JHARKHAND RAI UNIVERSITY

RANCHI

LAB MANUAL

RADIOLOGY

BPT IV

SL. NO.	CONTENT
1	To study about the Concept of Radiology.
2	X-Ray Study of Upper Extremities: • Shoulder • Glenohumeral joint • Clavicle • Humerus • Elbow • Forearm • Hand Basic projection, Position of Patient and Cassette, Direction & Centring of Beam, Radiological Consideration.
3	X-Ray Study of Lower limb: • Hip Joint. • Femur • Knee Joint. • Patella • Tibia and Fibula. • Ankle joint Basic projection, Position of Patient and Cassette, Direction & Centring of Beam, Radiological Consideration.
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TO STUDY ABOUT THE CONCEPT OF RADIOLOGY

The human body is a complicated structure, and errors in radio graphic positioning or diagnosis can easily occur unless practitioners have a common set of rules that are used to describe the body and its movements.

- **Anatomical terminology: - Patient aspect**
  - **Anterior 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. The side of the head would therefore be the lateral aspect of the cranium.
  - **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.
- **Positioning terminology**

1. **Planes of the body**

Three planes of the body are used extensively for descriptions of positioning both in plain-film imaging and in cross-sectional imaging techniques. The planes described are mutually at right angles to each other:

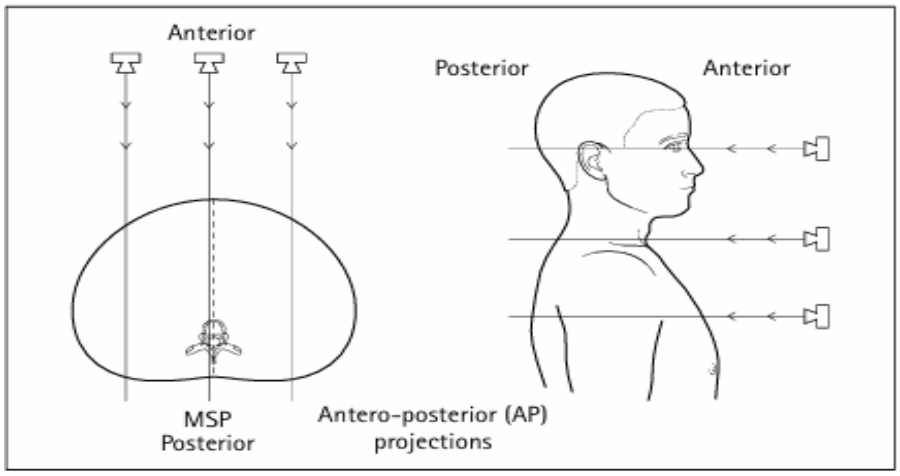
- **Median sagittal plane:** divides the body into right and left halves. Any plane that is parallel to this but divides the body into unequal right and left portions is known simply as a sagittal plane or parasagittal plane.
- **Coronal plane**: divides the body into an anterior part and a posterior part.
- **Transverse or axial plane:** divides the body into a superior part and an inferior part.

This section describes how the patient is positioned for the various radiographic projections described in this text:

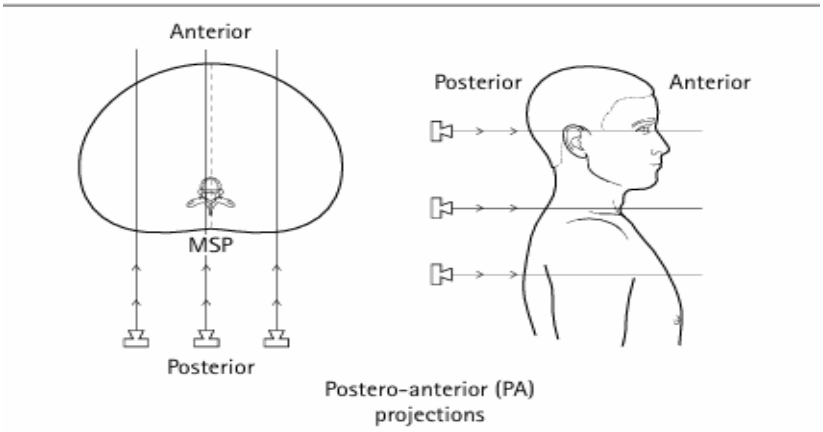
2. **Erect:** the projection is taken with the patient sitting or standing. In the erect position, the patient may be standing or sitting:
   - with the posterior aspect against the cassette; or
   - with the anterior aspect against the cassette; or
   - with the right or left side against the cassette.
3. **Decubitus:** the patient is lying down. In the decubitus position, the patient may be lying in any of the following positions**:**
   - **Supine (dorsal decubitus):** lying on the back**.**
   - **Prone (ventral decubitus):** lying face-down.
   - **Lateral decubitus:** lying on the side. Right lateral decubitus lying on the right side. Left lateral decubitus – lying on the left side.
   - **Semi-recumbent:** reclining, part way between supine and sit ting erect, with the posterior aspect of the trunk against the cassette.

- **Projection terminology**

I. **Antero-posterior: -** The central ray is incident on the anterior aspect, passes along or parallel to the median sagittal plane, and emerges from the posterior aspect of the body.

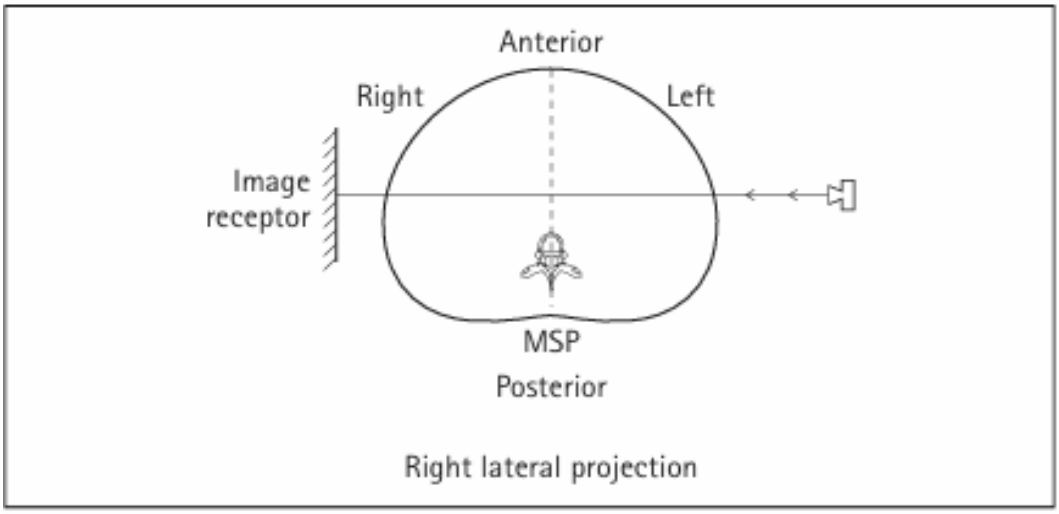


II. **Postero-anterior: -** The central ray is incident on the posterior aspect, passes along or parallel to the median sagittal plane, and emerges from the anterior aspect of the body.



III. Lateral

The central ray passes from one side of the body to the other along a coronal and transverse plane. The projection is called a right lateral if the central ray enters the body on the left side and passes through to the image receptor positioned on the right side. A left lateral is achieved if the central ray enters the body on the right side and passes through to the image receptor, which will be positioned parallel to the median sagittal plane on the left side of the body.



Right lateral projection

Beam angulation

Radiographic projections are often modified by directing the central ray at some angle to a transverse plane, i.e. either caudally (angled towards the feet) or cranially/cephalic angulation (angled towards the head).

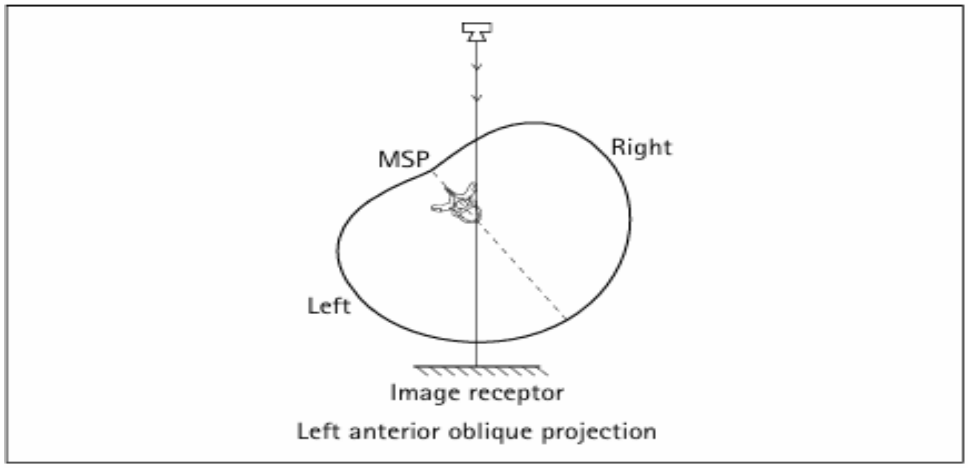
The projection is then described as, for example, a lateral 20-degree caudad or a lateral 15-degree cephalad.

IV. Oblique:

The central ray passes through the body along a transverse plane at some angle between the median sagittal and coronal planes. For this projection, the patient is usually positioned with the median sagittal plane at some angle between zero and 90 degrees to the cassette, with the central ray at right-angles to the cassette. If the patient is positioned with the median sagittal plane at right-angles to or parallel to the cassette, then the projection is obtained by directing the central ray at some angle to the median sagittal plane.

a) Anterior oblique:

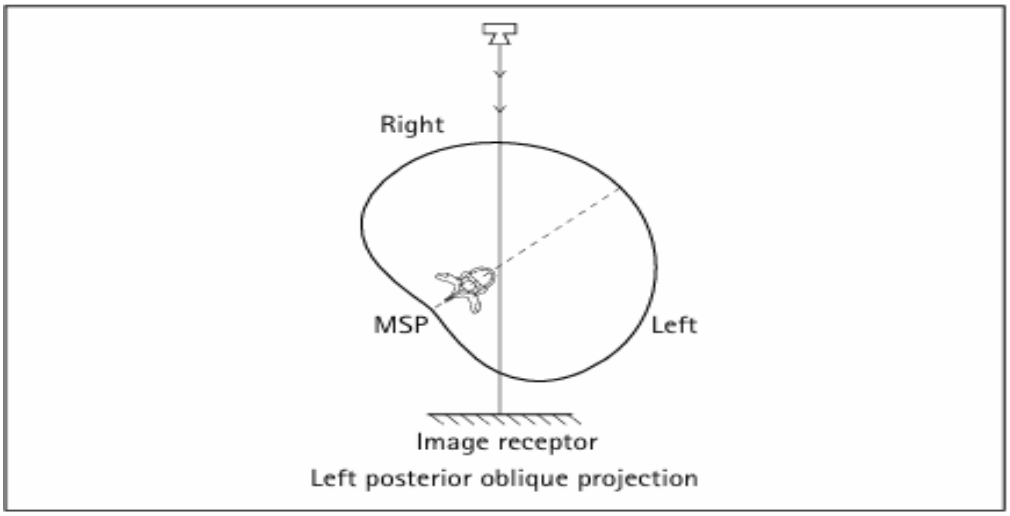
The central ray enters the posterior aspect, passes along a trans verse plane at some angle to the median sagittal plane, and emerges from the anterior aspect. The projection is also described by the side of the torso closest to the cassette. In the diagram below, the left side is closest to the cassette, and therefore the projection is a described as a left anterior oblique.



Left anterior oblique projection

b) Posterior oblique

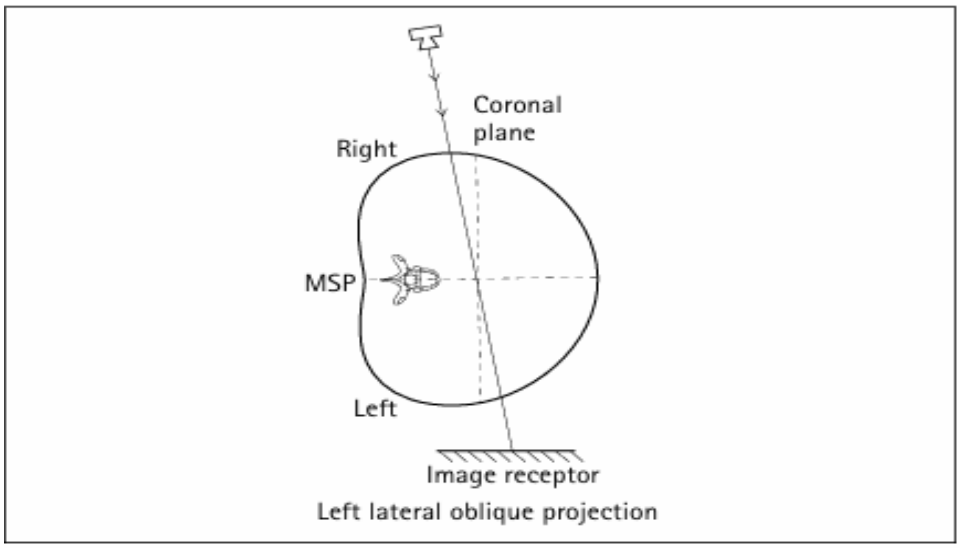
The central ray enters the anterior aspect, passes along a trans verse plane at some angle to the median sagittal plane, and emerges from the posterior aspect. Again, the projection is described by the side of the torso closest to the cassette. The diagram below shows a left posterior oblique.



Left posterior oblique projection

c) Lateral oblique

The central ray enters one lateral aspect, passes along a trans verse plane at an angle to the coronal plane, and emerges from the opposite lateral aspect.



Example of lateral oblique obtained using a beam angulation

X-RAY STUDY OF UPPER LIMB

1. To Study the X-Ray of Shoulder Joint

Basic projections

1. Antero-posterior (15 degrees) erect: Position of patient and cassette: -

- The patient stands with the affected shoulder against the cassette and is rotated 15 degrees to bring the shoulder closer to the cassette and the plane of the acromioclavicular joint parallel to the central beam.
- The arm is supinated and slightly abducted away from the body. The medial and lateral epicondyles of the distal humerus should be parallel to the cassette.
- The cassette is positioned so that its upper border is at least 5cm above the shoulder to ensure that the oblique rays do not project the shoulder off the cassette.

Direction and centring of the X-ray beam

- The horizontal central ray is directed to the palpable coracoid process of the scapula. The beam can then be directed caudally and collimated.
- The central ray passes through the upper glenoid space to separate the articular surface of the humerus from the acromion process.

Essential image characteristics

- The image should demonstrate the head and proximal end of the humerus, the inferior angle of the scapula and the whole of the clavicle.
- The head of the humerus should be seen slightly overlapping the glenoid cavity but separate from the acromion process.

- Arrested respiration aids good rib detail in acute trauma.

Antero-posterior radiograph of shoulder showing severe arthritic disease

2. Supero-inferior (axial): Position of patient and cassette

- The patient is seated at the side of the table, which is lowered to waist level.
- The cassette is placed on the tabletop, and the arm under examination is abducted over the cassette.
- The patient leans towards the table to reduce the object-to film distance (OFD) and to ensure that the glenoid cavity is included in the image. A curved cassette, if available, can be used to reduce the OFD.
- The elbow can remain flexed, but the arm should be abducted to a minimum of 45 degrees, injury permitting. If only limited abduction is possible, the cassette may be supported on pads to reduce the OFD.

Direction and centring of the X-ray beam

- The vertical central ray is directed through the proximal aspect head of the humeral head. Some tube angulation, towards the palm of the hand, may be necessary to coincide with the plane of the glenoid cavity.
- If there is a large OFD, it may be necessary to increase the overall focus-to-film distance (FFD) to reduce magnification.

3. Infero-superior (alternate):

This projection may be used as an alternative to the Supero- inferior projection in cases of dislocation or when the patient is supine, since it can be taken even when the patient is able to abduct the arm only slightly. No attempt should be made to increase the amount of abduction that the patient is able and willing to make. An 18 24-cm cassette is used.

Position of patient and cassette

- The patient lies supine, with the arm of the affected side slightly abducted and supinated without causing discomfort to the patient.
- The affected shoulder and arm are raised on non-opaque pads.
- A cassette is supported vertically against the shoulder and is pressed against the neck to include as much as possible of the scapula on the film. Direction and centring of the X-ray beam
- The horizontal central ray is directed towards the axilla with minimum angulation towards the trunk**.**
- The FFD will probably need to be increased, since the tube head will have to be positioned below the end of the trolley. Essential image characteristics
- The image should demonstrate the head of the humerus, the acromion process, the coracoid process and the glenoid cavity of the scapula.
- The lesser tuberosity will be in profile, and the acromion process and the superior aspect of the

glenoid will be seen superimposed on the head of humerus.

A. To Study the X-Ray of Glenohumeral joint:

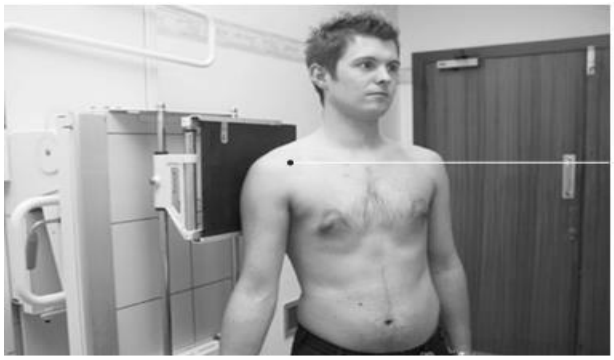
1. Antero-posterior – erect:

To demonstrate the glenoid cavity and glenohumeral joint space, the body of the scapula should be parallel to the cassette so that the glenoid cavity is at right-angles to the cassette. The horizontal central ray can now pass through the joint space parallel to the glenoid cavity of the scapula. **Position of patient and cassette**

- The patient stands with the affected shoulder against the cassette and is rotated approximately 30 degrees to bring the plane of the glenoid fossa perpendicular to the cassette.
- The arm is supinated and slightly abducted away from the body.
- The cassette is positioned so that its upper border is at least 5cm above the shoulder to ensure that the oblique rays do not project the shoulder off the cassette.

Direction and centring of the X-ray beam

- The horizontal central ray is centred to the palpable coracoid process of the scapula.
- The primary beam is collimated to an 18 24-cm cassette. Essential image characteristics
- The image should demonstrate clearly the joint space between the head of the humerus and the glenoid cavity.
- The image should demonstrate the head, the greater and lesser tuberosities of the humerus, together with the lateral aspect of the scapula and the distal end of the clavicle.



Normal antero-posterior radiograph of the shoulder to show glenohumeral joint

2. Antero-posterior – supine (trauma):

There are occasions when the patient cannot be examined in the erect position, e.g. due to multiple trauma or immobility. Often, such patients present on a trolley in the emergency situation.

Position of patient and cassette

- The patient lies supine on the trolley, and the unaffected shoulder is raised slightly to bring the scapula on the affected side parallel to the cassette.
- The arm is partially abducted and supinated clear of the trunk.
- The cassette is positioned under the patient so that its upper border is at least 5 cm above the shoulder to ensure that the oblique rays do not project the shoulder off the film. If the patient cannot be moved, then the cassette tray under the trolley can be used.

Direction and centring of the X-ray beam

- The vertical central ray is centred to the palpable coracoid process of the scapula.
- It may be necessary to direct the primary beam caudally in order to project the head of the humerus below the acromion process.

Essential image characteristics

- The subacromial space should be visible.

- The proximal end of the humerus, the lateral aspect of the scapula and the whole of the clavicle need to be included.
- The greater tuberosity will be in profile when the arm is supinated.
- If the arm cannot be supinated, then the head of humerus has the appearance of a ‘lightbulb’ shape.

3. Lateral oblique 'Y' projection (alternate) dislocation/fracture proximal humerus:

If the arm is immobilized and no abduction of the arm is possible, then a lateral oblique 'Y' projection is taken using a 24 30-cm cassette in an erect cassette holder or vertical Bucky if the patient is particularly large.

Position of patient and cassette:

- The patient stands or sits with the lateral aspect of the injured arm against an erect cassette and is adjusted so that the axilla is in the centre of the film.
- The unaffected shoulder is raised to make the angle between the trunk and cassette approximately 60 degrees. A line joining the medial and lateral borders of the scapula is now at right-angles to the cassette. The cassette is positioned to include the superior border of the scapula.

Direction and centring of the X-ray beam:

- The horizontal central ray is directed towards the medial border of the scapula and centred to the head of the humerus. Essential image characteristics
- The body of the scapula should be at right-angles to the cassette, and the scapula and the proximal end of the humerus are clear of the rib cage.
- The exposure should demonstrate the position of the head of the humerus in relation to the glenoid cavity between the coracoid and acromion processes.

4. Modifications in technique (post-manipulation)

A shoulder technique may be necessary immediately following manipulation to check that a shoulder dislocation has been reduced successfully. The affected arm will be immobilized,

usually in a collar and cuff support. An image of the joint space is taken in the antero-posterior position on an 18 24-cm cassette; this is achieved by raising the unaffected side approximately 30 degrees.

Antero-posterior – 25 degrees caudad:

A revised shoulder technique may be necessary immediately following manipulation to check that a shoulder dislocation has been reduced successfully. The affected arm will be immobilized, usually in a collar and cuff support. An image of the joint space is taken in the antero- posterior position on an 18 24-cm cassette; this is achieved by raising the unaffected side approximately 30 degrees.

Position of patient and cassette

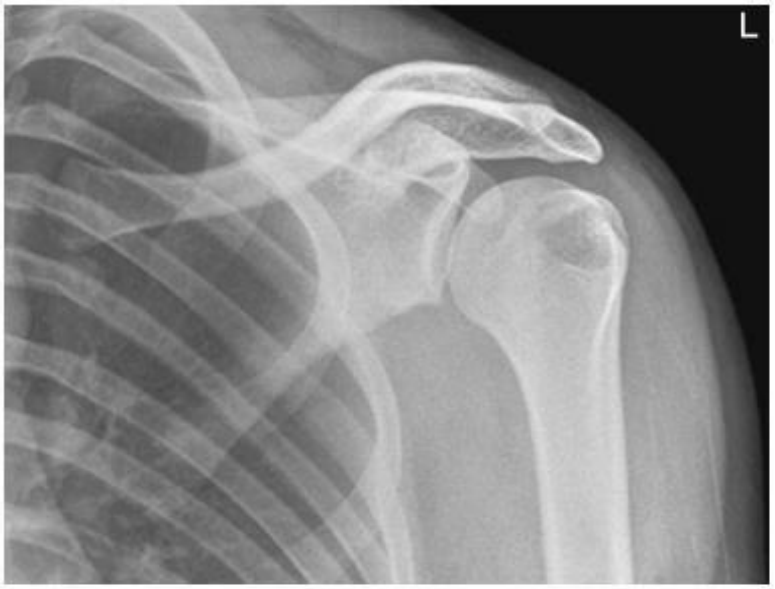
- The patient sits fully erect, if possible, on the accident and emergency trolley, with the head section of the trolley raised to a vertical position to support the patient.
- With the arm immobilized in a collar and cuff, the patient is turned 30 degrees towards the affected side.
- The unaffected shoulder is supported on pads to bring the posterior aspect of the affected shoulder into closer contact with the cassette, which is positioned under the affected arm and held in position with the patient's body weight.
- The cassette is positioned so that its upper border is at least 5cm above the shoulder to ensure that the oblique rays do not project the shoulder off the film.

Direction and centring of the X-ray beam

- The horizontal central ray is angled 25 degrees caudally and directed to the palpable coracoid process of the scapula.
- The beam is collimated to the 18 24-cm cassette.

Essential image characteristics

- The glenoid rim should be clear of the humeral head and the articular surface of the head of the humerus should be clear of the acromion process.
- Any avulsion fragments should be seen clearly in the joint space.



Antero-posterior radiograph of the shoulder, post manipulation, showing good technique

Antero-posterior radiograph of the shoulder, post manipulation, showing poor technique – joint space not adequately demonstrated

2. To Study the X-Ray of Clavicle

Postero-anterior – erect (basic)

Although the clavicle is demonstrated on the antero- posterior 'survey' image, it is desirable to have the clavicle as close to the cassette as possible to give optimum bony detail.

The Postero-anterior position also reduces the radiation dose to the thyroid and eyes, an important consideration in follow-up fracture images. Alternatively, the patient may be supine on the table or trolley for the antero-posterior projection in which immobility and movement are considerations. A 24 30-cm cassette is placed transversely in an erect cassette holder (or a vertical Bucky if the patient is particularly large).

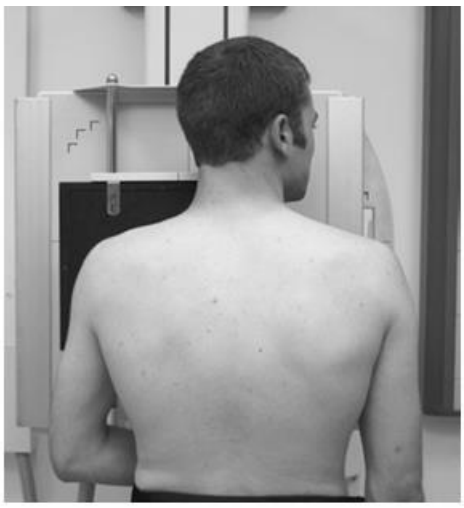
Position of patient and cassette

- The patient sits or stands facing an erect cassette holder.
- The patient's position is adjusted so that the middle of the clavicle is in the centre of the cassette.
- The patient's head is turned away from the side being examined and the affected shoulder rotated slightly forward to allow the affected clavicle to be brought into close contact with the Bucky. Direction and centring of the X-ray beam
- The horizontal central ray is directed to the centre of the clavicle and the centre of the image, with the beam collimated to the clavicle.

Essential image characteristics

- The entire length of the clavicle should be included on the image.
- The lateral end of the clavicle will be demonstrated clear of the thoracic cage.
- There should be no foreshortening of the clavicle.
- The exposure should demonstrate both the medial and the lateral ends of the clavicle.

Note: - Exposure is made on arrested respiration to reduce patient movement.



Normal postero-anterior radiograph of clavicle

Postero-anterior radiograph of clavicle showing comminuted fracture

3. To Study the X-Ray of Humerus

a. Humerus – supracondylar fracture

A type of injury commonly found in children is a fracture of the lower end of the humerus just proximal to the condyles. The injury is very painful and even small movements of the limb can exacerbate the injury, causing further damage to adjacent nerves and blood vessels. Any supporting sling should not be removed, and the patient should not be asked to extend the elbow joint or to rotate the arm or forearm. A 24 30-cm cassette is used.

Lateral:

Position of patient and cassette Method 1

- The patient sits or stands facing the X-ray tube.

- A cassette is supported between the patient's trunk and elbow, with the medial aspect of the elbow in contact with the cassette.
- A lead-rubber sheet or other radiation protection device is positioned to protect the patient's trunk from the primary beam.

Method 2

- A cassette is supported vertically in a cassette holder.
- The patient stands sideways, with the elbow flexed and the lateral aspect of the injured elbow in contact with the cassette. The arm is gently extended backwards from the shoulder. The patient is rotated forwards until the elbow is clear of the rib cage but still in contact with the cassette, with the line joining the epicondyles of the humerus at right-angles to the cassette.

Direction and centring of the X-ray beam Method 1

- The X-ray tube is angled so that the central ray is directed perpendicular to the shaft of the humerus and centred to the lateral epicondyle.

Method 2

- The horizontal central ray is directed to the medial epicondyle and the beam collimated to the elbow.

Essential image characteristics

- The image should include the lower end of the humerus and the upper third of the radius and ulna.

Lateral radiograph of elbow showing undisplaced supracondylar fracture

Lateral radiograph of elbow showing supracondylar fracture with displacement and bone disruption

Antero-posterior

As in the lateral projection, the cassette is held in a vertical cassette holder with the patient either standing or sitting during the procedure.

Position of patient and cassette

- From the lateral position, the patient's upper body is rotated towards the affected side.
- The cassette is placed in an erect cassette holder, and the patient's position is adjusted so that the posterior aspect of the upper arm is in contact with the cassette**.**

Direction and centring of the X-ray beam

- If the elbow joint is fully flexed, the central ray is directed at right-angles to the humerus to pass through the forearm to a point midway between the epicondyles of the humerus.
- If the elbow joint is only partially flexed, the central ray is directed at right-angles to the humerus to a point midway between the epicondyles of the humerus without first passing through the forearm.

Essential image characteristics

- If the elbow joint is fully flexed, sufficient exposure must be selected to provide adequate penetration of the forearm.

Antero-posterior radiograph in full flexion showing supracondylar fracture

Antero-posterior radiograph in partial flexion showing supracondylar fracture

b. Humerus – shaft

Antero-posterior – supine

A 35 43-cm cassette fitted with regular-speed screens can be used, providing it is large enough to demonstrate the elbow and shoulder joint on one film. To reduce the risk of patient,

movement, exposures are made on arrested respiration. When movement of the patient's arm is restricted, a modified technique may be required.

Position of patient and cassette

- The patient lies supine on the X-ray table, with the unaffected side raised and supported on pads.
- The cassette is positioned under the affected limb and adjusted to include the shoulder and elbow joints.
- The arm is slightly abducted and the elbow joint is fully extended, so that the posterior aspect of the upper arm is in contact with the cassette.
- The arm is adjusted to ensure that the medial and lateral epicondyles are equidistant from the cassette.
- The forearm is immobilized using a sandbag.

Direction and centring of the X-ray beam

- The vertical central ray is centred to a point midway between the shoulder and elbow joints.

Lateral – supine

Position of patient and cassette

- From the antero-posterior position, the elbow joint is flexed to 90 degrees.
- The arm is abducted and then medially rotated through 90 degrees to bring the medial aspect of the arm, elbow and forearm in contact with the table.
- The cassette is placed under the arm and adjusted to include both the shoulder and the elbow joints.
- The humerus is adjusted to ensure that the medial and lateral epicondyles of the humerus are superimposed.
- The forearm is immobilized using a sandbag.

Direction and centring of the X-ray beam

- The vertical central ray is centred to a point midway between the shoulder and elbow joints.

Essential image characteristics

- Both joints should be seen on the image.
- The elbow joint should be seen in the true lateral and Antero posterior positions.

Normal antero-posterior radiograph of humerus

Normal lateral radiograph of humerus

Antero-posterior – erect Position of patient and cassette

- The cassette is placed in an erect cassette holder.
- The patient sits or stands with their back in contact with the cassette.
- The patient is rotated towards the affected side to bring the posterior aspect of the shoulder, upper arm and elbow into contact with the cassette.
- The position of the patient is adjusted to ensure that the medial and lateral epicondyles of the humerus are equidistant from the cassette.

Direction and centring of the X-ray beam

- The central ray is directed at right-angles to the shaft of the humerus and centred midway between the shoulder and elbow joints.

Lateral – erect

Position of patient and cassette

- The cassette is placed in an erect cassette holder.
- From the anterior position, the patient is rotated through 90 degrees until the lateral aspect of the injured arm is in contact with the cassette.
- The patient is now rotated further until the arm is just clear of the rib cage but still in contact with the cassette.

Direction and centring of the X-ray beam

- The horizontal central ray is directed at right-angles to the shaft of the humerus and centred midway between the shoulder and elbow joint.

Essential image characteristics

- The exposure should be adjusted to ensure that the area of interest is clearly visualized.

Antero-posterior radiograph of humerus showing a fracture of the proximal shaft of the humerus

Lateral radiograph of the humerus in the same patient

C. Humerus – neck Antero-posterior

Position of patient and cassette

- The patient stands or lies supine facing the X-ray tube.
- The patient is rotated towards the affected side to bring the posterior aspect of the injured shoulder into contact with the midline of the cassette.
- The cassette is positioned to include the acromion process and the proximal half of the humerus.

Direction and centring of the X-ray beam

The central ray is directed at right-angles to the humerus and centred to the head of the humerus.

Essential image characteristics

- The image should include the acromion process and proximal half of the shaft of the humerus.
- The exposure should demonstrate adequately the neck of the humerus clear of the thorax.

Antero-posterior radiograph of neck of humerus taken erect to show fracture of the neck of the humerus

Lateral – Supero-inferior

This projection can be taken even when only a small degree of abduction is possible. It is important that no attempt should be made to increase the amount of movement that the patient is able or willing to make. An 18 24-cm cassette is selected.

Position of patient and cassette

- The patient is seated at one end of the table, with the trunk leaning towards the table, the arm of the side being examined in its maximum abduction, and the elbow resting on the table.
- The height of the table is adjusted to enable the patient to adopt a comfortable position and to maximize full coverage of the neck of the humerus and the shoulder joint.
- The cassette rests on the table between the elbow and the trunk**.**

Direction and centring of the X-ray beam

- The vertical central ray is directed from above to the acromion process of the scapula.
- Owing to increased object-to-cassette distance, a small focal spot together with an increased FFD should be selected.

Essential image characteristics

- The image should include the acromion and coracoid processes, the glenoid cavity and the proximal head and neck of the humerus.
- The exposure should demonstrate adequately the neck of the humerus.

Normal supero-inferior projection to show neck of humerus

Lateral – Infero-superior

This projection is usually undertaken with the patient supine on a trolley or the X-ray table.

Position of patient and cassette

- The patient lies supine on the trolley, with the arm of the affected side abducted as much as possible (ideally at right angles to the trunk), the palm of the hand facing upwards, and the medial and lateral epicondyles of the humerus equidistant from the tabletop.
- The shoulder and arm are raised slightly on non-opaque pads, and a cassette supported vertically against the shoulder is pressed against the neck to include as much of the scapula as possible in the image.

Direction and centring of the X-ray beam

The horizontal central ray is directed upwards and centred to the patient's axilla with minimum angulation towards the trunk.

Essential image characteristics

- The image should include the acromion and coracoid processes, the glenoid cavity and the proximal head and neck of the humerus.
- The exposure should demonstrate adequately the neck of the humerus.

4. To Study the X-Ray of Elbow

Lateral

Position of patient and cassette

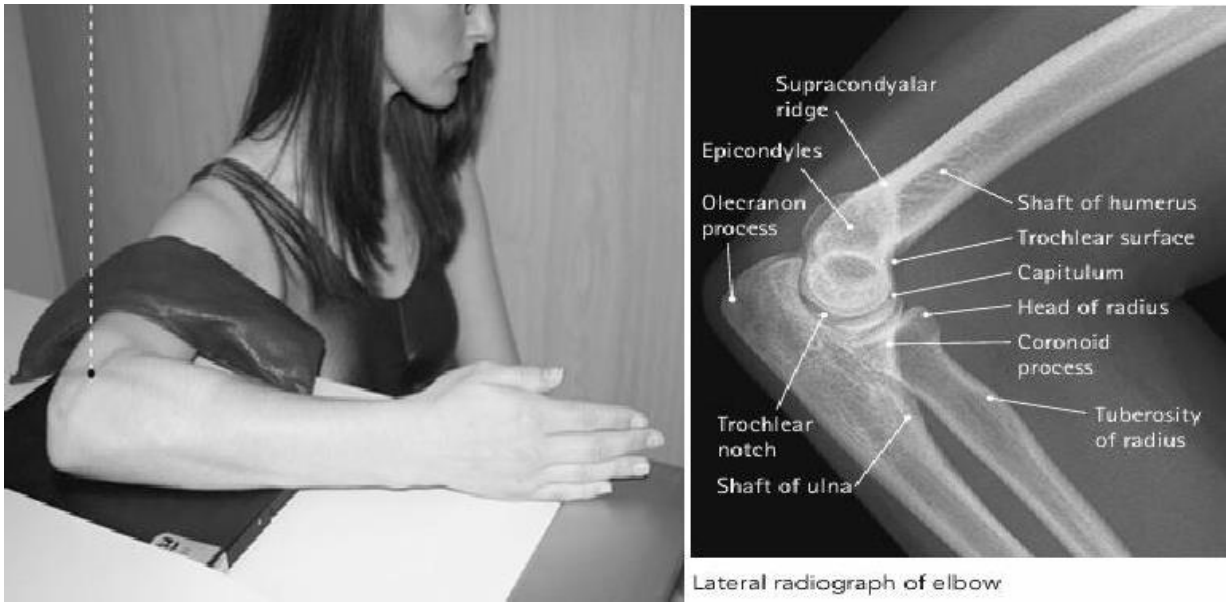
- The patient is seated alongside the table, with the affected side nearest to the table.
- The elbow is flexed to 90 degrees and the palm of the hand is rotated so that it is at 90 degrees to the tabletop.
- The shoulder is lowered so that it is at the same height as the elbow and wrist, such that the medial aspect of the entire arm is in contact with the tabletop.
- The half of the cassette being used is placed under the patient's elbow, with its centre to the elbow joint and its short axis parallel to the forearm.
- The limb is immobilized using sandbags.

Direction and centring of the X-ray beam

The vertical central ray is centred over the lateral epicondyle of the humerus.

Essential image characteristics

- The central ray must pass through the joint space at 90 degrees to the humerus, i.e. the epicondyles should be superimposed.
- The image should demonstrate the distal third of humerus and the proximal third of the radius and ulna.



Lateral radiograph of elbow

Antero-posterior

Position of patient and cassette

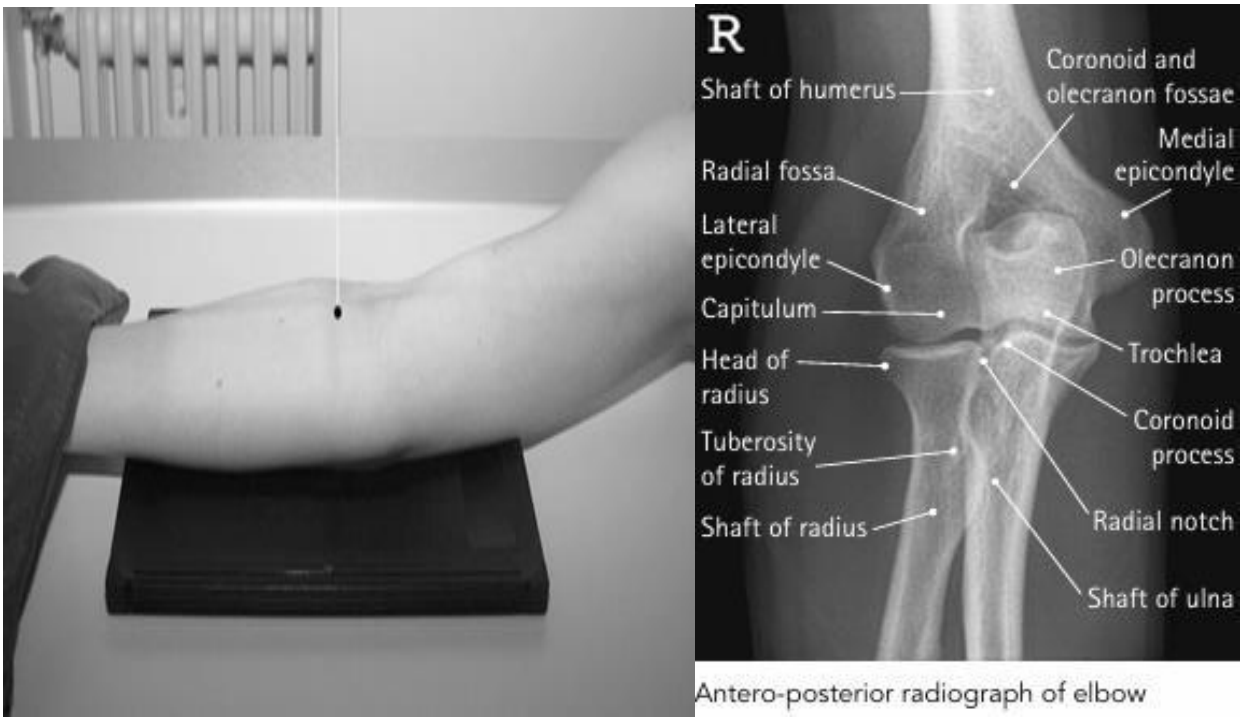
- From the lateral position, the patient's arm is externally rotated.
- The arm is then extended fully, such that the posterior aspect of the entire limb is in contact with the tabletop and the palm of the hand is facing upwards.
- The unexposed half of the cassette is positioned under the elbow joint, with its short axis parallel to the forearm.
- The arm is adjusted such that the medial and lateral epi condyles are equidistant from the cassette.
- The limb is immobilized using sandbags.

Direction and centring of the X-ray beam

The vertical central ray is centred through the joint space 2.5cm distal to the point midway between the medial and lateral epicondyles of the humerus.

Essential image characteristics

- The central ray must pass through the joint space at 90 degrees to the humerus to provide a satisfactory view of the joint space.
- The image should demonstrate the distal third of humerus and the proximal third of the radius and ulna.



Antero-posterior radiograph of elbow

Proximal radio-ulnar joint – oblique

An 18 24-cm cassette with high-resolution screens is used.

Position of patient and cassette

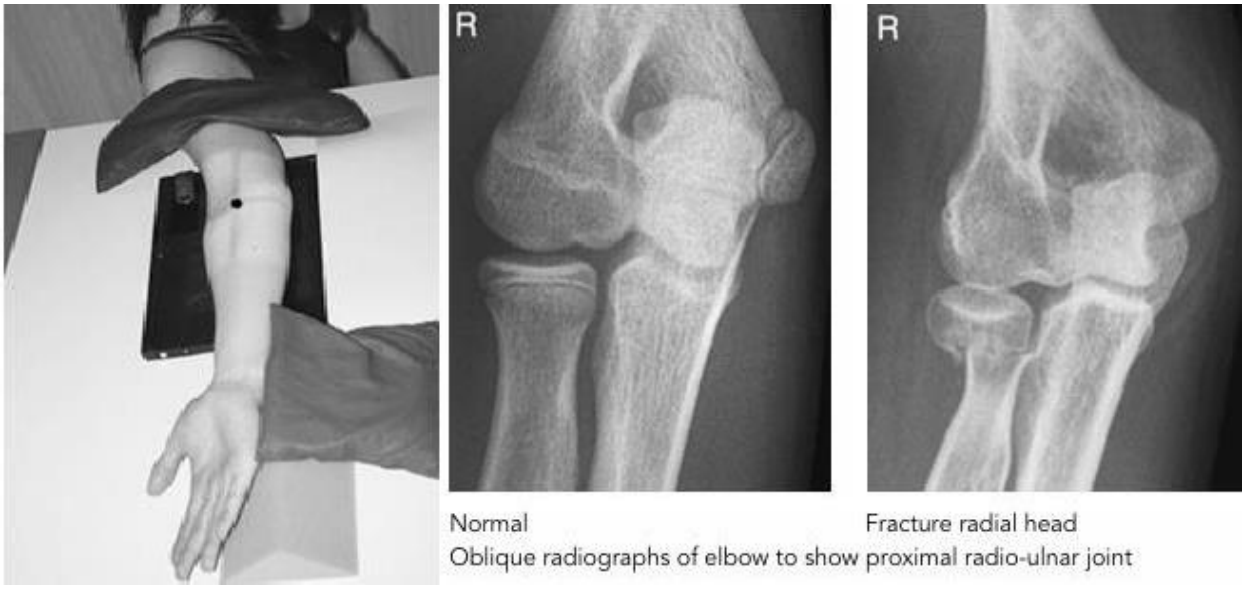
- The patient is positioned for an anterior projection of the elbow joint.
- The cassette is positioned under the elbow joint, with the long axis of the cassette parallel to the forearm.
- The humerus is then rotated laterally (or the patient leans towards the side under examination) until the line between the epicondyles is approximately 20 degrees to the cassette.
- The forearm is immobilized using a sandbag.

Direction and centring of the X-ray beam

The vertical central ray is centred 2.5cm distal to the midpoint between the epicondyles.

Essential image characteristics

The image should demonstrate clearly the joint space between the radius and the ulna.



Normal Fracture radial head

Oblique radiographs of elbow to show proximal radio-ulnar joint

5. To Study the X-Ray of Forearm

Two projections (antero-posterior and lateral) are required at right- angles to each other to demonstrate the full length of the radius and ulna to include both the elbow and the wrist joint. The antero- posterior projection with the forearm supinated demonstrates the radius and ulna lying side by side.

Antero-posterior

Position of patient and cassette

- The patient is seated alongside the table, with the affected side nearest to the table.
- The arm is abducted and the elbow joint is fully extended, with the supinated forearm resting on the table.
- The shoulder is lowered to the same level as the elbow joint.
- The cassette is placed under the forearm to include the wrist joint and the elbow joint.
- The arm is adjusted such that the radial and ulnar styloid processes and the medial and lateral epicondyles are equidistant from the cassette.
- The lower end of the humerus and the hand are immobilized using sandbags.

Direction and centring of the X-ray beam

The vertical central ray is centred in the midline of the fore arm to a point midway between the wrist and elbow joints.

Essential image characteristics

- Both the elbow and the wrist joint must be seen on the cassette.

- Both joints should be seen in the true antero-posterior position, with the radial and ulnar styloid processes and the epicondyles of the humerus equidistant from the cassette.

Normal antero-posterior radiograph of forearm

Lateral

Position of patient and cassette

- From the antero-posterior position, the elbow is flexed to 90 degrees.
- The humerus is internally rotated to 90 degrees to bring the medial aspect of the upper arm, elbow, forearm, wrist and hand into contact with the table.
- The cassette is placed under the forearm to include the wrist joint and the elbow joint.
- The arm is adjusted such that the radial and ulnar styloid processes and the medial and lateral epicondyles are super imposed.
- The lower end of the humerus and the hand are immobilized using sandbags.

Direction and centering of the X-ray beam

The vertical central ray is centred in the midline of the fore arm to a point midway between the wrist and elbow joints.

Essential image characteristics

Both the elbow and the wrist joint must be demonstrated on the image.

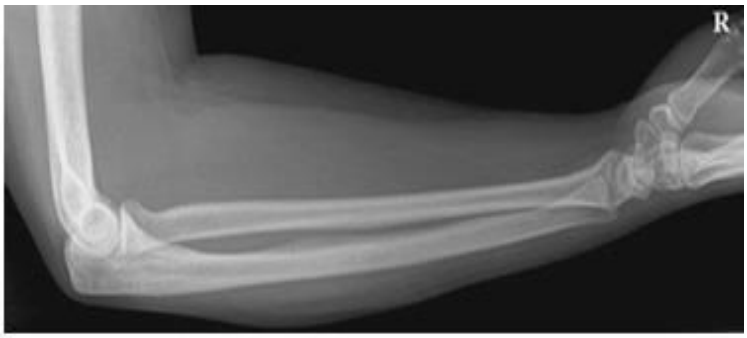
Both joints should be seen in the true lateral position, with the radial and ulnar styloid processes and the epicondyles of the humerus superimposed.

Radiological considerations

When two or more bones such as the radius and ulna form a ring, fracture of one of the bones is often associated with fracture or dislocation elsewhere in the ring, especially if the fracture is displaced or the bone ends overlap. In Galeazzi fracture there is a fracture of the radius with dislocation of the distal ulna, while in Monteggia fracture there is fracture of the ulna with dislocation of the head of the radius. In forearm fracture, therefore, both ends of both bones, as well as the proximal and distal radio-ulnar joints, must be demonstrated.

General forearm projections do not give adequate views of the elbow and should not be relied upon for diagnosis of radial head injury.

If an elbow joint effusion is shown, formal projections of the elbow joint will be required



Normal basic lateral radiograph of forearm

Lateral projection Antero-posterior projection
Radiographs of the forearm showing Galeazzi fracture

6. To Study the X-Ray of Hand Postero-anterior – dorsi-palmar Position of patient and cassette

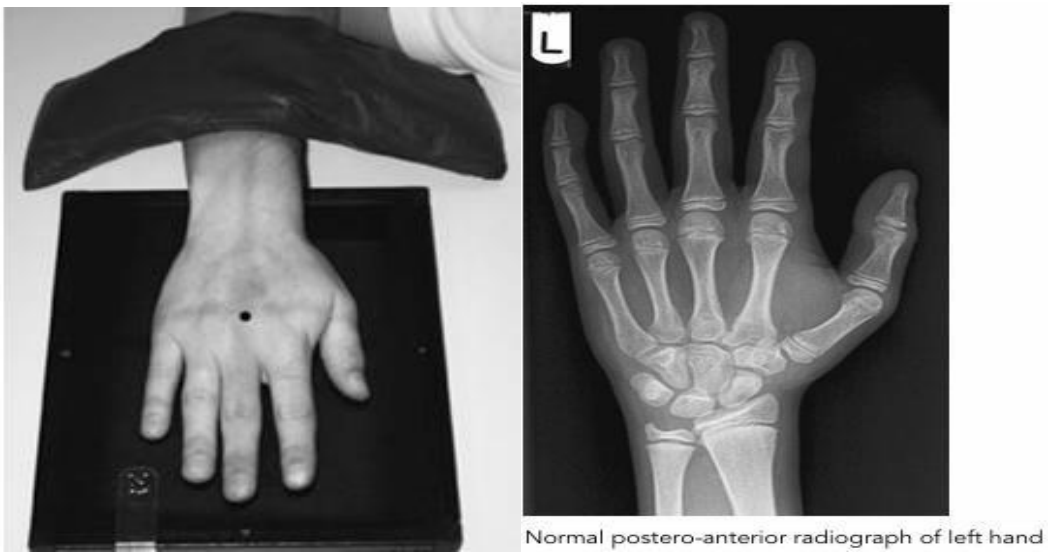
- The patient is seated alongside the table with the affected arm nearest to the table.
- The forearm is pronated and placed on the table with the palmer surface of the hand in contact with the cassette.
- The fingers are separated and extended but relaxed to ensure that they remain in contact with the cassette.
- The wrist is adjusted so that the radial and ulna styloid processes are equidistant from the cassette.
- A sandbag is placed over the lower forearm for immobilization.

Direction and centring of the X-ray beam

- The vertical central ray is centred over the head of the third metacarpal.

Essential image characteristics

- The image should demonstrate all the phalanges, including the soft-tissue fingertips, the carpal and metacarpal bones, and the distal end of the radius and ulna.
- The inter-phalangeal and metacarpo-phalangeal and carpometacarpal joints should be demonstrated clearly.
- No rotation.



Normal postero-anterior radiograph of left hand

Anterior oblique – dorsi-palmar oblique Position of patient and cassette

- From the basic Postero-anterior position, the hand is externally rotated 45 degrees with the fingers extended.
- The fingers should be separated slightly and the hand supported on a 45-degree non-opaque pad.
- A sandbag is placed over the lower end of the forearm for immobilization.

Direction and centring of the X-ray beam

- The vertical central ray is centred over the head of the fifth metacarpal.
- The tube is then angled so that the central ray passes through the head of the third metacarpal, enabling a reduction in the size of the field.

Essential image characteristics

- The image should demonstrate all the phalanges, including the soft-tissue of the fingertips, the carpal and metacarpal bones, and the distal end of the radius and ulna.
- The correct degree of rotation has been achieved when the heads of the first and second metacarpals are seen separated whilst those of the fourth and fifth are just superimposed.

Normal anterior oblique radiograph of left hand

X-RAY STUDY OF LOWER LIMB

1. To Study the X-Ray of Hip joint

Antero-posterior

Position of patient and cassette

- The patient lies supine and symmetrical on the X-ray table, with the median sagittal plane perpendicular to the tabletop.
- To avoid pelvic rotation, the anterior superior iliac spines must be equidistant from the tabletop.
- The affected limb is internally rotated to bring the neck of the femur parallel to the tabletop, and is then supported by sandbags.

Direction and centring of the X-ray beam

- The vertical central ray is directed 2.5cm distally along the perpendicular bisector of a line joining the anterior superior iliac spine and the symphysis pubis over the femoral pulse.
- The primary beam should be collimated to the area under examination and gonad protection applied where appropriate.

Notes

- The image must include the upper third of the femur. When taken to show the positioning and integrity of an arthroplasty, the whole length of the prosthesis, including the cement, must be visualized.

- Together with the oblique lateral projection, this is used for checking internal fixations following a fracture.
- If too high an mAs is used, the optical density around the greater trochanter may be too great for adequate visualization, particularly in very slender patients.
- Over-rotating the limb internally will bring the greater trochanter into profile. This may be a useful supplementary projection for a suspected avulsion fracture to this bone.

Antero-posterior radiograph of single hip

2. To Study the X-Ray of Shaft of femur

Antero-posterior

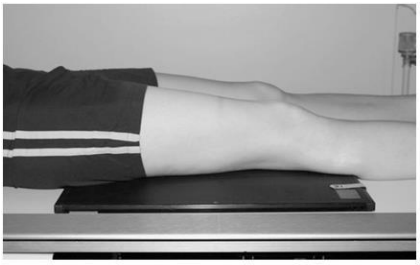
Position of patient and cassette

- The patient lies supine on the X-ray table, with both legs extended.
- The affected limb is rotated to centralize the patella over the femur.
- Sandbags are placed below the knee to help maintain the position.
- The cassette is positioned in the Bucky tray immediately under the limb, adjacent to the posterior aspect of the thigh to include both the hip and the knee joints.

- Alternatively, the cassette is positioned directly under the limb, against the posterior aspect of the thigh to include the knee joint.

Direction and centring of the X-ray beam

Centre to the middle of the cassette, with the vertical central ray at 90 degrees to an imaginary line joining both femoral condyles.



Antero-posterior radiograph of femur, hip down, showing fracture of upper femoral shaft

Antero-posterior radiograph of normal femur, knee up

Lateral

Position of patient and cassette

- From the antero-posterior position, the patient rotates on to the affected side, and the knee is slightly flexed.
- The pelvis is rotated backwards to separate the thighs.
- The position of the limb is then adjusted to vertically super impose the femoral condyles.

- Pads are used to support the opposite limb behind the one being examined.
- The cassette is positioned in the Bucky tray under the lateral aspect of the thigh to include the knee joint and as much of the femur as possible.
- Alternatively, the cassette is positioned directly under the limb, against the lateral aspect of the thigh, to include the knee joint.

Direction and centring of the X-ray beam

Centre to the middle of the cassette, with the vertical central ray parallel to the imaginary line joining the femoral condyles.

Lateral radiograph of femur, hip down, showing prosthetic hip

Lateral radiograph of femur, knee up, showing an area of myositis ossificans

3. To Study the X-Ray of Knee joint

Antero-posterior

Position of patient and cassette

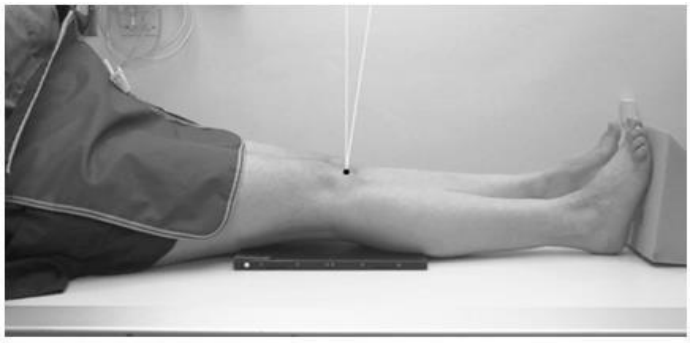
- The patient is either supine or seated on the X-ray table, with both legs extended. The affected limb is rotated to centralize the patella between the femoral condyles, and sandbags are placed against the ankle to help maintain this position.
- The cassette should be in close contact with the posterior aspect of the knee joint, with its centre level with the upper borders of the tibial condyles**.**

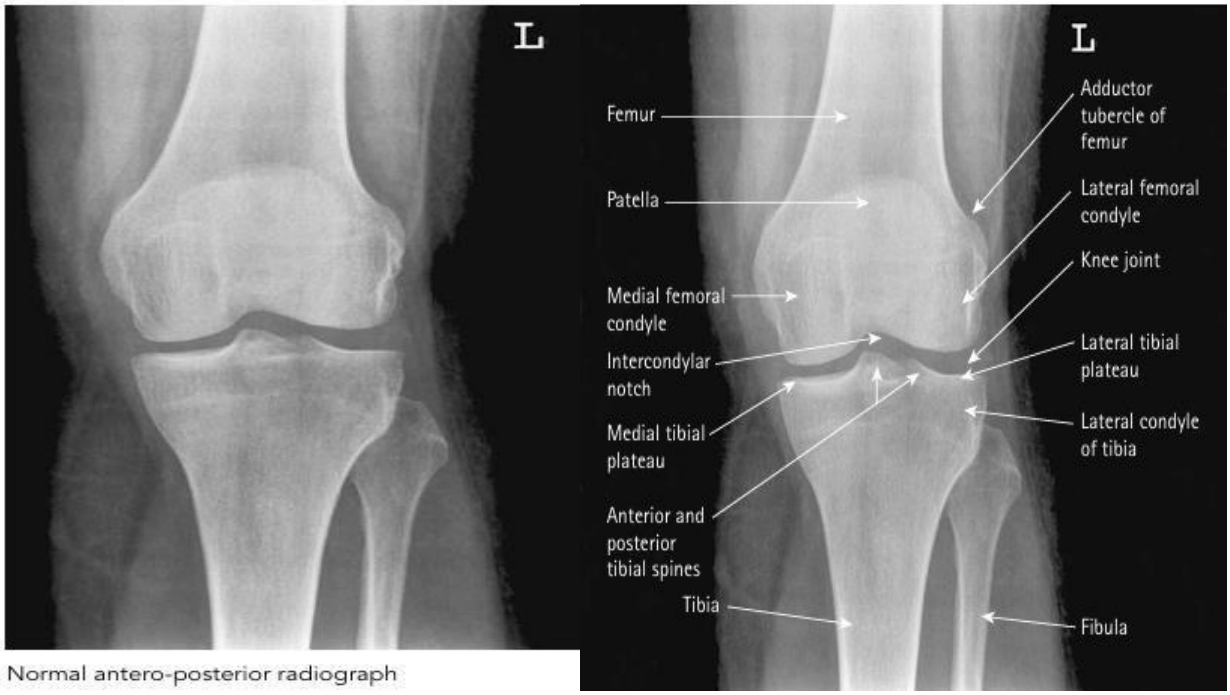
Direction and centring of the X-ray beam

- Centre 2.5cm below the apex of the patella through the joint space, with the central ray at 90 degrees to the long axis of the tibia.

Essential image characteristics

• The patella must be centralized over the femur**.**





Normal antero-posterior radiograph

Lateral

Position of patient and cassette

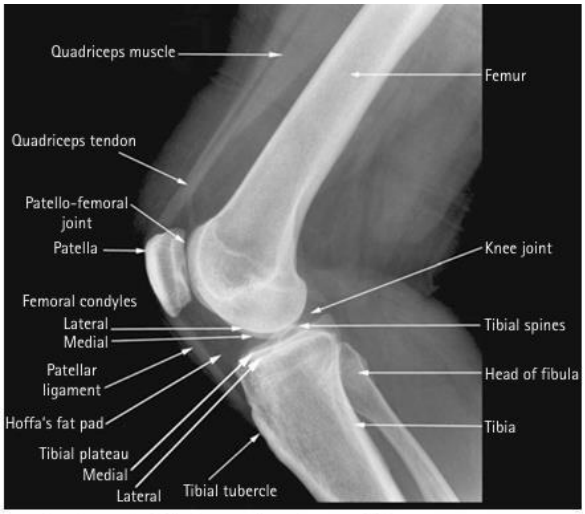
- The patient lies on the side to be examined, with the knee flexed at 45 or 90 degrees.
- The other limb is brought forward in front of the one being examined and supported on a sandbag.
- A sandbag is placed under the ankle of the affected side to bring the long axis of the tibia parallel to the cassette.
- The position of the limb is now adjusted to ensure that the femoral condyles are superimposed vertically.
- The centre of the cassette is placed level with the medial tibial condyle.

Direction and centring of the X-ray beam

- Centre to the middle of the superior border of the medial tibial condyle, with the central ray at 90 degrees to the long axis of the tibia.

Essential image characteristics

- The patella should be projected clear of the femur.
- The femoral condyles should be superimposed.
- The proximal tibio-fibular joint is not clearly visible.



Lateral radiograph of the knee with 45 degrees of flexion

4. To Study the X-Ray of Patella

Postero-anterior

Position of patient and cassette

- The patient lies prone on the table, with the knee slightly flexed.
- Foam pads are placed under the ankle and thigh for support.
- The limb is rotated to centralize the patella.
- The centre of the cassette is level with the crease of the knee.

Direction and centring of the X-ray beam

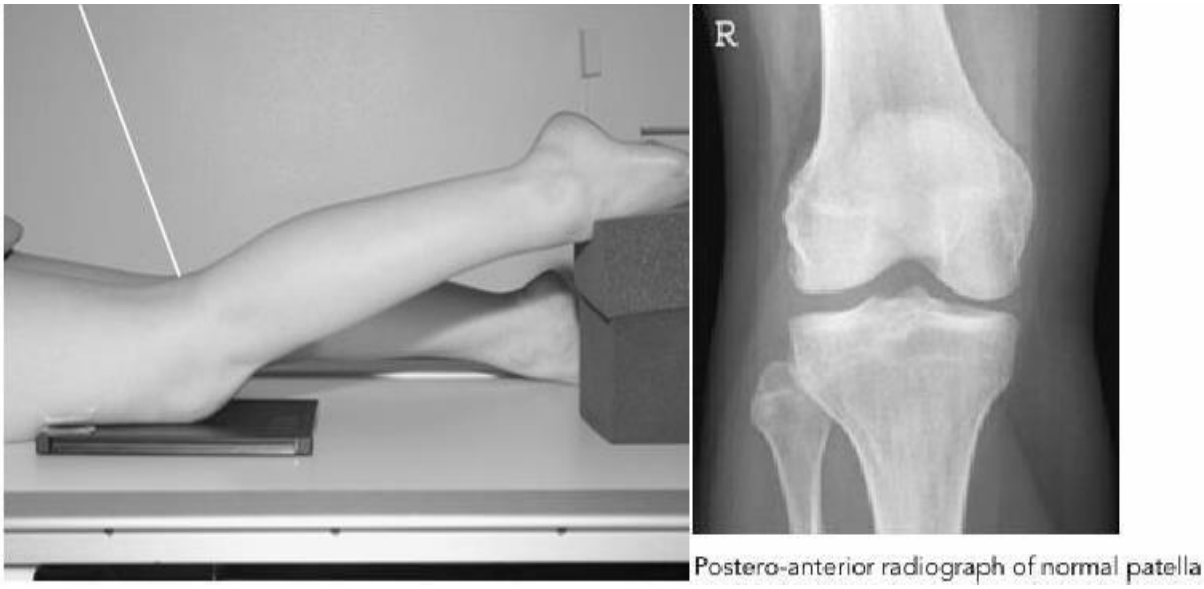
- Centre midway between the upper borders of the tibial condyles at the level of the crease of the knee, with the central ray at 90 degrees to the long axis of the tibia.

Radiological considerations

- A joint effusion is well demonstrated on the lateral projection as an ovoid density rising above the postero-superior aspect of the patella. Its significance varies according to the clinical setting. Causes include infection, haemorrhage and arthritis, but it may also be a marker of occult fracture, e.g. tibial spine or tibial plateau fracture. Lipohaemarthrosis occurs when a fracture passes into the marrow-containing medullary space. Fat (bone marrow) leaks into the joint, producing a fluid level between fat and fluid (blood) that can be seen when a horizontal beam is used.
- Fracture of the anterior tibial spine may be subtle, with demonstration requiring attention to

exposure and rotation. It is important as the attachment of the anterior cruciate ligament, avulsion of which may cause debilitating instability of the knee.

- Vertical fracture of the patella is not visible on the lateral projection and will be seen on the antero-posterior projection only if exposed properly (i.e. not underexposed). If clinically suspected, then a skyline view maybe requested.
- Tibial plateau fractures can be subtle and hard to detect, but again they are functionally very important. Good technique is the key. Full evaluation may be aided by three-dimensional CT in some cases.
- The fabella is a sesamoid bone in the tendon of medial head of gastrocnemius, behind the medial femoral condyle, and should not be confused with loose body.
- Osgood–Schlatter's disease is a clinical diagnosis and does not usually require radiography for diagnosis. Ultrasound may be useful if confirmation is required. Projections of the contralateral knee should not normally be needed.



Postero-anterior radiograph of normal patella

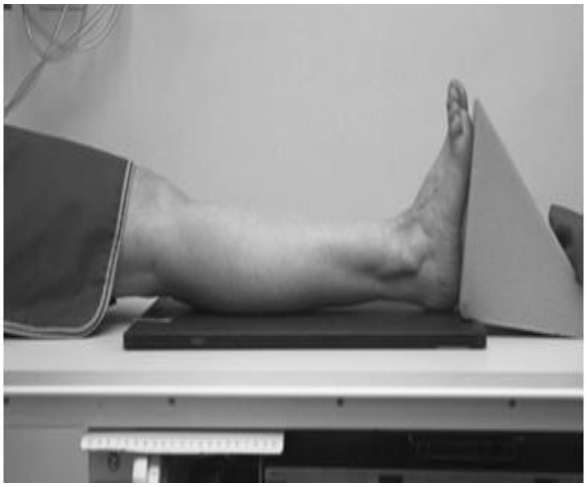
5. To study the x-ray Tibia and fibula

Antero-posterior – basic Position of patient and cassette

- The patient is either supine or seated on the X-ray table, with both legs extended.
- The ankle is supported in dorsiflexion by a firm 90-degree pad placed against the plantar aspect of the foot. The limb is rotated medially until the medial and lateral malleoli are equidistant from the cassette.
- The lower edge of the cassette is positioned just below the plantar aspect of the heel.

Direction and centring of the X-ray beam

- Centre to the middle of the cassette, with the central ray at right- angles to both the long axis of the tibia and an imaginary line joining the malleoli.



Antero-posterior

Antero-posterior radiograph showing fracture of proximal fibula and distal tibia

Lateral – basic

Position of patient and cassette

- From the supine/seated position, the patient rotates on to the affected side.
- The leg is rotated further until the malleoli are superimposed vertically.
- The tibia should be parallel to the cassette.
- A pad is placed under the knee for support.

The lower edge of the cassette is positioned just below the plantar aspect of the heel.

Direction and centring of the X-ray beam

Centre to the middle of the cassette, with the central ray at right- angles to the long axis of the tibia and parallel to an imaginary line joining the malleoli.

Essential image characteristics

The knee and ankle joints must be included, since the proximal end of the fibula may also be fractured when there is a fracture of the distal fibula

Lateral

Antero-posterior radiograph showing fracture of proximal fibula and distal tibia

F. To study the x-ray of Ankle joint

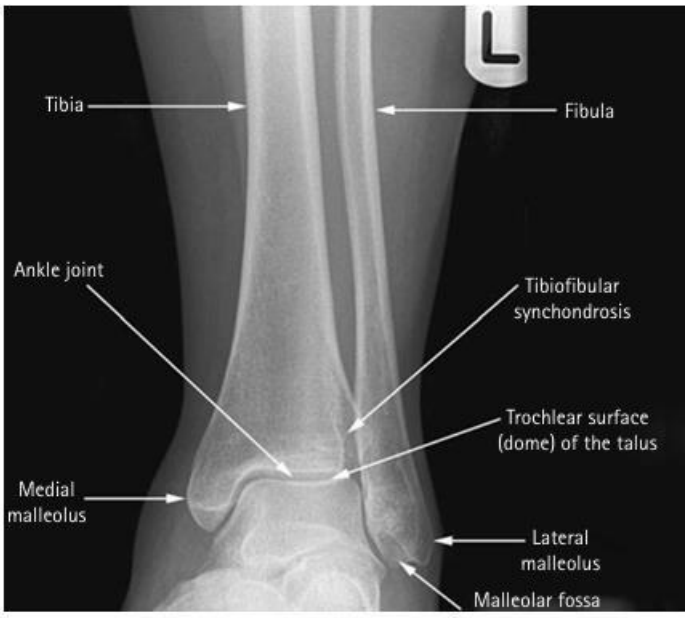
Antero-posterior

Position of patient and cassette

- The patient is either supine or seated on the X-ray table with both legs extended.
- A pad may be placed under the knee for comfort.
- The affected ankle is supported in dorsiflexion by a firm 90-degree pad placed against the plantar aspect of the foot. The limb is rotated medially (approximately 20 degrees) until the medial and lateral malleoli are equidistant from the cassette.
- The lower edge of the cassette is positioned just below the plantar aspect of the heel.

Direction and centring of the X-ray beam

- Centre midway between the malleoli with the vertical central ray at 90 degrees to an imaginary line joining the malleoli.
- Essential image characteristics
- The lower third of the tibia and fibula should be included.
- A clear joint space between the tibia, fibula and talus should be demonstrated (commonly called the Mortice view).



Annotated antero-posterior radiograph

Lateral – medio-lateral Position of patient and cassette

- With the ankle dorsiflexed, the patient turns on to the affected side until the malleoli are superimposed vertically and the tibia is parallel to the cassette.
- A 15-degree pad is placed under the lateral border of the forefoot and a pad is placed under the knee for support. The lower edge of the cassette is positioned just below the plantar aspect of the heel.

Direction and centring of the X-ray beam

- Centre over the medial malleolus, with the central ray at right- angles to the axis of the tibia.

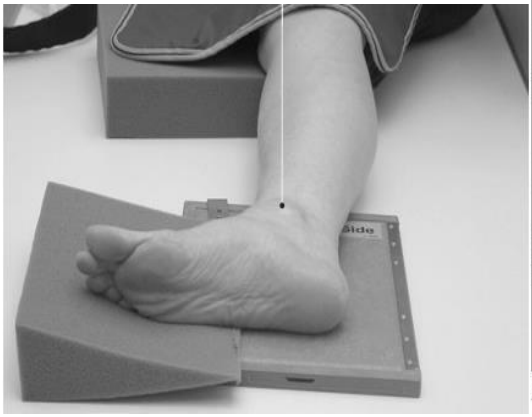
Essential image characteristics

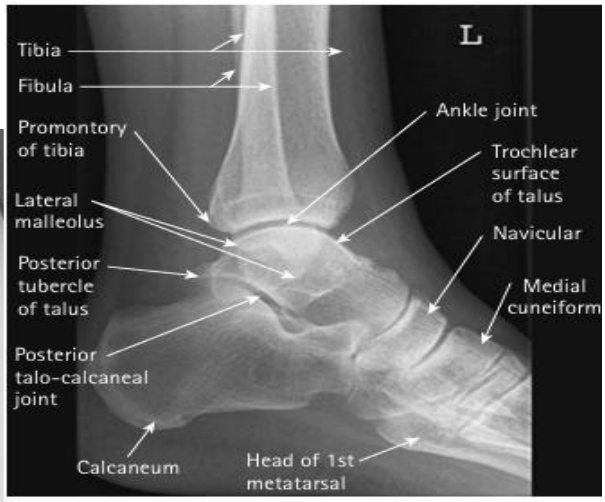
- The lower third of the tibia and fibula should be included.

The medial and lateral borders of the trochlear articular sur face of the talus should be superimposed on the image.

Radiological considerations

- Inversion injury of the ankle is common and may result in fracture of the lateral malleolus or the base of the fifth metatarsal. Investigation of the injury should therefore cover both areas.
- Tear of the collateral ligaments without bone fracture may make the ankle unstable, despite a normal radiograph. Stress projections may clarify this problem and ultrasound or MRI may be useful. Complex injuries may occur with fracture of both malleoli, rendering the ankle mortise very unstable, especially if associated with fracture of the posterior tibia – the so-called Tri-malleolar fracture – and/or disruption of the distal tibio-fibular synchondrosis. These injuries frequently require surgical fixation.





Annotated radiograph of lateral ankle

BASIC VIEW OF CHEST X-RAY

1. To Study the X-ray of Lower ribs

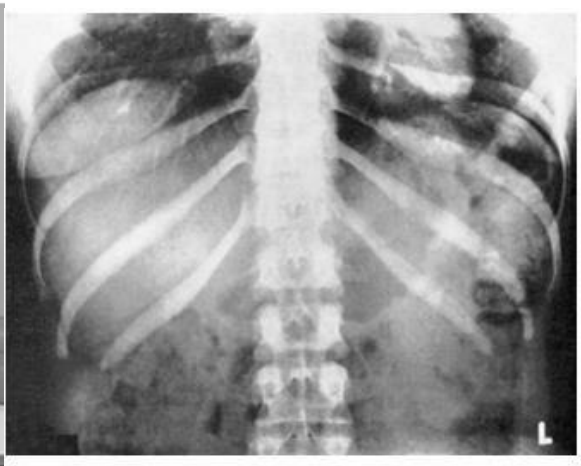
Antero-posterior (basic)

- A cassette is selected that is large enough to include the whole of the right and left sides, from the level of the middle of the body of the sternum to the lower costal margin. The cassette is placed in the Bucky tray. Position of patient and cassette
- The patient lies supine on the imaging couch, with the median sagittal plane coincident with the midline of the couch and Bucky mechanism.
- The anterior superior iliac spines should be equidistant from the couch top.
- The cassette is placed transversely, with its caudal edge positioned at a level just below the lower costal margin.

Direction and centring of the X-ray beam

The vertical central ray is centred in the midline at the level of the lower costal margin and then angled cranially to coincide with the centre of the film.

- This centring assists in demonstrating the maximum number of ribs below the diaphragm.
- Exposure made on full expiration will also assist in this objective**.**



Antero-posterior radiograph showing lower ribs on both sides

Right and left posterior oblique Position of patient and cassette

- The patient lies supine on the Bucky table or stands erect, with the mid-clavicular line of the side under examination coincident with the midline of the Bucky grid.
- The trunk is rotated 45 degrees on to the side being examined, with the raised side supported on non-opaque pads.
- The hips and knees are flexed for comfort and to assist in maintaining patient position.
- The caudal edge of the cassette is positioned at a level just below the lower costal margin.
- The cassette should be large enough to include the ribs on the side being examined from the level of the middle of the body of the sternum to the lower costal margin.

Direction and centring of the X-ray beam

- The vertical central ray is directed to the midline of the anterior surface of the patient, at the level of the lower costal margin.

- From this position, the central ray is then angled cranially to coincide with the centre of the cassette.
- Exposure is made on arrested full expiration.

Right posterior oblique radiograph of right lower ribs

2. To study the X-ray of Upper ribs.

Right and left posterior oblique Position of patient and cassette

- The patient sits or stands with the posterior aspect of the trunk against the vertical Bucky. Alternatively, the patient lies supine on the Bucky table.
- The mid-clavicular line of the side under examination should coincide with the central line of the Bucky or table.
- The trunk is rotated 45 degrees towards the side being examined and, if supine, is supported on non-opaque pads.

- If the condition of the patient permits, the hands should be clasped behind the head, otherwise the arms should be held clear of the trunk.
- The cranial edge of the cassette should be positioned at a level just above the spinous process of the seventh cervical vertebra.

Direction and centring of the X-ray beam

- Initially, direct the central ray perpendicular to the cassette and towards the sternal angle.
- Then angle the beam caudally so that the central ray coincides with the centre of the cassette. This assists in demonstrating the maximum number of ribs above the diaphragm.
- Exposure made on arrested full inspiration will also assist in maximizing the number of ribs demonstrated.

Right posterior oblique

Left posterior oblique

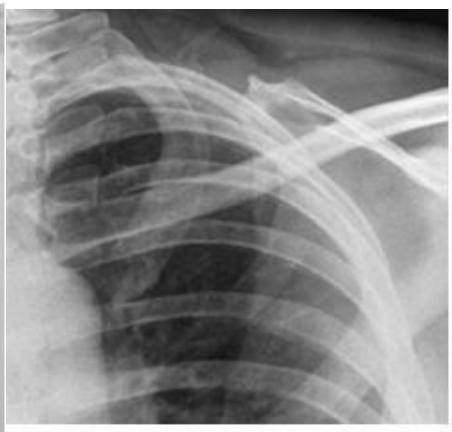
Antero-posterior

Position of patient and cassette

- The patient lies supine on the table or stands with the posterior aspect of the trunk against a cassette.
- When the patient is erect, the cassette is placed in a cassette holder attachment.
- The median sagittal plane is adjusted at right-angles to the cassette.
- The cassette is centred to the junction of the medial and middle thirds of the clavicle.

Direction and centring of the X-ray beam

- Direct the central ray perpendicular to the cassette and towards the junction of the medial and middle thirds of the clavicle.



Collimated antero-posterior radiograph of left first and second ribs

3. To study the X-ray of Sternum.

Anterior oblique

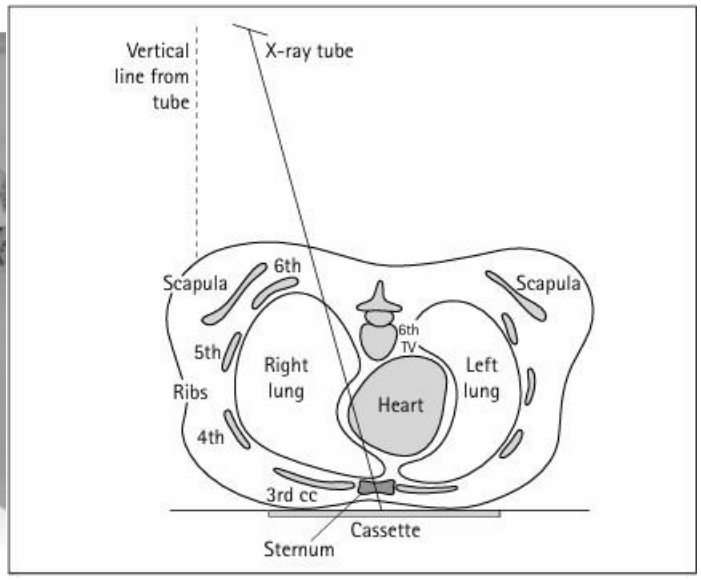
Position of patient and cassette

- The patient stands or sits facing the vertical Bucky or lies prone on the table.
- The medial sagittal plane should be at right-angles to, and centred to, the cassette.
- As the central ray is to be angled across the table, the cassette is placed transversely to avoid grid cut-off.
- If the Bucky is to be used on the table, the patient should lie on a trolley positioned at right-angles to the table, with the thorax resting on the Bucky table.
- The cassette is centred at the level of the fifth thoracic vertebra.

Immobilization will be assisted if it is possible to use an immobilization band**.**

Direction and centring of the X-ray beam

- The perpendicular central ray is centred initially to the axilla of either side at the level of the fifth thoracic vertebra.
- The central ray is then angled transversely so that the central ray is directed to a point 7.5 cm lateral to the midline on the same side.



Left anterior oblique

Postero-anterior oblique radiograph of sternum taken during gentle respiration

Lateral

Position of patient and cassette

- The patient sits or stands, with either shoulder against a vertical Bucky or cassette stand.
- The median sagittal plane of the trunk is adjusted parallel to the cassette.
- The sternum is centred to the cassette or Bucky.
- The patient's hands are clasped behind the back and the shoulders are pulled well back.
- The cassette is centred at a level 2.5 cm below the sternal angle**. Direction and centring of the X-ray beam**
- Direct the horizontal central ray towards a point 2.5cm below the sternal angle.
- Exposure is made on arrested full inspiration**. Radiological considerations**
- The lateral sternal projection can be confusing, especially in elderly patients, who often have heavily calcified costal cartilages.
- Interpretation of the lateral projection is much easier when the sternum is truly lateral and at right-angles to the image receptor, with corresponding superimposition of ribs and cartilage.
- It is important to remember that the initial interpretation is often done in the emergency department by inexperienced observers; therefore, care should be exercised to ensure that the sternum is projected in the true lateral position.
- Sternal fracture, especially when there is overlap of the bone ends, may be associated with compression (wedge) fracture of the fourth to sixth thoracic vertebrae. It is appropriate to image the thoracic spine if this is suspected**.**

Normal lateral radiograph of sternum

4. To study the X-ray of Lungs.

Antero-posterior – supine Position of patient and cassette

- With assistance, a cassette is carefully positioned under the patient's chest with the upper edge of the cassette above the lung apices**.**
- The median sagittal plane is adjusted at right-angles to the middle of the cassette, and the patient's pelvis is checked to ensure that it is not rotated.
- The arms are rotated laterally and supported by the side of the trunk. The head is supported on a pillow, with the chin slightly raised.

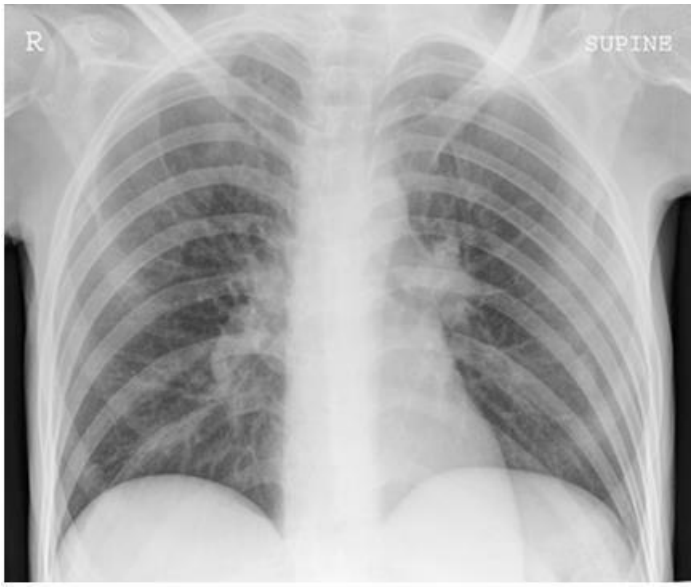
Direction and centring of the X-ray beam

- The central ray is directed first at right-angles and towards the sternal notch.
- The central ray is then angled until it is coincident with the middle of the film, thus avoiding unnecessary exposure to the eyes.

Radiological considerations

- Compared with the Postero-anterior projection, this projection moves the heart away from the image receptor plane, increasing magnification and reducing the accuracy of assessment of heart size (in this projection, a CTR of greater than 50% does not necessarily indicate cardiomegaly).
- The normal biomechanics of blood flow are different from those in the erect position, producing relative prominence of upper-lobe vessels and mimicking the signs of heart failure.
- Pleural fluid will layer against the posterior chest wall, producing an ill-defined increase attenuation of the affected hemithorax rather than the usual blunting of the Costo phrenic angle; fluid levels are not seen.

- A pneumothorax, if present, will be located at the front of the chest in the supine position. Unless it is large, it will be more difficult to detect if a lateral horizontal beam image is not employed**.**



Normal supine radiograph of thorax

Lateral

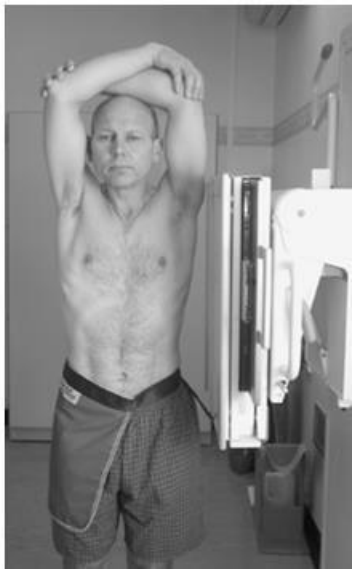
Position of patient and cassette

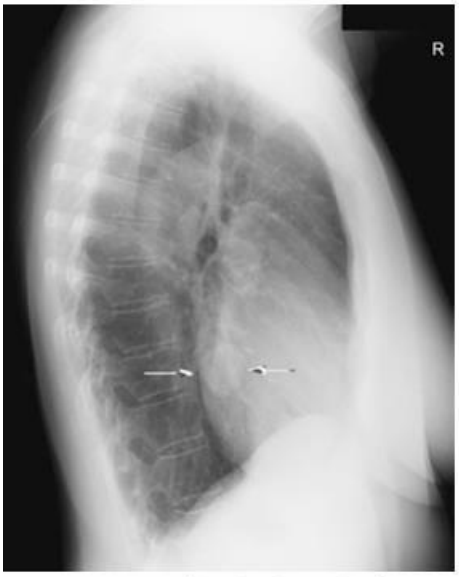
- The patient is turned to bring the side under investigation in contact with the cassette.
- The median sagittal plane is adjusted parallel to the cassette.
- The arms are folded over the head or raised above the head to rest on a horizontal bar.
- The mid-axillary line is coincident with the middle of the film, and the cassette is adjusted to include the apices and the lower lobes to the level of the first lumbar vertebra.

Direction and centring of the X-ray beam

- Direct the horizontal central ray at right-angles to the middle of the cassette at the mid-axillary line. Radiological considerations.

- Insufficient elevation of the arms will cause the soft tissues of the upper arms to obscure the lung apices and thoracic inlet, and even the retrosternal window, leading to masses or other lesions in these areas being missed.
- Rotation will also partially obscure the retrosternal window, masking anterior mediastinal masses. It will also render the sternum less distinct, which may be important in the setting of trauma when sternal fracture may be overlooked**.**





Postero-anterior and lateral radiographs of same patient showing a tumour in the right lower lobe

To Study the X-Ray of Skull

Cranium: non-isocentric technique

Lateral

Position of patient and cassette

- The patient lies supine, with the head raised and immobilized on a non-opaque skull pad. This will ensure that the occipital region is included on the final image.
- The head is adjusted, such that the median sagittal plane is perpendicular to the table/trolley and the interorbital line is perpendicular to the cassette.
- Support the grid cassette vertically against the lateral aspect of the head parallel to the median sagittal plane, with its long edge 5cm above the vertex of the skull.

Direction and centring of the X-ray beam

- The horizontal central ray is directed parallel to the inter orbital line, such that it is at right-angles to the median sagittal plane.
- Centre midway between the glabella and the external occipital protuberance to a point approximately 5cm superior to the external auditory meatus.
- The long axis of the cassette should be coincident with the long axis of the skull.

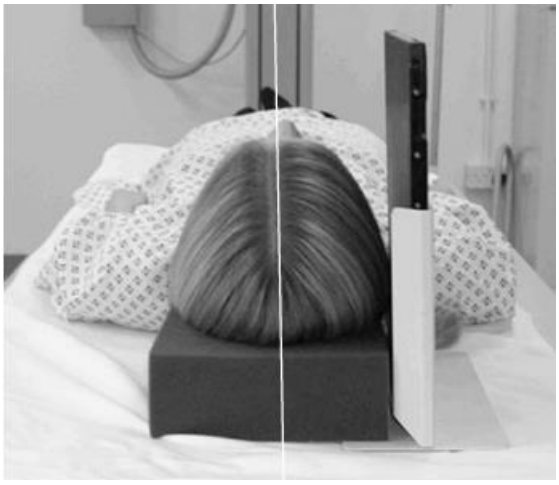
Essential image characteristics

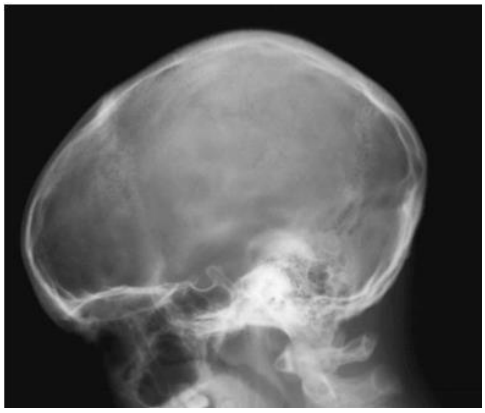
- The image should contain all of the cranial bones and the first cervical vertebra. Both the inner and outer skull tables should be included.

- A true lateral will result in perfect superimposition of the lateral portions of the floors of the anterior cranial fossa and those of the posterior cranial fossa. The clinoid processes of the sella turcica should also be superimposed**.**

Radiological considerations

- This projection is performed as part of the Advanced Trauma and Life Support (ATLS) primary screen.
- Skull-base fractures are potentially life-threatening due to the risk of intracranial infection and are often very difficult to detect. Lateral skull projections taken supine with a horizontal beam may reveal sinus fluid levels, which may be a marker of skull-base injury. They may also help to confirm the presence of free intracranial air, which is another sign of breach of the integrity of the cranium.





Occipito-frontal

Position of patient and cassette

- This projection may be undertaken erect or in the prone position. The erect projection will be described, as the prone projection is uncomfortable for the patient and will usually be carried out only in the absence of a vertical Bucky.
- The patient is seated facing the erect Bucky, so that the median sagittal plane is coincident with the midline of the Bucky and is also perpendicular to it.
- The neck is flexed so that the orbito-meatal base line is perpendicular to the Bucky. This can usually be achieved by ensuring that the nose and forehead are in contact with the Bucky.
- Ensure that the mid-part of the frontal bone is positioned in the centre of the Bucky.
- The patient may place the palms of each hand either side of the head (out of the primary beam) for stability.
- A 24 30-cm cassette is placed longitudinally in the Bucky tray. Ensure that the lead name blocker will not interfere with the final image.

Direction and centring of the X-ray beam Occipito-frontal

- The central ray is directed perpendicular to the Bucky along the median sagittal plane.
- A collimation field should be set to include the vertex of the skull superiorly, the region immediately below the base of the occipital bone inferiorly, and the lateral skin margins. It is important to ensure that the tube is centred to the middle of the Bucky**.**

Occipito-frontal caudal angulation: 10, 15 and 20 degrees

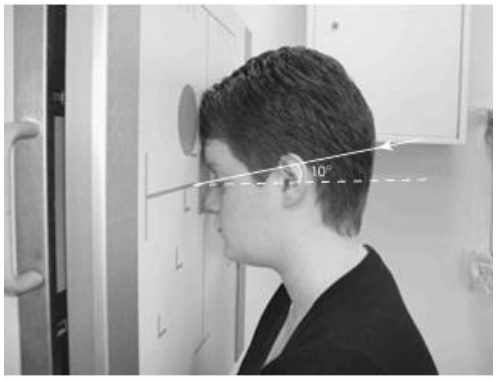
- The technique used for these three projections is similar to that employed for the occipito-frontal projection, except that a caudal angulation is applied. The degree of angulation will depend on the technique, e.g. for an OF20°↓ projection, a 20-degree caudal angulation will be employed.
- Ensure that the central ray is always centred to the middle of the Bucky once the tube angulation has been applied and not before.

Radiological considerations

- Asymmetry of projection of the squamo-parietal suture due to rotation increases the risk of it being mistaken for a fracture.
- As the beam angle increases, more of the orbital region is demonstrated and less of the upper part of the frontal bone anterior parietal bones is shown. Thus, the site of the suspected pathology should be considered when selecting the beam angle, e.g. an injury
- to the upper orbital region is best evaluated with an OF20°↓ projection**.**

Positioning for occipito-frontal skull projection

OF



Positioning for OF10°↓ skull projection


OF10°↓

Fronto-occipital

Position of patient and cassette

• The patient lies supine on a trolley or Bucky table, or with the posterior aspect of the skull resting on a grid cassette.

• The head is adjusted to bring the median sagittal plane at right angles to the film and coincident with its midline. In this position, the external auditory meatuses are equidistant from the cassette.

• The orbito-meatal baseline should be perpendicular to the cassette.

Direction and centring of the X-ray beam

All angulations for fronto-occipital projections are made cranially.

Fronto-occipital

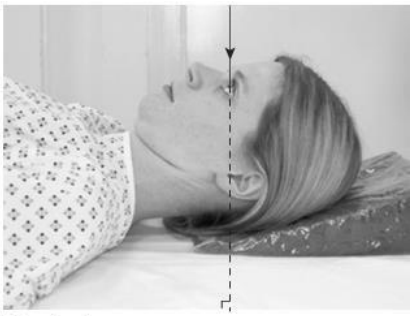
• The central ray is directed perpendicular to the cassette or Bucky along the median sagittal plane.

• A collimation field should be set to include the vertex of the skull superiorly, the base of the occipital bone inferiorly, and the lateral skin margins. It is important to ensure that all of the tube is centred to the middle of the Bucky.

Fronto-occipital caudal angulation: 10, 15 and 20 degrees

• The technique used for these three projections is similar to that employed for the occipito-frontal, except that a cranial angulation is applied. The degree of angulation will depend on the projection required.

• Remember that the cassette or Bucky must be displaced superiorly to allow for the tube angulation, otherwise the area of interest will be projected off the film. For a 20-degree angle, the top of the cassette will need to be 5 cm above the skull vertex.



FO projection

To Study the X-Ray of Abdomen

Radiographic examination of the abdomen and pelvic cavity is performed for a variety of reasons, including:

- obstruction of the bowel;
- perforation;
- renal pathology;
- acute abdomen (with no clear clinical diagnosis);
- foreign body localization;
- toxic megacolon;
- aortic aneurysm;
- to detect calcification or abnormal gas collections, e.g. abscess;

Antero-posterior – supine

A 35 43-cm cassette is selected. In the case of a large patient, an additional projection using a 35 43-cm cassette placed at right- angles to the spine of the upper abdomen may be necessary to include the upper abdomen.

Position of patient and cassette

• The patient lies supine on the imaging table, with the median sagittal plane at right-angles and coincident with the midline of the table**.**

• The pelvis is adjusted so that the anterior superior iliac spines are equidistant from the tabletop.

• The cassette is placed longitudinally in the cassette tray and positioned so that the symphysis pubis is included on the lower part of the film, bearing in mind that the oblique rays will project the symphysis pubis downwards.

• The centre of the cassette will be approximately at the level of a point located 1cm below the line joining the iliac crests. This will ensure that the symphysis pubis is included on the image.

Direction and centring of the X-ray beam

• The vertical central ray is directed to the centre of the cassette.

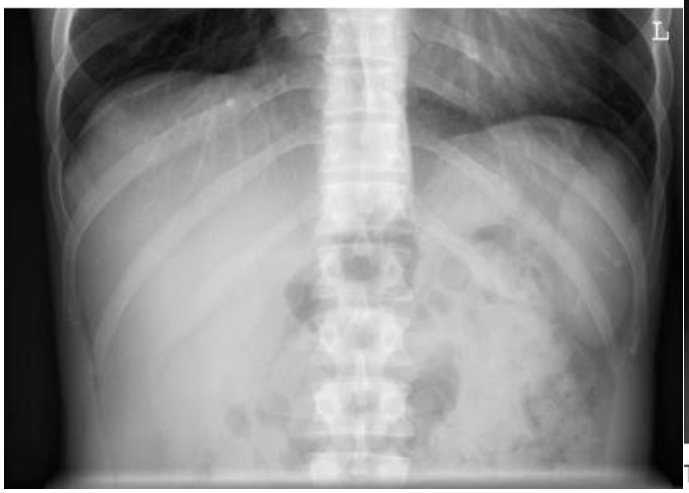
• Using a short exposure time, the exposure is made on arrested respiration.

Radiological considerations

• Any cause of movement unsharpness may render small or even medium-sized renal and ureteric calculi invisible.

• Some radiologists assert that the erect abdomen is rarely if ever needed to diagnose intestinal obstruction, as subtle signs will nearly always be present on a supine image. In the acute setting, however, the erect image can be very valuable to surgical staff who do not have immediate access to an experienced radiologist.

- Blunt trauma injury may be associated with the loss of the psoas muscle outline and loss of renal outline due to tissue damage and haematoma.



Two radiographs used to give full coverage of the abdomen

Antero-posterior supine radiograph of the abdomen showing distal ileum obstruction

Antero-posterior – erect

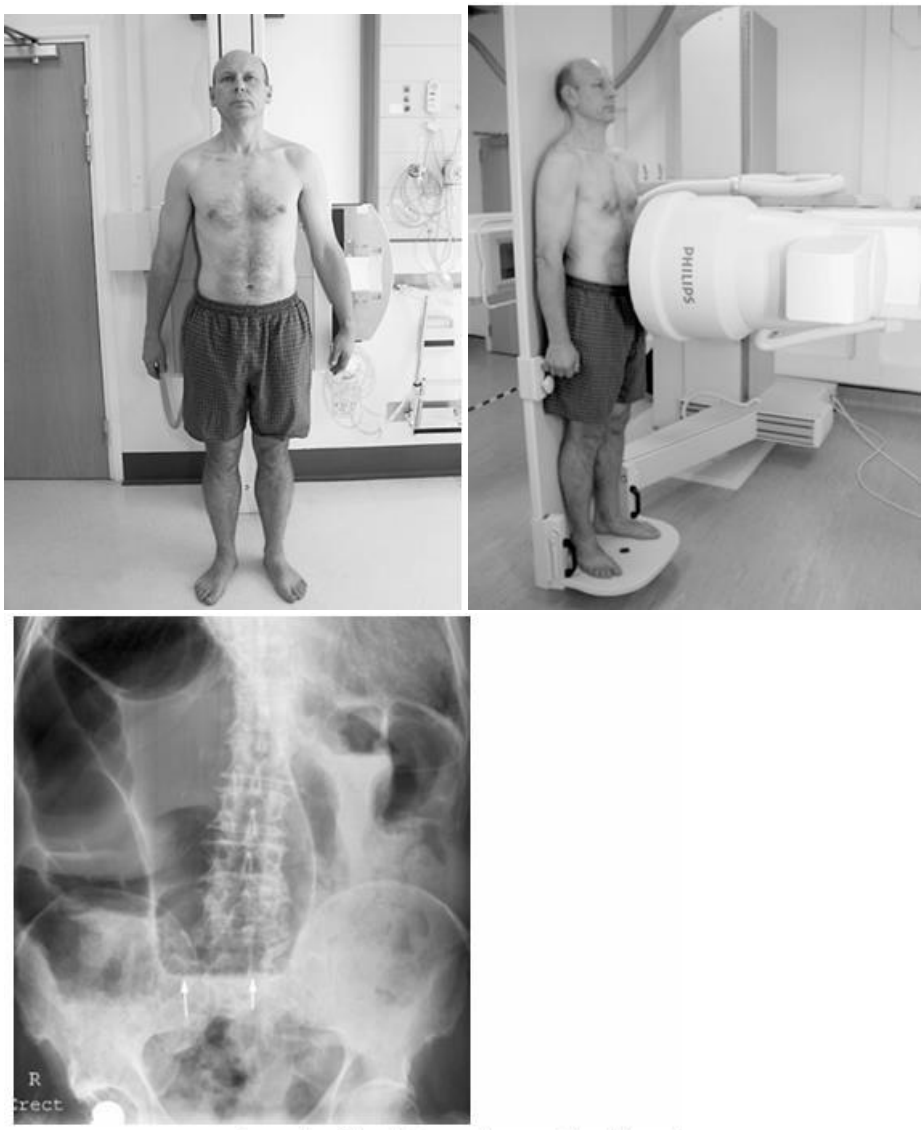
If possible, the patient is examined standing against a vertical Bucky. Alternatively, they may be examined on a tilting table with a C-arm using a large image intensifier/X-ray tube assembly. If necessary, the patient may be examined whilst sitting on a trolley or a chair using a stationary grid/cassette.

Position of patient and cassette (patient standing)

- The patient stands with their back against the vertical Bucky.
- The patient's legs are placed well apart so that a comfortable and steady position is adopted.
- The median sagittal plane is adjusted at right-angles and coincident with the midline of the table.
- The pelvis is adjusted so that the anterior superior iliac spines are equidistant from the imaging tabletop.
- A 35 43-cm cassette is placed in the Bucky tray with its upper edge at the level of the middle of the body of the sternum so that the diaphragms are included. NB: diverging rays will displace the diaphragms superiorly.

Direction and centring of the X-ray beam

- The horizontal ray is directed so that it is coincident with the centre of the cassette in the midline.
- An exposure is taken on normal full expiration.



Antero-posterior erect radiograph of the abdomen showing dilated bowel with small fluid levels (arrows)

Antero-posterior – erect (patient sitting) Position of patient and cassette

• Having set the exposure factors and positioned the X-ray tube so that a horizontal central ray will be approximately at the correct height, the patient, already erect, is turned through 90 degrees so that they are facing the X-ray tube.

• Care should be exercised to abduct the legs to avoid super imposing soft tissue of the thighs over the pelvic cavity.

• The median sagittal plane is adjusted at right-angles and coincident with the midline of the vertical Bucky or grid cassette.

• The patient is supported in this position with a 35 43-cm cassette in the Bucky or a grid cassette supported vertically against the patient's back, with its upper edge not lower than mid-sternum.

• Alternatively, depending on the patient's condition, the patient may sit on a stool or wheelchair with the back removed and with their back against a vertical Bucky. If necessary, the patient may also be examined with the backrest of the trolley raised to the vertical position.

Direction and centring of the X-ray beam

• Final adjustment is made to the position of the X-ray tube so that the horizontal central ray will be directed to the anterior aspect of the patient to the centre of the cassette at the correct focus-to-film distance (FFD).

• The exposure is made on arrested expiration, after which the patient is returned to the supine position.

Essential image characteristics

• The acquired image must include both domes of the diaphragm to ensure that any free air in the peritoneal cavity is demonstrated.

Radiological considerations

• Fluid levels on an erect film do not necessarily indicate obstruction, as a variety of other conditions may produce fluid levels, e.g. severe gastroenteritis, jejunal diverticulosis.

• Suspected intestinal obstruction is the usual indication for this request, but it may also be useful for confirming the presence of a gas-containing abscess.

Antero-posterior erect radiograph of the abdomen in sitting position showing postoperative small bowel obstruction (note lower abdominal clips on transverse incision). NB: If the legs are not abducted details of the pelvis are obscured, as in this example

Antero-posterior – left lateral decubitus

This projection is used if the patient cannot be positioned erect or sitting to confirm the presence of subdiaphragmatic gas suspected seen on the antero-posterior supine projection. It is also used for confirming obstruction. With the patient lying on the left side, free gas will rise, to be located between the lateral margin of the liver and the right lateral abdominal wall. To allow time for the gas to collect there, the patient should remain lying on the left side for 20 minutes before the exposure is made.

Position of patient and cassette

• The patient lies on the left side, with the elbows and arms flexed so that the hands can rest near the patient's head.

• A 35 43-cm cassette is positioned transversely in the vertical Bucky or alternatively a grid cassette is placed vertically against the posterior aspect of the trunk, with its upper border high enough to project above the right lateral abdominal and thoracic walls.

• A small region of the lung above the diaphragm should be included on the film.

• The patient's position is adjusted to bring the median sagittal plane at right-angles to the cassette.

Direction and centring of the X-ray beam

• The horizontal central ray is directed to the posterior aspect of the patient and centred to the centre of the film.

Fundamental Study of CT, MRI, and Ultrasonography

1) CT SCAN

- Computed Tomography (CT) scan is also called as Computer axial Tomography (CAT) scan. It provides detailed, cross sectional views of all types of tissues in the human body.
- CT scan is one of the best imaging method for analysing the chest, brain and abdomen. It is often used for the diagnosing various cancers like lung, liver and pancreatic cancers. The image reveals to a physician to confirm the presence of a tumour and to measure its size, location and the extent of damage for the near by tissue.

Principle of CT SCAN

- The term "computed tomography," or CT, refers to a computerized x-ray imaging procedure in which a narrow beam of x-rays is aimed at a patient and quickly rotated around the body, producing signals that are received by X–ray sensors that are placed on the opposite side of the circle from the x–ray source.
- These signals are then processed by the machine's computer to generate cross-sectional images, or "slices."
- Measurements are taken by passing x-rays throughout the body. Many data scans are taken progressively from the body and they are combined together by mathematical procedures know as tomographic reconstruction.

- The slices are called tomographic images and can give a clinician more detailed information than conventional x- rays.
- Once a number of successive slices are collected by the machine's computer, they can be digitally "stacked" together to form a three-dimensional (3D) image of the patient that allows for easier identification of basic structures as well as possible tumors or abnormalities.

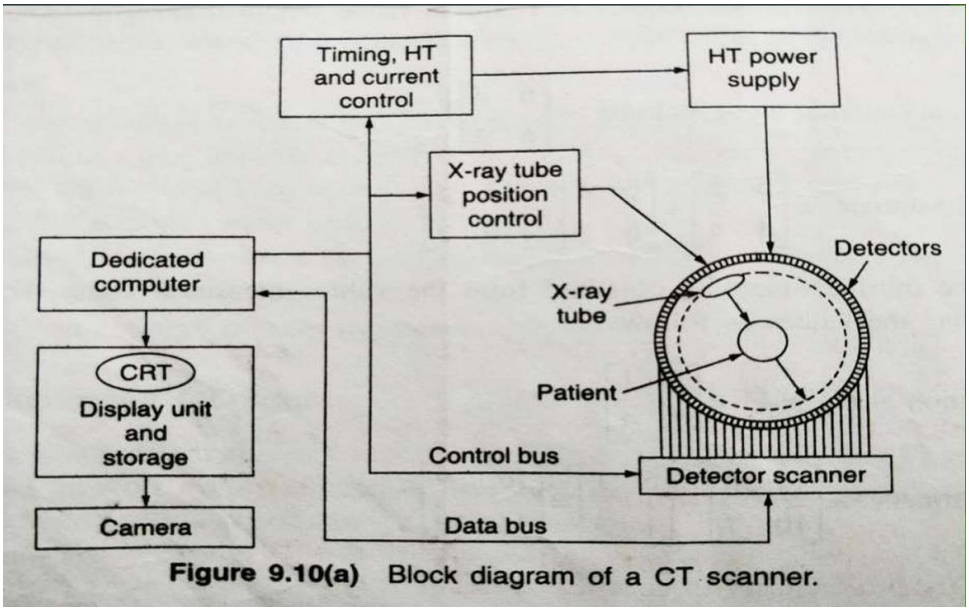


Figure 9.10(a) Block diagram of a CT scanner.

Procedure of CT SCAN

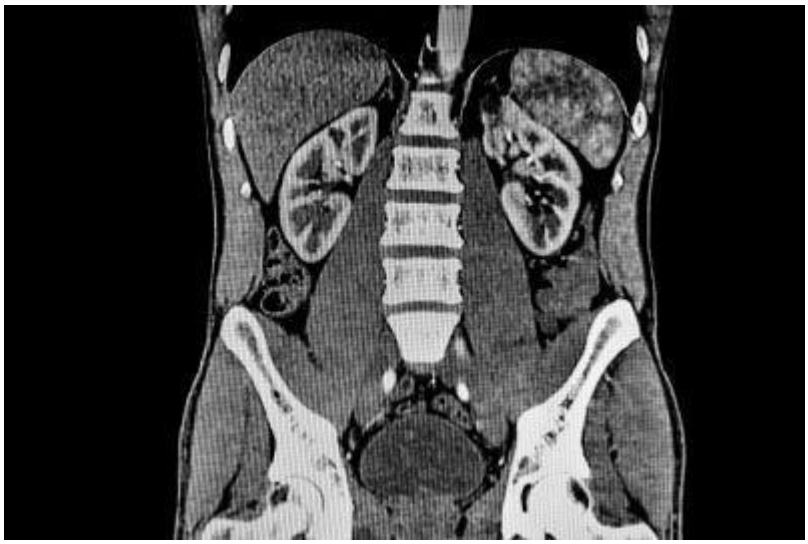
- The CT scanner machine rotates the X-ray tube around the patient's body through a circular structure known as the gantry.
- The patient is slowly moved up or down in the table, and different cross-section images are produced. In each rotation, a 2-dimensional image slice is constructed.

- Each subsequent image slice's thickness is decided on the operator's and the physician/radiologist's request but usually ranges from 1 to 10 millimeters.
- When the desired number of slices is obtained, a scan is reproduced into the computer image and can easily be reproduced and stored.
- The image is created using pixels according to its radiosensitivity and is displayed using the Hounsfield scale units, which are compared to known tissue density. Water is 0, air is negative 1000, and bone is positive 400 to 2000.
- Intravenous iodine can be injected into the bloodstream to demarcate blood vessels and tumors and identify infectious processes. Intravenous iodine- based or oral barium-based contrast is used to visualize the digestive system.
- The CT scans are obtained in the cranial direction, meaning from feet to head. It is important to note that current CT machines display the image opposite the patient's side as the image is produced as viewed from the patient's foot. Thus, the right side of the image is the patient's left side.

Indications

- Brain: tumors, traumatic or spontaneous hematomas, stroke, edema, skull fracture, calcifications, arteriovenous malformations, hydrocephalus, sinusitis, and empyema
- Neck: tumors, benign masses, thyroid nodules, lymphadenopathy

- Chest: tumor, pneumonia, metastasis, benign masses, pulmonary edema, pleural edema, tuberculosis, pulmonary embolism, traumatic injury to the lungs, esophageal rupture, ingested foreign body, fibrosis
- Abdomen: primary tumors, metastases, abscess, ascites, cholecystitis, appendicitis, renal calculi, pancreatitis, obstruction, lymphadenopathy, foreign body
- Spine: fractures, degenerative changes, stability, osteomyelitis, disc pathology
- Bone: complex bone fractures, eroded joints, knee, tumors, osteomyelitis
- Gyn: cyst, fibromas, tumors
- Screening: colon and lung cancer
- Biopsy: CT guided to different organs for adequate tissue extraction
- CT Angiography: brain, heart, lung, kidney, extremities
- Intraoperative: Can be used for neuronavigation procedures during brain biopsy or tumor resection



CT SCAN of abdomen

Disadvantages

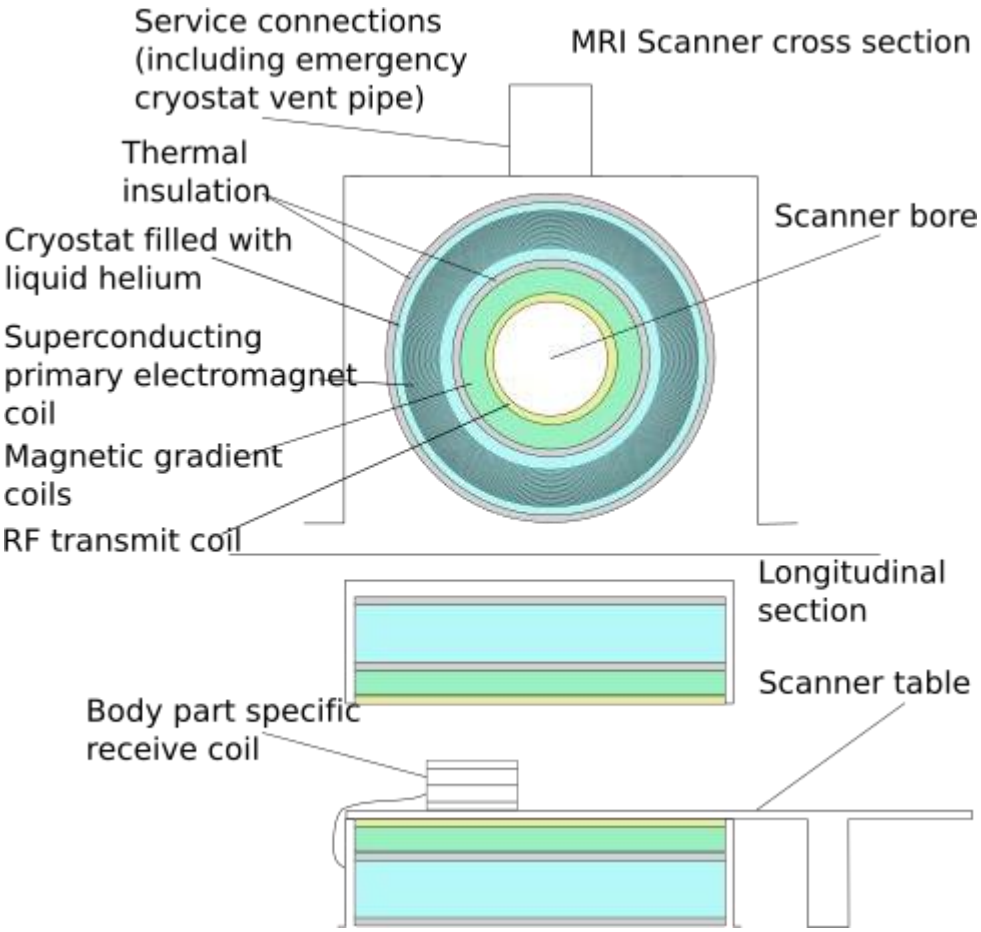
- Ct scan involves exposure to xray radiation which is not really good for health
- Pregnant women connot undergo ct scan
- Lactating mothers cannot breastfeed for 24 hrs after contrast injection
- This gives images of only transverse sections of the body
- Contrast material injected may lead to allergic reaction.

2) MRI

- Magnetic Resonance Imaging (MRI) is a non-invasive imaging technology that produces three dimensional detailed anatomical images.
- It is often used for disease detection, diagnosis, and treatment monitoring.
- It is based on sophisticated technology that excites and detects the change in the direction of the rotational axis of protons found in the water that makes up living tissues.
- MRI scanners use strong magnetic fields, magnetic field gradients, and radio waves to form images of the organs in the body.

Princliples of MRI

- In most medical applications, hydrogen nuclei, which consist solely of a proton, that are in tissues create a signal that is processed to form an image of the body in terms of the density of those nuclei in a specific region.
- The major components of an MRI scanner are the main magnet, which polarizes the sample, the shim coils for correcting shifts in the homogeneity of the main magnetic field, the gradient system which is used to localize the region to be scanned and the Radio Frequency(RF) system, which excites the sample and detects the resulting NMR signal. The whole system is controlled by one or more computers.
- MRI requires a magnetic field that is both strong
  and uniform to a few parts per million across the scan volume. The field strength of the magnet is measured in tesla(T).



Schematic of a cylindrical superconducting MR scanner. Top: cross section of the cylinder with primary coil, gradient coils and RF transmit coils. Bottom: longitudinal section of the cylinder and table, showing the same coils and the RF receive coil.

T1 and T2

- Each tissue returns to its equilibrium state after excitation by the independent relaxation processes of T1 (spin-lattice; that is, magnetization in the same direction as the static magnetic field) and T2 (spin- spin; transverse to the static magnetic field).
- To create a T1-weighted image, magnetization is allowed to recover before measuring the MR signal by

changing the repetition time (TR). This image weighting is useful for assessing the cerebral cortex, identifying fatty tissue, characterizing focal liver lesions, and in general, obtaining morphological information, as well as for post-contrast imaging.

- To create a T_2-weighted image, magnetization is allowed to decay before measuring the MR signal by changing the echo time (TE). This image weighting is useful for detecting edema and inflammation, revealing white matter lesions, and assessing zonal anatomy in the prostate and uterus.

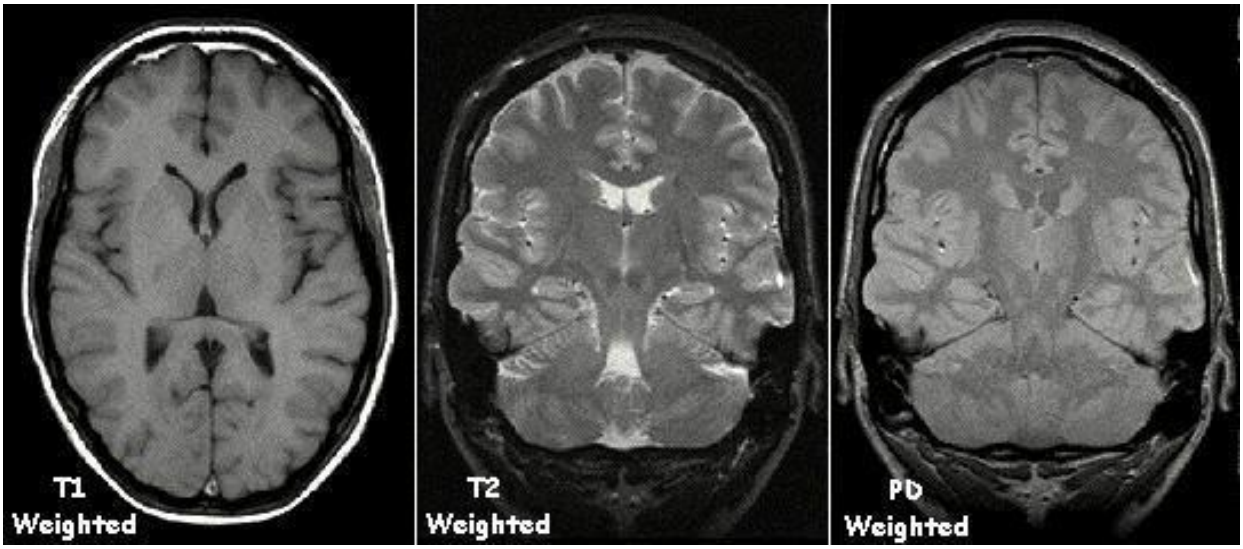
Diagnostics

- Neuro-imaging: MRI is the investigative tool of choice for neurological cancers over CT, as it offers better visualization of the posterior cranial fossa, containing the brainstem and the cerebellum. The contrast provided between grey and white matter makes MRI the best choice for many conditions of the central nervous system, including demyelinating diseases, dementia, cerebrovascular disease, infectious diseases, Alzheimer's disease and epilepsy.
- Cardiovascular: Cardiac MRI is complementary to other imaging techniques, such as echocardiography, cardiac CT, and nuclear medicine. It can be used to assess the structure and the function of the heart. Its applications include assessment of myocardial ischemia and viability, cardiomyopathies, myocarditis, iron overload, vascular diseases, and congenital heart disease.

- Musculoskeletal: Applications in the musculoskeletal system include spinal imaging, assessment of joint disease, and soft tissue tumors. MRI techniques can also be used for diagnostic imaging of systemic muscle diseases including genetic muscle diseases.

Contrast agents

- MRI for imaging anatomical structures or blood flow do not require contrast agents since the varying properties of the tissues or blood provide natural contrasts.
- However, for more specific types of imaging, exogenous contrast agents may be given intravenously, orally, or intra-articularly.
- Most contrast agents are either paramagnetic (e.g.: gadolinium, manganese, europium), and are used to shorten T1 in the tissue they accumulate in, or super- paramagnetic (SPIONs), and are used to shorten T2 in healthy tissue reducing its signal intensity (negative contrast agents).



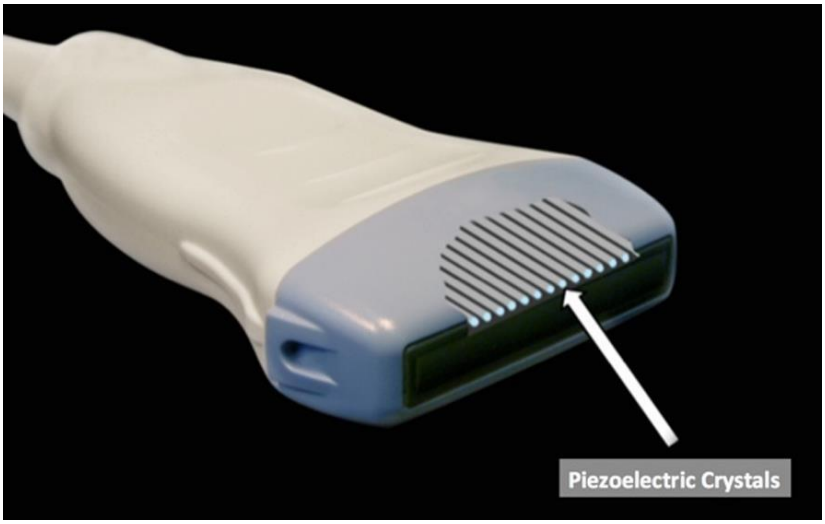
3) Ultrasonography

- Sound is classified based upon the ability of the human ear to hear it.
- Sounds sensed by young healthy adult human ears are in the range of 20 cycles per second or Hertz, abbreviated as Hz, to 20,000 Hz, or 20 KHz (Kilo Hertz) termed audible sound (Range of 20 – 20,000 Hz).
- If the frequency of a sound is less than 20 Hz, it cannot be heard by humans and is defined as infrasonic or infrasound.
- If the frequency of sound is higher than 20 KHz, it cannot be heard by humans and is called ultrasonic or **ultrasound**.

Generation of Ultrasound

- Ultrasound waves are generated from tiny piezoelectric crystals packed within the ultrasound transducers.
- When an alternate current is applied to these crystals, they contract and expand at the same frequency at which the current changes polarity and generate an ultrasound beam.
- The ultrasound beam traverses into the body at the same frequency generated. Conversely, when the ultrasound beam returns to the transducer, these crystals change in shape and this minor change in shape generate a tiny electric current that is amplified by the ultrasound machine to generate an ultrasound image on the monitor.

- The piezoelectric crystals within the transducer therefore transform electric energy into mechanical energy (ultrasound) and vice-versa.
- One crystal is not sufficient to produce an ultrasound beam for clinical imaging and modern transducers have large number of crystals arranged into parallel rows.
- The high frequency sound generated by a transducer do not travel well through air, so in order to facilitate their transfer from the transducer to the skin of the patient, a watery gel is applied that couples the transducer to the skin and permits the sound to go back and forth.
- Modern transducers have crystals made of synthetic plumbium zirconium titanate (PZT).



Ultrasonography image formation

- Modern ultrasound equipment create an ultrasound image by sending multiple sound pulses from the transducer at slightly different directions and analyzing returning echoes received by the crystals.

- Tissues that are strong reflectors of the ultrasound beam, such as bone or air will result in a strong electric current generated by the piezoelectric crystals which will appear as a hyperechoic image on the monitor.
- On the other hand, weak reflectors of ultrasound beam, such as fluid or soft tissue, will result in a weak current, which will appear as a hypoechoic or anechoic image on the monitor.
- The ultrasound image is thus created from a sophisticated analysis of returning echoes in a grey scale format.
- Given that the ultrasound beam travels in a longitudinal format, in order to get the best possible image, keep the angle of incidence of the ultrasound beam perpendicular to the object of interest, as the angle of incidence is equal to the angle of reflection.