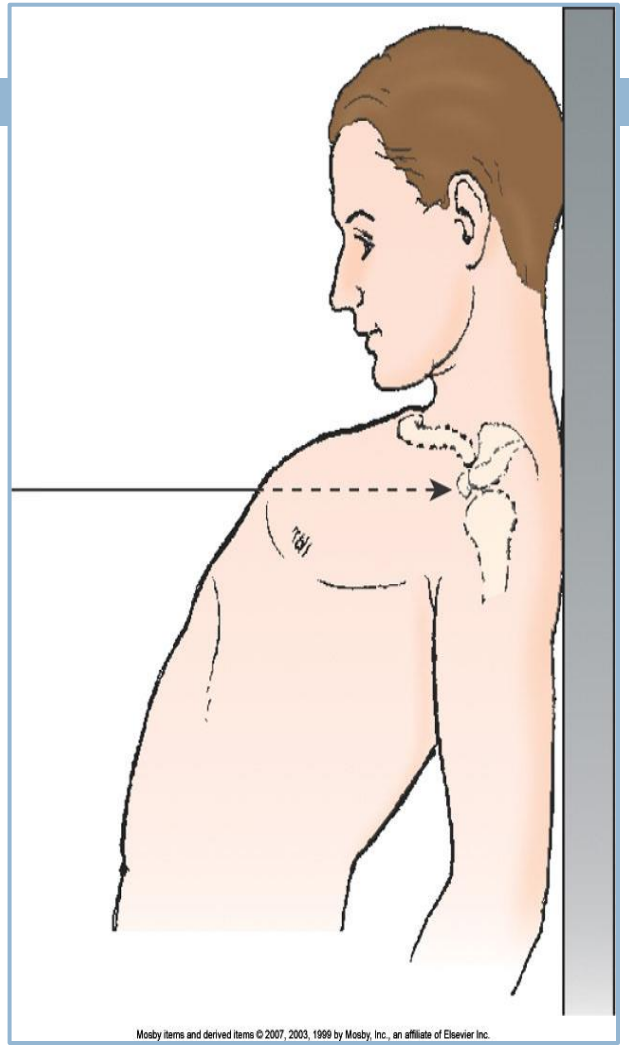
- ***Lordotic position:-***
  - Upright position in which the patient is leaning backward.



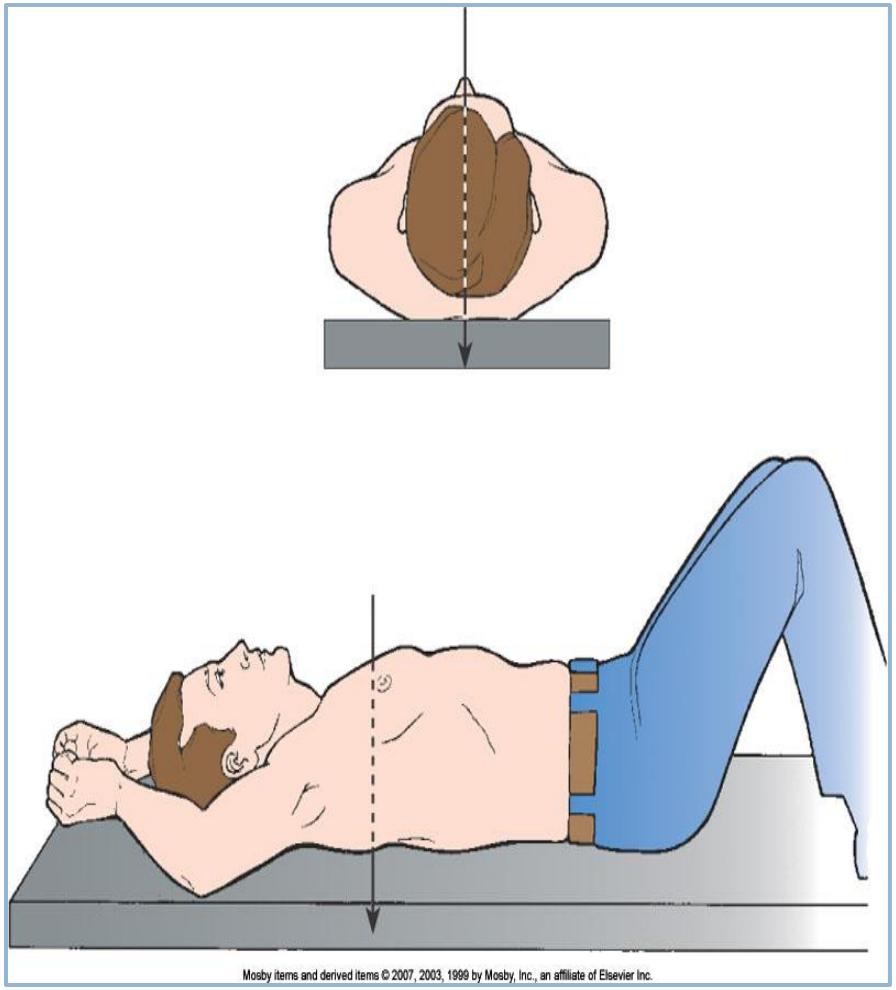
III. Projection Terminology

❖ *Projection:-*

- Is a term that describes the ***direction or path of the CR of the x-ray beam*** as it passes through the patient, projecting an image onto the IR.
- Which is ***identified by the entrance and exit points*** of the body.

❖ *Common projection terms:-*

- ***AP(Anteroposterior) projection:-***
  - refers to a projection of CR from anterior to posterior.



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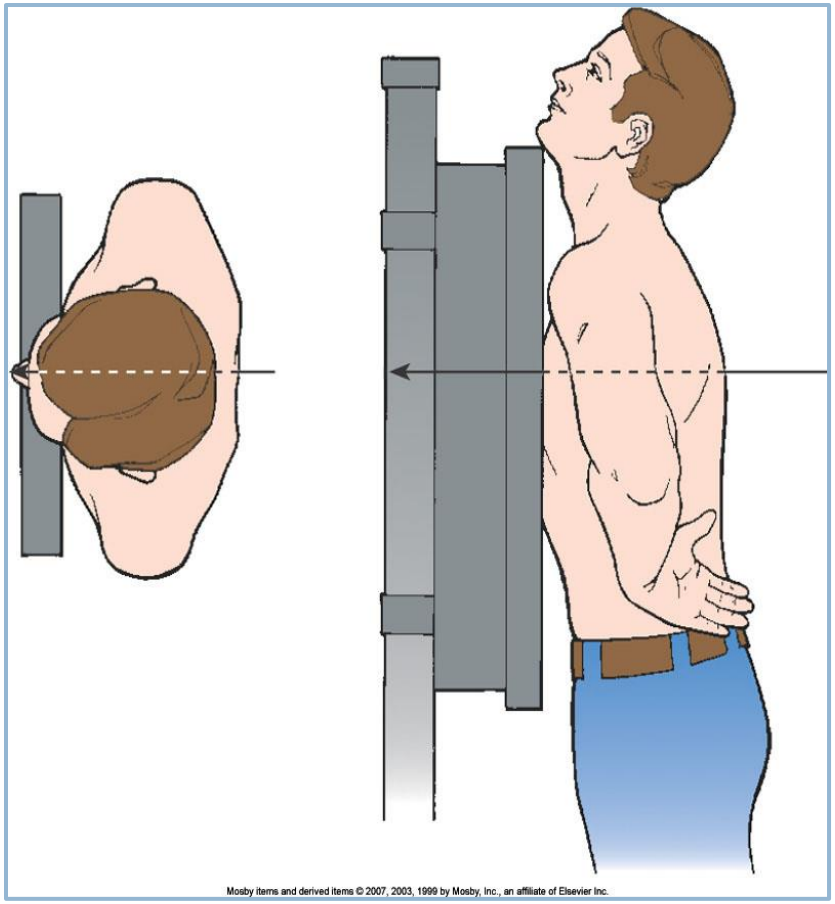
- ***PA(posteroanterior) projection:-***
  - refers to a projection of the CR from posterior to anterior.



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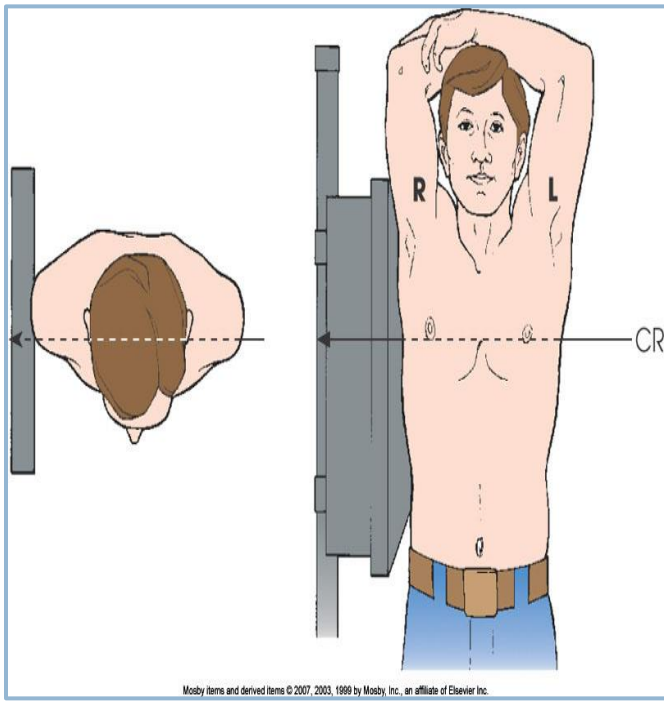
- ***Lateral projection:-***
  - The ***CR passes*** from one side of the body to other side along a coronal and transverse plane.

i. ***Right lateral;*** if the CR enters on the left side.

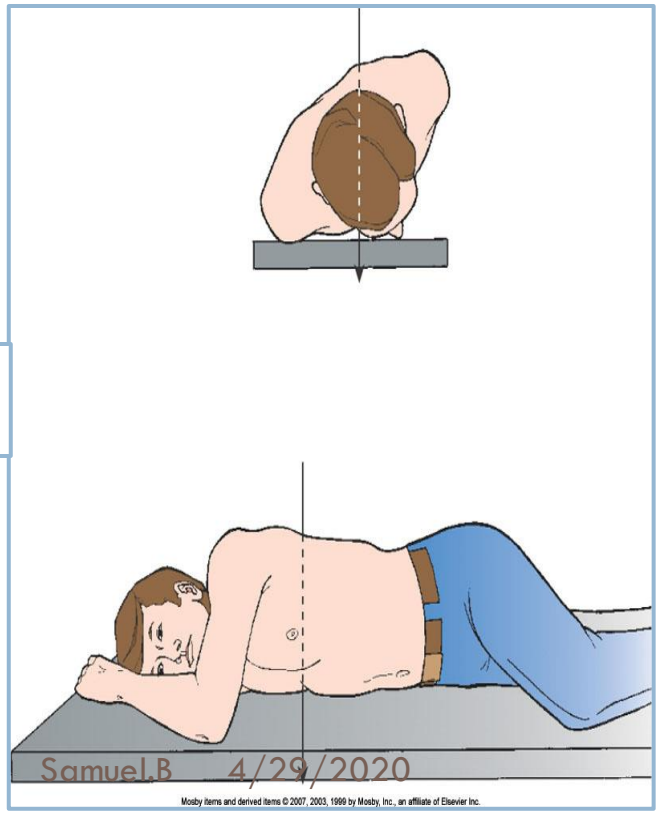
ii. ***Left lateral;*** if the CR enters on the right side.



❑ ***Oblique*:-**

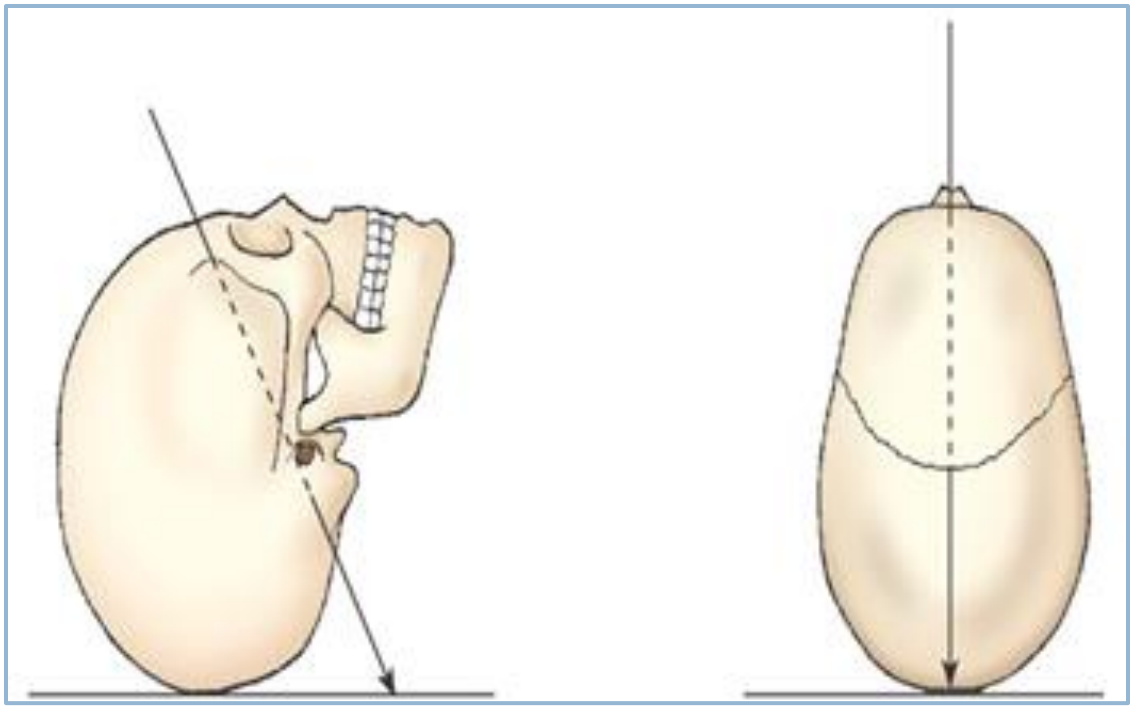
- The CR passes through the body along a transverse plane ***at some angle*** between the median sagittal and coronal planes.

- ***Fig.PA oblique***



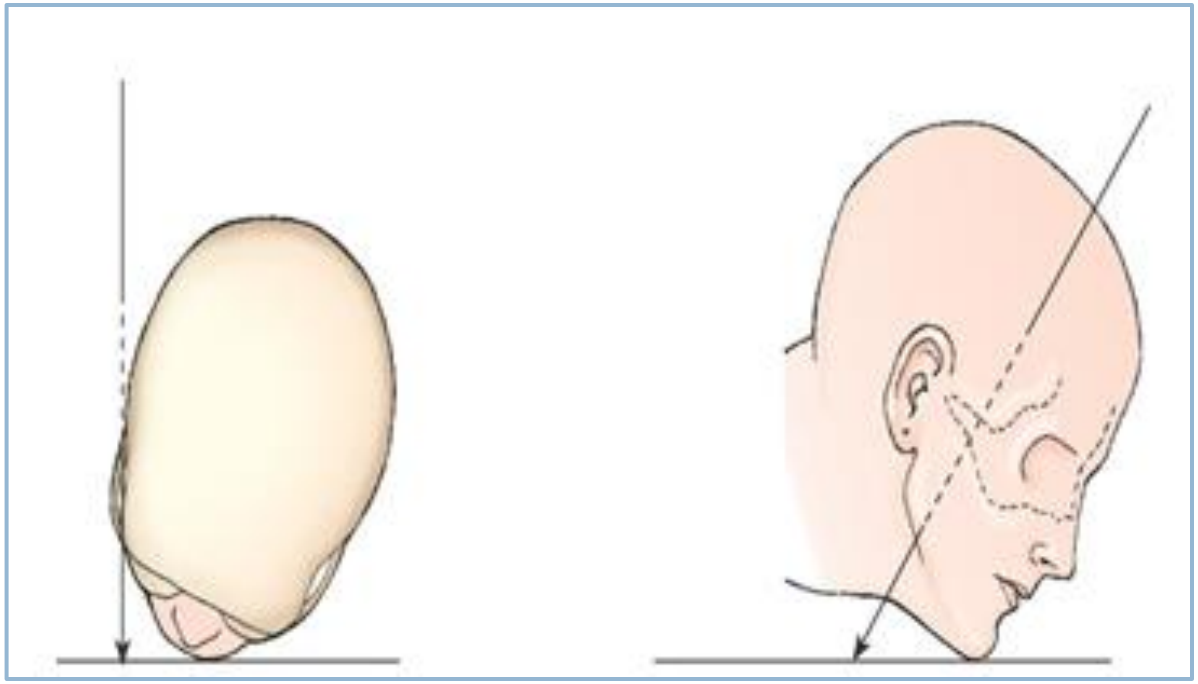
❑ ***Axial:-***

- Longitudinal angle of the ***CR of 10 degrees or more.***



❑ ***Tangential*:-**

- CR directed ***along the outer margin of a curved body surface***.



Summary

- ***Anatomic position:-*** is the reference position that defines specific surfaces and planes of the body.
- ***Position*** is a term that is used to indicate the patient's general physical position.
- ***Projection*** is a correct positioning term that describes the path of the central ray (CR).
- ***View:-*** describes the body part as seen by the IR or other recording medium, such as a fluoroscopic screen.

Imaging principles

- There are two methods of acquiring and storing x-ray images;
  - A. ***Conventional film-screen(Analog) technology:-***
    - involves chemical processing and film libraries
  - B. ***Digital technology:-***
    - uses computers and x-ray receptors to acquire and process images.

A. Technical exposure Factors

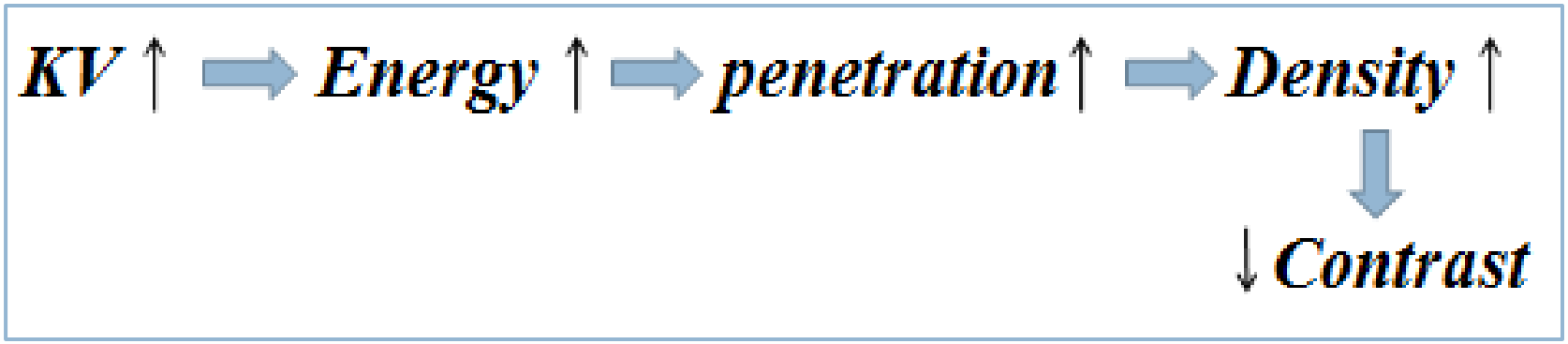
- For each radiographic image obtained, we must select exposure factors on the control panel of the imaging equipment.
- Exposure factors required for each examination are determined by;-
  - ✓ density/atomic number
  - ✓ thickness of the anatomic part,
  - ✓ any pathology present, and
  - ✓ image acquisition technology

Cont'd…

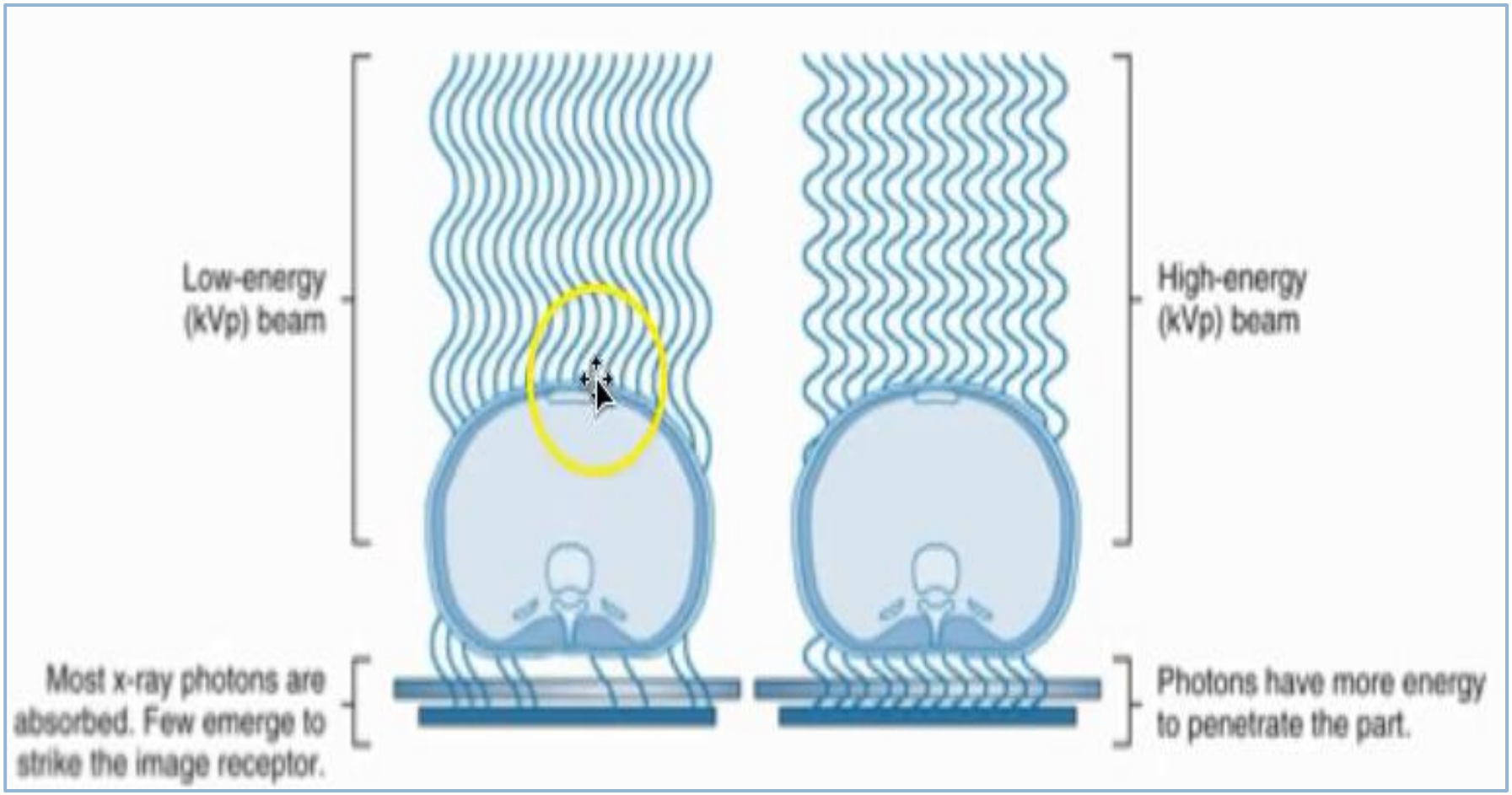
- ***Exposure factors to be selected are:-***
  - ✓ Kilovoltage (***KVp***),
  - ✓ Milliamperage(***mA***), &
  - ✓ Time (***ms***),
  - ✓ Focus to film distance (***FFD***).

1. Kilovoltage peak (KVp):-

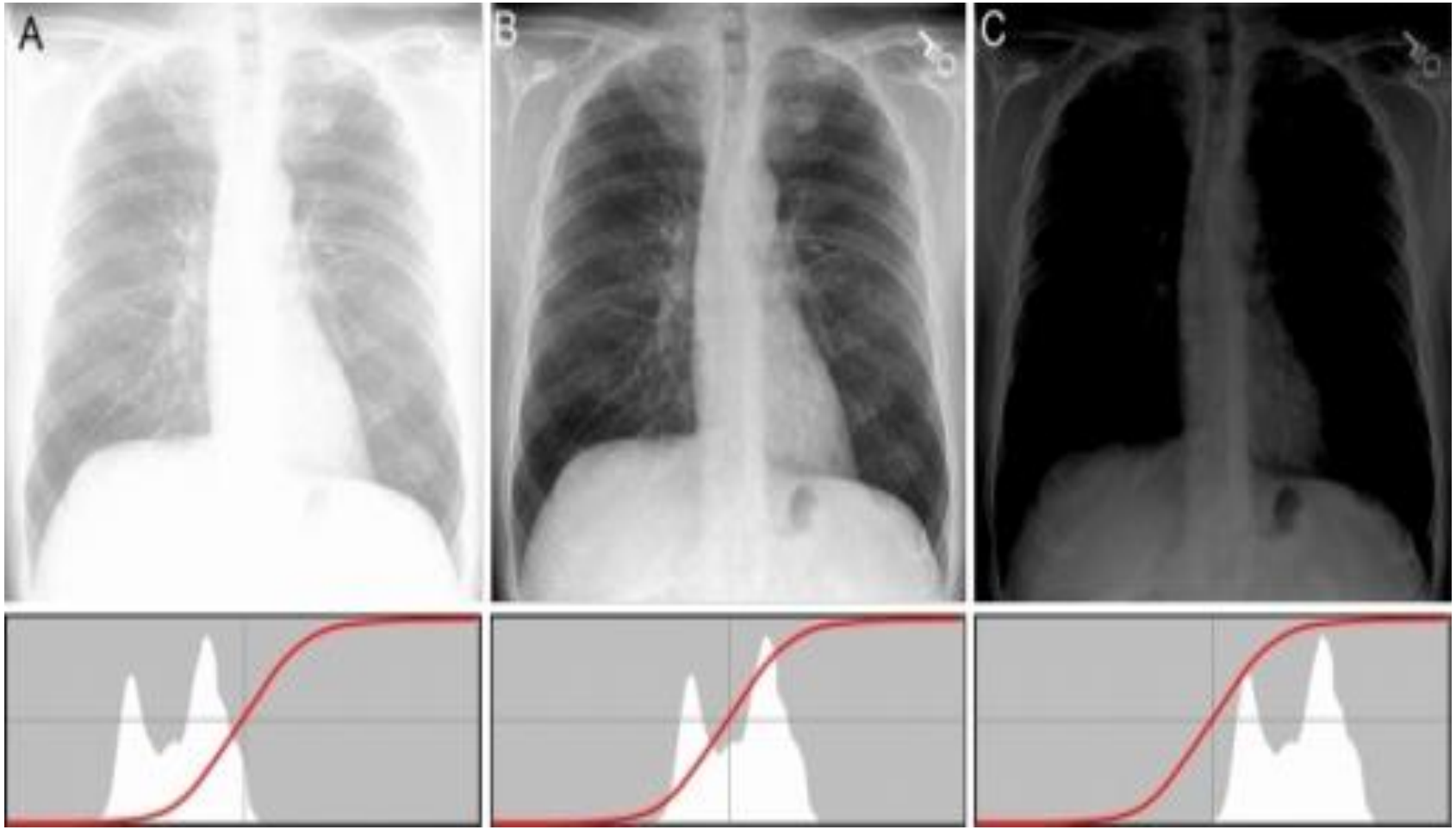
- Controls the energy(penetrating power) of the x-ray beam.
  - Typical diagnostic range is ***50 & 120 Kvp.***
- ***KVp*** affects both the beam ***quantity & quality.***
- ***KVp*** is also a chief controlling factor of contrast



Fig, KVp directly affect x-ray beam quality



Fig, Effect of KV with the same mAs



2. ***Milliamperage (mA) & time*:-**

- ***mA*** indicates the intensity or amount of radiation produced by x-ray tube.
- $\boldsymbol{mA \times Time = mAs}$;-
  - ✓ which controls the ***quantity*** *or* ***number*** of x-rays produced and duration of exposure.
- ***As a rule***, the ***mA*** should be ***as high as*** possible with ***short time***, to reduce the risk of ***movement unsharpness***.

***Fig*, Changing mAs with the same KVp**

3. ***FFD*:-**

- ***FFD*** is the distance from x-ray tube to the receptor
  - Affect the relative intensity of x-ray beam reaching the receptor.
  - For a given ***KVp & mAs***, the ***greater FFD the lower intensity of radiation*** reaching the film.
- ***Typically;-*** 100cm, 180cm & 120cm

FFD cont'd…

- When choosing the FFD, the following are taken in to consideration:-
  - The x-ray tube must not be too close to the skin of the pateint;-
    - ✓Short FFD could give unacceptable ***geometric unsharpeness.***
  - The ***FFD*** must not be excessive:-
    - ✓because you need to increase the ***mAs***, which can cause high tube loading.

Table; Variables and their effect on the photographic property of x-ray image

Variables	*Density*	*Contrast*
Increase mAs	*Increase*	*No change*
Decrease mAs	*Decrease*	*No change*
Increase Kvp	*Increase*	*Decrease*
Decrease Kvp	*Decrease*	*Increase*
Increase SID	*Decrease*	*No change*
Decrease SID	*Increase*	*No change*
Increase OID	*Decrease*	*Increase*

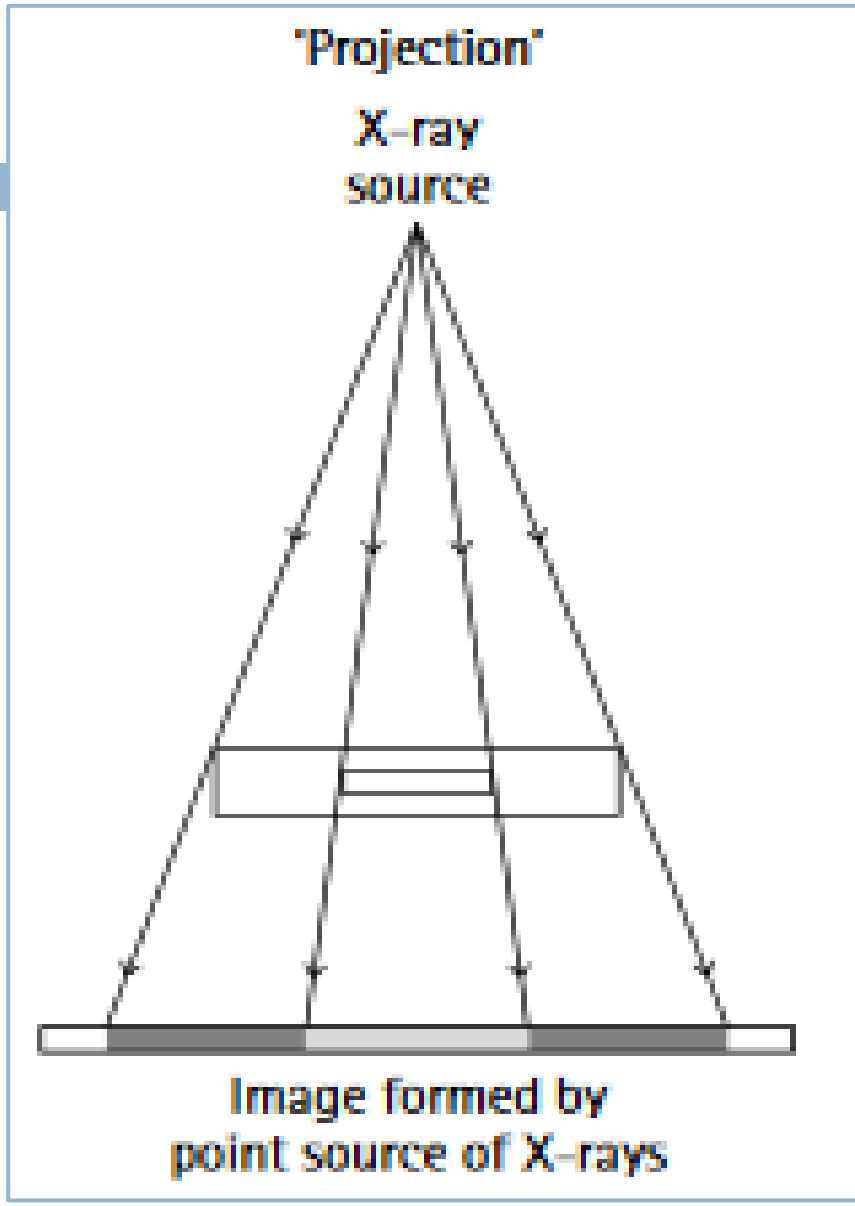
B. Radiographic Image

- ***X-rays*** were discovered in 1895.
- X-ray beam energy is produced using high-voltage electricity;
  - They are produced from small area in the x-ray tube
  - They diverge outward, traveling in a straight lines.
- X-rays pass through matter and strike an image receptor.
- ***Image receptor*** converts the energy of x-rays into an image

❑ ***Image formation*:-**

- Image is formed based on ***differential absorption.***
- As the x-rays pass through our body, same will be ***absorbed*** and others will ***penetrate(pass)*** to the IR.
  - and they encounters various structures in our body with ***different density.***
- ***The primary x-ray beam loses some of its energy as it interact with anatomical tissue.***

Fig, Image formation



❑ *Image quality factors*

- Radiographic images are evaluated on the basis of four primary image quality factors:-

  I. ***Density,***

  II. ***Contrast,***

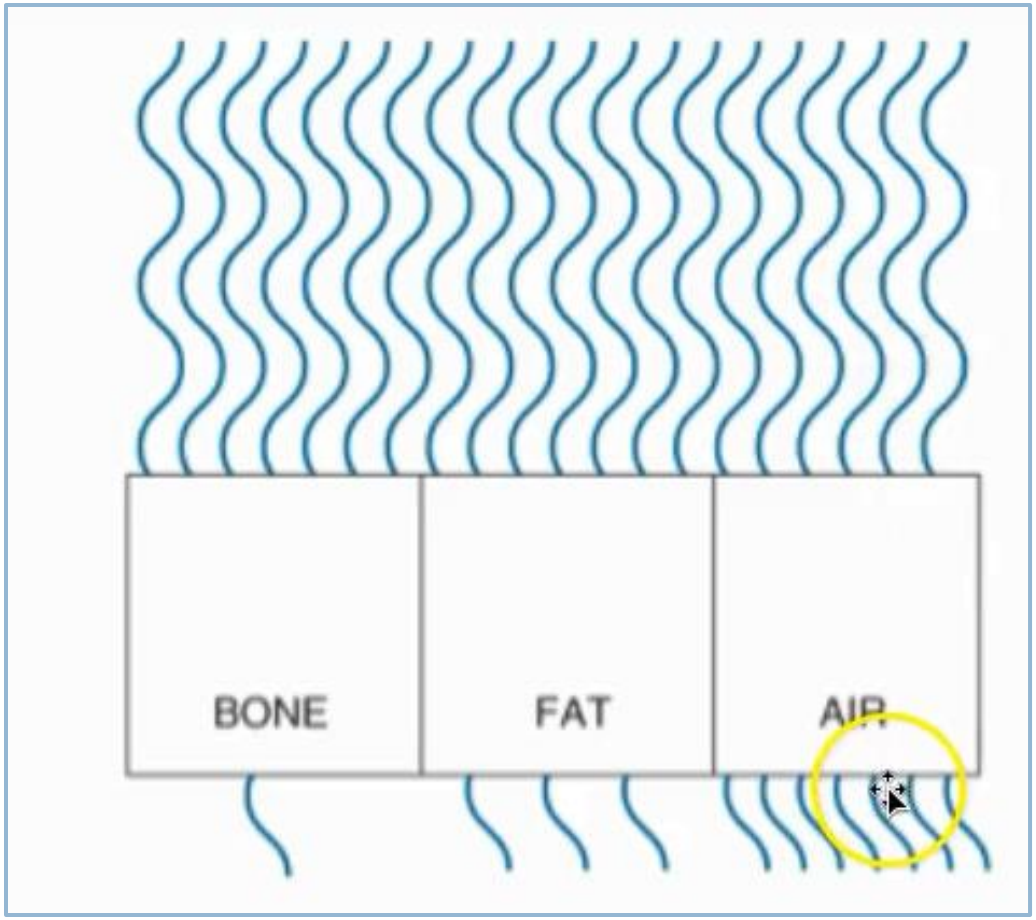
  III. ***Spatial resolution, &***

  IV. ***Distortion***

I. Density

- ***Density*** is degree of blackening in the image.
- ***physical density:-*** refers to the ***high mass per unit volume,*** which depend on type of tissue;
  - Bone has high density because it has relatively ***high mass per unit volume,*** and
  - The lung contains air , which have relatively a **low density**, therefore more x-rays pass through the lung.

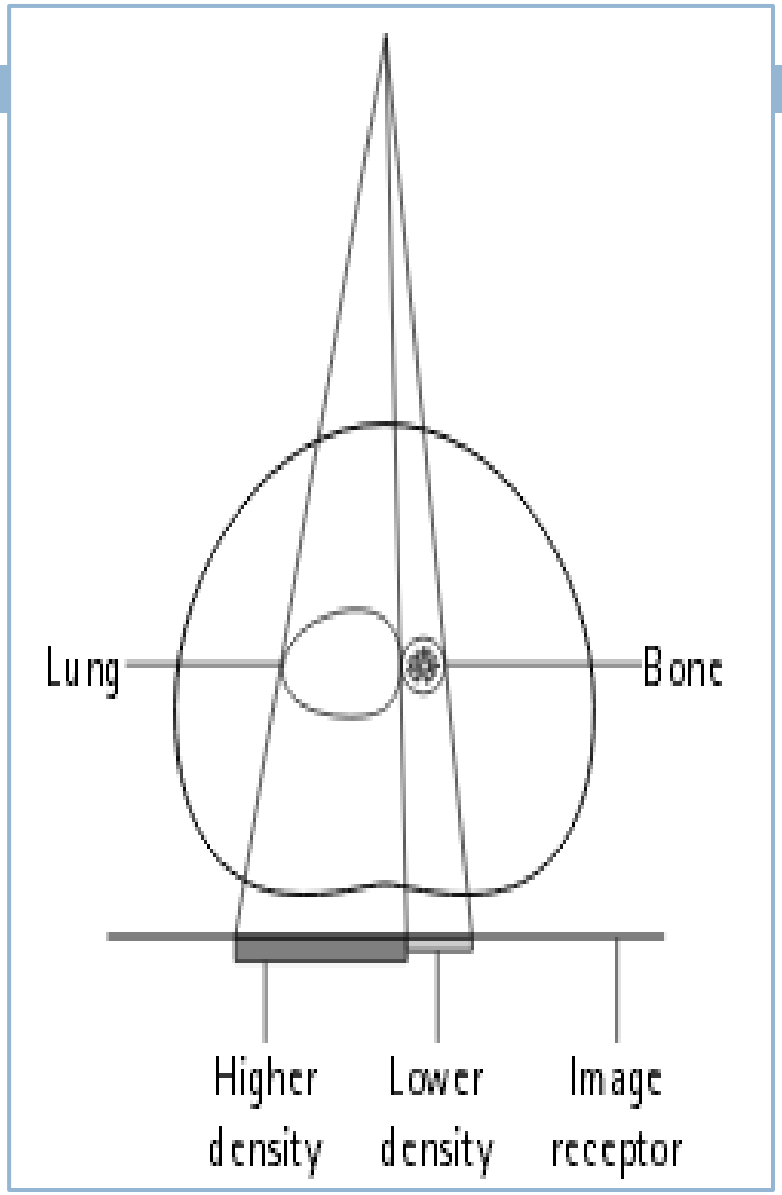
***Fig,* Bone has high density consequently they absorbs more x-rays than fat and air**

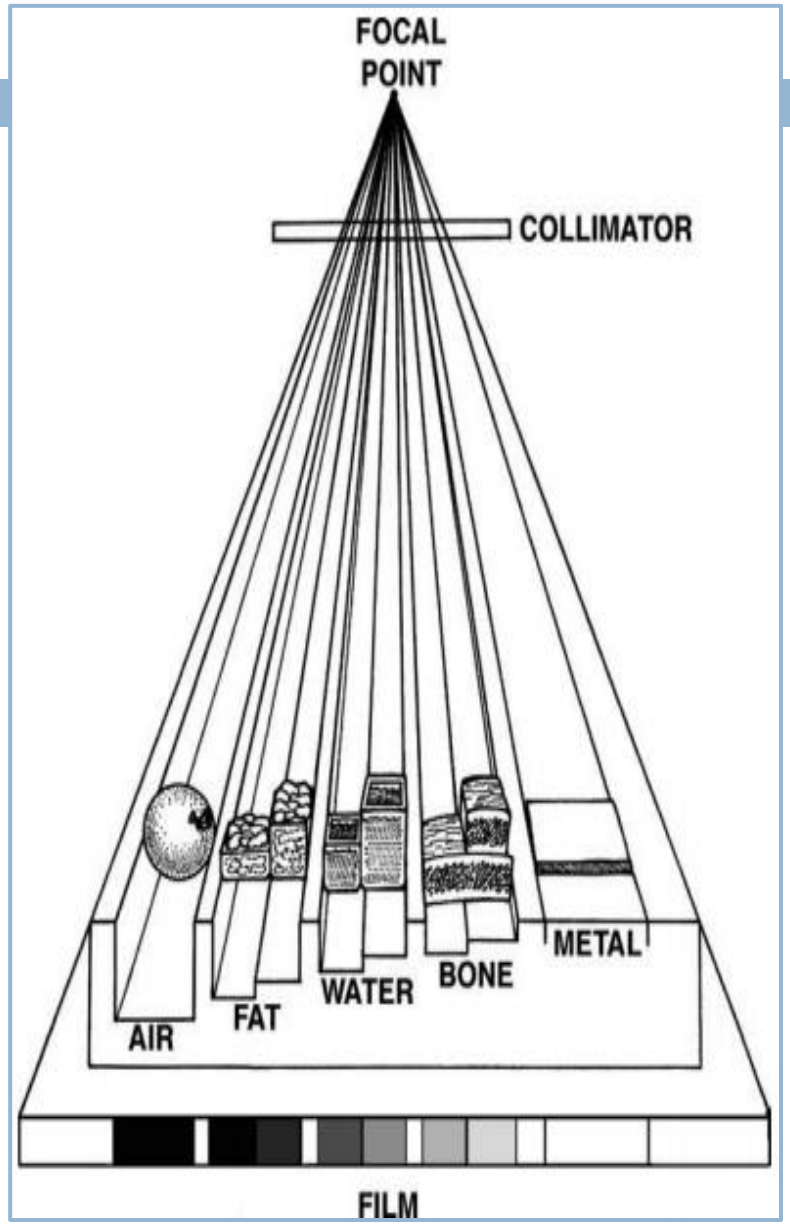


Cont'd…

- ***Radiographic image density:-*** defined as the amount of ***"blackness"*** on the processed radiograph.
  - The ***greater the amount radiation*** that incident on the image receptor the ***greater will be the density*** within the image.
  - The area under the bone will appear ***lighter***, since fewer x-rays will come into contact with the film. This area therefore has a ***lower image density.***
- **N.B:** film density is primarily controlled by **mAs**.

Fig, Radiographic film density



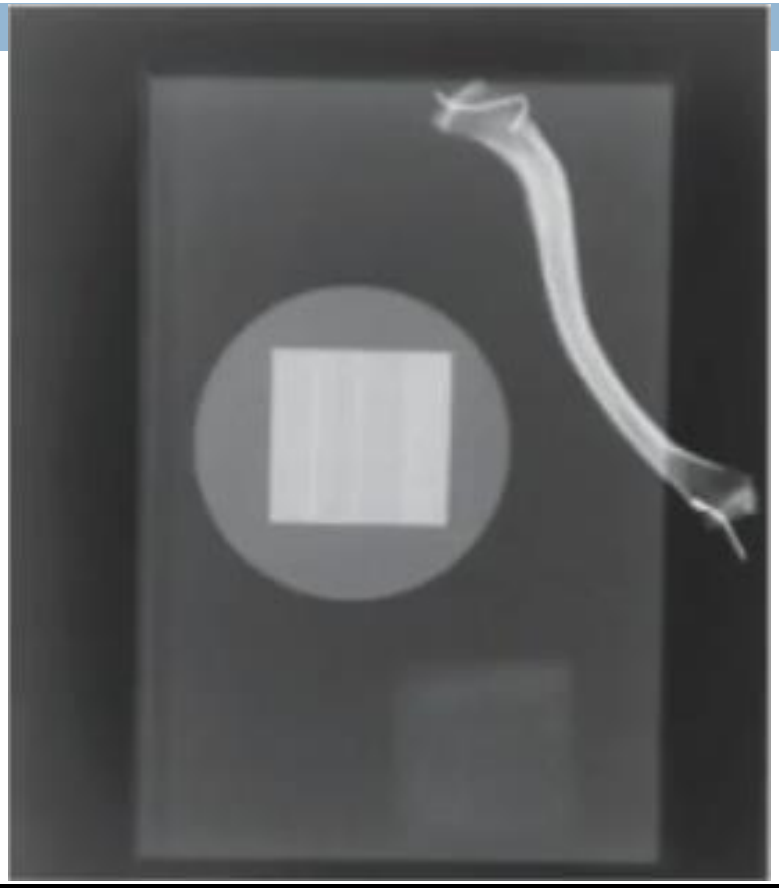


II. Contrast

- ***Contrast*** is difference in density between adjacent areas of a radiographic image.
  - When the ***density difference is large, the contrast is high,*** &
  - When the ***density difference is small, the contrast is low.***
- Contrast allows the anatomic detail on a radiographic image to be visualized.

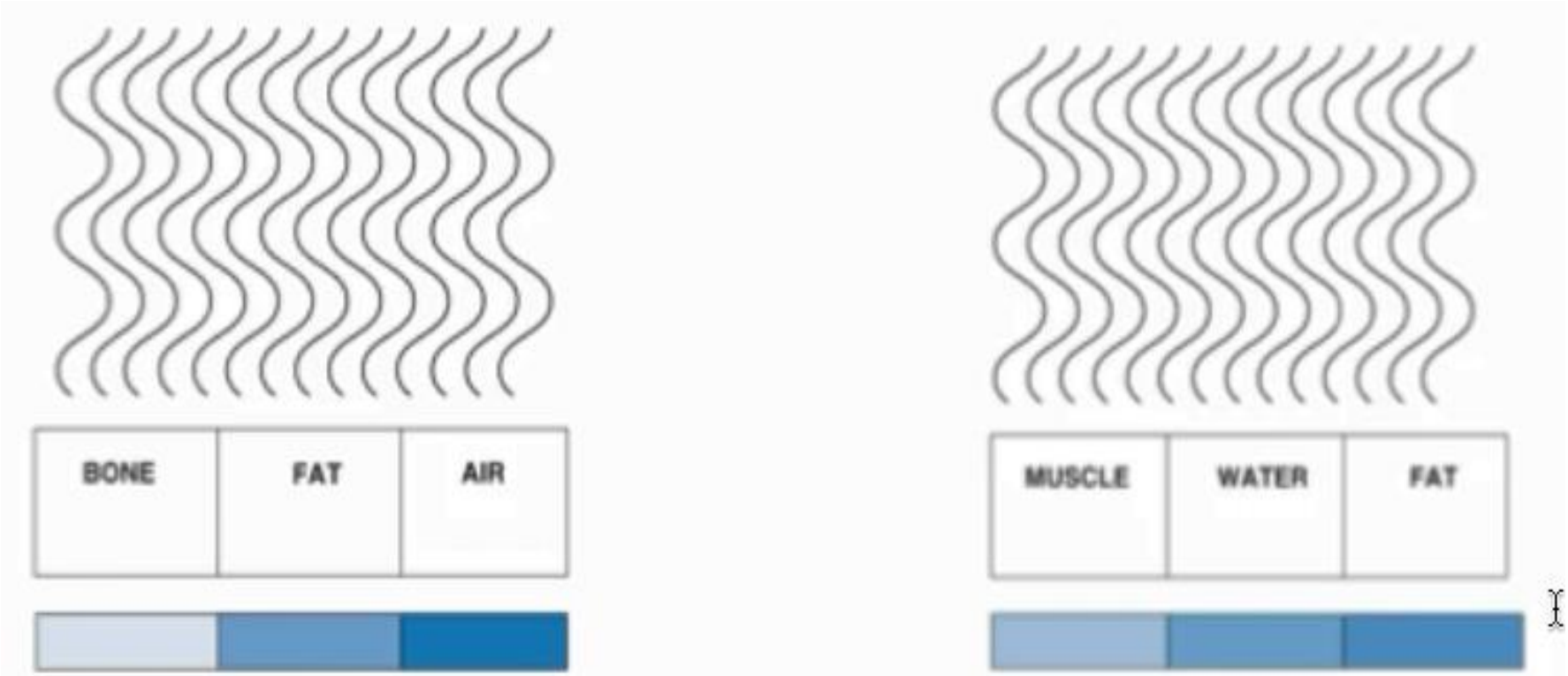
Fig, The range of brightness levels is a result of tissues differential absorption of x-ray photons

An image having sufficient brightness but no differences



An image with varying level of brightness

Fig, *subject contrast*



- ***Higher contrast***
- ***Lower contrast***

III. Spatial resolution

- ***Spatial resolution*** is defined as the recorded sharpness /clarity of structures on the image.
- Resolution is also known as ***detail, recorded detail, image sharpness, or definition.***
- The optimal radiograph displays a sharp image.
  - And is measured and expressed as ***line pairs per millimeter (lp/mm).***

❑ *Image unsharpness(blur):-*

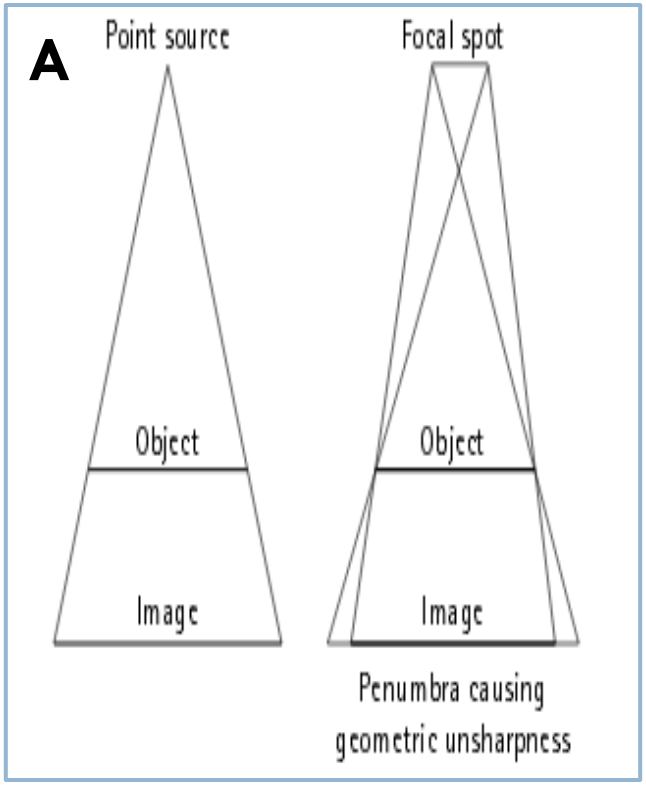
- ***Is lack of visible sharpness or resolution***
- All radiographic image have some degree of unsharpness
- Its important when looking subtle fractures.
- There are unsharpness due to:-
  a. ***Geometry,***
  b. ***Movement,***
  c. ***Inherent factors(Absorbtion), &***
  d. ***Acquisition/photographic factors.***

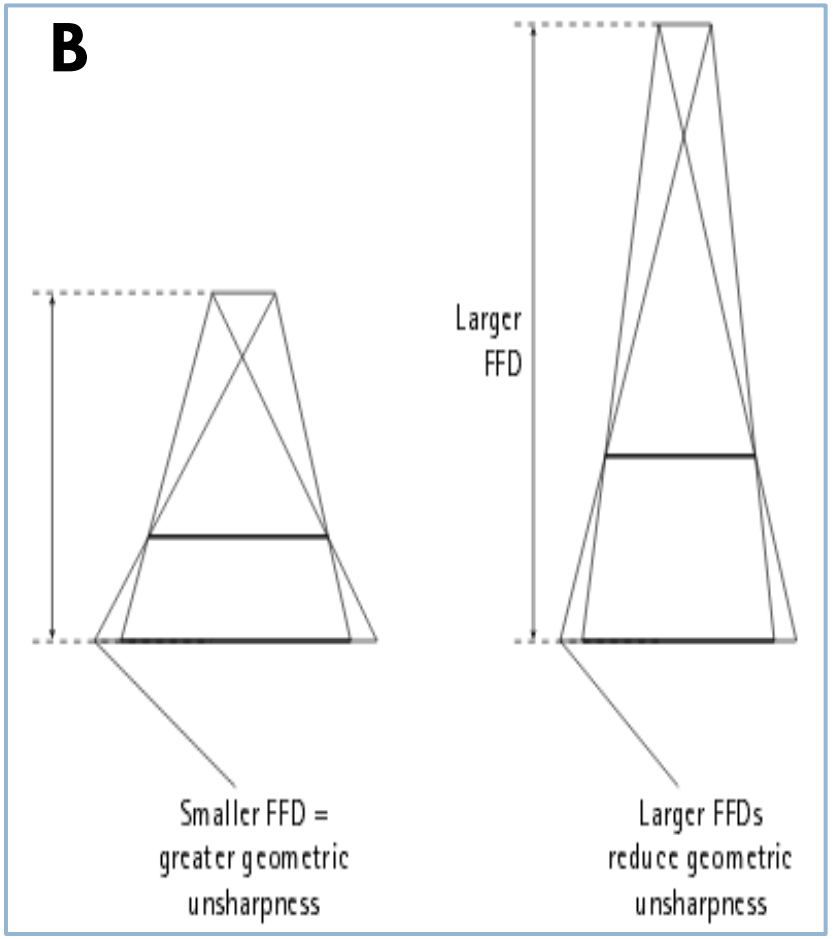
a. Geometric Unsharpness(Ug):-

- is unsharpness resulting from geometric factors of the ***radiographic equipment and setup***.
- which can be originated from:-
  - ✓Size of x-ray source ***(focal spot size),***
  - ✓Distance between the subject and the film**(*SFD*),** &
  - ✓Distance between the source and subject**(*SSD*).**

a. Geometric cont'd…

$$Ug = \frac{SFD}{SSD} \times focal\ spot\ size$$





b. Movement Unsharpness:-

- is due to ***patient, equipment or film movement*** during exposure.

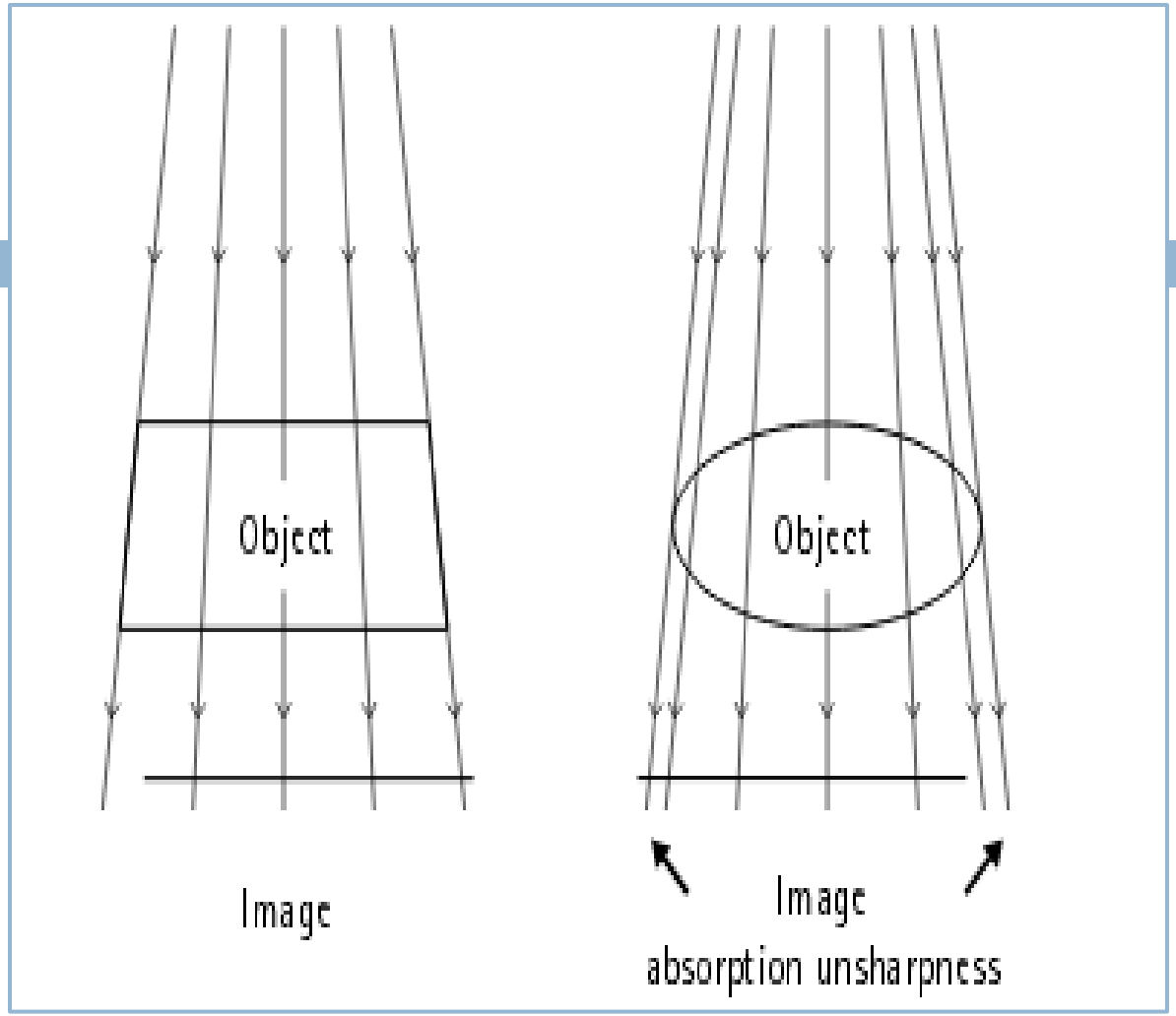
- Patient movement can be:-
  1. ***voluntarily:-*** can be controlled by immobilizing the patient, and
  2. ***Involuntarily:-***which can not be avoided, but we can reduce this by using small exposure time.

Fig, Movement Unsharpness

c. Absorption unsharpness:-

- Is due to the ***inherent shape of the structure in the body***.
- ***Considering a spherical object*** of uniform density, then absorption will be greatest at the centre and least at the periphery due to the difference in thickness.
- This ***gradual fall-off in absorption*** towards the edges leads to the image having an ***ill-defined boundary.***

Fig,
Absorption unsharpness

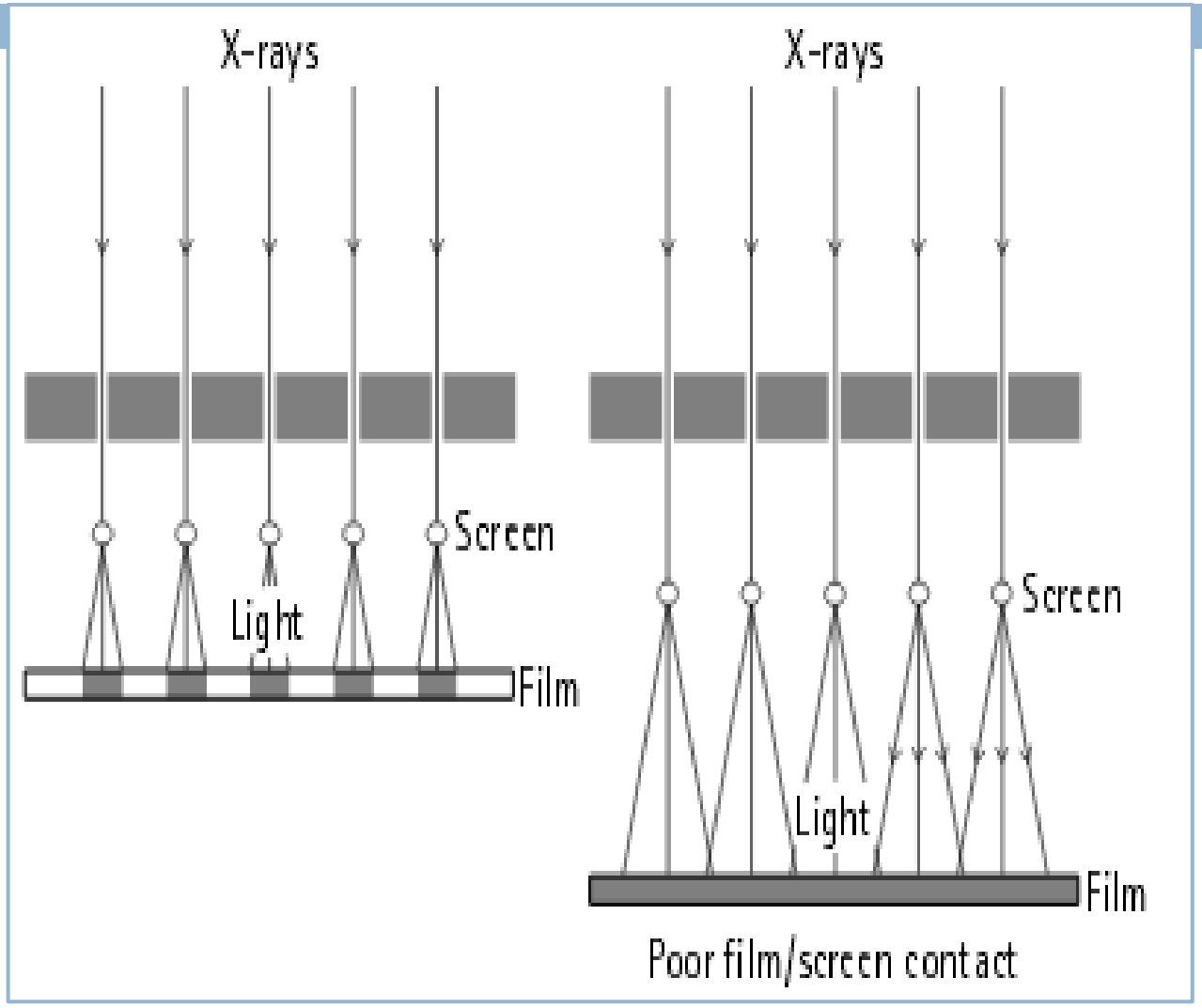


- ***Can be lessened by optimum use of focal spot size, OID & SID***

d. Photographic unsharpness:-

- is due to the ***recording system;***
- ***Intensifying screen*** (crystal size & screen speed),
  - ✓ with larger crystals or fast screen, the spread of light will be greater .
  - ✓ this spread of light between crystal and the emulsion is called ***Photographic unsharpness.***
- ***film material used*** (film/screen contact).
  - ✓ with poor film screen contact, the unsharpness will be greater.

Fig, Film/screen contact



IV. Distortion:-

- ***Distortion*** is defined as the misrepresentation of object size or shape.
  - Two types of distortion have been identified:
    1. size distortion (magnification) and
    2. shape distortion.
- ***It always exists as a result of OID and divergence of the x-ray.***

Fig, Distortion

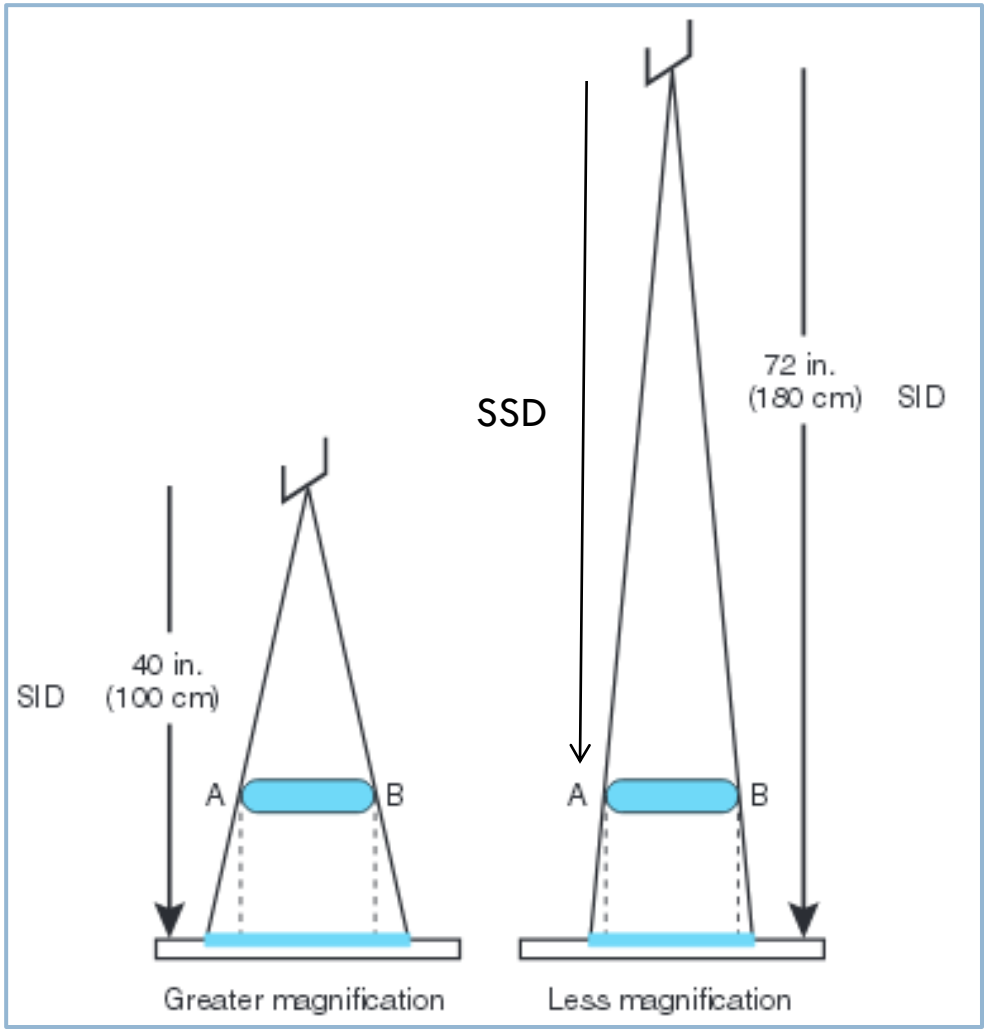
Shape distortion

❑ *Magnification:-*

- is determined by:-
  - ✓ the distance separating structure being examined from the x-ray source(***SSD***), and
  - ✓ the distance between the x-ray source and the film (***SID***).

➢ $$\textbf{magnification} = \frac{\boldsymbol{Image\ size}}{\boldsymbol{Object\ size}} = \frac{\boldsymbol{FFD(SID)}}{\boldsymbol{FOD(SSD)}}$$

Fig, magnification



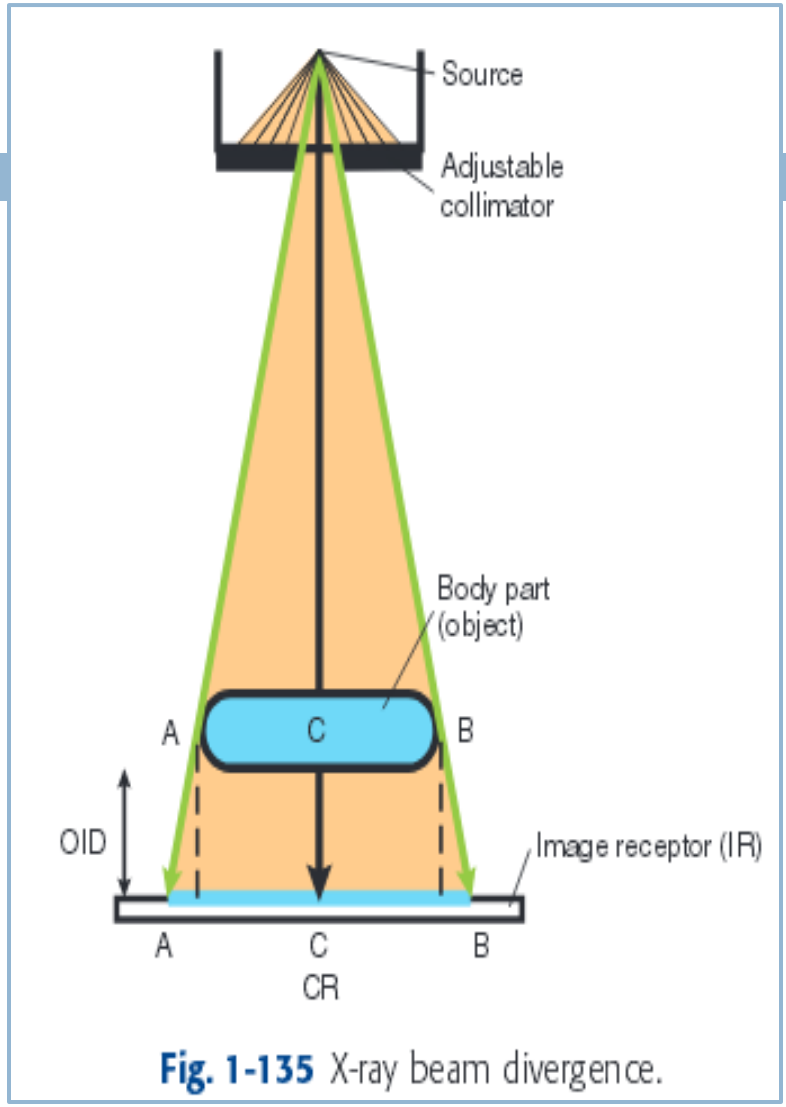


Fig. 1-135 X-ray beam divergence.

C. Evaluating Images

- The technologist should review and compare the radiographic images ***to ensure that they fit for purpose.***
- A ***systematic method of learning*** how to critique radiographs is to break the evaluation down into these ***four*** parts.

❑ *Evaluation criteria:-*

1. ***Anatomy demonstrated:-*** Describes precisely what anatomic parts and structures should be clearly visualized on that image(radiograph).
2. ***Position:-*** Generally evaluates placement of body part that are important for the projection, correct centering of anatomy, and collimation.
3. ***Exposure:-*** Describes how exposure technique can be evaluated for optimum exposure for that body part.
4. ***Image markers:-*** Anatomic side markers, “Right” or “Left,” patient position, or time markers.

Anatomical land marks

- Areas of the body easily palpable or seen so that one could be able to identify area of interest.

a. ***Cervical area:-***

- ***mastoid process ---------- C1(atlas)***
- ***angle of mandible(gonion) -------C3***
- ***hyoid bone – ----------C3, C4***
- ***thyroid cartilage ----------C5***
- ***Vertebral prominence ---------- C7, T1***

Cont'd…

b. ***Thoracic area:-***

- ***Jugular notch –---------- T2, T3***
- ***Sternal angle –----------T4, T5***
- ***Inferior angle of scapula --------- T7***
- ***Xiphisternal joint ---------- T9***

Cont'd…

c. lumbar area:-

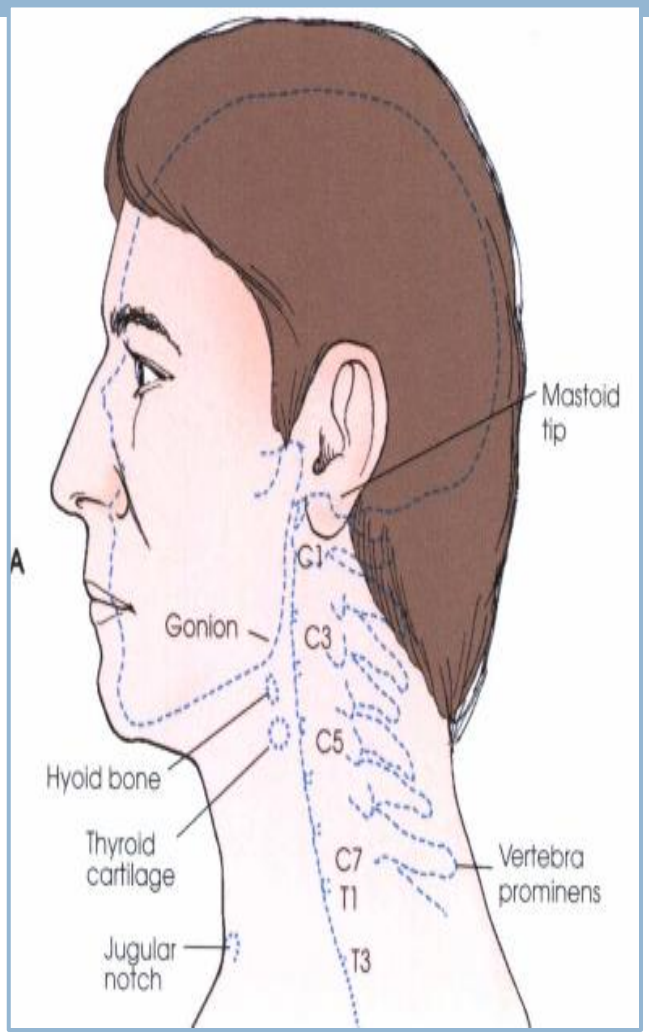
- Inferior costal margin --------**L2, L3**
- Iliac crest ----------**L4**

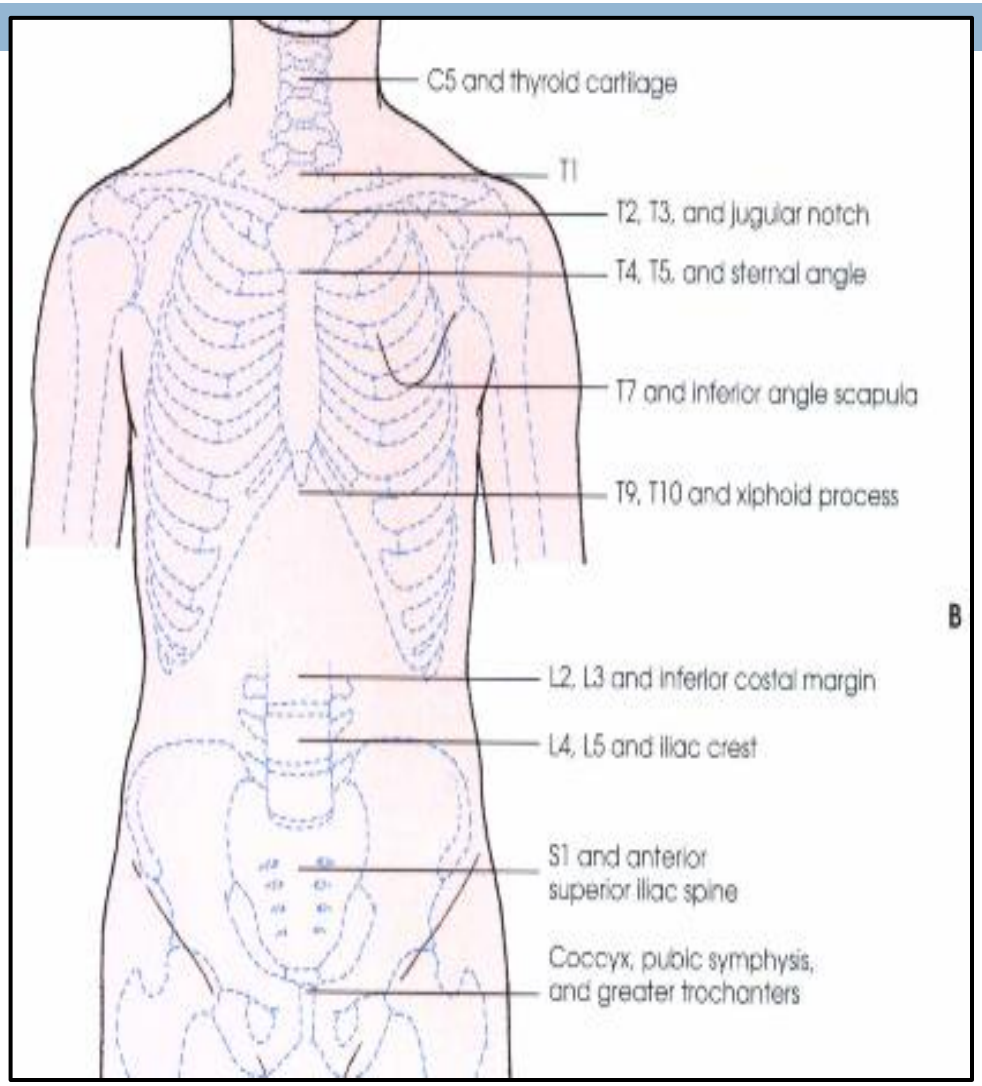
d. Pelvic area:-

- ASIS ----------sacroiliac joint
- Symphysis pubis ----------coccyx

- ***External auditory meatus(EAM) ---TMG joint***

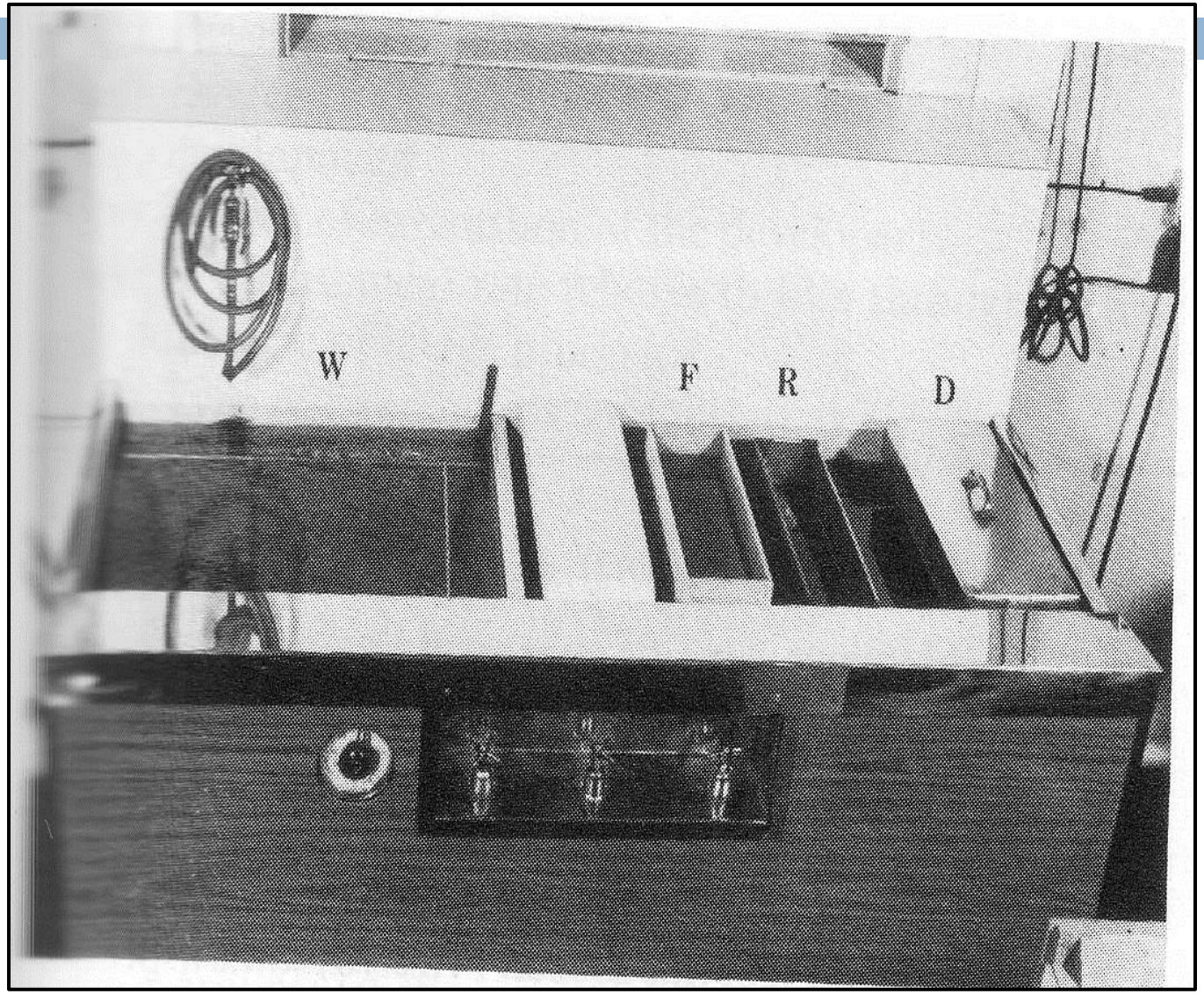
Fig, external land marks





THE END...

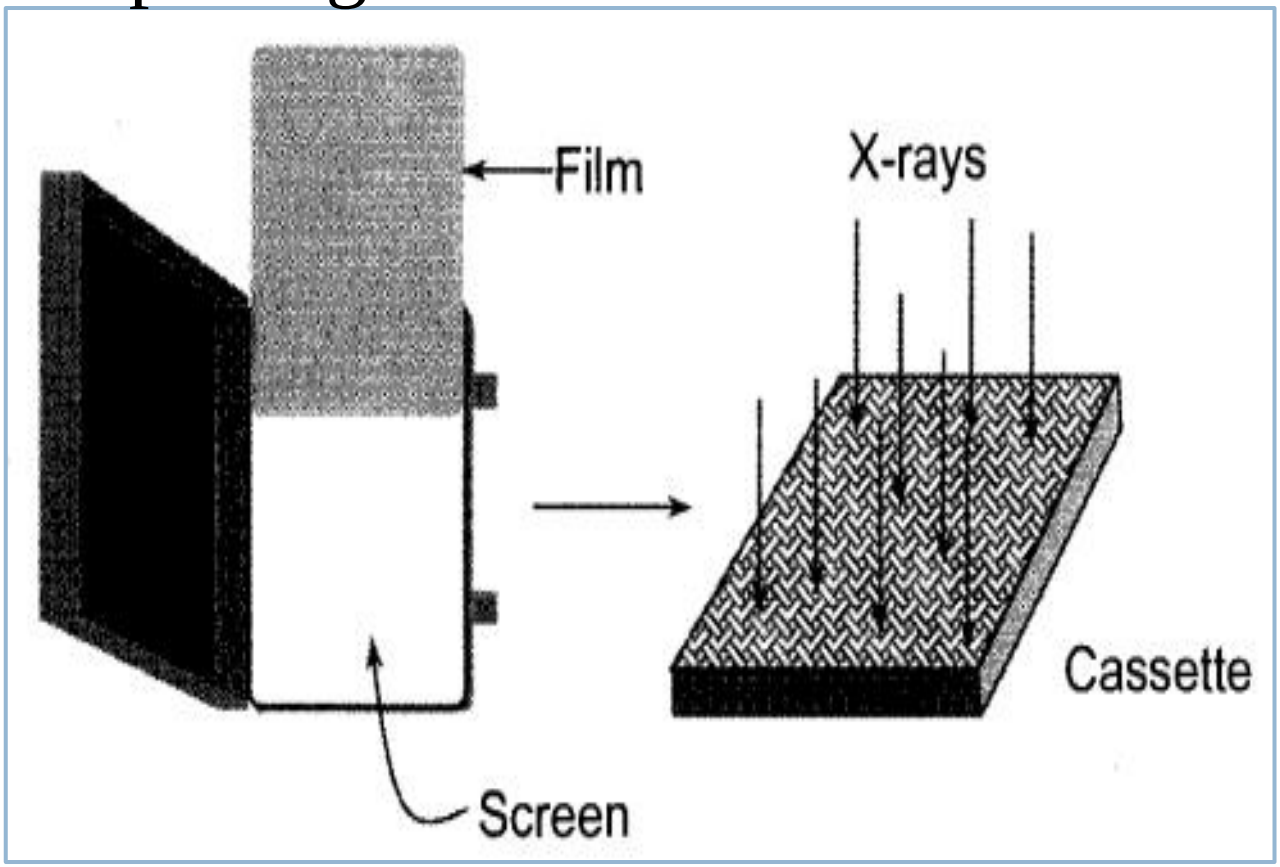
Fig, Typical manual processing unit



BACK

Image receptor:-

- **Fig, Cassette**, which is a small flat box used for transporting a film



BACK