B.SC. IN RADIOLOGY AND IMAGING TECHNIQUES

2nd Year

Prepared By

Paramedical & Allied Science Dept.

Radiology and Imaging Techniques

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Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

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Paper Title: Radiographic Positioning and Techniques (practical)

Paper Code: Paper –II

Syllabus
Application of Different Radiographic Positioning technology in different treatments.

SHOULDER GIRDLE

The **shoulder series** is fundamentally composed of two orthogonal views of the glenohumeral joint including the entire scapula. The extension of the shoulder series depends on the radiography department protocols and the clinical indications for imaging.

Basic and special projections Shoulder non-trauma routine

AP (external rotation)

Indications

This projection is often done as a series, it is useful to demonstrate the greater tubercle humerus in profile.

Patient position

- patient is preferably erect
- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- glenohumeral joint of the affected side is at the center of the image receptor
- affected arm is externally rotated
- the patient is slightly rotated 5-10°. Therefore, the body of the scapula is laying parallel with the image receptor
- some departments may require further rotation to mimic that of 'true AP' projection

Technical factors

- **anteroposterior projection**
- **centering point**
  - 2.5 cm inferior to the coracoid process, or 2 cm inferior to the lateral clavicle at the level of the glenohumeral joint

- **collimation**
  - superior to the skin margins
  - inferior to include one-third of the proximal humerus
  - lateral to include the skin margin
  - medial to include 2/3 of the clavicle
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- 2/3 of the clavicle is visible
- overlap of the humeral head with the glenoid
- no foreshortening of the scapular body (as per the patient rotation discussed in the positioning)
- the greater tubercle of the humerus is in profile

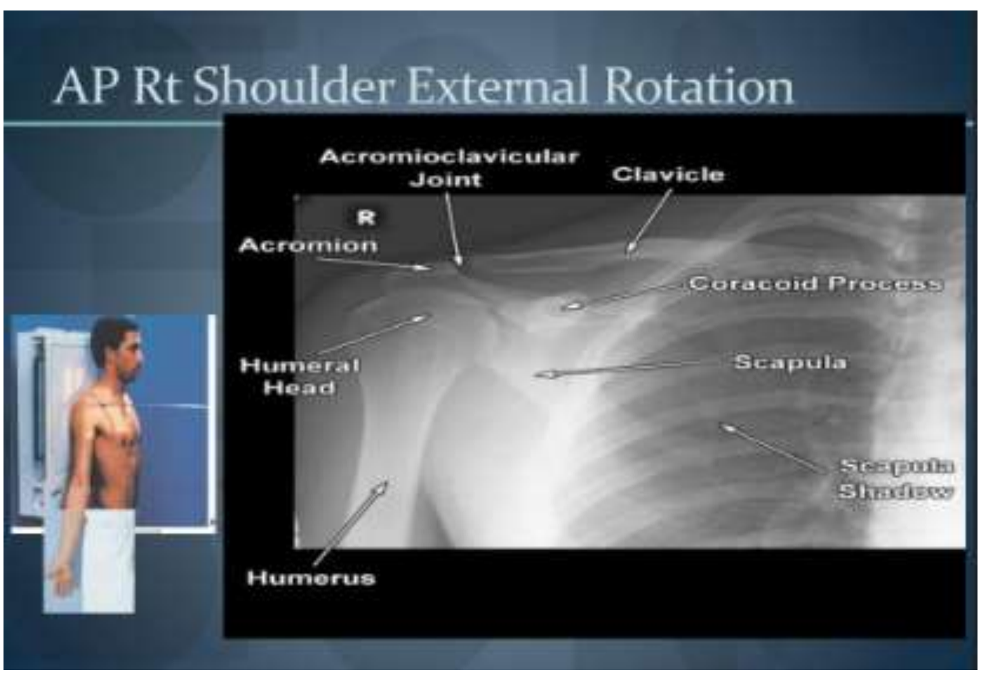


Fig : AP External rotation View

Shoulder AP (internal rotation view)

Indications

This projection shows the lesser tubercle of the humerus in profile and can be used to detected suspected Hill-Sachs lesions.

Patient position

- patient is preferably erect
- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- the glenohumeral joint of the affected side is at the center of the image receptor
- the affected arm is internally rotated
- the patient is slightly rotated 5-10°. Therefore, the body of the scapula is laying parallel with the image receptor
- some departments may require further rotation to mimic that of 'true AP' projection

Technical factors

- **anteroposterior projection**
- **centering point**
  - 2.5 cm inferior to the coracoid process, or 2 cm inferior to the lateral clavicle at the level of the glenohumeral joint
- **collimation**
  - superior to the skin margins
  - inferior to include one-third of the proximal humerus
  - lateral to include the skin margin
  - medial to include 2/3 of the clavicle
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- 2/3 of the clavicle is visible

- overlap of the humeral head with the glenoid
- no foreshortening of the scapular body (as per the patient rotation discussed in the positioning)
- the lesser tubercle of the humerus is in profile

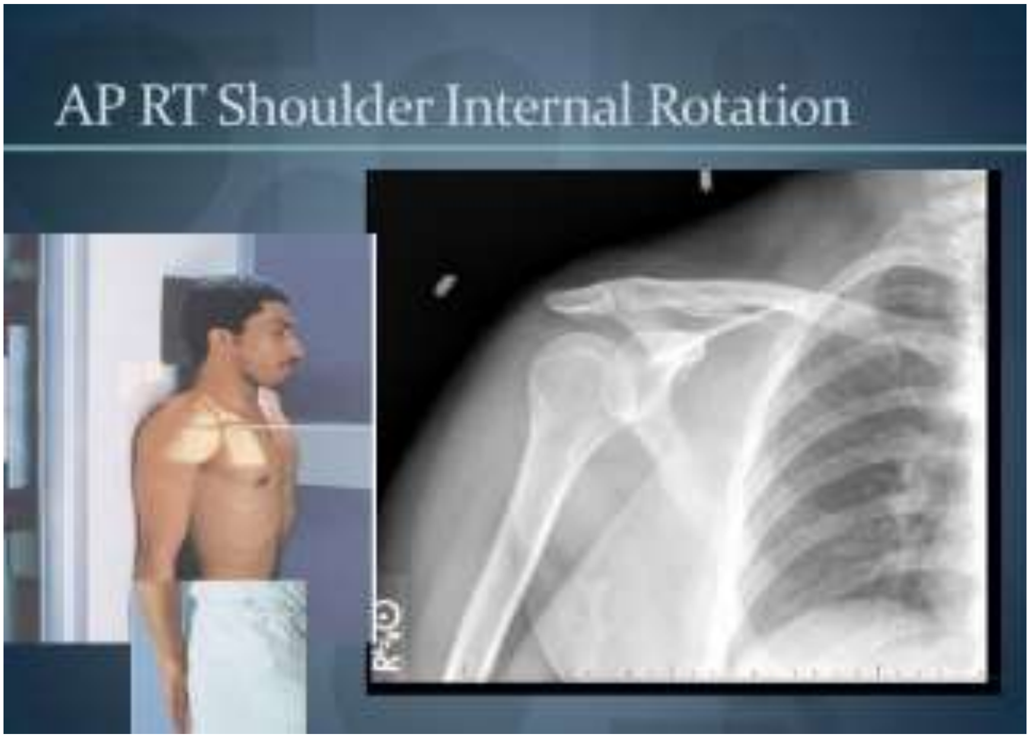


Fig: AP internal rotation

Superior-inferior (axial view)

Indication

The axial view provides additional information when assessing dislocations and glenohumeral instability; particularly if these are not seen well on a standard AP view . If the positioning is difficult to achieve, the inferior-superior axial view can be performed instead.

Patient position

- patient seated next to the image receptor
- image receptor at mid thoracic height
- affected arm is abducted with the elbow resting on the detector
- the arm must be abducted enough that the glenohumeral joint is central to the image detector (the patient may need to lean slightly)
- the patient's head is to be tilted away towards the unaffected side (and slightly

forward if possible); check your collimation light to ensure the head will not be irradiated.

Technical factors

- **axial projection (superior-inferior)**
- **centering point**
  - glenohumeral joint with a 5-15° degree towards the patient's elbow
- **collimation**
  - anterior-posterior to the skin margins
  - lateral to proximal third of the humerus
  - medial to include glenohumeral joint
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60kVp
  - 8-15 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- clear visualization of the humeral head (with no superimposition)
- relationship of the humeral head to the glenoid of the scapula
- assessment of the acromion and the coracoid process.

Fig : Shoulder (superior-inferior axial view)

Inferio-superior axial (Lawrence method)

Indications

It is an appropriate projection to assess suspected dislocations, proximal humerus pathology and effective in demonstrating the articular surfaces of the humeral head and glenoid. Hill-Sachs lesions are well demonstrated on this projection along with the lesser tubercle of the humerus.

This view is performed when the patient can only lie supine; thus making the superior-inferior axial view difficult to achieve. This view provides additional information for assessing dislocations and glenohumeral instability; particularly if these are not seen well on a standard AP view .

Patient position

- the patient is supine
- image receptor is rested upon the superior part of the affected shoulder
- the affected arm is abducted as much as achievable
- the arm is externally rotated
- the patient's head is to be tilted away towards the unaffected side

Technical factors

- **axial projection (inferosuperior)**
- **centering point**
  - the x-ray tube is in the same plane as the glenohumeral joint shooting inferosuperior
- there is a 20-30° medial angle aimed at the glenohumeral joint
- **collimation**
  - anterior-posterior to the skin margins
  - lateral to proximal third of the humerus
  - medial to include glenohumeral joint
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60kVp
  - 8-15 mAs
- **SID**
  - 100-150 cm
- **grid**
  - no

Image technical evaluation

Clear visualization of the humeral head (with no superimposition) and its relationship with the glenoid of the scapula. In addition to the acromion and the coracoid process. The lesser tubercle should be seen projected anteriorly in profile. The coracoid process is pointing anteriorly.

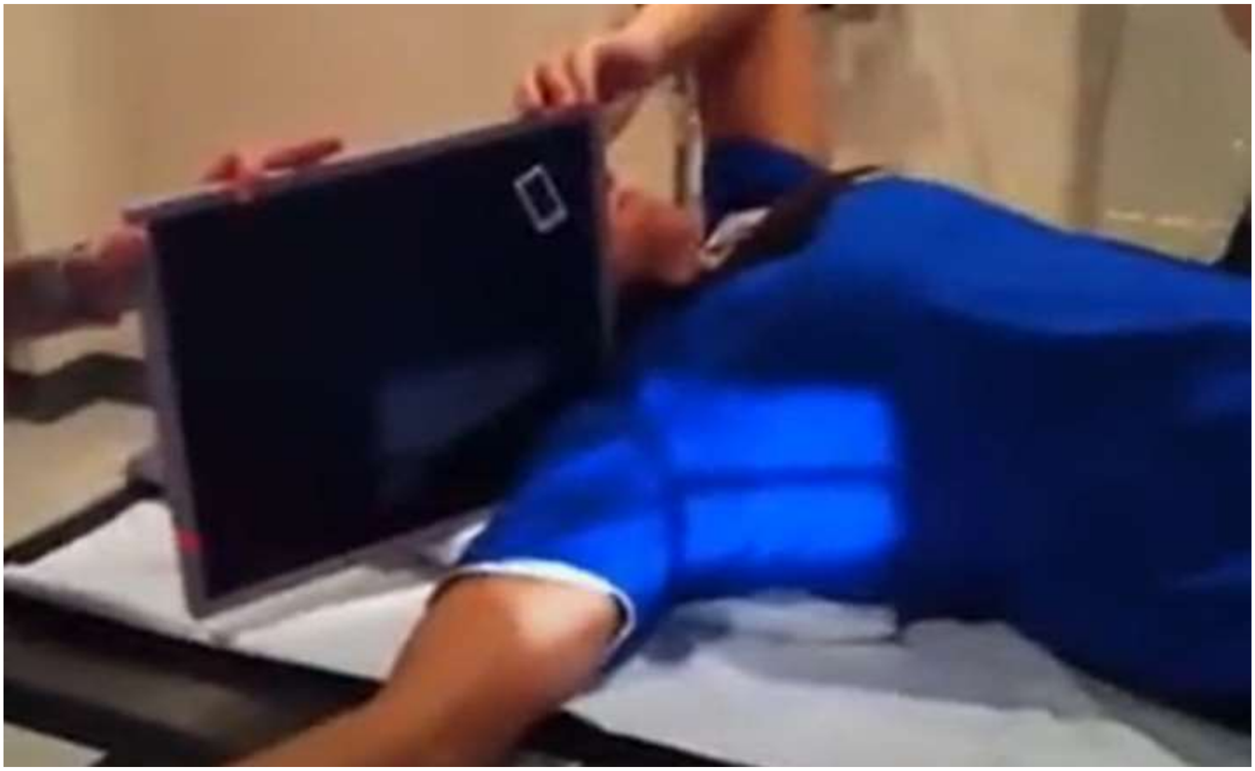


Fig : Lawrence view

Inferio-superior shoulder projection (west point method)

Indications

The West Point view is a highly specific radiographic projection to assess the anteroinferior glenoid rim often in the context of recurrent instability [1,2]. This is a useful projection to assess for bony Bankart lesions or other glenoid rim fractures.
It should be noted that this projection requires the patient to lay prone, and may not be possible in some contexts for a multi-trauma setting.

Patient position

- the patient is prone
- the shoulder is placed on a sponge to elevate it approximately 8 cm for the projection
- the arm is abducted approximately 90 degrees with the forearm hanging over the table
- image receptor is rested upon the superior part of the affected shoulder

- the patient's head is to be tilted away towards the unaffected side

Technical factors

- **modified axial projection (inferosuperior)**
- **centering point**
  - the x-ray tube is in the same plane as the glenohumeral joint shooting inferosuperior
  - 25° medial angle
  - 25° anterior angle
- **collimation**
  - anterior-posterior to the skin margins
  - lateral to proximal third of the humerus
  - medial to include glenohumeral joint
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60kVp
  - 8-15 mAs
- **SID**
  - 100-150 cm
- **grid**
  - no

Image technical evaluation

Clear visualization of the humeral head (with no superimposition) and its relationship with the glenoid of the scapula. The glenoid rim should be able to be easily inspected.

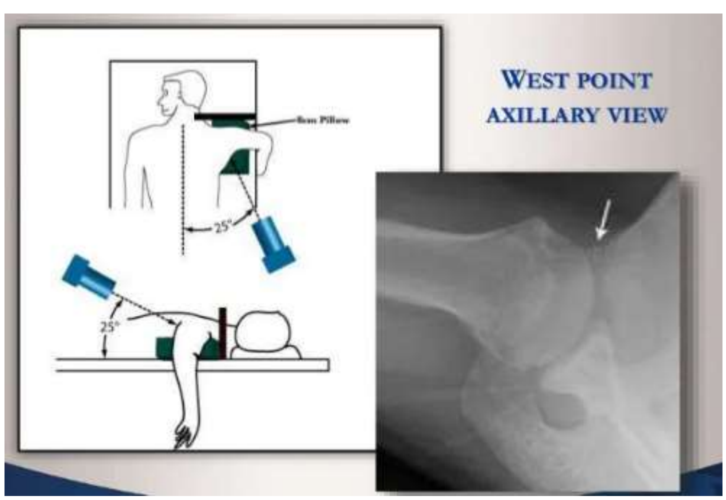


Fig: West Point method

Posterior oblique - glenoid cavity (grashey method)

The **shoulder AP glenoid view** also known as a **true AP** or a **'Grashey view**' is an additional projection to the two view shoulder series. The projection is used to assess the integrity of the glenohumeral joint.

Indications

The glenoid view is an ideal projection to inspect the glenoid rim, the glenohumeral joint and the articular surface of the humerus. This view is great to inspect the joint space for subtle fractures such as a bankart lesion post-dislocation-relocation, to look for proximal migration of humerus, as a general joint space assessment, or during post-operative evaluation.

Patient position

- the patient is preferably erect
- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- the glenohumeral joint of the affected side is at the center of the image receptor
- patient is turned toward the affected side to show the glenohumeral joint space; this is achieved by rotating the patient 30-45°
- affected arm is internally rotated

Technical factors

- **anteroposterior projection**
- **centering point**
  - 2.5 cm inferior to the coracoid process, or 2 cm inferior to the lateral clavicle at the level of the glenohumeral joint
- **collimation**
  - superior to the skin margins
  - inferior to include one-third of the proximal humerus
  - lateral to include the skin margin
  - medial to 1/3 of the medial clavicle
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 60-70 kVp

  - 10-18 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- the glenohumeral joint should be open
- the anterior and posterior aspects of the glenoid are superimposed
- the coracoid process is foreshortened
- no foreshortening of the scapular body (as per the patient rotation discussed in the positioning)

Fig: Post-op Grashey view

Shoulder (trauma routine)

AP neutral rotation

Indications

This view helps in visualizing potential fractures or dislocations to the proximal humerus and shoulder girdle in a trauma setting. Additionally, this view is useful in assessing for degenerative diseases which may be seen as calcium deposits in bursal structures, muscles or tendons around the shoulder.

Patient position

- patient is preferably erect

- midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- glenohumeral joint of the affected side is at the center of the image receptor
- affected arm is in a neutral position by the patient side
- the patient is slightly rotated 5-10° toward the affected side. Therefore, the body of the scapula is laying parallel with the image receptor

Technical factors

- **anteroposterior projection**
- **centering point**
  - 2.5 cm inferior to the coracoid process, or 2 cm inferior to the lateral clavicle at the level of the glenohumeral joint
- **collimation**
  - superior to the skin margins
  - inferior to include one-third of the proximal humerus
  - lateral to include the skin margin
  - medial to include the sternoclavicular joint
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

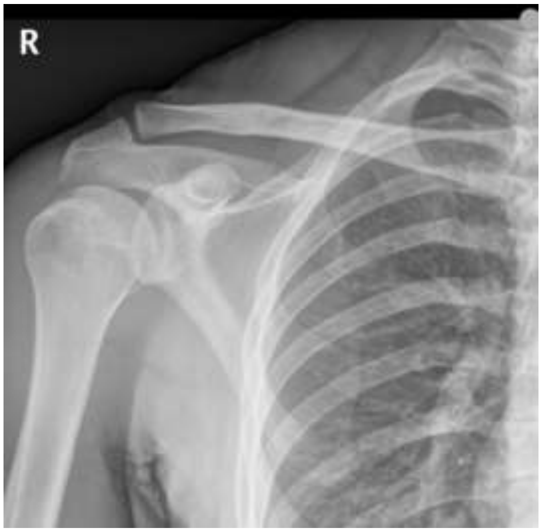


Image technical evaluation

- the entire clavicle is visualized alongside the glenoid cavity and scapula in the AP position
- a slight overlap of the humeral head with the glenoid
- no foreshortening of the scapular body (as per the patient rotation discussed in the positioning).

Transthoracic lateral (Lawrence method)

Indications:

1. **Trauma:** This method is particularly useful in cases of trauma where the patient is unable to move the affected arm.
2. **Dislocation:** Evaluation of shoulder dislocations.
3. **Fractures:** Assessment of fractures of the proximal humerus and scapula.

Patient Position:

- **Position the Patient**: The patient can be either seated or standing. Place the patient in a lateral position with the affected side closest to the X-ray receptor.

- **Arm Positioning:** The unaffected arm is raised above the head. This helps to move the humeral head of the unaffected side out of the way. The affected arm remains in a neutral position at the patient's side.

Technical Factors:

1. **Centering:** The central ray is directed through the thorax to the level of the surgical neck of the humerus. The central ray is directed perpendicular to the image receptor.
2. **SID (Source to Image Distance):** Typically 40 inches.
3. **IR Size and Orientation:** Use a 10x12 inch image receptor, preferably in the portrait orientation.
4. **Exposure:** Adjust the exposure factors based on the patient's size and the imaging equipment.

Evaluation Criteria:

- **Image Assessment**: The resulting image should clearly demonstrate the proximal humerus, the glenoid cavity, and the scapula. The ribs should appear blurred if a breathing technique is used, providing a clear view of the shoulder joint.

Tangential projection - supraspinatus outlet (neer method)

Indication

The **outlet view** is performed to assess subacromial impingement. This view is often performed instead of a lateral shoulder view for the impingement series only.

Patient position

- erect or sitting, facing the upright detector
- rotated in an anterior oblique position, so the anterior portion of the shoulder is touching the upright detector
- the hand is placed on the patient's abdomen with the arm flexed
- the degree of anterior rotation can vary from patient to patient
- scapula should be end-on to the upright detector, and this can be done via palpation of the scapula border.

Technical factors

- **posteroanterior lateral projection**
- **centering point**
  - the level of the glenohumeral joint on the posterior aspect of the patient (5 cm below the top of the shoulder)
  - 10-15 degree caudal angulation of the x-ray tube
  - central to the medial scapula border
- **collimation**
  - laterally to include the skin margin
  - medially to cover the entirety of the medial scapula
  - superior to the skin margin

    - inferior to the inferior angle of the scapula
- **orientation**
    - portrait
- **detector size**
    - 24 x 30 cm
- **exposure**
    - 60-70 kVp
    - 10-20 mAs
- **SID**
    - 100 cm
- **grid**
    - yes

Image technical evaluation

- the scapula is demonstrated in a lateral profile, giving the clear appearance of a ‘Y'
- clear visualization of the supraspinatus outlet
- acromion and the coracoid process form the upper arms of the ‘Y'
- if intact, the humeral head is superimposed at the base of the ‘Y'

Fig: outlet view demonstrating subacromial impingement

Apical oblique projections (garth method)

The **apical oblique projection** or the **Garth view** of the shoulder is the tangential projection of the shoulder used in trauma.

Indications

The view is best for evaluating the glenohumeral joint for dislocations and trauma to the glenoid of the scapula; this projection can be used as a replacement to the lateral scapula view in trauma, however, interpretation is difficult. The angle of the beam means it is tangential to the anterior-inferior glenoid rim (great for Bankart fractures) and gives a better view of the posterior humeral head (ideal for Hill-Sachs defect).

Patient position

- the patient is preferably erect, best placed on a seat sitting against the upright bucky (due to the angle of the tube)
- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- the glenohumeral joint of the affected side is at the center of the image receptor
- the patient is turned toward the affected side to show the glenohumeral joint space; this is achieved by rotating the patient 30-45°
- if possible the patient has the affected side's hand resting on the unaffected shoulder

Technical factors

- **axial oblique projection**
- **centering point**
  - 45° caudal angle of the x-ray tube
  - 2.5 cm inferior to the coracoid process, or 2 cm inferior to the lateral clavicle at the level of the glenohumeral joint
- **collimation**
  - superior to the skin margins
  - inferior to include one-third of the proximal humerus
  - lateral to include the lateral portion of the humeral head often the skin margins (dependent on body habitus)
  - medial to 1/3 of the medial clavicle
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs

- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- the humeral head will appear elongated (due to angle)
- the coracoid process is sometimes projected over the humeral head
- the AC joint should be superior to the humeral head
- posterior dislocation
  - the humeral head will be projected superior to the glenoid often obstructed by the acromion
- anterior dislocation
  - in the majority of cases, the humeral head will be projected inferior to the glenoid.

Fig :Garth view

Clavicle

AP and AP axial

The clavicle **AP view** is a standard projection part of the clavicle series. The projection demonstrates the shoulder in its natural anatomical position allowing for adequate radiographic examination of the entire clavicle.

Indications

The AP clavicle is often indicated in patients with suspected clavicular injuries following trauma such as falling onto ones side. It can be requested as part of a concentrated radiograph to assess for metastasis or multiple myeloma. It is seldom conducted in isolation, often part one of the two part clavicle series. It is an ideal projection to asses the AC joint although not so ideal to inspect the sternoclavicular joint (see sternoclavicular joint series for a better alternative).

Patient position

- patient is preferably erect
- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- the clavicle of the affected side is at the center of the image receptor
- affected arm is in a neutral position by the patient side

Technical factors

- **anteroposterior projection**
- **centering point**
  - mid clavicle
- **collimation**
  - superior to the skin margins
  - inferior to include mid scapula
  - lateral to include the skin margin
  - medial to include the sternoclavicular joint
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- the entire clavicle is visual alongside the glenoid cavity and scapular in the AP position
- a slight overlap of the humeral head with the glenoid.

Fig: clavicle radiograph

Acromioclavicular joints

The acromioclavicular (AC) joint **radiographic series** is used to evaluate the acromioclavicular joint and the distal clavicle.

Indications

AC radiographs are performed for a variety of indications including:

- shoulder trauma
- direct blows to the shoulder region
- following a fall onto an adducted arm
- suspected dislocation
- suspected arthritis

Projections

Standard projections

- AP view
  - erect view demonstrating the AC joint in the anteroposterior plane
  - best view to inspect widening of the AC joint

Additional projections

- AP with weight bearing
  - also known as a stress view, the patient holds onto a weight on the affected side, placing inferior pressure on the AC joint
  - this view is used to rule out displacement when it is suspected yet not confirmed on the AP view
- AP comparison views
  - both AC joints are imaged separately, to rule out a suspected

displacement or differentially anatomical variation

- Zanca view
  - AP projection with a 10-15 degree cephalad angle to free the AC joint from superimposition

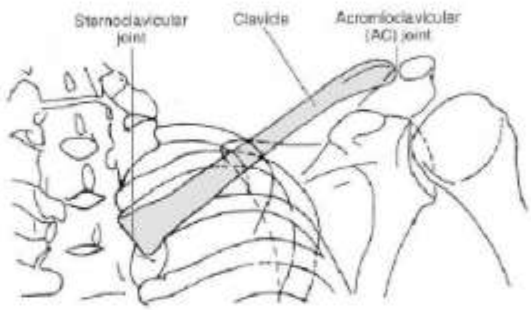


Fig : Acromioclavicular joint

AP bilateral with and without weight

A clavicle AP (anteroposterior) bilateral X-ray, both with and without weights, is a diagnostic imaging procedure used to evaluate the clavicles (collarbones) on both sides of the body. This procedure is often done to assess for fractures, dislocations, or other abnormalities of the clavicles.

Indications

- Suspected clavicle fractures
- Evaluation of acromioclavicular (AC) joint injuries or dislocations
- Chronic shoulder pain
- Post-surgical follow-up

Positioning:

- The patient will be positioned standing or sitting upright.
- For the AP view, the patient faces the X-ray machine, and the back of the shoulders and upper back are in contact with the X-ray plate.
- The arms should be relaxed at the sides.

X-ray Without Weights:

- The initial images will be taken without the patient holding any weights.
- The radiologic technologist will instruct the patient to remain still and might ask the patient to take a deep breath and hold it to prevent movement during the exposure.

X-ray With Weights:

- The patient will be given weights to hold in each hand. The weights are typically around 5-10 pounds.
- Holding weights can help to accentuate any minor separation or dislocation of the acromioclavicular (AC) joint, as the added weight pulls the shoulders downward.
- The technologist will again instruct the patient to remain still and take a deep breath and hold it during the exposure.

Technical Factors

1. **Positioning**:
    - **Patient Position**: The patient should be standing or seated with their back against the image receptor. The arms should be relaxed at the sides for the non-weighted image and holding weights for the weighted image.
    - **Central Ray (CR)**: The CR should be directed perpendicular to the image receptor at the midline level of the clavicles.
    - **Image Receptor (IR)**: The IR should be positioned to cover both clavicles. A large cassette (14 x 17 inches) is typically used for bilateral imaging.
    - **Collimation**: Collimate to include both clavicles and the entire shoulder girdle.
2. **Exposure Settings**:
    - **kVp (kilovoltage peak)**: Typically set between 60-70 kVp to provide adequate penetration and contrast.
    - **mAs (milliampere-seconds)**: Adjust according to the patient's body habitus. Common settings range from 5-10 mAs.
    - **SID (Source-to-Image Distance)**: A standard distance of 40 inches (102 cm) is typically used.
3. **Breathing Instructions**:
    - Instruct the patient to take a deep breath in and hold it during the exposure to elevate the clavicles and minimize motion.
4. **Weights**:
    - **Weight Amount**: Typically, 5-10 pounds (2.3-4.5 kg) per hand, depending on the patient's strength and tolerance.

- Ensure the weights are evenly distributed and the patient can hold them comfortably without causing excessive discomfort.

Image Evaluation Criteria

- Both clavicles should be visible from the sternoclavicular joints to the acromioclavicular joints.
- The images should be free from rotation and motion artifacts.
- The clavicles should be adequately penetrated and contrasted to assess bone detail.
- For weighted images, check for any separation or dislocation at the acromioclavicular joints compared to the non-weighted images.

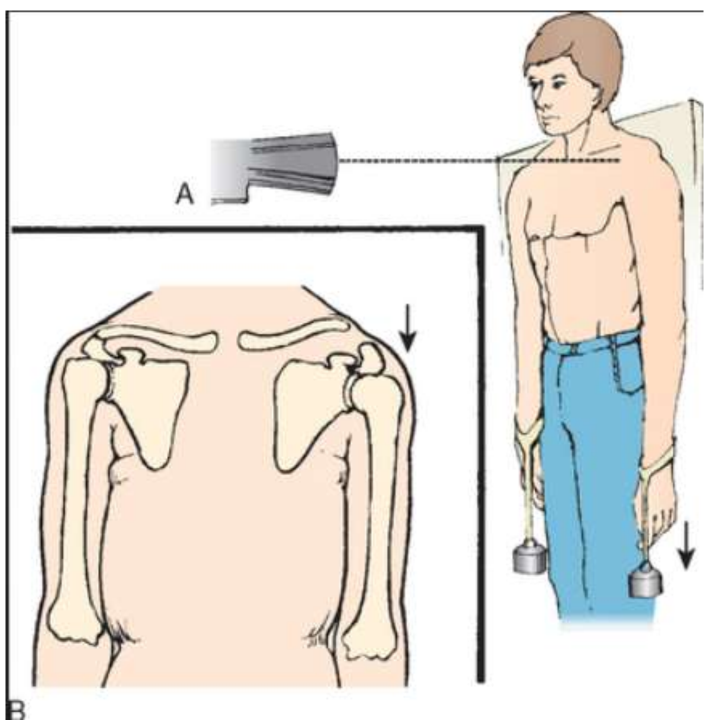


Fig: AP bilateral with weight

Stemoclavicular joints

The **sternoclavicular radiographic series** is a used to evaluate sternoclavicular joint and the proximal clavicle. Imaging of the sternoclavicular joint has since been replaced by computed tomography.

Indications

Sternoclavicular joint radiographs are performed for a variety of indications including:

- trauma
- infection
- deformity in the absence of trauma
- congenital abnormalities

Projections

Standard projections

- PA view
  - standard projection demonstrating the sternoclavicular joints articulating with the manubrium
- anterior oblique views
  - oblique projection best utilized when assessing for joint separation, often performed bilaterally. With the RAO best used to demonstrate the right sternoclavicular joint and the LAO best suited to demonstrate the left sternoclavicular joint

Additional projections

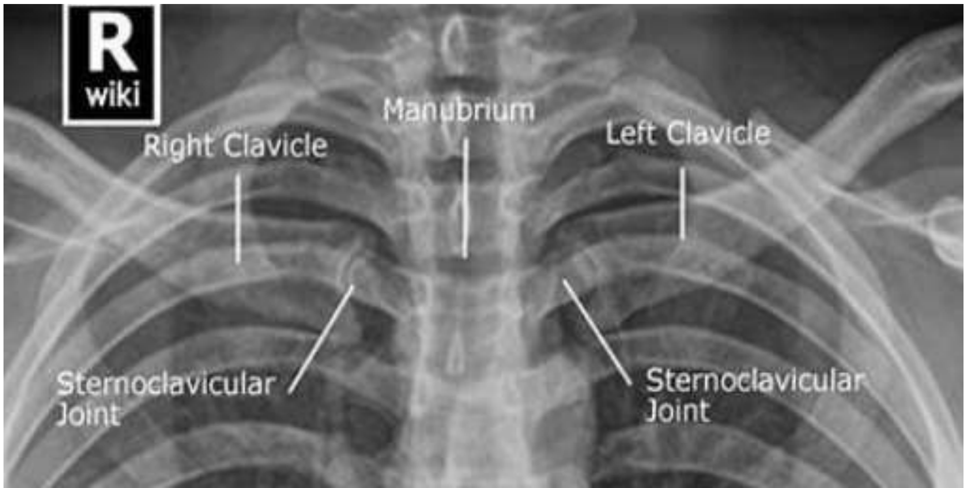
- lateral sternal view
  - radiographic investigation of the entire length of the sternum in profile. The view is used to query fractures or infection
- serendipity view
  - specialized axial projection employed to investigate suspected anterior/posterior dislocations.

Technical Factors

1. **Positioning**:

- **Patient Position**: The patient can be either seated or standing.
  - For the PA (posteroanterior) view, the patient faces the image receptor with the arms relaxed at the sides.
  - For oblique views, the patient is rotated approximately 10-15 degrees to the left or right, depending on which SC joint is being examined.
- **Central Ray (CR)**:
  - For the PA view, direct the CR perpendicular to the image receptor at the level of the T2-T3 interspace, approximately 3 inches (7.5 cm) below the jugular notch.
  - For oblique views, angle the CR 15 degrees medially towards the side being examined to project the opposite SC joint away from the spine.

2. **Image Receptor (IR)**:
   - Use an 8 x 10 inch or 10 x 12 inch cassette, depending on patient size and departmental protocols.
   - Ensure the IR is positioned to include both SC joints and the manubrium.
3. **Collimation**:
   - Collimate tightly to include only the SC joints and the manubrium to reduce patient dose and improve image quality.
4. **Exposure Settings**:
   - **kVp (kilovoltage peak)**: Typically set between 60-70 kVp to provide adequate penetration and contrast.
   - **mAs (milliampere-seconds)**: Adjust according to the patient's body habitus. Common settings range from 5-10 mAs.
   - **SID (Source-to-Image Distance)**: A standard distance of 40 inches (102 cm) is typically used.
5. **Breathing Instructions**:
   - Instruct the patient to take a deep breath in and hold it during the exposure to minimize motion and elevate the clavicles.



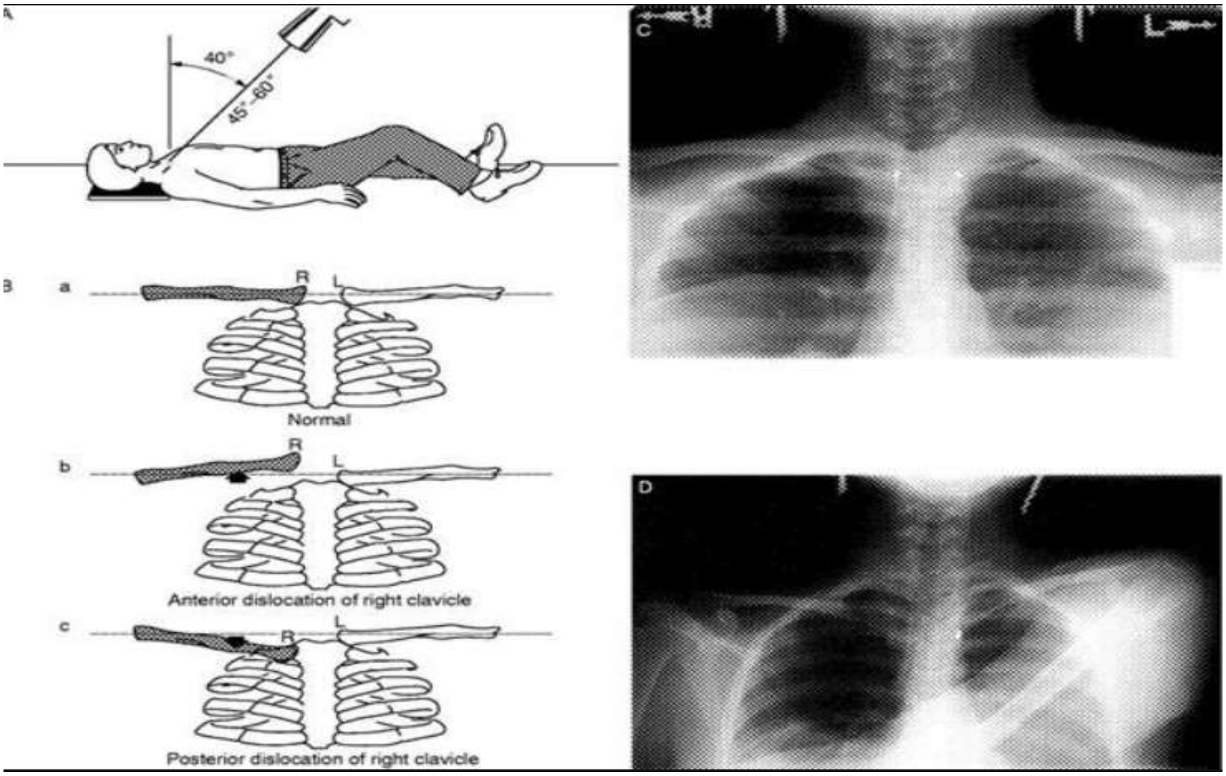


Fig : Stemoclavicular joints

Scapula

AP view

The **scapula AP view** is a specialized projection of the scapular bone, performed in conjunction with the lateral scapular view. This projection can be performed erect or supine, involving 90-degree abduction of the affected arm.

Indications

This view is rarely requested due to the accessibility of CT and the ability to inspect the scapula on shoulder radiographs. However, it can be requested and performed for the 'better look' at the scapula if there is a suspected fracture or lesion.

Patient position

- the patient is preferably erect however this can be performed supine

- the midcoronal plane of the patient is parallel to the image receptor, in other words, the patient's back is against the image receptor
- scapula of the affected side is at the center of the image receptor
- affected sides arm is abducted with the hand in supination, this action will 'pull' the scapula away from ribs
- the patient is slightly rotated 5°, therefore, the body of the scapula is laying parallel with the image receptor

Technical factors

- **anteroposterior projection**
- **centering point**
  - 5 cm inferior to the coracoid process
- **collimation**
  - superior to the skin margins
  - inferior to include the inferior margin of the scapula
  - lateral to include the skin margin
  - medial to include 1/2 of the clavicle
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-18 mAs (with 3 seconds breathing see mAs for more details)
- **breathing**
  - a breathing technique is the most effective way to perform this projection
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- the scapula should be clearly visualized, free from any motion blur
- the medial border is superimposed by the ribs
- the lateral border should be free from any superimposition
- no foreshortening of the scapular body (as per the patient rotation discussed in the positioning).

Fig : Scapula RT AP view

Scapula Y view

The lateral scapula shoulder or Y view is part of the standard shoulder series.

Indications

Orthogonal to the AP shoulder (note: as is an axillary view); this view is a pertinent projection to assess suspected dislocations, scapula fractures, and degenerative changes. It is also useful in seeing both the coracoid and acromion process in profile.

Patient position

- erect or sitting, facing the upright detector
- rotated in an anterior oblique position so the anterior portion of the shoulder is touching the upright detector
- the hand is placed on the patient's abdomen with the arm flexed
- degree of anterior rotation can vary from patient to patient
- scapula should be end-on to the upright detector, and this can be done via palpation of the scapula border

Technical factors

- **posteroanterior lateral projection**
- **centering point**

  - the level of the glenohumeral joint on the posterior aspect of the patient (5 cm below the top of the shoulder)
  - central to the medial scapula border
- **collimation**
  - laterally to include the skin margin
  - medially to cover the entirety of the medial scapula
  - superior to the skin margin
  - inferior to the inferior angle of the scapula
- **orientation**
  - portrait
- **detector size**
  - 24 x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-20 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- the scapula is clearly demonstrated in a lateral profile, giving the clear appearance of a ‘Y’
- acromion and the coracoid process form the upper arms of the ‘Y’
- if intact, the humeral head is superimposed at the base of the ‘Y’

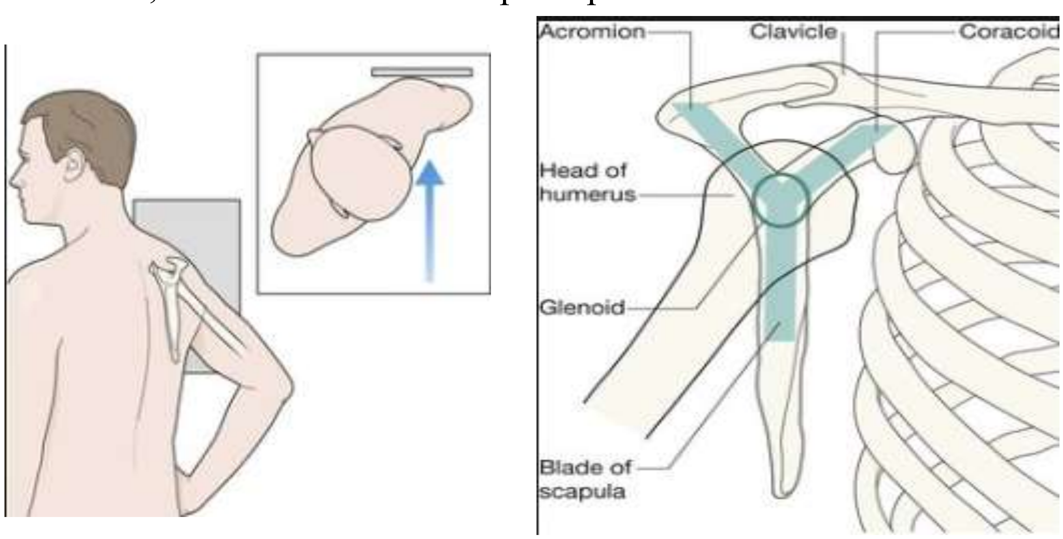


Fig: Scapula Y view

HUMERUS:

Related radiological anatomy

The humerus is the long bone in the upper arm, extending from the shoulder to the elbow. It is crucial for the function and movement of the arm. The humerus can be divided into three main parts: the proximal end, the shaft, and the distal end. Here's a detailed look at its anatomy:

Proximal End

1. **Head**:
   - A large, round, smooth surface that articulates with the glenoid cavity of the scapula to form the shoulder joint.
2. **Anatomical Neck**:
   - A narrow constriction immediately distal to the head, marking the boundary between the head and the shaft.
3. **Greater Tubercle**:
   - A prominent, lateral projection that serves as the attachment site for the supraspinatus, infraspinatus, and teres minor muscles.
4. **Lesser Tubercle**:
   - A smaller, anterior projection that serves as the attachment site for the subscapularis muscle.
5. **Intertubercular (Bicipital) Groove**:
   - A groove between the greater and lesser tubercles, where the tendon of the long head of the biceps brachii muscle runs.
6. **Surgical Neck**:
   - The area just distal to the tubercles, commonly a site of fractures.

Shaft (Diaphysis)

1. **Deltoid Tuberosity**:
   - A rough, V-shaped area on the lateral aspect of the shaft where the deltoid muscle attaches.
2. **Radial Groove (Spiral Groove)**:
   - A shallow groove running obliquely down the posterior aspect of the shaft, accommodating the radial nerve and deep brachial artery.

Distal End

1. **Medial Epicondyle**:

   - A prominent bony projection on the medial side, serving as the attachment site for the flexor muscles of the forearm.
2. **Lateral Epicondyle**:
   - A smaller projection on the lateral side, serving as the attachment site for the extensor muscles of the forearm.
3. **Capitulum**:
   - A round, lateral condyle that articulates with the head of the radius.
4. **Trochlea**:
   - A pulley-shaped, medial condyle that articulates with the trochlear notch of the ulna.
5. **Olecranon Fossa**:
   - A deep, posterior depression that accommodates the olecranon process of the ulna when the elbow is extended.
6. **Coronoid Fossa**:
   - An anterior depression that receives the coronoid process of the ulna during elbow flexion.
7. **Radial Fossa**:
   - A small depression just above the capitulum that receives the head of the radius when the elbow is flexed.

Articulations

1. **Shoulder Joint (Glenohumeral Joint)**:
   - Formed by the articulation of the head of the humerus with the glenoid cavity of the scapula.
2. **Elbow Joint**:
   - The distal humerus articulates with the radius and ulna, forming the hinge-like elbow joint.

Muscular Attachments

The humerus serves as an attachment site for several muscles, including:

- **Rotator Cuff Muscles**: Supraspinatus, Infraspinatus, Teres Minor, Subscapularis.
- **Deltoid**: Attaches to the deltoid tuberosity.
- **Pectoralis Major**: Attaches to the humeral shaft.
- **Biceps Brachii**: Attaches via the bicipital groove.
- **Triceps Brachii**: Attaches to the posterior shaft.

Understanding the anatomy of the humerus is essential for comprehending its function in movement and its role in the musculoskeletal system.

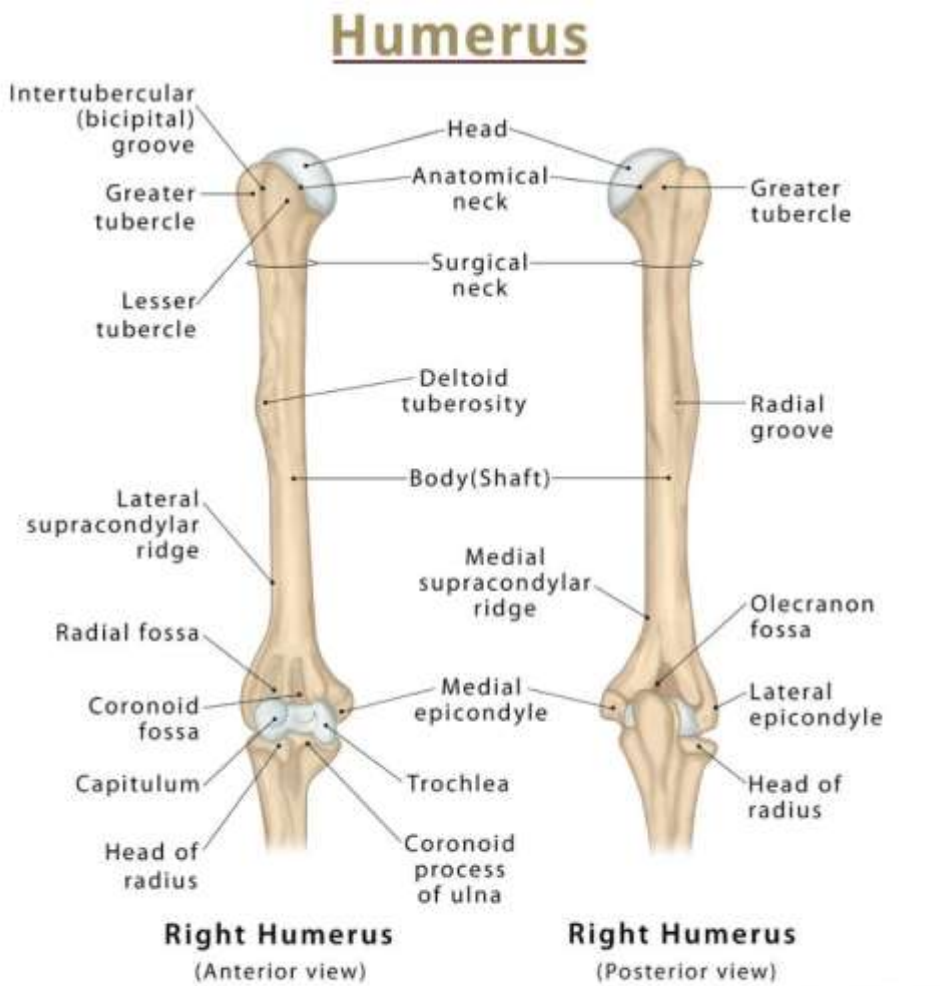


Fig : Humerus

Humerus AP view

The **AP view of the humerus** is part of the humerus series and is usually taken in a standing position. However, it can also be obtained in a supine position.

Indications

Humerus views are often done to exclude large humeral shaft fractures or suspected symptomatic metastatic lesions [1]. If an occult fracture is suspected at either the proximal or distal end, it is best to do a separate elbow or shoulder series.

Patient position

- the patient is preferably erect
- the patient's back is against the image receptor
- the affected arm is abducted and centered to the upright detector, if possible, the arm is slightly externally rotated to mimic the true anatomical position

Technical factors

- **anteroposterior projection**
- **centering point**
  - mid humerus shaft
- **collimation**
  - superior to the skin margins above the glenohumeral joint
  - inferior to include the distal humerus including the elbow joint
  - lateral to include the skin margin
  - medial to include skin margin
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 60-70 kVp
  - 7-15 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

The humerus is positioned AP, evidenced by the medial and lateral epicondyles seen in profile and the greater tuberosity being seen on the lateral aspect of the humerus. The shaft is abducted away from the patient's body, minimizing superimposition.

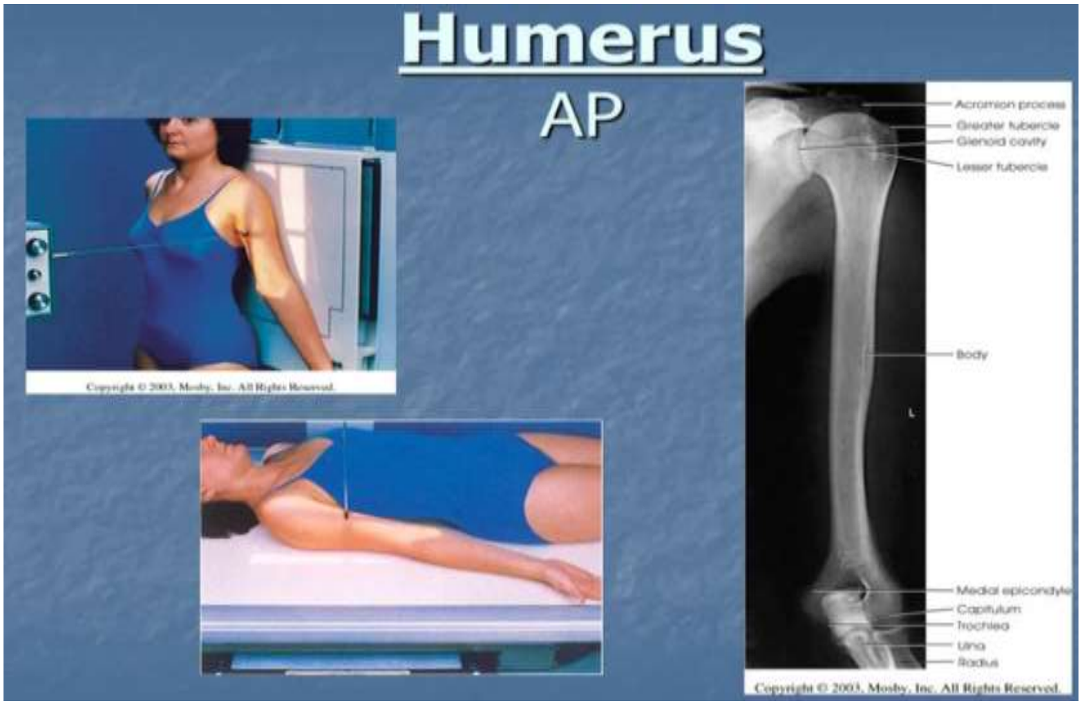


Fig: Humerus AP view

Humerus LAT view

The **lateral view of the humerus** is part of the humerus series and is usually taken in a standing position. However, it can also be taken in the supine position in the acute, trauma setting.

Indications

Humerus views are often done to exclude large humeral shaft fractures or suspected symptomatic metastatic lesions [1], if an occult fracture is suspected at either the proximal or distal end, it is best to do a separate elbow or shoulder series.

Patient position

- patient is preferably erect
- patient stands facing the detector with the injured side closest to the detector
- patient is then rotated so that the lateral aspect of the shoulder of the affected side, the arm and the elbow are all in contact with the upright bucky
- the elbow is flexed 90° (as close to 90° as possible)
- place the patient's hand on their ASIS or stomach to maintain position

Technical factors

- **posteroanterior projection**
- **centering point**
  - mid humerus shaft
- **collimation**
  - superior to the skin margins above the glenohumeral joint
  - inferior to include the distal humerus including the elbow joint
  - lateral to include the skin margin
  - medial to include medial skin margin
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 60-70 kVp
  - 7-15 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

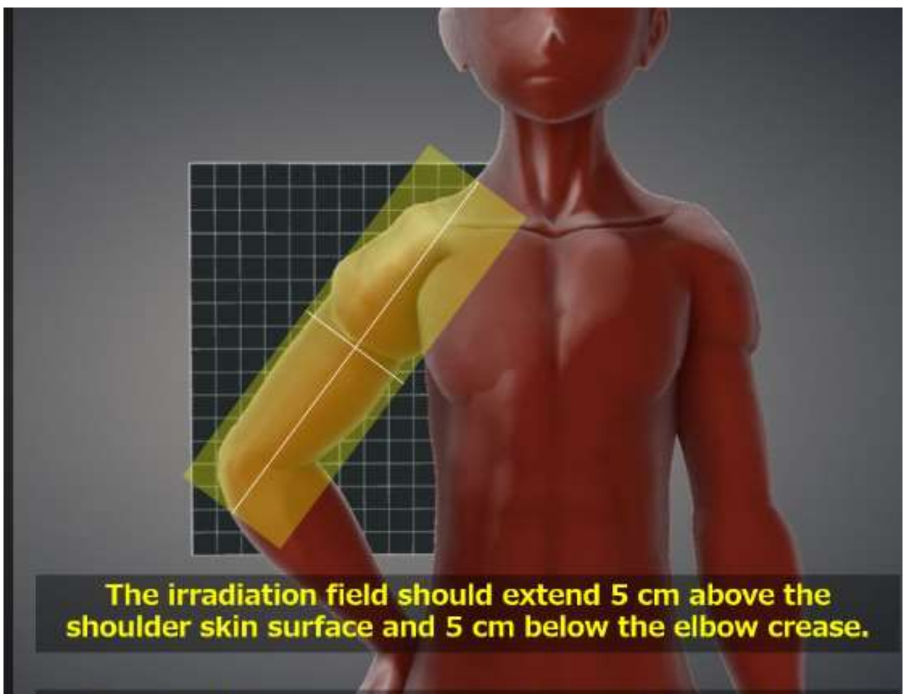


Fig: Humerus LAT view

Image technical evaluation

- medial and lateral epicondyles superimposed and scapula in lateral (Y-shaped) position
- humerus is positioned away from the patient's body, minimizing superimposition.

Horizontal beam LAT

WARNING: Do not attempt to rotate the arm if a fracture or dislocation is suspected.

Clinical Indications

• Fractures and dislocations of the midhumerus and distal humerus

• Pathologic processes including os-teoporosis

Technical Factors

• Minimum SID—40 inches (102 cm)

• IR size—30 × 35 cm (11 × 14 inches); for smaller patient, 24 × 30 cm (10 × 12 inches) crosswise

• Nongrid with analog imaging

• Analog—64 ± 6 kV range

• Digital systems—70 to 85 kV range Shielding Shield radiosensitive tissues outside region of interest.

Patient and Part Position

• With patient recumbent, perform image as a horizontal beam lateral, placing support under the arm.

• Flex elbow if possible, but do not attempt to rotate arm; projection should be 90° from AP.

• Gently place cassette between arm and thorax (top of IR to axilla).

CR

• CR perpendicular to midpoint of distal two-thirds of humerus Recommended Collimation Collimate to soft tissue margins

Recommended Collimation

Collimate to soft tissue margins.

Evaluation Criteria

Anatomy Demonstrated:

• Lateral projection of the mid humerus and distal humerus, including the elbow joint, is visible.

• The distal two-thirds of the humerus should be well visualized.

Position:

• The long axis of the humerus should be aligned with the long axis of the IR.

• Elbow is flexed 90°.

• Collimation to area of interest.

Exposure:

• Optimal density (brightness) and contrast with no motion should visualize sharp cortical borders and clear, sharp bony trabecular markings.

Fig: Horizontal beam LAT view

Proximal humerus views

Clinical Indications

• Fractures or dislocations of proximal

humerus and shoulder girdle

• Calcium deposits in muscles, tendons, or

bursal structures

• Degenerative conditions including osteoporosis and osteoarthritis

Technical Factors

• Minimum SID—40 inches (102 cm)

• IR size—24 × 30 cm (10 × 12 inches),

crosswise (or lengthwise to show more

of humerus if injury includes proximal half of humerus)

• Grid

• Analog—70 to 75 kV range

• Digital systems—75 to 85 kV range

Shielding: Shield radiosensitive tissues outside region of interest.

Patient Position: Perform radiograph with the patient in an erect

or supine position. (The erect position is usually less painful for

patient, if condition allows.) Rotate body slightly toward affected side if necessary to place shoulder in contact with IR or tabletop.

Part Position

• Position patient to center scapulohumeral joint to center of IR.

• Abduct extended arm slightly; externally rotate arm (supinate hand) until epicondyles of distal humerus are parallel to IR.

CR

• CR perpendicular to IR, directed to 1 inch (2.5 cm) inferior to coracoid process.

Recommended Collimation: Collimate on four sides, with lateral and upper borders adjusted to soft tissue margins.

Evaluation Criteria

Anatomy Demonstrated: • AP projection of proximal humerus and lateral two-thirds of clavicle and upper scapula, including relationship of the humeral head to the glenoid cavity.

Position: • Full external rotation is evidenced by greater tubercle visualized in full profile on the lateral aspect of the proximal humerus. • Lesser tubercle is superimposed over humeral head. • Collimation to area of interest.

Exposure: • Optimal density (brightness) and contrast with no motion demonstrate clear, sharp bony trabecular markings with soft tissue detail visible for possible calcium deposits.

Fig: Proximal Humerus

Elbow

Related radiological anatomy

The elbow joint is where your humerus (your upper arm bone) meets your radius and ulna (the two bones in your forearm). It joins your upper arm to your forearm. Your elbow also contains cartilage, ligaments, muscles, nerves and blood vessels. Your elbow moves in two main directions. You use it almost any time you move your arm.

The elbow is the joint that connects your upper arm to your forearm.

Like all your joints, your elbows are part of your skeletal system. Your elbows also contain cartilage, muscles, ligaments, nerves and blood vessels.

Visit a healthcare provider if you're experiencing elbow pain or other symptoms that make it hard to use your elbow. They'll diagnose the cause and suggest treatments to help you get back to your usual routine and activities.

What is the function of the elbow

Your elbow flexes to bend your arm. It can move in four directions:

- **Extension:** Straightening your arm out further away from your body to reach objects.
- **Flexion:** The opposite of extension — bending in your lower arm toward your body.
- **Supination:** Moving the palm of your hand up.

Elbow joint located

The elbow joint is in the middle of your arm — the part that bends where your upper arm and forearm meet.

Type of joint is the elbow

Healthcare providers classify joints based on:

- **Their composition:** What they're made of.

- **Their function:** How they move.

The elbow is a synovial joint. Synovial joints have the most freedom to move. They're made of a cavity in one bone that another bone fits into. Slippery hyaline cartilage covers the ends of bones that make up a synovial joint. A synovial membrane — a fluid-filled sac that lubricates and protects the joint — lines the space between the bones. This extra cushioning helps synovial joints move with as little friction as possible.

Functionally, the elbow is both a hinge joint and a pivot joint (a trochoginglymus joint). Hinge joints move just like the hinges that hold a door in place. They have a few parts that don't move, but other pieces travel a specific distance to open and close. Your elbow hinges to bend and straighten your arm.

It's also a pivot joint. Pivot joints rotate in place without moving out of their original position. Your elbow pivoting is what lets you turn your forearm over to move your palm up and down.

Bones in the elbow joint

Three bones make up your elbow joint:

- Humerus (upper arm bone).
- Ulna (the longer bone in your forearm).
- Radius (the shorter forearm bone).

Cartilage in the elbow

Cartilage is a strong, flexible tissue that protects your joints. It acts as a shock absorber throughout your body. Your elbows are lined with hyaline cartilage. Hyaline cartilage is the most common type of cartilage in your body. Some healthcare providers call it articular cartilage.

Hyaline cartilage is slippery and smooth, which helps bones in your joints move smoothly past each other. The surfaces of your humerus, ulna and radius that touch each other have a hyaline cartilage lining.

Elbow joint ligaments

Ligaments are like cords that connect bones together.

There are three main ligaments in your elbows:

- **Medial collateral ligament:** The ligament that connects the inside edge of your humerus to your ulna.
- **Lateral collateral ligament:** The ligament that connects the outside edge of your humerus to your ulna.
- **Annular ligament:** A ligament that wraps around the head (top) of your radius and connects it to your ulna and humerus.

Muscles in the elbow

Muscles are soft tissue made of stretchy fibers. They tense up (flex) to pull and move parts of your body. Muscles attached to your arm bones help move your elbow.

Muscles that control flexion let you flex your lower arm in, toward your body. They include the:

- Biceps.
- Brachialis.
- Brachioradialis.

Two extensor muscles let you move your lower arm out, away from your body:

- Triceps.
- Anconeus.

Muscles that control supination let you move your palm up:

- Supinator.
- Biceps

Pronator muscles help you move your palm down:

- Pronator teres.
- Pronator quadratus.
- Brachioradialis.

Nerves in the elbow

Nerves are like cables that carry electrical impulses between your brain and the rest of your body. These impulses help you feel sensations and move your muscles. Nerves that give your elbow feeling include the:

- Radial nerve.
- Ulnar nerve.
- Median nerve.
- Musculocutaneous nerve.

Blood vessels in the elbow

Blood vessels are channels that carry blood throughout your body. They form a closed loop, like a circuit, that begins and ends at your heart. Three arteries carry blood to and from your elbow, including the:

- Radial artery.
- Ulnar artery.
- Brachial artery.

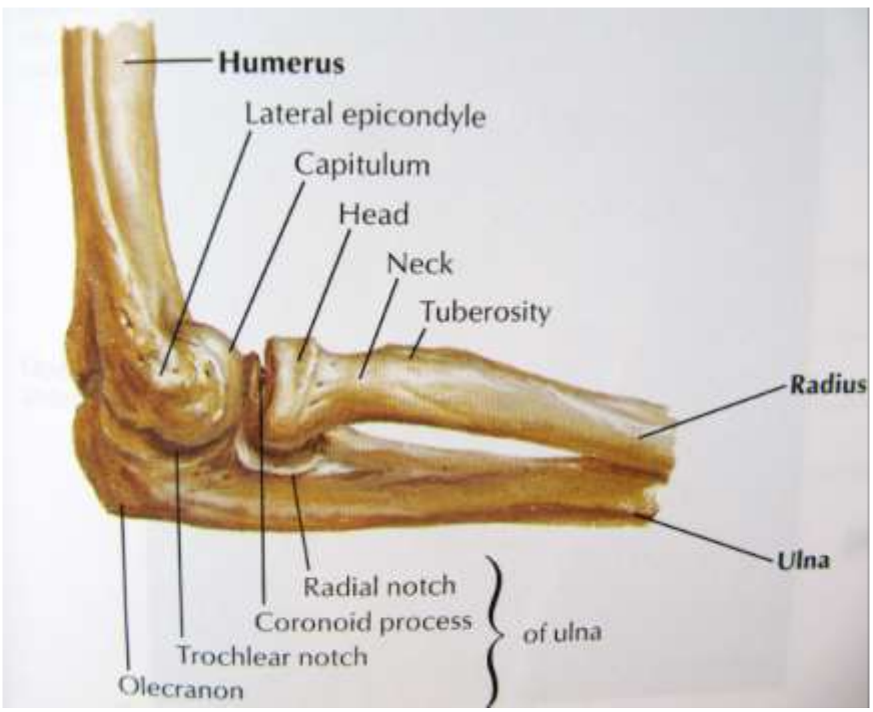


Fig: Elbow joint

AP- fully extended

Indications

This view is clinically indicated for trauma, chronic discomfort or infection of the elbow joint. It aids in visualizing fractures and/or dislocations of the elbow joint, in addition to osteomyelitis and arthritic changes. It is the preferred projection to assess the medial and lateral epicondyles of the humerus for avulsion-type fractures [2,3].

Patient position

- patient is seated alongside the table
- the fully extended arm and forearm, in a supinated position, are kept in contact with the table by lowering the shoulder joint to the level of the table they all must be in the same plane as the detector (see Figure 1)
- the detector is placed below the elbow joint

Technical factors

- **anteroposterior projection**
- **centering point**
  - mid elbow which is approximately the midpoint between the epicondyles
- **collimation**
  - superior to the distal third of the humerus
  - inferior to include one-third of the proximal radius and ulna
  - lateral to include the skin margin
  - medial to include medial skin margin
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 2-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- the elbow is in an AP position, with slight internal rotation.

- patient's arm should be rotated externally to ensure that the trochlea and capitulum are seen in profile.

Fig: AP Elbow joint

Partially flexed

Indications

This is a modified projection (chosen by the radiographer when a conventional AP is not possible) for patients who are unable to straighten their arm due to pain. It is often conducted in the context of suspected supracondylar fractures in younger patients, however, can also be utilized in acute elbow imaging following trauma.

Patient position

Distal humerus projection

- patient is seated alongside the table
- the distal humerus is placed on the image receptor with the arm remaining in flexion
- the forearm is supported by a sponge
- if possible the hand is supinated

Proximal forearm projection

- the patient is sat high in relation to the table
- the patient then places the posterior aspect of the forearm on the IR
- patient may have to stand for this projection

Technical factors

- **anteroposterior projection**
- **centering point**
    - **distal humerus projection**
        - perpendicular the humerus at the level of the elbow joint
    - **proximal forearm projection**
        - perpendicular to the forearm at the level of the elbow joint
- **collimation**
    - superior to the distal third of the humerus
    - inferior to include one-third of the proximal radius and ulna
    - lateral to include the skin margin
    - medial to include medial skin margin
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 50-60 kVp
    - 2-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

- **distal humerus projection**
    - the distal humerus should demonstrate little signs of distortion, with the proximal forearm structures notably foreshortened and distorted
- **proximal forearm projection**
    - the proximal forearm structures including the ulna, radial tubercle and radial head should demonstrate little signs of distortion, with the distal humerus notably foreshortened and distorted.

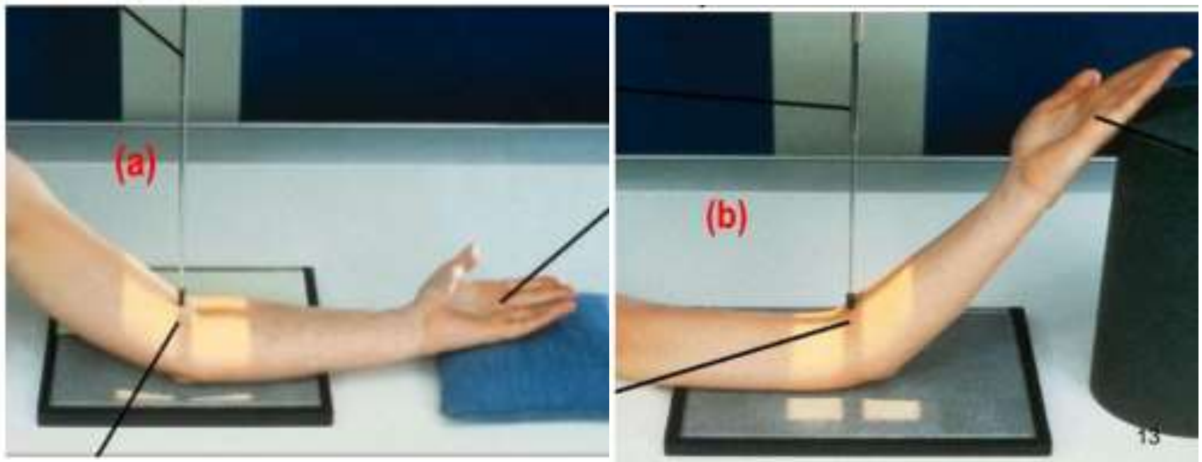


Fig: Partially flexed

Elbow external oblique view

Indications

This external oblique view is an additional projection often used to separate the proximal radius from the ulna for closer inspection of structures such as the radial head.

Patient position

- patient is seated alongside the table
- the fully extended arm and forearm, in a supinated position, are kept in contact with the table by lowering the shoulder joint to the level of the table they all must be in the same plane as the detector
- the patient externally rotates the arm to isolate the radial head
- the detector is placed below the elbow joint

Technical factors

- **anteroposterior external oblique projection**
- **centering point**
  - mid elbow which is approximately the midpoint between the epicondyles
- **collimation**
  - superior to the distal third of the humerus

    - inferior to include one-third of the proximal radius and ulna
    - lateral to include the skin margin
    - medial to include medial skin margin
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 50-60 kVp
    - 2-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

- the elbow is in an external oblique project position
- patient's arm should be rotated externally more so than the AP projection so the radial head is free from superposition.

Fig: Elbow oblique view

Lateral view

Indications

This view is clinically indicated for trauma to, chronic discomfort or infection of the elbow joint. It aids in visualizing fractures and/or dislocations to any articulating bones of the elbow joint, in addition to osteomyelitic and arthritic changes.

The visualization of the posterior fat pad sign on a true lateral projection indicates an elbow joint effusion and is suggestive of an occult fracture if no obvious fracture is seen. The sail sign or the triangular appearance of the elevated anterior fat pad should also raise suspicions of an occult fracture.

Patient position

- patient is sitting next to the table
- at 90 degrees elbow flexion, the medial border of the palm and forearm are kept in contact with the tabletop.
- the shoulder, elbow and wrist are kept in the same horizontal plane.
- rotate the hand so the thumb is pointing towards the ceiling, ensuring all aspects of the arm from the wrist to the humerus are in the same plane

Technical factors

- **lateral projection**
- **centering point**
  - lateral epicondyle of the humerus
- **collimation**
  - superior to distal third of the humerus
  - inferior to include one-third of the proximal radius and ulna
  - anterior to include the skin margin
  - posterior to skin margin
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 2-5 mAs
- **SID**
  - 100 cm

- **grid**
  - no

Image technical evaluation

- medial epicondyle is superimposed over the anterior third of the distal humerus, rather than dead center
- there is a superimposed, concentric relationship of the trochlear groove (smallest circle) and the medial lip of the trochlea with the capitellum
- olecranon process is visible in profile
- elbow joint is open
- radial tuberosity is superimposed and not in profile (indicating the arm is not pronated).

Fig: Elbow Lateral view

Trauma axial lateral (coyle method)

Indications

The Coyle's view is performed for any patient with a suspected radial head fracture or dislocation. It is also an effective view to better demonstrate the capitellum of the distal humerus. It is effective in patients who are unable to extend their arm fully and isolates the radial head using a modified radiographic technique.

Patient position

- patient is sitting next to the table
- at 90° elbow flexion, the medial border of the palm and forearm are kept in contact with the tabletop
- the shoulder, elbow and wrist are kept in the same horizontal plane
- rotate the hand so the thumb is pointing towards the ceiling, ensuring all aspects of the arm from the wrist to the humerus are in the same plane
- the beam is angled 45° towards the long axis of the humerus

Technical factors

- **axial projection**
- **centering point**
  - the radial head
- **collimation**
  - superior to distal third of the humerus
  - inferior to include the entity of the radial head
  - anterior to include the skin margin
  - posterior to skin margin
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 55-65 kVp
  - 3-6 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- the radial head should be almost free from superimposition and projected away from the ulna
- the radial head is slightly elongated
- the radiocapitellar joint space should be open.

Fig : Coyle's View

Forearm

Related radiological anatomy

The forearm consists of two bones, the radius and the ulna, which run parallel to each other from the elbow to the wrist. The radiological anatomy of the forearm is essential for diagnosing fractures, dislocations, and other pathologies. Here's a detailed overview:

Bones of the Forearm

Radius

1. **Proximal End**:
   - **Head**: A disk-shaped structure that articulates with the capitulum of the humerus and the radial notch of the ulna.
   - **Neck**: A narrow area just distal to the head.
   - **Radial Tuberosity**: A bony prominence below the neck where the biceps brachii muscle attaches.
2. **Shaft**:

   - **Interosseous Border**: A ridge on the medial aspect of the shaft where the interosseous membrane attaches, connecting the radius and ulna.
   - **Anterior, Posterior, and Lateral Surfaces**: The shaft has three surfaces, each serving as attachment sites for various muscles.
3. **Distal End**:
   - **Styloid Process**: A bony projection on the lateral aspect of the distal radius.
   - **Ulnar Notch**: A concave surface on the medial aspect that articulates with the head of the ulna.
   - **Carpal Articular Surface**: The distal end articulates with the carpal bones (scaphoid and lunate) to form part of the wrist joint.

Ulna

1. **Proximal End**:
   - **Olecranon**: The prominent, posterior projection that forms the bony point of the elbow and articulates with the olecranon fossa of the humerus.
   - **Coronoid Process**: A triangular projection on the anterior aspect that fits into the coronoid fossa of the humerus during elbow flexion.
   - **Trochlear Notch**: The deep, C-shaped notch that articulates with the trochlea of the humerus.
   - **Radial Notch**: A small, concave surface that articulates with the head of the radius.
2. **Shaft**:
   - **Interosseous Border**: A ridge on the lateral aspect of the shaft where the interosseous membrane attaches.
   - **Anterior, Posterior, and Medial Surfaces**: The shaft has three surfaces, each serving as attachment sites for various muscles.
3. **Distal End**:
   - **Head**: The small, rounded distal end that articulates with the ulnar notch of the radius.
   - **Styloid Process**: A bony projection on the medial aspect of the distal ulna.

Joints and Articulations

1. **Proximal Radioulnar Joint**:
   - The head of the radius articulates with the radial notch of the ulna.

   - Allows for rotation of the radius around the ulna, facilitating supination and pronation of the forearm.
2. **Distal Radioulnar Joint**:
   - The head of the ulna articulates with the ulnar notch of the radius.
   - Allows for rotation of the distal radius around the ulna, also involved in supination and pronation.
3. **Interosseous Membrane**:
   - A fibrous sheet that connects the interosseous borders of the radius and ulna.
   - Provides stability and serves as an attachment site for muscles.

Radiographic Views

1. **AP (Anteroposterior) View**:
   - The forearm is extended with the palm facing up.
   - Both the radius and ulna are visible along their entire lengths.
   - Used to assess alignment, fractures, and pathology of both bones.
2. **Lateral View**:
   - The elbow is flexed to 90 degrees with the thumb pointing up.
   - The radius and ulna are superimposed, providing a clear view of their anterior-posterior relationships.
   - Useful for evaluating displacement and angulation of fractures.

Fig: Forearm

Forearm (AP view)

Indications

This view demonstrates the elbow joint in its natural anatomical position allowing for assessment of suspected dislocations or fractures and localizing foreign bodies within the forearm.

Patient position

- patient is seated alongside the table
- forearm is supinated, and its dorsal surface is kept in contact with the cassette with extension at the elbow joint
- both elbow joint and wrist joints are also kept in contact with the cassette

Technical factors

- **anteroposterior projection**
- **centering point**
  - mid-forearm region
- **collimation**
  - distal to the wrist joint
  - proximal to elbow joint
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- trochlea and capitulum being seen in profile
- the wrist is in AP position, with minimal superimposition of the distal radius and ulna

- the arm should be extended appropriately, as evidenced by the radial head being seen in profile.

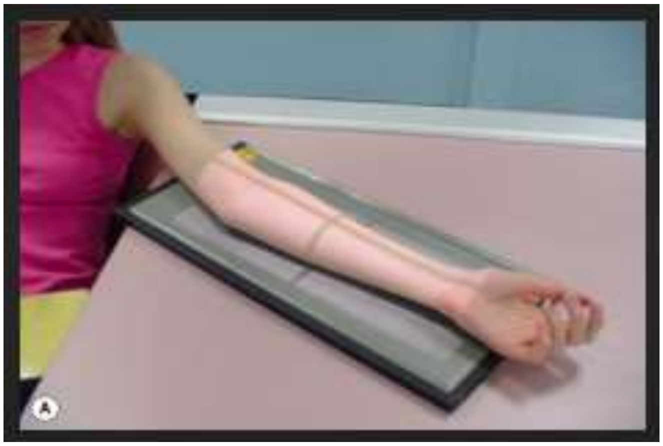


Fig: Forearm AP view

Forearm (lateral view)

Indications
This view allows for the assessment of suspected dislocations or fractures and localizing foreign bodies within the forearm.
Patient position
- patient is seated alongside the table
- elbow is flexed to 90 degrees, and the medial aspect of the wrist, forearm and elbow joint are placed in contact with the detector
- shoulder, elbow and wrist should be in the same horizontal plane

Technical factors
- **lateral projection**
- **centering point**
  - mid forearm region
- **collimation**
  - distal to the wrist joint
  - proximal to the elbow joint
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs

- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- elbow is in a lateral position, as confirmation by the trochlea and capitulum being superimposed and the radial head being seen in profile
- there should be superimposition of the distal radius and ulna indicating a lateral position .

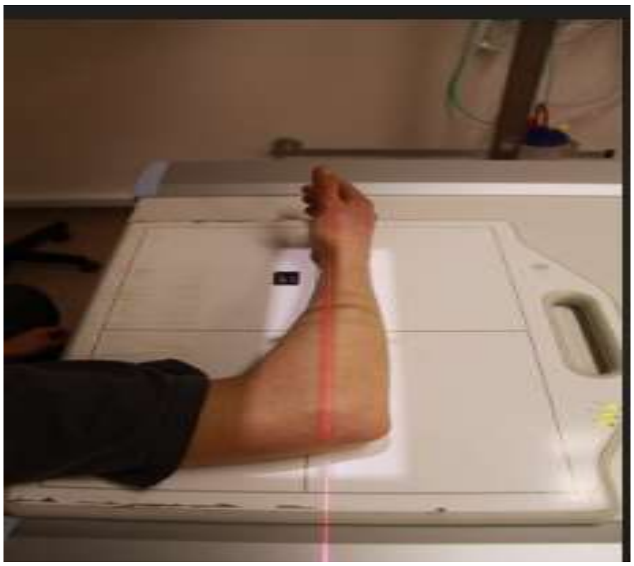


Fig: Forearm Lateral View

Wrist

Related radiological anatomy

The wrist is a complex joint that connects the hand to the forearm, consisting of the distal ends of the radius and ulna, and eight carpal bones arranged in two rows. The radiological anatomy of the wrist is crucial for diagnosing fractures, dislocations, and other pathologies. Here's a detailed overview:

Bones of the Wrist

Distal Ends of the Radius and Ulna

1. **Radius**:
   - **Styloid Process**: A bony projection on the lateral aspect.
   - **Ulnar Notch**: A concave surface on the medial aspect that articulates

with the head of the ulna.
  - **Lunate and Scaphoid Fossae**: Concave areas that articulate with the lunate and scaphoid carpal bones, respectively.
2. **Ulna**:
   - **Head**: The small, rounded distal end.
   - **Styloid Process**: A bony projection on the medial aspect.

Carpal Bones

The eight carpal bones are arranged in two rows:

1. **Proximal Row (lateral to medial)**:
   - **Scaphoid**: Boat-shaped bone that articulates with the radius.
   - **Lunate**: Crescent-shaped bone that articulates with the radius.
   - **Triquetrum**: Pyramid-shaped bone that articulates with the lunate and pisiform.
   - **Pisiform**: A small, pea-shaped bone that sits on the palmar surface of the triquetrum.
2. **Distal Row (lateral to medial)**:
   - **Trapezium**: Saddle-shaped bone that articulates with the first metacarpal (thumb).
   - **Trapezoid**: Wedge-shaped bone that articulates with the second metacarpal.
   - **Capitate**: The largest carpal bone, centrally located, articulating with the third metacarpal.
   - **Hamate**: Wedge-shaped bone with a hook-like projection (hamulus), articulating with the fourth and fifth metacarpals.

Joints and Articulations

1. **Radiocarpal (Wrist) Joint**:
   - Formed by the distal end of the radius and the proximal row of carpal bones (scaphoid, lunate, and triquetrum).
   - Allows for flexion, extension, radial deviation (abduction), and ulnar deviation (adduction).
2. **Distal Radioulnar Joint**:
   - Formed by the head of the ulna and the ulnar notch of the radius.
   - Allows for pronation and supination of the forearm.
3. **Intercarpal Joints**:
   - Joints between the carpal bones within each row and between the proximal and distal rows.
   - Allow for slight gliding movements, contributing to the overall mobility of the wrist.

Fig: Wrist Joint

Wrist (PA view)

Indications

The PA wrist radiograph is requested for myriad reasons including but not limited to trauma, suspected infective processes, injuries the distal radius and ulna, suspected arthropathy or even suspected foreign bodies.

What is probably more useful is remembering that a PA wrist radiograph will not rule out a forearm fracture given the limited coverage (for this, one would request a forearm series).

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and wrist can rest on the table
- the affected hand is placed, palm down on the image receptor
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- the wrist and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **posteroanterior projection**
- **centering point**
  - mid carpal region
- **collimation**
  - laterally to the skin margins

  - distal to the midway up the metacarpals
  - proximal to the include one-quarter of the distal radius and ulna
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- there is only minor superimposition of the metacarpal bases
- the articulation between the distal radius and the ulna is open or has little superimposition.
- the concavity of the metacarpal shafts is equal.

Fig: wrist PA view

Wrist (oblique view)

Indications

The oblique wrist radiograph is requested for myriad reasons including but not limited to trauma, suspected infective processes, injuries the distal radius and ulna,

suspected arthropathy or even suspected foreign bodies. It is also a handy projection to better assess the scaphoid and subtle distal radial fractures.
What is probably more useful is remembering that an oblique wrist radiograph will not rule out a forearm fracture given the limited coverage (for this, one would request a forearm series).

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and wrist can rest on the table
- the affected hand is placed, palm down on the image receptor
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- wrist and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)
- from the positioning of the PA projection, the wrist is externally rotated 40° - 45°; a sponge can be placed under the wrist to aid stability. In some departments, the DR systems will pick up the outline of the sponge so check your local protocol.

Technical factors

- **posteroanterior projection**
- **centering point**
    - mid carpal region
- **collimation**
    - laterally to the skin margins
    - distal to the midway up the metacarpals
    - proximal to the include one-quarter of the distal radius and ulna
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 50-60 kVp
    - 3-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

The ulna head and distal radius are slight superimposed. The proximal metacarpals

3 to 5 also being partly superimposed.

Fig: Wrist Oblique

Wrist (lateral view)

Indications

The lateral wrist radiograph is requested for myriad reasons including but not limited to trauma, suspected infective processes, injuries the distal radius and ulna, suspected arthropathy or even suspected foreign bodies.

What is probably more useful is remembering that a lateral wrist radiograph will not rule out a forearm fracture given the limited coverage (for this, one would request a forearm series).

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and wrist can rest on the table
- abduct the humerus so that it is parallel to the image receptor
- shoulder, elbow, and wrist should all be in transverse plane, perpendicular to the central beam
- wrist and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **lateral projection**
- **centering point**: mid carpal region
- **collimation**
  - anteroposterior to the skin margins
  - distal to the midway up the metacarpals
  - proximal to include one-quarter of the distal radius and ulna
- **orientation**: portrait
- **detector size**: 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**: 100 cm
- **grid**: no

Image technical evaluation

The academic rule of a true lateral wrist radiograph is defined by the pisoscaphocapitate relationship, where the palmar cortex of the pisiform should lie centrally between the anterior surface of the distal pole of the scaphoid and the capitate, ideally in the central third of this interval [1].

There is a superimposition of the carpal bones, including the distal portion of the scaphoid and the pisiform. The radius and ulna are also superimposed. The ulnar styloid can be seen posterior.

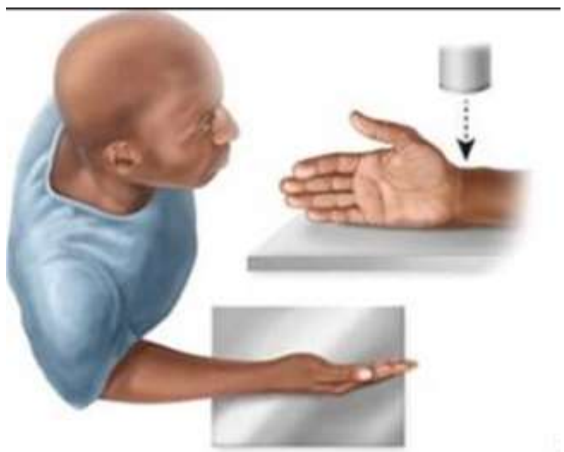


Fig: Lateral view

Wrist (radial deviation view)

Indications

Suspected abnormality at the ulnar aspect of the wrist, or in conjunction with a PA and ulnar deviation view to assess carpal movement.

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and wrist can rest on the table
- the affected hand is placed, palm down on the image receptor with hand in radial deviation (see practical points)
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- the wrist and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **posteroanterior projection**
- **centering point**
  - central carpal zone
- **collimation**
  - laterally to the skin margins
  - distal to the midway up the metacarpals
  - proximal to the include one-quarter of the distal radius and ulna
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Fig: Radial Deviation

Image technical evaluation

- hand is in radial deviation
- minor superimposition of the metacarpal bases.

Ulnar deviation (Scaphoid)

The **posteroanterior ulnar deviation scaphoid view** is part of a four view series of the scaphoid, wrist and surrounding carpal bones. Although performed PA, the view can often be referred to as an AP view. The view is performed with the wrist in ulnar deviation to free the scaphoid from bony superimposition.

Indications

This view aims to show the scaphoid in its anatomical position, hence allowing the visualization of any subtle distal, middle or proximal fractures [1] of the scaphoid.

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and wrist can rest on the table
- the affected hand is placed, palm down on the image receptor with hand in ulnar deviation (see practical points)
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- the wrist and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **posteroanterior projection**
- **centering point**
  - anatomical snuffbox
- **collimation**
  - laterally to the skin margins
  - distal to the midway up the metacarpals
  - proximal to the include one-quarter of the distal radius and ulna
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp

  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- hand is in ulnar deviation with little superimposition over the scaphoid bone
- minor superimposition of the metacarpal bases
- articulation between the distal radius and the ulna is open or has little superimposition
- concavity of the metacarpal shafts is equal.

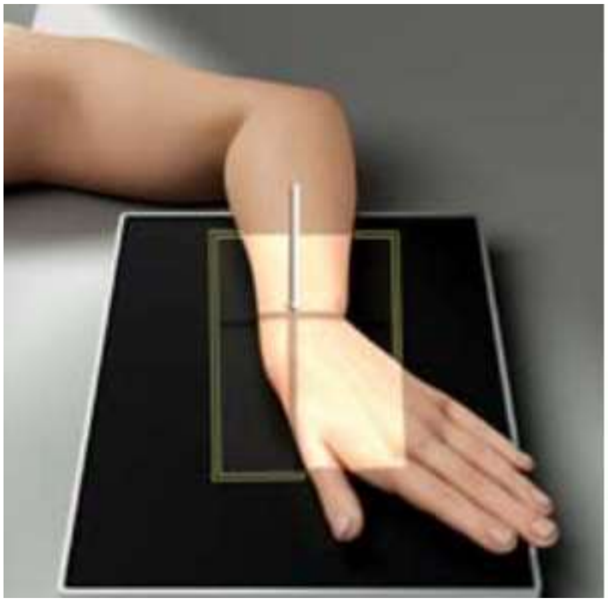


Fig: Ulnar Deviation

Wrist (carpal tunnel view)

The **carpal tunnel view** is an axial projection to demonstrate the medial and lateral prominences and the concavity.

Indications

This carpal tunnel view is seldom performed however it can be utilized to investigate potential hook of hamate, pisiform and trapezium fractures.

Patient position

- patient stands with the back facing the table
- palmar surface of hand is placed in contact with the cassette which is placed at the table margin

- wrist is dorsiflexed approximately 135º, making the carpals and metacarpals lift away from the cassette

Technical factors

- **axial projection**
- **centering point**
  - mid carpal region
  - the central ray is vertical and will be centered to the midpoint of the dorsiflexed wrist
- **collimation**
  - laterally to the skin margins
  - dorsal to the skin margins
  - ventral to the carpometacarpal joint
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

There should be a clear outline of the ventral aspect of the carpal bones with no superimposition.

Fig: Carpal Tunnel View

Wrist (carpal bridge view)

The **carpal bridge view** an additional view of the three view series of the wrist and carpal bones. It is a specialized projection that involves keeping the patient's wrist in flexion.

Indications

The carpal bridge view is requested to assess the dorsal aspect of the scaphoid, lunate and the triquetrum.

Patient position

- the patient is seated alongside the table
- dorsal aspect of affected wrist is placed on the detector in flexion
- flex the wrist as much as tolerable to the patient

Technical factors

- **tangential projection**
- **centering point**
  - midcarpal region
  - the central ray is angled approximately 45 degrees to the long axis of the forearm
- **collimation**
  - laterally to the skin margins
  - dorsal to the skin margins
  - ventral to the carpometacarpal joint
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

There should be a clear outline of the dorsal aspect of the carpal bones with no superimposition.

Fig: Carpal Bridge view

Hand

Related radiological anatomy

The hand is a complex structure composed of numerous bones, joints, and soft tissues. Radiographic evaluation of the hand is essential for diagnosing fractures, dislocations, arthritis, and other pathologies. Here's a detailed overview of the radiological anatomy of the hand:

Bones of the Hand

The hand consists of three main groups of bones:

1. **Carpal Bones**:
    - The carpal bones form the wrist and are arranged in two rows (proximal and distal), as mentioned previously.
2. **Metacarpal Bones**:
    - There are five metacarpal bones, numbered I to V from the thumb to the little finger.
    - Each metacarpal bone has a base (proximal end), shaft, and head (distal

end).

3. **Phalanges**:
   - The fingers are composed of phalanges. Each finger has three phalanges (proximal, middle, and distal), except the thumb, which has two (proximal and distal).
   - Each phalanx has a base (proximal end), shaft, and head (distal end).

Joints and Articulations

1. **Carpometacarpal (CMC) Joints**:
   - The joints between the carpal bones and the bases of the metacarpals.
   - The CMC joint of the thumb is a saddle joint, allowing a wide range of motion, including opposition.
2. **Metacarpophalangeal (MCP) Joints**:
   - The joints between the heads of the metacarpals and the bases of the proximal phalanges.
   - These joints are condyloid, allowing flexion, extension, abduction, and adduction.
3. **Interphalangeal (IP) Joints**:
   - Each finger has two IP joints (proximal and distal), except the thumb, which has one.
   - These are hinge joints, allowing flexion and extension.

Hand (PA view)

The **PA hand view** is part of a two view series metacarpals, phalanges, carpal bones and distal radial ulnar joint.

Indications

The PA hand view is requested for diagnosing a variety of clinical indications such as rheumatoid arthritis, osteoarthritis, suspected fracture or dislocation and localizing foreign bodies.

This view complements the ball-catcher view as it is particularly useful for diagnosing early signs of rheumatoid arthritis and osteoarthritis in the metacarpals, carpal bones and distal radio ulnar joint.

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and hand can rest on the table
- the affected hand is placed, palm down on the image receptor
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- the hand and elbow should be at shoulder height which makes radius and ulna

parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **posteroanterior projection**
- **centering point**
  - third metacarpal head
- **collimation**
  - laterally to the skin margins
  - proximal to include distal radioulnar joint
  - distal to the tips of the distal phalanges
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 1-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

5th finger is positioned PA, with no rotation as evidenced by the symmetric appearance of the concavities of the phalanges. Interphalangeal and metacarpophalangeal joint spaces of digits 2 to 5 appear open.

The concavity of the metacarpal shafts is equal.

Fig: Hand PA

Hand (oblique view)

The hand oblique view is part of a two view series metacarpals, phalanges, carpal bones and distal radial ulnar joint.

Indications

The oblique hand view is requested for diagnosing a variety of clinical indications such as rheumatoid arthritis, osteoarthritis, suspected fracture or dislocation and localizing foreign bodies.

It is also particularly useful in providing more information regarding the degree and location of any suspected fracture or dislocation.

Patient position

- patient is seated alongside the table
- the affected arm if possible is flexed at 90° so the arm and hand can rest on the table
- the hand is rotated externally by 45 degrees from the basic PA position with fingers kept in extension and parallel to image receptor
- shoulder, elbow, and wrist should all be in the transverse plane, perpendicular to the central beam
- the hand and elbow should be at shoulder height which makes radius and ulna parallel (lowering the arm makes radius cross the ulna and thus relative shortening of radius)

Technical factors

- **posteroanterior projection**
- **centering point**
  - third metacarpal head
- **collimation**
  - laterally to the skin margins
  - proximal to include distal radioulnar joint
  - distal to the tips of the distal phalanges
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 1-5 mAs

- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

Fingers are positioned parallel to image receptor, indicated by open interphalangeal and metacarpophalangeal joint spaces. Correct obliquity is evidenced by the following:

- midshafts of 3rd to 5th metacarpals do not overlap
- some overlap of the distal heads of the 3rd to 5th metacarpals
- no overlap of the distal heads of the 2nd and 3rd metacarpals

Fig: PA Oblique

Hand (lateral view)

The **lateral hand view** is an orthogonal view taken along with the PA view of the hand.

Indications

The lateral hand view is requested for diagnosing a variety of clinical indications such as rheumatoid arthritis, osteoarthritis, suspected fracture or dislocation and localizing foreign bodies.

It is particularly useful for visualizing the degree of fracture displacement and the exact location of a foreign body. Spreading the fingers into a fan lateral view is also essential for visualizing each phalange separately, allowing for diagnosis of rheumatoid and osteoarthritis.

Patient position

- patient is seated alongside the table
- hand is externally rotated by 90 degrees from the PA position so that the palm is perpendicular to the image receptor
- fingers are kept extended with thumb abducted
- fingers should ideally be separated to minimize superimposition and increase diagnostic information contained in the image

Technical factors

- **lateral projection**
- **centering point**
    - over the head of the second metacarpal
- **collimation**
    - anteroposterior to the skin margins
    - distal to the tips of the fingers
    - proximal to include one-third of the distal radius and ulna
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 50-60 kVp
    - 3-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

Fingers should appear equally separated. The third and fourth digits in this image are mostly superimposed so more care should have been taken to separate these. (This, however, is of no concern if that is not the area of interest - e.g. if the patient states no pain in that area.)

Correct lateral positioning is evidenced by the following:

- interphalangeal joint spaces are open
- metacarpals are mostly superimposed, with slight over-rotation externally allowing the fracture at the base of the 5th metacarpal to be visualized
- posterior aspect of the distal radius and ulna are superimposed

Fig: Hand Lateral

AP bilateral oblique (norgaard method/ Ball Catcher's)

The **ball-catcher view**, **Nørgaard projection**, or **posterior oblique view of both hands** is an additional projection of the routine hand series.

Indications

The ball-catcher view is typically undertaken to assess for erosive arthropathies such as rheumatoid arthritis. It often complements the bilateral PA view of the hands and is generally thought to be the superior view to illustrate joint erosions.

Patient position

- the patient may be seated alongside or facing the table
- both hands are supinated with their dorsal surfaces are placed on the cassette/FPDs
- the hands are then rotated medially by 45 degrees to assume a position likened to one about to receive or catch a ball

Technical factors

- **anterior bilateral projection**
- **centering point**
  - between the two hands at the level of the metacarpophalangeal joints
- **collimation**
  - laterally to the skin margins
  - distal to the skin margins of the fingertips
  - proximal to the include one-third of the distal radius and ulna
- **orientation**

    - landscape
- **detector size**
    - 24 cm x 30 cm
- **exposure**
    - 50-60 kVp
    - 3-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

- no overlap of the midshafts of the metacarpals, nor is there an overlap of the phalange bases
- hands are equal distance apart

Fig: Ball Catcher's View

FINGERS

Related radiological anatomy

The radiological anatomy of the fingers involves the study of their structures using imaging techniques such as X-rays, CT scans, MRI, and ultrasound. Here's an overview of the key anatomical features and what to look for in radiological images:

Bones

The fingers (digits) are composed of phalanges:

- **Proximal Phalanges**: These are the bones closest to the hand.
- **Middle Phalanges**: These bones are present in all fingers except the thumb.
- **Distal Phalanges**: These are the bones at the tips of the fingers.

Joints

There are several joints within the fingers:

- **Metacarpophalangeal (MCP) Joints**: Connect the metacarpal bones of the hand to the proximal phalanges.
- **Proximal Interphalangeal (PIP) Joints**: Connect the proximal phalanges to the middle phalanges.
- **Distal Interphalangeal (DIP) Joints**: Connect the middle phalanges to the distal phalanges (except in the thumb, which has an interphalangeal joint instead).

Soft Tissue Structures

- **Tendons and Ligaments**: Tendons attach muscles to bones, enabling movement. Ligaments connect bones to each other, providing stability. Key tendons include the flexor and extensor tendons.
- **Muscles**: Intrinsic muscles within the hand control fine motor movements, while extrinsic muscles in the forearm provide strength and gross movements.
- **Nerves**: The digital nerves supply sensation to the fingers and also contribute to motor control.
- **Blood Vessels**: Arteries and veins provide blood supply, with the digital arteries branching off from the radial and ulnar arteries.

<u>Finger (PA view)</u>

Indications

This projection is best to access the joint spaces and distal, middle and proximal phalanx in the AP plane. It is not advisable to only obtain one view of the fingers (or any extremity), given how subtle pathology can be in this region. Note that the AP position of the finger radiograph is not the <u>AP position of the thumb</u> (this is a different radiograph altogether).

Patient position

- patient is seated alongside the table (similar to the projection of hand)
- palmar aspect of pronated hand is placed over the detector, and extended fingers are kept in contact with little separation, allowing interphalangeal joint spaces to appear open.

Technical factors

- **posteroanterior projection**
- **centering point**
  - approximately over the proximal interphalangeal joint
- **collimation**
  - laterally to the adjacent fingers
  - proximal to include the carpometacarpal joint
  - distal to the tips of the distal phalanges
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 1-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

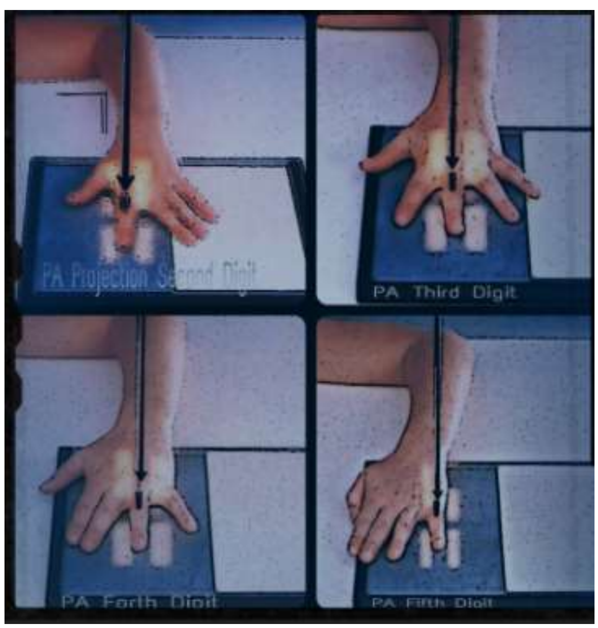


Fig: Fingers PA view

Image technical evaluation

Digit is visualized to include the carpometacarpal joint. Alongside finger is included to ensure the correct finger identified. The concavity of the metacarpal shafts is equal.

Finger Lateral view

Indications

The lateral projection is an ideal projection to assess the joint spaces for dislocations, arthropathic conditions and elucidate subtle avulsion fracture of the dorsal and volar aspects of the joint capsule.

Patient position

Lateral of the index and middle fingers

- patient seated alongside the table
- hand is pronated and then medially rotated further to keep the lateral aspect of the index finger in contact with cassette
- index finger is in extension while the middle finger is slightly flexed at the metacarpophalangeal joint to avoid superimposition (only if imaging of this finger is required, otherwise it should be fully flexed, see Figure 1)
- other fingers are fully flexed

Lateral of ring and little fingers

- patient seated alongside the table
- medial aspect of the extended little finger is kept in contact with cassette while ring finger is slightly flexed at metacarpophalangeal joint to avoid superimposition (only if ring finger requires imaging, otherwise it should be fully flexed, see Figure 2)
- rest of the fingers are fully flexed

Technical factors

- **lateral projection**
- **centering point**
  - approximately over the proximal interphalangeal joint
- **collimation**
  - anteroposterior to the skin margins
  - proximal to include the carpometacarpal joint
  - distal to the tips of the distal phalanges
- **orientation**
  - portrait

- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 1-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

There should be no foreshortening; all interphalangeal spaces are open and no obstruction by other digits over the digit of question.

Fig: Finger Lateral View

Fingers Oblique View

Indications

The oblique view s not required for follow-up studies, or 'query foreign body' unless specifically requested. It is, however, a very useful projection in the acute setting and should be included in the acute finger series to ensure no subtle pathology is missed [2].

Patient position

- the patient is seated alongside the table (similar to a projection of hand)
- from a pronated position for PA fingers, the hand is rotated approximately 45 degrees (thumb side up), resting on a sponge if required (see Figure 1)

- fingers are separated to avoid superimposition
- the long axis of the finger should run parallel to the image receptor (in horizontal and vertical planes)

Technical factors

- **posteroanterior oblique projection**
- **centering point**
  - approximately over the proximal interphalangeal joint
- **collimation**
  - laterally to the skin margins
  - proximal to include the carpometacarpal joint
  - distal to the tips of the distal phalanges
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 50-60 kVp
  - 1-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

Digit is examined to include the carpometacarpal joint. The condyles of the phalanges are oblique as seen via little superimposition of the two domes. There is a noted uneven concavity of the mid-shaft of the metacarpal. On the raised side, there is more soft tissue

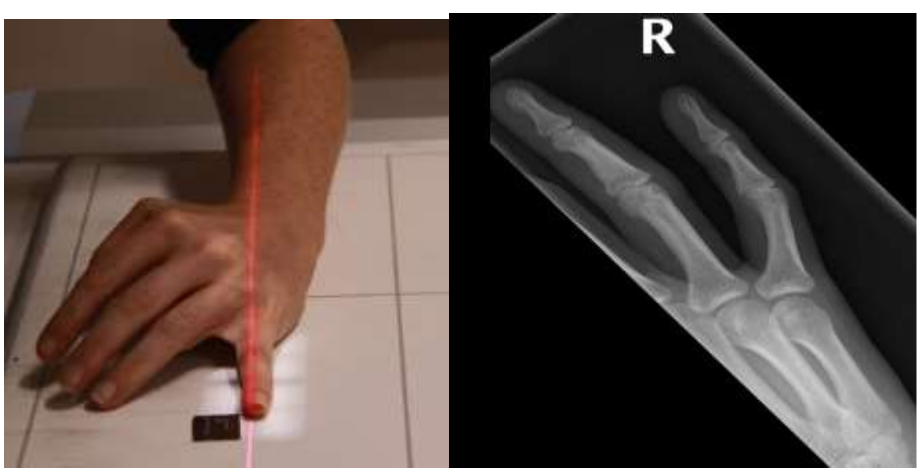


Fig: Fingers Oblique View

THUMB

Related radiological anatomy

The radiological anatomy of the thumb involves specific bones, joints, and soft tissue structures. Understanding these elements is crucial for accurate diagnosis and treatment. Here's a detailed overview:

Bones

The thumb (pollex) consists of three bones:

- **Distal Phalanx**: The bone at the tip of the thumb.
- **Proximal Phalanx**: The bone between the distal phalanx and the metacarpal.
- **First Metacarpal**: The bone that connects the thumb to the wrist.

Joints

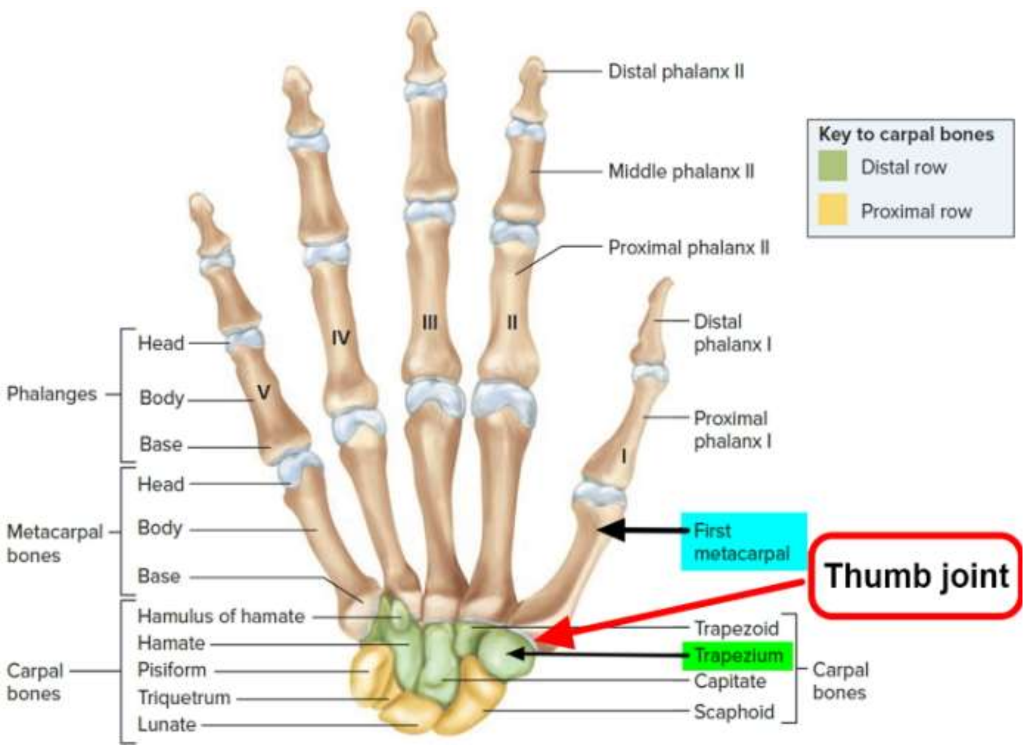
The thumb has unique joint structures compared to other fingers:

- **Interphalangeal (IP) Joint**: Connects the distal phalanx to the proximal phalanx.
- **Metacarpophalangeal (MCP) Joint**: Connects the proximal phalanx to the first metacarpal.
- **Carpometacarpal (CMC) Joint**: Connects the base of the first metacarpal to the trapezium bone of the wrist. This saddle joint allows for a wide range of thumb movements.

Soft Tissue Structures

- **Tendons**: The thumb has several key tendons:
    - **Flexor Pollicis Longus (FPL)**: Runs along the volar (palmar) side and flexes the IP joint.
    - **Extensor Pollicis Longus (EPL)**: Runs along the dorsal side and extends the IP joint.
    - **Extensor Pollicis Brevis (EPB)**: Assists in extending the MCP joint.
    - **Abductor Pollicis Longus (APL)**: Abducts the thumb.
- **Ligaments**: Important for joint stability:
    - **Ulnar Collateral Ligament (UCL)**: Supports the MCP joint on the ulnar (medial) side.
    - **Radial Collateral Ligament (RCL)**: Supports the MCP joint on the radial (lateral) side.
    - **Volar Plate**: Provides additional stability to the MCP joint.
- **Muscles**: Intrinsic muscles like the thenar muscles (abductor pollicis brevis, flexor pollicis brevis, opponens pollicis) contribute to thumb movement and strength.
- **Nerves**: The median and radial nerves supply sensation and motor function.

- **Blood Vessels**: The princeps pollicis artery, a branch of the radial artery, supplies blood to the thumb.



Thumb (AP/PA view)

Indications

The AP thumb can be requested for many reasons including trauma, suspected arthritic changes, or foreign body to name a few. It is an ideal view to inspect the metacarpal joint spaces, as well as the regions of ligamentous attachments, it may be the only view in which one could observe a collateral ligamentous injury such as a gamekeeper's thumb.

Patient position

AP thumb

- patient is seated alongside the table
- the arm is extended and medially rotated so as bring the dorsal aspect of thumb in contact with the cassette (see Figures 1 and 2)

PA thumb

- patient is seated alongside the table
- the thumb rests on a sponge, ensuring that the entire thumb is in the same horizontal plane.

Technical factors

- **posteroanterior/anteroposterior projection**
- **centering point**
    - base of the thumb
- **collimation**
    - laterally to the skin margins
    - distal to skin margin
    - proximal to the carpometacarpal joint
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 50-60 kVp
    - 3-5 mAs
- **SID**
    - 100 cm
- **grid**
    - no

Image technical evaluation

1st digit is positioned PA, evidenced by the symmetric appearance of the concave aspects of the phalanges and metacarpals. Correct alignment in the horizontal plane is evidenced by open carpometacarpal and interphalangeal joint spaces.


AP **PA**

Thumb Roberts method x-ray view

The Roberts method is a specialized X-ray technique used to obtain a clear and unobstructed view of the base of the thumb, particularly focusing on the first carpometacarpal (CMC) joint. This method is particularly useful for diagnosing conditions such as Bennett's fracture and other pathologies affecting the base of the thumb.

Indications

- **Bennett's Fracture**: A fracture-dislocation of the base of the first metacarpal bone.
- **Rolando Fracture**: A comminuted intra-articular fracture at the base of the first metacarpal.
- **Arthritis**: Assessing degenerative changes in the first CMC joint.
- **Other Traumatic Injuries**: Including dislocations or subluxations of the first CMC joint.

Patient Positioning

1. **Patient Position**: The patient can be seated at the end of the X-ray table or standing, with the arm extended.
2. **Arm and Hand Position**: The affected hand is positioned palm down (pronated) on the image receptor.
3. **Thumb Position**: The thumb is abducted (moved away from the palm) to be perpendicular to the plane of the hand. The thumb should be in true AP (anteroposterior) position.
4. **Central Ray**: The central ray is directed at a 15-degree angle proximally (towards the wrist) to the first CMC joint. This angle helps to project the CMC joint free of superimposition from the other bones.

Image Criteria

1. **Visualization**: The image should clearly show the base of the first metacarpal, the trapezium, and the first CMC joint without superimposition.
2. **Bone Detail**: The cortical margins of the bones should be sharp, indicating good bone detail.
3. **Joint Space**: The first CMC joint space should be well visualized and open.
4. **No Rotation**: The thumb should appear straight without any rotation, as rotation can obscure the anatomy of the CMC joint.

Fig : Thumb Roberts method

FEMUR

Related radiological anatomy

The radiological anatomy of the femur, the longest and strongest bone in the human body, includes its various structural features and the surrounding soft tissues. Understanding the anatomy through imaging is crucial for diagnosing fractures, tumors, infections, and other pathologies.

Bones and Landmarks

The femur consists of several key parts:

1. **Proximal Femur**
    - **Head**: The rounded, proximal end that articulates with the acetabulum of the pelvis to form the hip joint.
    - **Neck**: The narrow region just below the head.
    - **Greater Trochanter**: The large, palpable projection on the lateral aspect.
    - **Lesser Trochanter**: The smaller projection on the medial side.
    - **Intertrochanteric Line**: The ridge between the greater and lesser trochanters on the anterior side.
    - **Intertrochanteric Crest**: The ridge between the greater and lesser trochanters on the posterior side.
2. **Shaft**
    - **Body (Shaft)**: The long, cylindrical portion of the femur.
    - **Linea Aspera**: A prominent ridge running longitudinally along the posterior aspect.
3. **Distal Femur**
    - **Medial and Lateral Condyles**: The rounded projections at the distal end that articulate with the tibia and patella.

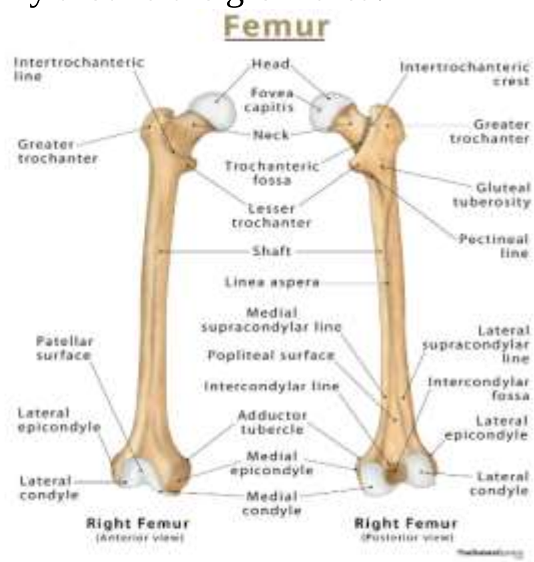
  - **Intercondylar Fossa (Notch)**: The deep groove between the condyles on the posterior side.
  - **Medial and Lateral Epicondyles**: The bony prominences just above the condyles.

Joints

- **Hip Joint**: Formed by the articulation of the femoral head with the acetabulum.
- **Knee Joint**: Formed by the articulation of the femoral condyles with the tibial plateau and the patella.

Soft Tissue Structures

- **Muscles**: Various muscles attach to the femur, including the quadriceps, hamstrings, adductors, and gluteal muscles.
- **Ligaments**: Several key ligaments support the femur at the hip and knee joints, including the iliofemoral, ischiofemoral, and pubofemoral ligaments at the hip, and the collateral and cruciate ligaments at the knee.
- **Nerves and Blood Vessels**: The femoral nerve, artery, and vein run close to the femur, particularly around the groin area.



AP PROJECTION: FEMUR - MID AND DISTAL

Pathology demonstrated

Mid and distal femur is demonstrated including knee joint for detection and avaluation of fractures or bone legends lessions.

Technical factors.

- IR Size – 35 X 43 cm (14X17inches). Lengthwise

- Moving or stationary grid
- 75 ±5 kV range
- Because of anode heel effect, place hip or head end of patient at cathode end of x-ray beam.
- mAs : 12

Shielding:
Place lead shield over pelvic area to ensure correct gonadal shielding because of proximity to primary beam.

Patient position:
Take radiograph with patient in the supine position, with femur centered to midline of table; give pillow for head. (this projection also may be done on a stretcher with a portable grid placed under the femur.)

Part position:

- Align femur to CR and to Midland of table or IR.
- Rotate leg internally about 5 degree for a true AP, as for an AP knee. (For proximal femur 15 to 20 degree internal leg rotation is required, as for an AP hip).
- Ensure that knee joint is included on IR, considering the divergence of the X ray beam. (Low cassette margin should be approximately 2 inches below knee joint).

Central Ray

- CR is perpendicular to femur and IR.
- Direct CR2 midpoint of IR.
- Minimum SID is 40 inches (100cm)

Collimation

- Collimate closely on both sides to femur with end collimation to film borders.

- Routine to include both joints: common departmental routines include both joint on all initial famous exams. For a large adult, a second smaller IR than should be used for an AP of either the knee or the hip, ensuring that both hip and knee joints are included. If the hip is included, the leg should be rotated 15 to 20 degrees internally to place the femoral neck in profile.

Structure Shown:

- Distal two-thirds of distal femur, including knee joints, is shown.
- Knee joint space will not appear fully open because of divergent x-ray beam.

Position:

- No rotation is evidenced; femoral and tibial condyles should appear symmetric in size and shape with the outline of patella slightly toward medial side of femur.
- The approximate medial half of fibula head should be superimposed by tibia.

Collimation and CR:

- Femur should be centered to collimation field and aligned with long axis of IR with knee joint space a minimum of 1 inch (2.5 cm) from distal IR margins.
- Minimal collimation borders should be visible on proximal and distal margins of IR.

Exposure Criteria:

- Optimal exposure with correct use of anode heel effect will result in near uniform density of entire femur.
- No motion should occur; fine trabecular markings should be clear and sharp throughout length of femur.

Fig : AP PROJECTION

Femur (lateral view)

Indications

This view demonstrates the femur in an orthogonal position to the AP view. This allows assessment of suspected dislocations, fractures, localizing foreign bodies and osteomyelitis within the long bone. Depending on departments, this view can be crucial for orthopedic surgeons to determine the length of the femur for prosthetic purposes.

Patient position

- the patient is rolled at least 45° onto the side of interest
- the unaffected leg is bent to stabilize the patient position i.e. foot firm on the bed to ensure stability
- if acquiring the entire femur in one image, place the detector in a diagonal position parallel with the femur

Technical factors

- **anteroposterior projection**
- **centering point**
  - for one image: mid femur region
  - for two images:
    - proximal femur: place detector to include anatomy from ASIS to mid-femoral shaft
    - distal femur: place detector to include anatomy from mid-femoral shaft to knee joint
    - to ensure overlap of anatomy, a physical side marker can be positioned at mid-femur region
- **collimation**
  - laterally to the skin margins
  - superior to ASIS
  - inferior to proximal third of tibia/fibula
- **orientation**
  - portrait
- **detector size**
  - 30 cm x 43 cm
- **exposure**
  - 65-70 kVp
  - 8-12mAs
- **SID**
  - 100 cm
- **grid**

- yes

Image technical evaluation

- greater and lesser trochanters should be superimposed by the femoral neck
- a small part of the lesser trochanter is visible medially
- anterior and posterior margins of the femoral condyles should be superimposed.

Fig : Femur (lateral view)

KNEE:

Related radiological anatomy

The radiological anatomy of the knee involves understanding the bones, joints, soft tissues, and associated structures that can be visualized through various imaging techniques. This knowledge is essential for diagnosing a range of knee pathologies, including fractures, ligament injuries, meniscal tears, and degenerative diseases.

Bones and Landmarks

The knee joint is formed by the articulation of three bones:

1. **Femur (Distal)**
   - **Medial and Lateral Condyles**: Rounded projections that articulate with the tibia.
   - **Intercondylar Fossa (Notch)**: The deep groove between the condyles on the posterior side.
   - **Medial and Lateral Epicondyles**: Bony prominences above the condyles.
2. **Tibia (Proximal)**
   - **Medial and Lateral Tibial Condyles**: The flat surfaces on top of the tibia that articulate with the femoral condyles.

- **Tibial Plateau**: The upper surface of the tibia, including the condyles and the intercondylar eminence.
- **Tibial Tuberosity**: The bony prominence on the anterior surface where the patellar tendon attaches.

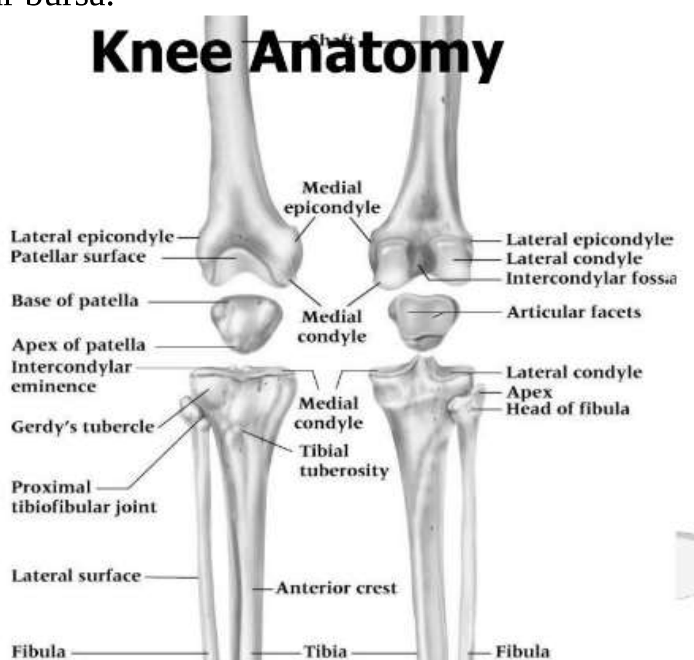
3. **Patella**
   - **Base**: The superior aspect of the patella.
   - **Apex**: The inferior tip of the patella.
   - **Articular Surface**: The posterior surface that articulates with the femur.

Joints

- **Tibiofemoral Joint**: The primary hinge joint between the tibia and femur.
- **Patellofemoral Joint**: The joint between the patella and the femur.

Soft Tissue Structures

- **Menisci**: Medial and lateral menisci are fibrocartilaginous structures that cushion and stabilize the knee joint.
- **Ligaments**:
  - **Anterior Cruciate Ligament (ACL)**: Prevents anterior translation of the tibia.
  - **Posterior Cruciate Ligament (PCL)**: Prevents posterior translation of the tibia.
  - **Medial Collateral Ligament (MCL)**: Provides medial stability.
  - **Lateral Collateral Ligament (LCL)**: Provides lateral stability.
- **Tendons**:
  - **Quadriceps Tendon**: Connects the quadriceps muscles to the patella.
  - **Patellar Tendon**: Connects the patella to the tibial tuberosity.
- **Bursae**: Fluid-filled sacs that reduce friction, such as the prepatellar bursa and the infrapatellar bursa.



Knee AP

Clinical Indications

• Fractures, lesions, or bony changes related to degenerative joint disease involving the distal femur, proximal tibia and fibula, patella, and knee joint

Technical Factors

• Minimum SID—40 inches (102 cm)
• IR size—24 × 30 (10 × 12 inches), lengthwise
• Grid or Bucky, >10 cm (70 ± 5 kV)
• Non grid, tabletop, <10 cm (65±5 kV)
• Digital systems—70 to 85 kV range

Shielding Shield radiosensitive tissues outside region of interest.

Patient Position

Place patient in supine position with no rotation of pelvis; provide pillow for patient's head; leg should be fully extended

Part Position

• Align and center leg and knee to CR and to midline of table or IR.
• Rotate leg internally 3° to 5° for true AP knee (or until interepicondylar line is parallel to plane of IR).
• Place sandbags by foot and ankle to stabilize if needed. CR
• Align CR parallel to articular facets (tibial plateau); for average-size patient, CR is perpendicular to IR (see Note).
• Direct CR to a point 1 2 inch (1.25 cm) distal to apex of patella. Recommended Collimation Collimate on both sides to skin margins at ends to IR borders.

Evaluation Criteria

Anatomy Demonstrated: • Distal femur and proximal tibia and fibula are shown. • Femorotibial joint space should be open, with the articular facets of the tibia seen on end with only minimal surface area visualized.

Position: • No rotation is evidenced by symmetric appearance of femoral and tibial condyles and the joint space. • The approximate medial half of the fibular head should be superimposed by tibia. • The intercondylar eminence is seen in the center of intercondylar fossa. • Center of collimation field (CR) should be to the midknee joint space.

Exposure: • Optimal exposure visualizes the outline of the patella through the distal femur, and the fibular head and neck do not appear overexposed.

Fig: AP knee

Oblique- medial (internal) rotations

Clinical Indications

• Pathology involving the proximal tibiofibular and femorotibial (knee) joint articulations

• Fractures, lesions, and bony changes related to degenerative joint disease, especially on the anterior and medial or posterior and lateral portions of knee.

Technical Factors

• Minimum SID—40 inches (102 cm)

• IR size—24 × 30 cm (10 × 12 inches), lengthwise

• Grid or Bucky, >10 cm (70 ± 5 kV)

• Non grid, tabletop, <10 cm (65 ± 5 kV)

• Digital systems—70 to 85 kV range

Shielding Shield radiosensitive tissues outside region of interest.

Patient Position Place patient in semisupine position with entire body and leg rotated partially away from side of interest; place support under elevated hip; provide a pillow for patient's head.

Part Position

• Align and center leg and knee to CR and to midline of table or IR.

• Rotate entire leg internally 45°. (Interepicondylar line should be 45° to plane of

IR.)
• If needed, stabilize foot and ankle in this position with sandbags.

CR

• Angle CR 0° on average patient (see AP Knee on p. 244).
• Direct CR to midpoint of knee at a level 1/2 inch (1.25 cm) distal to apex of patella.

Recommended Collimation

Collimate on both sides to skin margins, with full collimation at ends to IR borders to include maximum femur and tibia-fibula.

Evaluation Criteria

Anatomy Demonstrated: • Distal femur and proximal tibia and fibula with the patella superimposing the medial femoral condyle are shown. • Lateral condyles of the femur and tibia are well demonstrated, and the medial and lateral knee joint spaces appear unequal.

Position: • The proper amount of part obliquity demonstrates the proximal tibiofibular articulation open with the lateral condyles of the femur and tibia seen in profile. • The head and neck of the fibula are visualized without superimposition, and approximately half of the patella should be seen free of superimposition by the femur. The center of the collimated field is to the femorotibial (knee) joint space.

Exposure: • Optimal exposure with no motion should visualize soft tissue in the knee joint area, and trabecular markings of all bones should appear clear and sharp.
• Head and neck area of fibula should not appear overexposed.

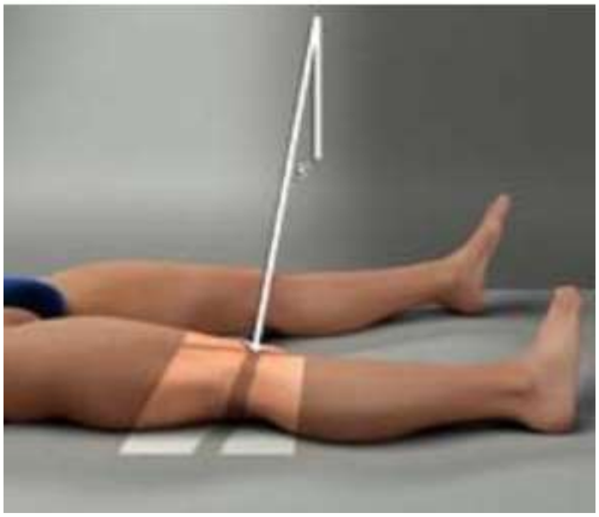


Fig: AP medial oblique

Ap Oblique Projection—Lateral (External) Rotation: Knee

Clinical Indications

• Pathology involving the proximal tibiofibular and femorotibial (knee) joint articulations

• Fractures, lesions, and bony changes related to degenerative joint disease, especially on the anterior and medial or posterior and lateral portions of knee

NOTE: A common departmental routine is to include both medial and lateral rotation oblique projections for the knee. If only one oblique is routine, it is most commonly the medial rotation oblique.

Technical Factors

• Minimum SID—40 inches (102 cm)

• IR size—24 × 30 cm (10 × 12 inches), lengthwise

• Grid or Bucky, >10 cm (70 ± 5 kV)

• Nongrid, tabletop, <10 cm (65 ± 5 kV)

• Digital systems—70 to 85 kV range

Shielding Shield radiosensitive tissues outside region of interest.

Patient Position Place patient in semisupine position with entire body and leg rotated partially away from side of interest; place support under elevated hip; provide a pillow for patient's head.

Part Position

• Align and center leg and knee to CR and to midline of table or IR.

• Rotate entire leg internally 45°. (Interepicondylar line should be 45° to plane of IR.)

• If needed, stabilize foot and ankle in this position with sandbags.

CR

• Angle CR 0° on average patient (see AP Knee on p. 244).

• Direct CR to midpoint of knee at a level 1/2 inch (1.25 cm) distal to apex of patella.

Recommended Collimation Collimate on both sides to skin margins, with full collimation at ends to IR borders to include maximum femur and tibia-fibula.

NOTE: The terms medial (internal) oblique and lateral (external) oblique positions refer to the direction of rotation of the anterior or patellar surface of the knee. This is true for descriptions of AP or PA oblique projections.

Evaluation Criteria

Anatomy Demonstrated: • Distal femur and proximal tibia and fibula with the patella superimposing the medial femoral condyle are shown. • Lateral condyles of the femur and tibia are well demonstrated, and the medial and lateral knee joint spaces appear unequal.

Position: • The proper amount of part obliquity demonstrates the proximal tibiofibular articulation open with the lateral condyles of the femur and tibia seen in profile. • The head and neck of the fibula are visualized without superimposition, and approximately half of the patella should be seen free of superimposition by the femur. The center of the collimated field is to the femorotibial (knee) joint space.

Exposure: • Optimal exposure with no motion should visualize soft tissue in the knee joint area, and trabecular markings of all bones should appear clear and sharp. • Head and neck area of fibula should not appear overexposed.

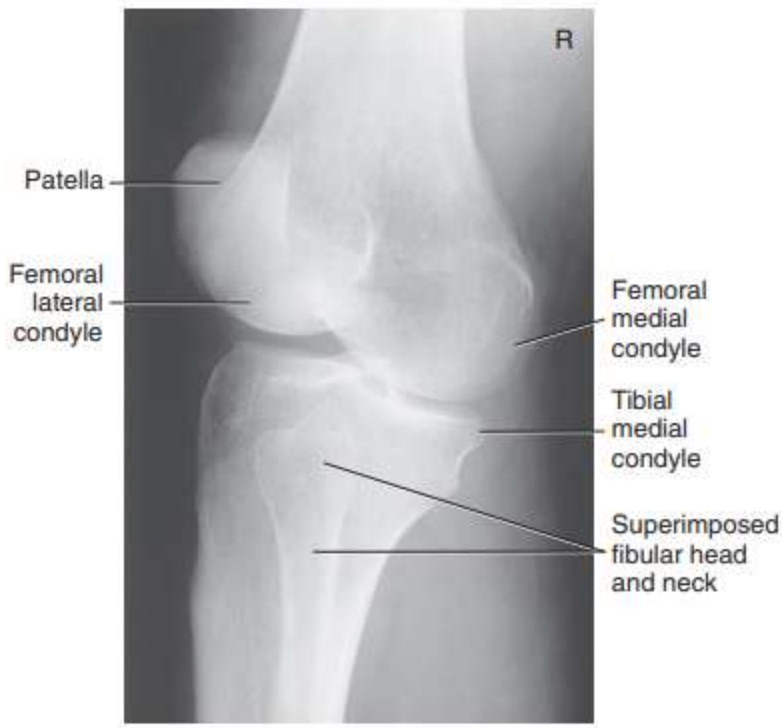


Fig: AP lateral oblique.

<u>Skyline view</u>

Clinical Indications

• Subluxation of patella and other abnormalities of the patella and femoropatellar joint

Technical Factors

• SID—48 to 72 inches (123 to 183 cm) (increased SID reduces magnification)
• IR size—24 × 30 cm (10 × 12 inches), or 35 × 43 cm (14 × 17 inches) for larger knees; crosswise
• Nongrid (grid is not needed because of air gap caused by increased OID)
• Analog—65 ± 5 kV range
• Digital systems—70 to 80 kV range
• Some type of leg support and cassette holder should be used

Shielding
Shield radiosensitive tissues outside region of interest.

Patient Position Place patient in the supine position with knees flexed 40° over the end of the table, resting on a leg support. Patient must be comfortable and relaxed for quadriceps muscles to be totally relaxed (see Note).

Part Position
• Place support under knees to raise distal femurs as needed so that they are parallel to tabletop.
• Place knees and feet together and secure legs together below the knees to prevent rotation and to allow patient to be totally relaxed.
• Place IR on edge against legs about 1/2 inches (30 cm) below the knees, perpendicular to x-ray beam.

CR
• Angle CR caudad, 30° from horizontal (CR 30° to femora). Adjust CR angle if needed for true tangential projection of femoropatellar joint spaces.
• Direct CR to a point midway between patellae.

Recommended Collimation
Collimate tightly on all sides to patellae.

Evaluation Criteria
Anatomy Demonstrated: • Intercondylar sulcus (trochlear groove) and patella of each distal femur should be visualized in profile with femoropatellar joint space open.
Position: • No rotation of knee is present, as evidenced by symmetric appearance of patella, anterior femoral condyles, and intercondylar sulcus. • Correct CR angle and centering are evidenced by open femoropatellar joint spaces.
Exposure: • Optimal exposure should clearly visualize soft tissue and joint space margins and trabecular markings of patellae. • Femoral condyles appear underexposed with only anterior margins clearly defined.

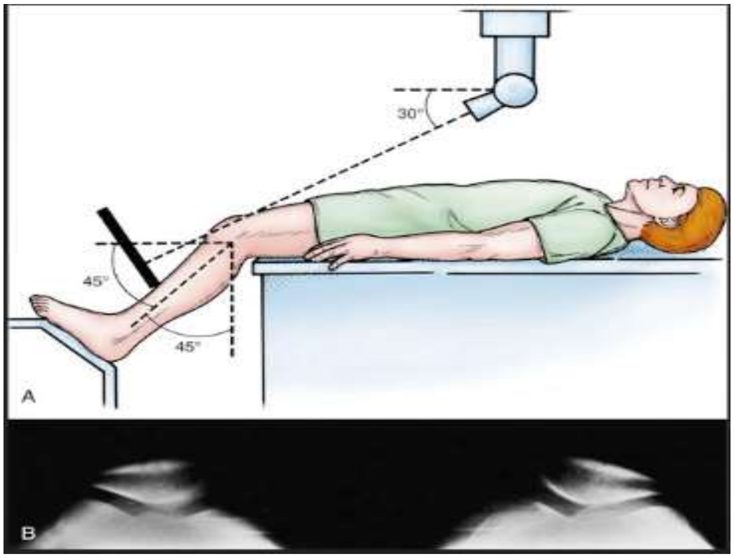


Fig: skyline view

<u>AP (weight bearing)</u>

Clinical Indications

• Femorotibial joint spaces of the knees demonstrated for possible cartilage degeneration or other knee joint pathologies
• Bilateral knees included on same exposure for comparison
NOTE: This projection most commonly is taken AP but may be taken PA with a cephalic CR angle rather than caudal as with an AP. (This may be easier for patients who are unable to straighten their knee joints fully, such as patients with arthritic conditions or with certain neuromuscular disorders involving the lower limbs.)

Technical Factors

• Minimum SID—40 inches (102 cm)
• IR size—35 × 43 cm (14 × 17 inches), crosswise
• Grid
• Analog—70 ± 5 kV range
• Digital systems—70 to 85 kV range
Shielding Shield radiosensitive tissues outside region of interest.

Patient and Part Position

• Position patient erect and standing on attached step or on step stool to place patient high enough for horizontal beam x-ray tube.
• Position feet straight ahead with weight evenly distributed on both feet; provide support handles for patient stability.
• Align and center bilateral legs and knees to CR and to midline of table and IR; IR

height is adjusted to CR.

CR

• CR perpendicular to IR (average-sized patient), or 5° to 10° caudad on thin patient, directed to midpoint between knee joints at a level 1/2 inch (1.25 cm) below apex of patellae.

Recommended Collimation Collimate to bilateral knee joint region, including some distal femurs and proximal tibia for alignment purposes.

Alternative PA If requested, an alternative PA may be performed with patient facing the table or IR holder, knees flexed at approximately 20°, feet straight ahead, and thighs against tabletop or IR holder. Direct CR 10° caudad (parallel to tibial plateaus) to level of knee joints for PA projection.

Evaluation Criteria

Anatomy Demonstrated: • Distal femur, proximal tibia, and fibula and femorotibial joint spaces are demonstrated bilaterally.

Position:

• No rotation of both knees is evident by symmetric appearance of femoral and tibial condyles.

• Approximately one-half of proximal fibula is superimposed by tibia. • Collimation field should be centered to knee joint spaces and should include sufficient femur and tibia to determine long axes of these long bones for alignment.

Exposure: • Optimal exposure should visualize faint outlines of patellae through femora. • Soft tissue should be visible, and trabecular markings of all bones should appear clear and sharp, indicating no motion.

Fig: AP bilateral weight-bearing—CR 10° caudad.

Pa Axial Projection—Tunnel View: Knee—Intercondylar Fossa

Clinical Indications

• Intercondylar fossa, femoral condyles, tibial plateaus, and intercondylar eminence demonstrated

• Evidence of bony or cartilaginous pathology, osteochondral defects, or narrowing of joint space

NOTE: Several methods are described for demonstrating these structures. The prone position is an easier position for the patient to assume. The Holmblad kneeling method provides another option with a slightly different projection of these structures. The disadvantage is that this position is sometimes uncomfortable for the patient. With the advent of x-ray tables that raise and lower, several Holmblad variations can be used to alleviate the pain of kneeling on both knees. These methods do not require a complete kneeling position, but they do require a cooperative ambulatory patient.

Technical Factors

• Minimum SID—40 inches (102 cm)

• IR size—18 × 24 cm (8 × 10 inches), lengthwise

• Grid

• Analog—70 ± 5 kV range (increase 4 to 6 kV from PA knee)

• Digital systems—70 to 85 kV range

Shielding Place lead shield over gonadal area. Secure around waist in kneeling position and extend shield down to mid femur level.

Patient Position

1. Place patient prone; provide a pillow for patient's head (Camp Coventry method).
2. Have patient kneel on x-ray table (Holmblad method).
3. Have patient partially standing, straddling x-ray table with one leg (Holmblad variation, requires elevation of examination table).
4. Have patient partially standing with affected leg on a stool or chair (Holmblad variation).

Evaluation Criteria

Anatomy Demonstrated: • Intercondylar fossa, articular facets (tibial plateaus), and knee joint space are demonstrated clearly.

Position: • Intercondylar fossa should appear in profile, open without

superimposition by patella. • No rotation is evidenced by symmetric appearance of distal posterior femoral condyles and superimposition of approximately half of fibular head by tibia. • Articular facets and intercondylar eminence of tibia should be well visualized without superimposition.
Exposure: • Optimal exposure should visualize soft tissue in knee joint space and an outline of the patella through the femur. • Trabecular markings of femoral condyles and proximal tibia should appear clear and sharp, with no motion.

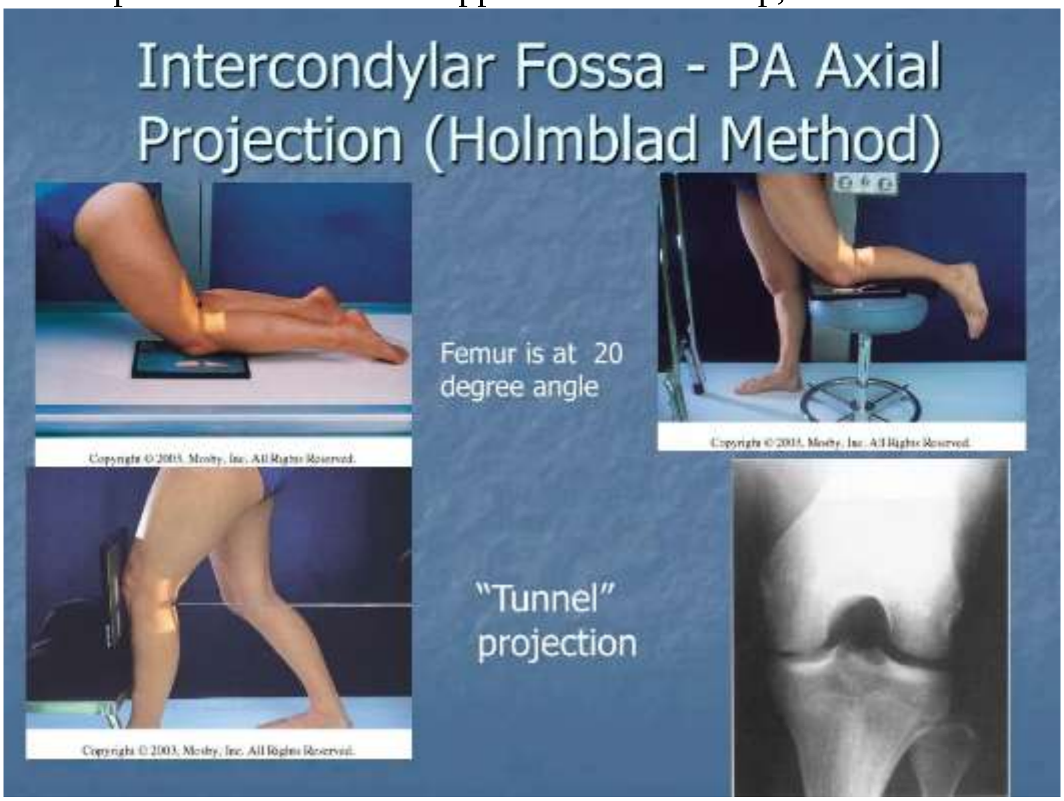


Fig: PA axial Projection

LEG

Related radiological anatomy

The radiological anatomy of the leg primarily involves the tibia and fibula, the two long bones of the lower leg, and the associated joints, muscles, tendons, and ligaments. Imaging these structures is crucial for diagnosing fractures, soft tissue injuries, and other pathologies.

Bones and Landmarks

1. **Tibia (Shin Bone)**
    - **Proximal End**:
        - **Medial and Lateral Condyles**: Articulate with the femur.

        - **Tibial Plateau**: The flat upper surface of the tibia.
        - **Intercondylar Eminence**: The raised area between the condyles.
    - **Shaft**:
        - **Anterior Border**: The sharp ridge running down the front of the tibia.
        - **Medial Surface**: The inner side of the tibia.
    - **Distal End**:
        - **Medial Malleolus**: The bony prominence on the inner side of the ankle.
2. **Fibula**
    - **Proximal End**:
        - **Head**: Articulates with the tibia.
    - **Shaft**: Slender and runs parallel to the tibia.
    - **Distal End**:
        - **Lateral Malleolus**: The bony prominence on the outer side of the ankle.

Joints

- **Proximal Tibiofibular Joint**: Between the head of the fibula and the lateral condyle of the tibia.
- **Distal Tibiofibular Joint**: Between the distal ends of the tibia and fibula.
- **Ankle Joint (Tibiotalar Joint)**: Between the distal tibia and fibula and the talus of the foot.

Soft Tissue Structures

- **Muscles**:
    - **Anterior Compartment**: Includes the tibialis anterior, extensor hallucis longus, and extensor digitorum longus.
    - **Lateral Compartment**: Includes the fibularis longus and fibularis brevis.
    - **Posterior Compartment**: Divided into superficial (gastrocnemius, soleus) and deep (tibialis posterior, flexor digitorum longus, flexor hallucis longus) muscles.
- **Tendons**: Various tendons cross the ankle joint, including the Achilles tendon.
- **Ligaments**:
    - **Medial (Deltoid) Ligament**: Supports the medial side of the ankle.
    - **Lateral Ligaments**: Includes the anterior talofibular, calcaneofibular, and posterior talofibular ligaments.
- **Nerves and Blood Vessels**: The major nerves include the common fibular (peroneal) and tibial nerves. Major arteries include the anterior tibial,

posterior tibial, and fibular arteries.

AP X-Ray View of the Leg: Positioning and Technique

Patient Positioning

1. **Patient Position**: The patient can be positioned lying supine on the X-ray table or standing upright, depending on the clinical situation and the patient's mobility.
2. **Leg Position**: The leg of interest is extended and positioned so that it lies flat on the image receptor. The foot is dorsiflexed so that the toes point upwards, ensuring the leg is in a true AP position.
3. **Central Ray**: The central ray is directed perpendicular to the image receptor, centered at the midpoint of the tibia and fibula. Typically, this is about halfway between the knee and the ankle joints.

Image Criteria

1. **Entire Leg Visualization**: The X-ray should include the entire length of the tibia and fibula from the knee joint to the ankle joint.
2. **Bone Detail**: The cortical margins of both the tibia and fibula should be clearly visible.
3. **Joint Spaces**: The knee and ankle joint spaces should be visible and free of superimposition.
4. **No Rotation**: The tibia and fibula should appear without rotation, with the interosseous space visible between the two bones.

Common Pathologies

- **Fractures**:
  - **Tibial Shaft Fractures**: Look for any discontinuity or displacement in the tibial cortex.
  - **Fibular Fractures**: Assess for similar discontinuities in the fibula.
- **Bone Lesions**:
  - **Tumors**: Benign or malignant bone lesions may appear as radiolucent

    or radiopaque areas.
    - **Infections**: Osteomyelitis may present with localized bone destruction and periosteal reaction.
- **Alignment**:
    - **Malalignment**: Evaluate the alignment of the tibia and fibula in relation to each other and the adjacent joints.
    - **Joint Involvement**: Ensure that the knee and ankle joints are properly aligned and assess for joint space narrowing or widening.
- **Soft Tissue**:
    - **Swelling**: Soft tissue swelling may indicate underlying injury or infection.
    - **Foreign Bodies**: Any radiopaque foreign bodies should be noted.

ANKLE:

Related radiological anatomy

The radiological anatomy of the ankle involves understanding the bones, joints, and soft tissues that make up the ankle region. Imaging these structures is essential for diagnosing fractures, ligament injuries, tendon pathologies, and other conditions affecting the ankle.

Bones and Landmarks

The ankle joint, also known as the talocrural joint, is formed by the articulation of three bones:

1. **Tibia**
    - **Medial Malleolus**: The bony prominence on the inner side of the ankle.
    - **Plafond**: The distal, weight-bearing surface of the tibia that forms the roof of the ankle joint.
2. **Fibula**
    - **Lateral Malleolus**: The bony prominence on the outer side of the ankle.
3. **Talus**
    - **Trochlea**: The dome-shaped superior surface that articulates with the tibia and fibula.

Joints

- **Talocrural Joint**: The primary ankle joint, formed by the tibia, fibula, and talus, allowing dorsiflexion and plantarflexion.
- **Subtalar Joint**: The joint between the talus and calcaneus, allowing inversion and eversion.

Soft Tissue Structures

- **Ligaments**:
    - **Medial (Deltoid) Ligament**: Comprising the tibionavicular, tibiocalcaneal, anterior tibiotalar, and posterior tibiotalar ligaments, it provides medial stability.
    - **Lateral Ligaments**: Includes the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL), providing lateral stability.
- **Tendons**:
    - **Achilles Tendon**: Attaches the calf muscles (gastrocnemius and soleus) to the calcaneus.
    - **Peroneal Tendons**: Includes the peroneus longus and brevis, running behind the lateral malleolus.
    - **Posterior Tibial Tendon**: Runs behind the medial malleolus.
    - **Anterior Tendons**: Includes the tibialis anterior, extensor hallucis longus, and extensor digitorum longus.
- **Bursae**: Fluid-filled sacs reducing friction, such as the retrocalcaneal bursa and the subcutaneous calcaneal bursa.
- **Nerves and Blood Vessels**: Includes the tibial nerve, superficial and deep peroneal nerves, and the posterior tibial and dorsalis pedis arteries.

Radiological Signs

- **Joint Space**: Assess for narrowing (indicative of arthritis) or widening (indicative of ligament injury).
- **Alignment**: Check for proper alignment of the tibia, fibula, and talus.
- **Bone Density**: Look for signs of osteoporosis, bone lesions, or fractures.
- **Soft Tissue Shadows**: Observe for swelling, masses, or abnormal structures.
- **Effusion**: Increased fluid in the joint space, visible on X-ray, MRI, or ultrasound.

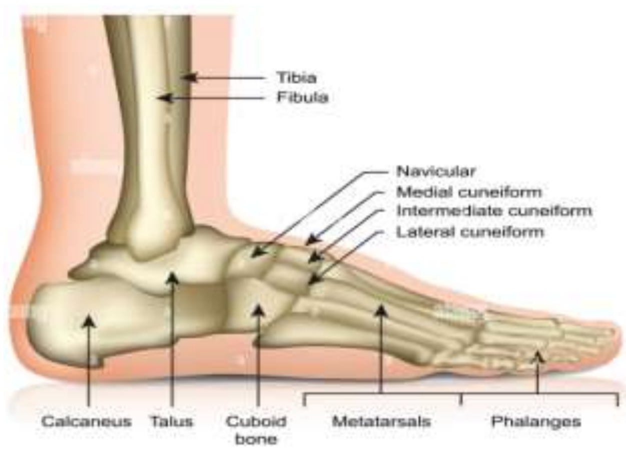


Fig: Ankle

AP mortise (15° oblique)

Terminology

Mortise and mortice are variant spellings and equally valid.

Indications

This projection is the most pertinent for assessing the articulation of the tibial plafond and two malleoli with the talar dome, otherwise known as the mortise joint of the ankle [1,2].

The most common indication is a trauma to the ankle in the setting of suspected ankle fractures and/or dislocations including talar fractures.

Other indications include:

- assessment of fragment position and implants in postoperative follow up
- evaluation of fracture healing
- osteochondral injuries of the talus
- osteoarthritis of the ankle

Patient position

- the patient may be supine or sitting upright with the leg straightened on the table
- the leg must be rotated internally 15° to 20°, thus aligning the intermalleolar line parallel to the detector. This usually results in the 5th toe being directly in line with the center of the calcaneum
- internal rotation must be from the hip; isolated rotation of the ankle will result in a non-diagnostic image
- foot should be in slight dorsiflexion

Technical factors

- **anteroposterior projection**
- **centering point**
  - the midpoint of the lateral and medial malleoli
- **collimation**
  - laterally to the skin margins
  - superiorly to examine the distal third of the tibia and fibula
  - inferior to the proximal aspect of the metatarsals
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs

- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- the lateral and medial malleoli of the distal fibula and tibia, respectively, should be seen in profile
- uniformity of the mortise joint should be seen without any superimposition of either malleolus
- the base of the 5th metatarsal must be included in the inferior aspect of the image.

Fig: AP mortise view

Ankle (stress view)

Indications

In intermediate ankle injuries that have no syndesmotic widening on x-ray — yet a high suspicion of injury — will warrant a stress view to demonstrate dynamic widening of the ankle joint [1].

Patient position (mechanical stress view)

- the patient may be supine or sitting upright with the leg straightened on the table
- the leg must be rotated internally 15° to 20°

- the second person (often requesting physician) will then place the ankle into supination and external rotation

Technical factors

- **AP projection**
- **centering point**
  - the midpoint of the lateral and medial malleoli
- **collimation**
  - attempt to avoid hands conducting stress view
  - laterally to the skin margins
  - superiorly to examine the distal third of the tibia and fibula
  - inferior to the proximal aspect of the metatarsals
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Patient position (gravity assisted stress view)

The end-goal here is to have ankle hanging over an edge to replicate a mechanical stress view.

- the patient can lay in the lateral decubitus position OR sitting in a chair with the ankle in question overhanging a sponge or cushion with the lateral aspect in contact essential placing the ankle into supination and external rotation
- the leg must be rotated internally 15° to 20°

Technical factors

- **AP horizontal beam projection**
- **centering point**
  - the midpoint of the lateral and medial malleoli
- **collimation**
  - attempt to avoid persons conducting stress view
  - laterally to the skin margins
  - superiorly to examine the distal third of the tibia and fibula
  - inferior to the proximal aspect of the metatarsals
- **orientation**
  - often held up by a detector holder or using the upright Bucky

  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-60 kVp
  - 3-5 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- the lateral and medial malleoli of the distal fibula and tibia, respectively, should be seen in profile
- there should be no movement present in the form of blurring, a particular risk when performing these views

FOOT

Related radiological anatomy

The radiological anatomy of the foot involves the detailed study of bones, joints, and soft tissues as visualized through various imaging techniques. This knowledge is essential for diagnosing fractures, deformities, soft tissue injuries, and other pathologies affecting the foot.

Bones and Landmarks

The foot is divided into three main regions: the forefoot, midfoot, and hindfoot.

1. **Forefoot**
    - **Phalanges**: Bones of the toes. Each toe has three phalanges (proximal, middle, and distal), except the big toe (hallux), which has two (proximal and distal).
    - **Metatarsals**: Five long bones numbered I-V from the big toe to the little toe. The heads of the metatarsals form the ball of the foot.
2. **Midfoot**
    - **Cuneiform Bones**: Three bones (medial, intermediate, and lateral) that articulate with the first three metatarsals.
    - **Cuboid Bone**: Articulates with the fourth and fifth metatarsals.
    - **Navicular Bone**: Located medially and articulates with the cuneiform bones and the talus.
3. **Hindfoot**
    - **Talus**: Sits above the calcaneus and forms the lower part of the ankle joint.
    - **Calcaneus**: The heel bone, the largest bone in the foot.

Joints

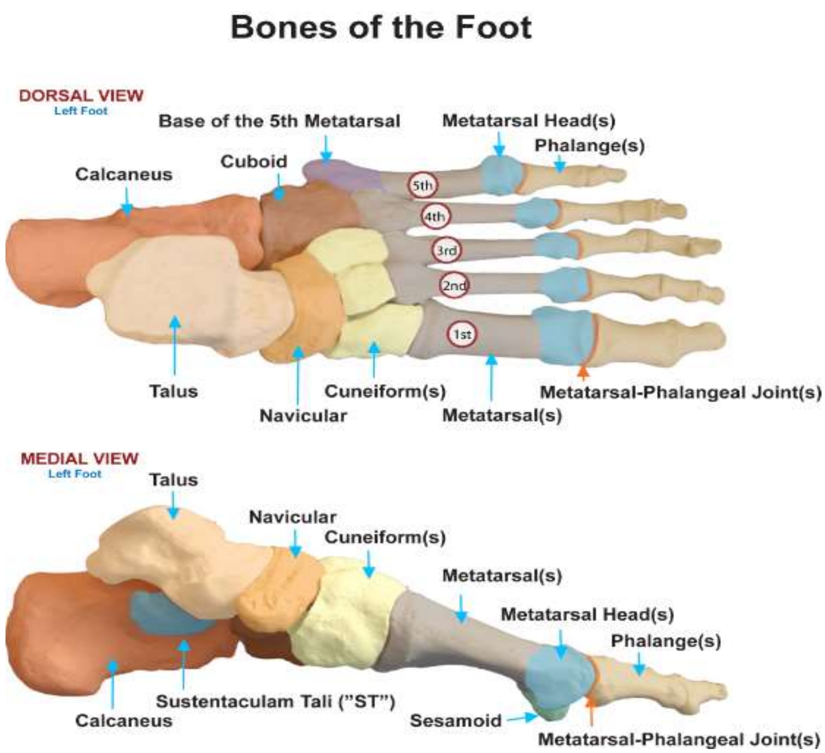
1. **Interphalangeal Joints**:
    - Between phalanges in each toe.
    - **DIP (Distal Interphalangeal) Joint**: Between distal and middle phalanges.
    - **PIP (Proximal Interphalangeal) Joint**: Between middle and proximal phalanges.
2. **Metatarsophalangeal (MTP) Joints**:
    - Between the metatarsals and proximal phalanges.
3. **Tarsometatarsal (TMT) Joints**:
    - Between the tarsal bones (cuneiforms and cuboid) and the bases of the metatarsals.
4. **Midtarsal (Chopart's) Joint**:
    - Includes the talonavicular and calcaneocuboid joints.
5. **Subtalar Joint**:
    - Between the talus and calcaneus, allowing inversion and eversion.
6. **Talocrural (Ankle) Joint**:
    - Between the talus and the tibia and fibula, allowing dorsiflexion and plantarflexion.

Soft Tissue Structures

1. **Ligaments**:
    - **Plantar Fascia**: Thick band of connective tissue running from the heel

to the toes.
- **Collateral Ligaments**: Support the sides of the interphalangeal and MTP joints.
- **Spring Ligament**: Supports the arch of the foot.

2. **Tendons**:
   - **Achilles Tendon**: Attaches the calf muscles to the calcaneus.
   - **Tibialis Anterior and Posterior Tendons**: Involved in dorsiflexion and inversion of the foot.
   - **Peroneal (Fibular) Tendons**: Run along the lateral aspect of the foot, involved in eversion.
3. **Muscles**:
   - Numerous intrinsic muscles control the fine movements of the toes.
   - Extrinsic muscles (originating in the leg) control larger movements.
4. **Bursae**:
   - Fluid-filled sacs that reduce friction, such as the retrocalcaneal bursa.



Foot (weight-bearing lateral view)

Indications

This view is key to the assessment of foot alignment and the diagnosis of abnormalities causing malalignment and foot pain, i.e. Lisfranc injury. This view may also be crucial in determining the integrity of any functional joint prior to a partial foot amputation or corrective surgery for pes planus.

Patient position

- patient stands on a stable, raised radiolucent platform (e.g. using wooden blocks) that matches the x-ray tube's lowest height
- lateral aspect of foot is kept in contact with the detector
- patient applies weight on affected foot
- unaffected foot is lifted; if possible, the contralateral toes can be positioned posterior to the affected foot's calcaneus as counterbalance

Technical factors

- **mediolateral projection**
- **centering point**
  - base of metatarsals or midfoot
- **collimation**
  - anteriorly to skin margin of the distal phalanges
  - posteriorly to skin margin of the calcaneus
  - superior to the talocrural joint
- **orientation**
  - landscape
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 55-60 kVp
  - 3-4 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- 5th metatarsal tuberosity is seen in profile
- the superior aspect of the talar domes are superimposed
- tibiotalar joint is open

Useful measurements

- calcaneal pitch
- medial cuneiform-fifth metatarsal height
- lateral talocalcaneal angle
- lateral talo-first metatarsal angle
- lateral calaneo-first metatarsal angle
- first metatarsal declination angle

Fig: Foot (weight-bearing lateral view)

Calcaneus:

Related radiological anatomy

The calcaneus, or heel bone, is the largest tarsal bone in the foot and plays a crucial role in weight-bearing and locomotion. Understanding its radiological anatomy is essential for diagnosing fractures, deformities, and other pathologies affecting the heel.

Bones and Landmarks

1. **Calcaneus**:
    - **Body**: The main, thick portion of the calcaneus.
    - **Sustentaculum Tali**: A bony ledge on the medial side that supports the talus.
    - **Calcaneal Tuberosity**: The posterior aspect where the Achilles tendon attaches.
    - **Peroneal Tubercle**: A small prominence on the lateral side where the peroneal tendons pass.
    - **Anterior Process**: Articulates with the cuboid bone.
    - **Posterior Facet**: Part of the subtalar joint, articulating with the talus.
    - **Middle and Anterior Facets**: Additional articulations with the talus, contributing to the subtalar joint.

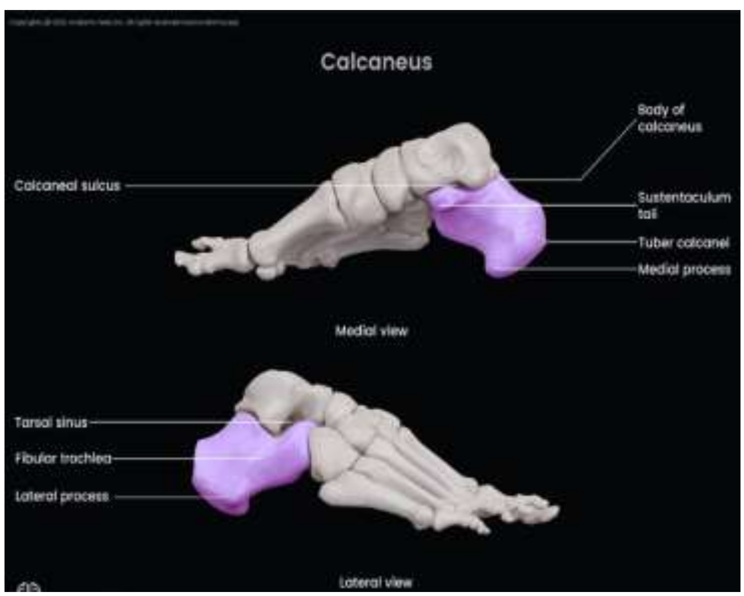
Joints

1. **Subtalar (Talocalcaneal) Joint**:
    - Formed between the talus and the calcaneus, allowing inversion and eversion of the foot.
2. **Calcaneocuboid Joint**:
    - Formed between the anterior process of the calcaneus and the cuboid

bone, part of the midtarsal joint (Chopart's joint).

Soft Tissue Structures

1. **Ligaments**:
   - **Plantar Calcaneonavicular (Spring) Ligament**: Supports the medial arch of the foot.
   - **Long Plantar Ligament**: Extends from the calcaneus to the bases of the metatarsals, supporting the lateral arch.
   - **Short Plantar Ligament**: Supports the calcaneocuboid joint.
2. **Tendons**:
   - **Achilles Tendon**: Attaches to the calcaneal tuberosity.
   - **Peroneal Tendons**: Pass posterior to the lateral malleolus and peroneal tubercle.
   - **Flexor Tendons**: Pass medially and are supported by the sustentaculum tali.
3. **Muscles**:
   - **Intrinsic Muscles**: Small muscles originating in the foot that attach to the calcaneus.
4. **Bursae**:
   - **Retrocalcaneal Bursa**: Located between the Achilles tendon and the calcaneus.
   - **Subcutaneous Calcaneal Bursa**: Between the skin and Achilles tendon.



Planto-dorsal (axial)

Pathology demonstrated

- Pathologies or fractures with medial or lateral displacement are demonstrated.

Technical factors

- IR size- 18 X 24cm (8 x 10 inches).
- Divide in half, crosswise.
- Detail screen.
- Digital IR-use lead masking
- 70 ± 5 kV range
- Increase by eight to 10KV over other food projection.
- mAs-5

Shielding

- Place lead shield over pelvic area to shield gonads.

Patient Position

- Take radiograph with patient supine or seated on table with leg fully extended.

Part Position

- Center and align ankle joint to CR and to portion of IR being exposed.
- Dorsiflex foot so planter surface is near perpendicular to IR.
- Loop gauze or a tourniquet around foot, and ask patient to pull gently but firmly and hold the planter surface of foot as near perpendicular to IR as possible. (Do not keep patient in this position any longer then is necessary because it may be very uncomfortable).

Central ray

- Direct CR base of third metatarsal to emerge at a level just distal to lateral malleolus.
- Angle CR 40degree cephalad from long axis of foot (which also would be 40degree from vertical if long axis of foot is perpendicular to IR).
- Minimum SID is 40 inches (100 cm).

Collimation

- Collimate closely to area of calcaneus.

CR and DR

- Close collimation and lead masking are important over unused portions of image plate to prevent fogging from scatter radiation to the hypersensitive image plate or receptor.

Position

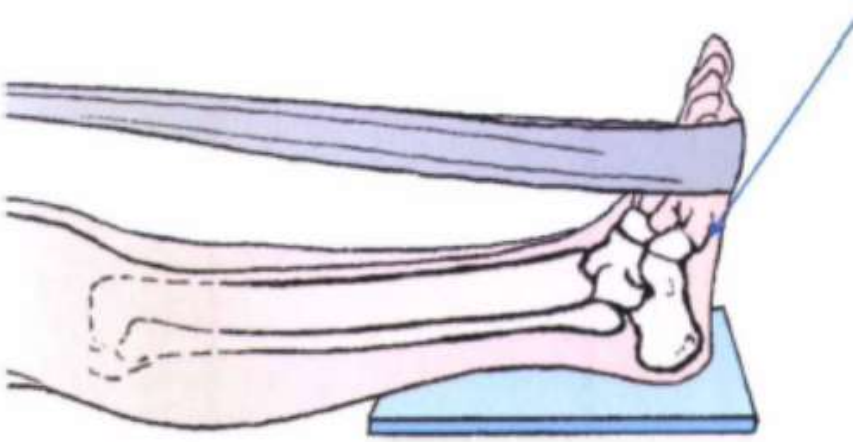
- No rotation; a portion of the sustentaculum tali should appear in profile medially.

Collimation and CR

- CR and center of collimation field should be midway between the distal lateral malleolus and the sustentaculum tali.
- With the foot in proper 90 degree flexion, correct alignment and angulation of the CR are evidenced by an open talocalcaneal joint space, no distortion of the calcaneal tuberosity, and adequate elongation of the calcaneus.

Exposure Criteria

- Optimal density and contrast with no motion will demonstrate sharp bony margins and trabecular markings and will at least faintly visualize the talocalcaneal joint without overexposing the distal tubersosity area.



Plantodorsal (axial) calcaneus

<u>Pelvic girdle and proximal femur</u>

The pelvis is a complex bony structure located at the base of the spine and in the lower part of the torso. It serves several critical functions, including supporting the weight of the upper body when sitting and standing, providing attachment points for muscles, and protecting the internal pelvic organs. The pelvis is composed of several bones that are fused together in adults. Here’s an overview of its anatomy:

Bones of the Pelvis

1. **Hip Bones (Coxal Bones/Innominate Bones)**
    - **Ilium**: The largest and uppermost part of the hip bone. It has a broad, flaring shape and forms the superior region of the pelvis.
        - **Iliac Crest**: The curved superior border of the ilium.
        - **Anterior Superior Iliac Spine (ASIS)**: A bony projection at the anterior end of the iliac crest.
        - **Posterior Superior Iliac Spine (PSIS)**: A bony projection at the posterior end of the iliac crest.
    - **Ischium**: The lower, posterior portions of the hip bone. It forms the lower and back part of the hip bone.
        - **Ischial Tuberosity**: A roughened area that bears the weight of the body when sitting.
    - **Pubis**: The anterior portion of the hip bone. The two pubic bones meet at the midline to form the pubic symphysis.
        - **Pubic Symphysis**: A cartilaginous joint where the two pubic bones are joined by a fibrocartilage disc.
2. **Sacrum**
    - A triangular bone located at the base of the lumbar vertebrae and connected to the pelvis. It consists of five fused vertebrae.
3. **Coccyx (Tailbone)**
    - A small, triangular bone at the very base of the spinal column, composed of three to five fused vertebrae.

Key Features

- **Pelvic Brim**: The edge of the pelvic inlet, a bony ring formed by the sacral promontory, the arcuate line of the ilium, and the pubic crest.
- **Greater (False) Pelvis**: The portion of the pelvis above the pelvic brim, which is part of the abdominal cavity.
- **Lesser (True) Pelvis**: The portion below the pelvic brim, which contains the pelvic cavity and organs.

Joints and Ligaments

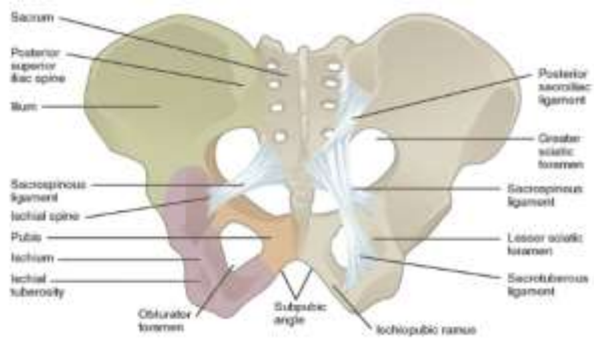
- **Sacroiliac Joints**: The joints between the sacrum and the ilium of the hip bones.
- **Pubic Symphysis**: The cartilaginous joint uniting the left and right pubic bones.

- **Sacrospinous and Sacrotuberous Ligaments**: Ligaments that connect the sacrum to the ischium, contributing to the stability of the pelvis.

Functions

- **Support**: Supports the weight of the upper body when standing and transfers this weight to the lower limbs.
- **Attachment**: Provides attachment points for muscles and ligaments involved in movement and stability.
- **Protection**: Protects the internal organs of the pelvic cavity, including the bladder, reproductive organs, and rectum.

Anterior View



Posterior View

<u>Pelvis (AP view)</u>

Indications

This view is of considerable importance in the management of severely injured patients presenting to emergency departments [1]. It helps to assess joint dislocations and fractures (i.e. <u>iliopectineal line</u>, <u>ilioischial line</u>, <u>Shenton line</u>) in the trauma setting, as well as, bone lesions and degenerative diseases. A properly aligned AP pelvis view is imperative in the assessment of early hip degeneration, in particular for the assessment of <u>femoroacetabular impingement (FAI)</u> and <u>hip dysplasia</u> [3].

Patient position

- patient is supine or standing
- lower limbs are internally rotated 15-25° from the hip (do not attempt this if a fracture is suspected) to demonstrate an AP view of the proximal femur

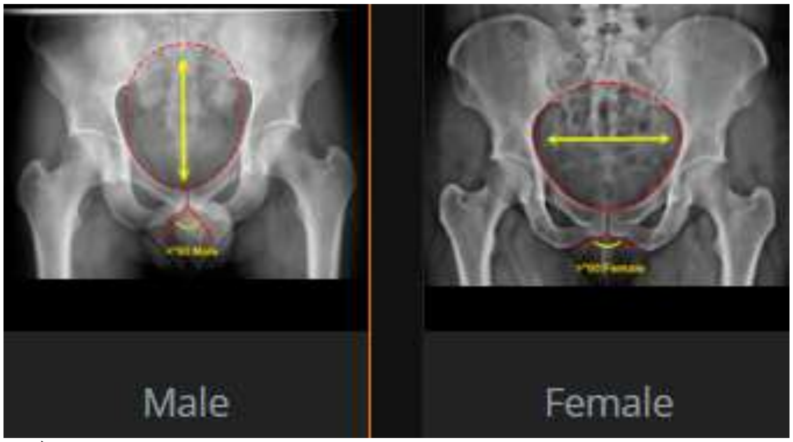
Technical factors

- **AP projection**
- **centering point**
    - the midpoint of the anterior superior iliac spine and the pubic symphysis

- **collimation**
  - laterally to the skin margins
  - superior to above the iliac crests
  - inferior to the proximal third of the femur
- **orientation**
  - landscape
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 20-30 mAs
- **SID**
  - 100 cm [2] or 120 cm [3]
- **grid**
  - yes

Image technical evaluation

- entirety of the bony pelvis is imaged from superior of the iliac crest to the proximal shaft of the femur
- obturator foramina and acetabular teardrops appear symmetrical and midsacral line aligns with the pubic symphysis
- iliac wings have an equal concavity
- greater trochanters of the proximal femur are in profile and the lesser trochanters are partially superimposed over the femoral neck.
- sacrococcygeal joint 1-3 cm superior to the upper surface of the pubic symphysis.



<u>Pelvis (inlet view)</u>

Indications

It is of considerable importance in the management of severely injured patients presenting to emergency departments . This particular view is perpendicular to the pelvic rim, allowing for assessment of any suspected narrowing or widening of that rim. Additionally, it is used to assess the anterior-posterior displacement of pubic rami fractures.

Patient position

- patient is supine
- lower limbs are internally rotated 15-25° from the hip (do not attempt this if a fracture is suspected)
- patient's hands are out of the imaging field

Technical factors

- **anteroposterior superoinferior projection**
- **centering point**
  - midline at the level of the anterior superior iliac spine
  - the central ray is angled 25-40° caudal to be perpendicular to the plane of the pelvic inlet
  - ensure central ray is aligned with the image receptor
- **collimation**
  - laterally to the skin margins
  - superior to above the iliac crests
  - inferior to the proximal femur
- **orientation**
  - landscape
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 20-30 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- the entirety of the bony pelvic rim is central to the image without superimposition
- the iliac wings are evident on the superior portion of the image, the inferior and superior pubic rami are superimposed on the inferior portion

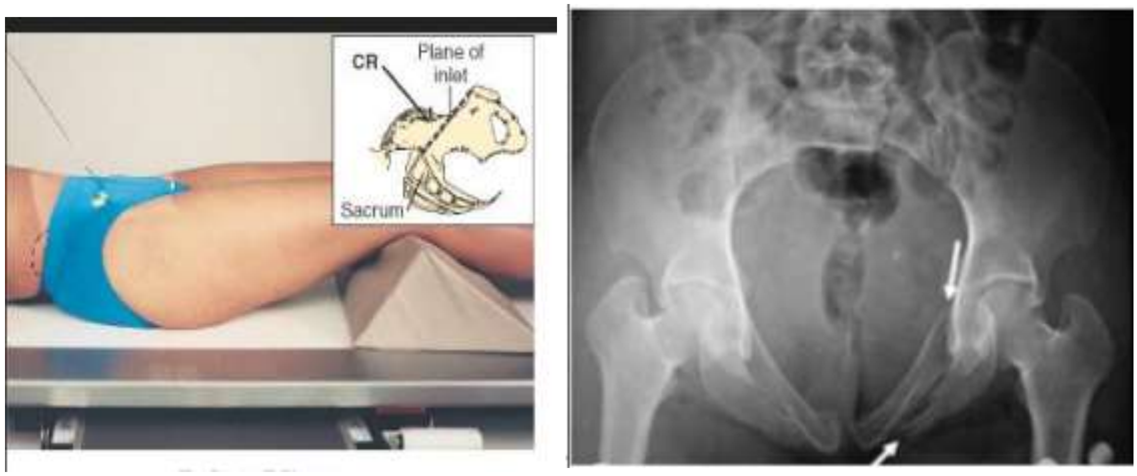


Fig: Pelvis inlet view

Pelvis (outlet view)

Indications

The outlet view is of considerable importance in the management of severely injured patients presenting to emergency departments [1-5]. This particular view allows for assessment of the cephalic/caudal translation and superior migration of the hemipelvis following trauma [2]. It can also be used to further demonstrate suspected fractures or lesions of the pubic rami.

Patient position

- patient is supine
- lower limbs are internally rotated 15-25° from the hip (do not attempt this if a fracture is suspected)
- patient's hands are out of the imaging field

Technical factors

- **anteroposterior axial projection**
- **centering point**
  - 5 cm distal to the superior pubic symphysis border
  - the central ray is angled 20-35° cephalic for males and 30-45° for females (see figures 2 and 3)
  - ensure primary beam is aligned with the image receptor
- **collimation**
  - laterally to the skin margins
  - superior to above the iliac crests
  - inferior to the proximal femur

- **orientation**
  - landscape
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 20-30 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- the entirety of the bony pelvis is imaged from superior of the iliac crest to the proximal shaft of the femur
- the pubic symphysis should be central to the image with little to no patient rotation
- there is a clear demonstration of both the anterior and inferior pubic ramus with little to no foreshortening.

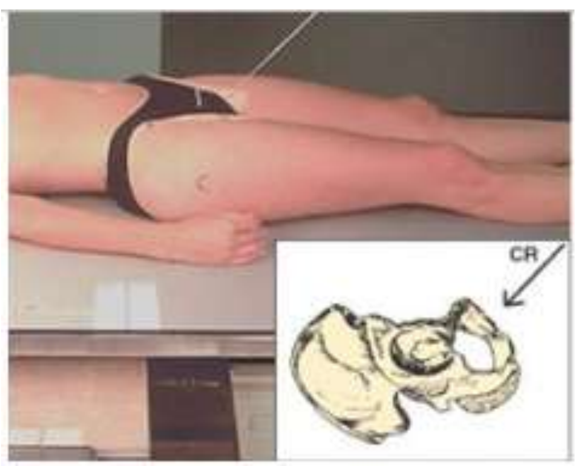


Fig: Pelvis Outlet view

Pelvis (Judet view)

Indications

The Judet views are comprised of two projections.

First the **iliac oblique** for assessment of the ilioischial line of the posterior column, the posterior column, the roof of the acetabulum, and Iliac crest.
Secondly, the **obturator oblique** view demonstrating the iliopectineal line of the anterior column, the anterior column of the pelvis, the posterior acetabular wall and the obturator foramen.

Patient position

- iliac oblique
  - patient is supine
  - the *unaffected* side is rotated roughly 45° anterior, generally aided by a 45° sponge
  - central beam directed vertically toward the affected hip
  - it is advisable that the patient is positioned central on the table and at no risk of over-rolling
- obturator oblique
  - patient is supine
  - the *affected* side is rotated roughly 45° anterior, generally aided by a 45° sponge
  - central beam directed vertically toward the affected hip
  - ensure the patient is central on the table and at no risk of over rolling

Technical factors

- **anteroposterior projection**
- **centering point**
  - iliac oblique
    - 5 cm distal and 5 cm medial of the ASIS closest to the image receptor
  - obturator oblique
    - 5 cm distal and 5 cm medial of the ASIS that is rolled up anterior to the image receptor
- **collimation**
  - superior to the level of the ASIS
  - inferior to the proximal femur
  - laterally to the skin margins
  - medially to the pubic symphysis
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 70-80 kVp
  - 10-20 mAs

- **SID**
    - 100 cm
- **grid**
    - yes

Image technical evaluation

The iliac oblique projection should demonstrate the anterior rim of the acetabulum as well as the posterior ilioischial column. The iliac wing, as it is 'flatten' out on the image, should be well demonstrated.

The obturator oblique projection should distinctly show the posterior rim as well as the anterior ilioischial line. As per the name, the obturator foramen is well demonstrated.

Fig: Judet view

Pelvis (flamingo view)

Indications

It is used for assessing instability of the pubic symphysis, often in the context of previous pelvic trauma. This projection should only be performed under specialist supervision or referral.

Patient position

The series is comprised of three separate projections traditionally performed AP erect, however patients with balance issues can benefit from a PA projection.

- **neutral**
  - patient is erect with both feet evenly planted on the ground
  - standing AP (or PA) with the posterior aspect of the pelvis resting against the upright detector
  - patient's hands are out of the way of the imaging field
- **left foot raised**
  - patient is erect with left foot off the floor for the projection, patient is reminded to place weight on right foot
  - standing AP (or PA) with the posterior aspect of the pelvis resting against the upright detector
  - patient's hands are out of the way of the imaging field
- **right foot raised**
  - patient is erect with right foot off the floor for the projection, patient is reminded to place weight on left foot
  - standing AP (or PA) with the posterior aspect of the pelvis resting against the upright detector
  - patient's hands are out of the way of the imaging field

Technical factors

- **AP/PA erect dynamic projection**
- **centering point**
  - the midpoint of the anterior superior iliac spine and the pubic symphysis
- **collimation**
  - laterally to the skin margins
  - superior to include the anterior superior iliac spine
  - inferior to the proximal third of the femur
- **orientation**
  - landscape
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 20-30 mAs
- **SID**
  - 100-150 cm

- **grid**
    - yes

Image technical evaluation

- clear annotations indicating what image the projection is in the series
- entirety of the superior and inferior pubic rami visulised
- proximal femur visible

Fig: Flamingo view

Paediatric hip (frog leg lateral view)

Indications

The bilateral examination allows for better visualisation of the hip joints and femoral neck. It is almost exclusively used in the paediatric population. It is an important view in the assessment of:

- slipped capital femoral epiphysis
- Perthes disease

Patient position

- the patient is supine with no rotation of the pelvis
- the affected limb is flexed at the knee approximately 30° to 40°, and the hip is abducted 45° (this can be bilateral)
- if unilateral, the heel of the affected limb should rest against the medial aspect of the contralateral knee
- if it is a bilateral examination, both knees are to be resting on sponges, giving the appearances of "frog legs"

Technical factors

- **lateral projection**
- **centring point**: midway between the anterior superior iliac spine and the pubic symphysis
- **collimation**
    - superior to the iliac crest
    - inferior to the proximal third of the femur
    - lateral to the skin margins
- **orientation**: landscape
- **detector size**: 24 x 30 cm or will vary depending on the patient's size
- **exposure** [2]
    - 63-70 kVp
    - 2-5 mAs
- **SID**: 100 cm
- **grid**: highly variable due to the view being a specialised paediatric projection

Image technical evaluation

- the entirety of the bony pelvis is imaged from the superior of the iliac crest to the proximal shaft of the femur
- the obturator foramina appear equal
- the iliac wings have an equal concavity
- greater trochanters of the proximal femur are in profile

Fig : Frog leg lateral view

CHEST

The chest, or thorax, is a part of the body situated between the neck and the abdomen.

It houses vital organs such as the heart and lungs and includes the rib cage, which protects these organs. Below is a description of the anatomy of the chest, accompanied by an image:

Anatomy of the Chest

1. **Bones**
    - **Sternum (Breastbone)**
        - **Manubrium**: The upper part of the sternum.
        - **Body (Gladiolus)**: The central part of the sternum.
        - **Xiphoid Process**: The small, lower part of the sternum.
    - **Ribs**
        - **True Ribs (1-7)**: Directly attached to the sternum.
        - **False Ribs (8-10)**: Indirectly attached to the sternum via cartilage.
        - **Floating Ribs (11-12)**: Not attached to the sternum at all.
    - **Thoracic Vertebrae**: The twelve vertebrae in the middle section of the vertebral column, which form the rear portion of the rib cage.
2. **Muscles**
    - **Intercostal Muscles**: Muscles located between the ribs, helping in the expansion and contraction of the chest during breathing.
    - **Pectoralis Major and Minor**: Chest muscles that play a role in the movement of the shoulder and upper arm.
    - **Diaphragm**: A major muscle that separates the thoracic cavity from the abdominal cavity and plays a crucial role in breathing.
3. **Organs**
    - **Heart**: Located in the mediastinum, between the lungs, and slightly to the left.
    - **Lungs**: Pair of organs responsible for gas exchange; they occupy most of the thoracic cavity.
    - **Trachea**: The windpipe, which connects the larynx to the bronchi of the lungs.
    - **Esophagus**: The tube that carries food from the mouth to the stomach, located behind the trachea and heart.
4. **Other Structures**
    - **Pleura**: A double-layered membrane surrounding each lung.
    - **Mediastinum**: The central compartment of the thoracic cavity, which includes the heart, trachea, esophagus, and major blood vessels.

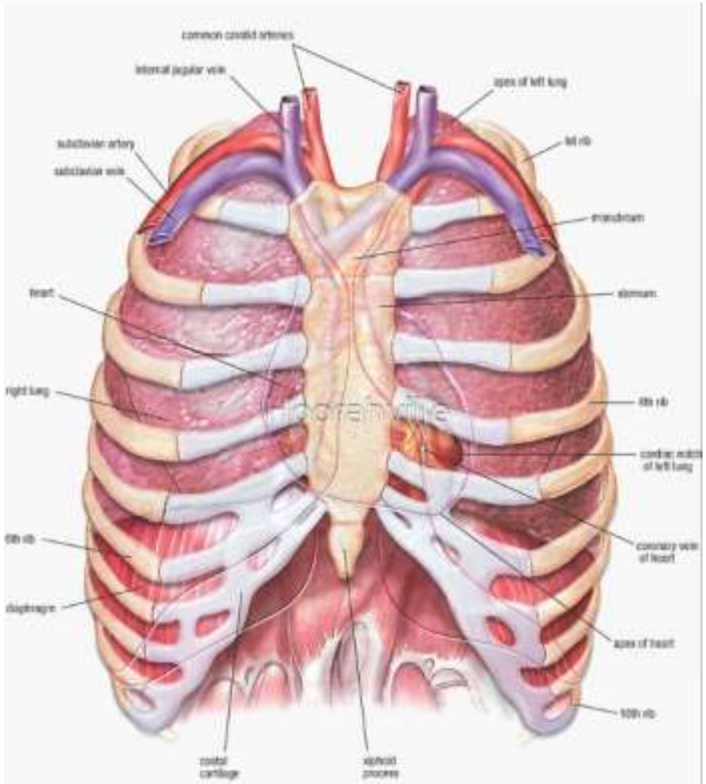


Fig: Chest

<u>Chest (AP erect view)</u>

Indications

The erect anteroposterior chest view is an alternative to the PA view when the patient is too unwell to tolerate standing or leaving the bed [1]. The AP view examines the <u>lungs</u>, bony thoracic cavity, <u>mediastinum</u>, and <u>great vessels</u>. This particular projection is often used frequently to aid diagnosis of acute and chronic conditions in intensive care units and wards. The AP view is of lesser quality than the PA view for many reasons, yet sometimes it is the only imaging available to that patient.

It is important to note that the AP projection will produce a magnified mediastinal shadow due to the increased distance of the heart from the image receptor and beam divergence (see figure 3 *AP supine* and figure 4 *PA projection* of the same patient).

Patient position

- patient is upright as possible with their back against the image receptor

- the chin is raised as to be out of the image field
- if possible, the hands are placed by the patient's side
- shoulders are depressed to move the clavicles below the lung apices

Technical factors

- **anteroposterior projection**
- **suspended inspiration**
- **centering point**
  - the level of the 7th thoracic vertebra, approximately 7 cm below the jugular notch of the sternum
  - the central ray is angled to be perpendicular to the long axis of the patient's sternum generally resulting in a caudal angle
- **collimation**
  - superiorly 5 cm above the shoulder joint to allow proper visualization of the upper airways
  - inferior to the inferior border of the 12th rib
  - lateral to the level of the acromioclavicular joints
- **orientation**
  - portrait *or* landscape
- **detector size**
  - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
  - 100-110 kVp
  - 4-8 mAs
- **SID**
  - 180 cm
- **grid**
  - yes (this may be departmentally dependent)

Image technical evaluation

The entire lung fields should be visible from the apices down to the lateral costophrenic angles.

- three posterior ribs should be seen above the superior aspect of the clavicle
- the chin should not be superimposing any structures
- sternoclavicular joints are equal distant apart
- the clavicle is in the same horizontal plane
- a minimum of eight posterior ribs are visualized above the diaphragm
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible.

Fig: AP Erect

Chest (PA view)

Indications

The chest x-ray is the most common radiological investigation in the emergency department [1]. The PA view is frequently used to aid in diagnosing a range of acute and chronic conditions involving all organs of the thoracic cavity. Additionally, it serves as the most sensitive plain radiograph for the detection of free intraperitoneal gas or pneumoperitoneum in patients with acute abdominal pain.

Patient position

- patient is erect facing the upright image receptor, the superior aspect of the receptor is 5 cm above the shoulder joints
- the chin is raised as to be out of the image field
- shoulders are rotated anteriorly to allow the scapulae to move laterally off the lung fields, and this can be achieved by either:
  - hands placed on the posterior aspect of the hips, elbows partially flexed rolling anterior or
  - hands are placed around the image receptor in a hugging motion with a

focus on the lateral movement of the scapulae

- shoulders are depressed to move the clavicles below the lung apices

Technical factors

- **posteroanterior projection**
- **suspended inspiration**
- **centering point**
  - the level of the 7th thoracic vertebra, approximately the inferior angle of the scapulae
- **collimation**
  - superiorly 5 cm above the shoulder joint to allow proper visualization of the upper airways
  - inferior to the inferior border of the 12th rib
  - lateral to the level of the acromioclavicular joints
- **orientation**
  - portrait *or* landscape
- **detector size**
  - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
  - 100-110 kVp
  - 4-8 mAs
- **SID**
  - 180 cm
- **grid**
  - yes

Image technical evaluation

The entire lung fields should be visible from the apices down to the lateral costophrenic angles.

- the chin should not be superimposing any structures
- arms are not superimposed over lateral chest wall (this can mimic pleural thickening)
- minimal to no superimposition of the scapulae borders on the lung fields
- sternoclavicular joints are equidistant from the spinous process
- the clavicle is in the same horizontal plane
- a maximum of ten posterior ribs are visualized above the diaphragm
- The 5th-7th anterior ribs should intersect the diaphragm at midclavicular line
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible

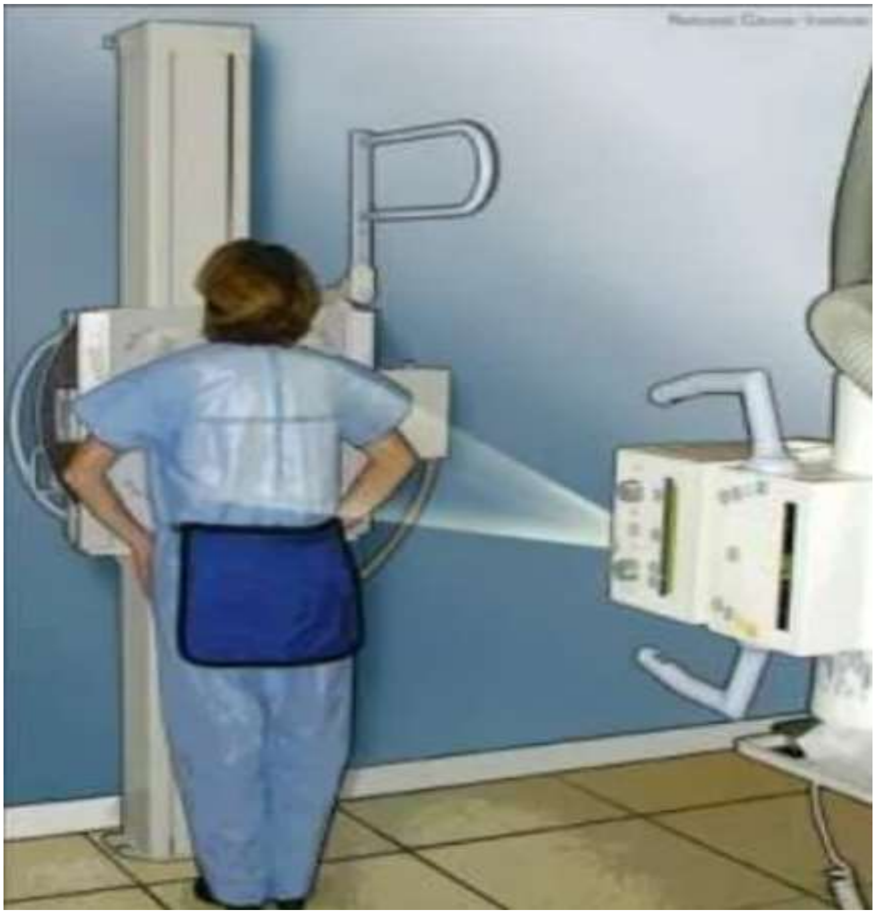


Fig: Chest PA

Chest (lateral decubitus view)

Indication

Undertaken to demonstrate small pleural effusions, or for the investigation of pneumothorax and air trapping due to inhaled foreign bodies.

Patient position

- the patient is lying either left lateral or right lateral on a trolley on top of a radiolucent sponge
  - note: when investigating pneumothorax the side of interest should be up; when investigating pleural effusions the side of interest should be down
- the detector is placed landscape posterior to the patient running parallel with the long axis of the thorax

- patient's hands should be raised to avoid superimposing on the region of interest, legs may be flexed for balance
- rotation of shoulders or pelvis should be minimized
- patients should be changed into a hospital gown, with radiopaque items (e.g. belts, zippers) removed
- x-ray is taken in full inspiration

Technical factors

- **lateral decubitus**
- **centering point**
  - midsagittal place (xiphisternum) at the level of T7
- **collimation**
  - laterally to include both lungs
  - superior to the apex
  - inferior to the costodiaphragmatic recess
- **orientation**
  - portrait (relative to the patient)
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 100 - 125 kVp
  - 3 - 10 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

A marker annotating 'horizontal beam decubitus" should always be present, with the side of interest clearly labeled.

The entire lungs should be visible from the apices down to the lateral costophrenic angles.

- the chin should not be superimposing any structures
- minimal to no superimposition of the scapulae borders on the lung fields
- sternoclavicular joints are equal distant apart
- the clavicle is in the same horizontal plane
- a minimum of ten posterior ribs is visualized above the diaphragm
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible

Fig: Lateral Decubitus

Chest (expiratory view)

Indication

They are used to help detect small pneumothoraces (although sensitivity is not increased over inspiratory chest radiographs [1]), and to assess for inhaled foreign bodies or gas trapping in COPD [2,3].

Patient position

- **PA projection**
    - patient is erect facing the upright image receptor, the superior aspect of the receptor is 5 cm above the shoulder joints
    - the chin is raised as to be out of the image field
    - shoulders are rotated anteriorly to allow the scapulae to move laterally off the lung fields, this can be achieved by either:
        - hands placed on the posterior aspect of the hips, elbows partially flexed rolling anterior or
        - hands are placed around the image receptor in a hugging motion with focus on lateral movement of the scapulae
    - shoulders are depressed to move the clavicles below the lung apices
- **AP projection**
    - patient is erect facing the X-ray tube, the superior aspect of the receptor

    is 5 cm above the shoulder joints
    - the chin is raised as to be out of the image field
    - the arms are internally rotated to attempt to remove superimposition of the scapulae over the lung fields, although this is not always possible on an AP projection
    - shoulders are depressed to move the clavicles below the lung apices

Patient position

- patient is erect facing the upright image receptor, the superior aspect of the receptor is 5 cm above the shoulder joints
- the chin is raised as to be out of the image field
- shoulders are rotated anteriorly to allow the scapulae to move laterally off the lung fields, this can be achieved by either:
    - hands placed on the posterior aspect of the hips, elbows partially flexed rolling anterior or
    - hands are placed around the image receptor in a hugging motion with focus on lateral movement of the scapulae
- shoulders are depressed to move the clavicles below the lung apices

Technical factors

- **posteroanterior *or* anteroposterior projection**
- **suspended *expiration***
- **centering point**
    - the level of the 7^{th} thoracic vertebra, approximately the inferior angle of the scapulae
- **collimation**
    - superiorly 5 cm above the shoulder joint to allow proper visualization of the upper airways
    - inferior to the inferior border of the 12^{th} rib
    - lateral to the level of the acromioclavicular joints
- **orientation**
    - portrait *or* landscape
- **detector size**
    - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
    - 100-110 kVp
    - 4-8 mAs
- **SID**
    - 180 cm
- **grid**
    - yes

Image technical evaluation

The entire lung fields should be visible from the apices down to the lateral costophrenic angles.

- the chin should not be superimposing any structures
- minimal to no superimposition of the scapulae borders on the lung fields
- sternoclavicular joints are equal distant apart
- the clavicle are in the same horizontal plane
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible

Chest (AP lordotic view)

Indication

The AP lordotic projection is often used to evaluate suspicious areas within the lung apices that appeared obscured by overlying soft tissue, upper ribs or the clavicles on previous chest views (e.g. in cases of tuberculosis or tumor).

Patient position

- the patient is standing with feet approximately 30 cm away from the image

receptor, with back arched until upper back, shoulders and head are against the image receptor
- the shoulders and elbows are rolled anteriorly
- the angle formed between the midcoronal body plane and image receptor should be approximately 45 degrees

Technical factors

- **anteroposterior projection**
- **suspended inspiration**
- **centering point**
  - midsagittal plane, halfway between the manubriosternal junction and the xiphoid process
- **collimation**
  - superiorly 5 cm above the shoulder joint to allow proper visualization of the upper airways
  - inferior to the inferior border of the 12th rib
  - lateral to the level of the acromioclavicular joints
- **orientation**
  - portrait *or* landscape
- **detector size**
  - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
  - 100-110 kVp
  - 4-8 mAs
- **SID**
  - 180 cm
- **grid**
  - yes (this may be departmentally dependent)

Image technical evaluation

- superior lung fields should be in the middle of the image with the clavicles, lung apices and two thirds of the lungs within the collimation field
- sternoclavicular ends of the clavicles should be projected above the lung apices, and the first to fourth ribs should appear horizontal and near superimposed, demonstrating a correct lordotic position and/or angle
- lateral borders of the scapulae demonstrated away from the lung fields, demonstrating sufficient anterior rotation of the patient's shoulders and elbows
- there should be equal distances from the vertebral column to the sternal clavicular ends, demonstrating no rotation
- the clavicles should appear in the same horizontal plane, and projected above lung apices.

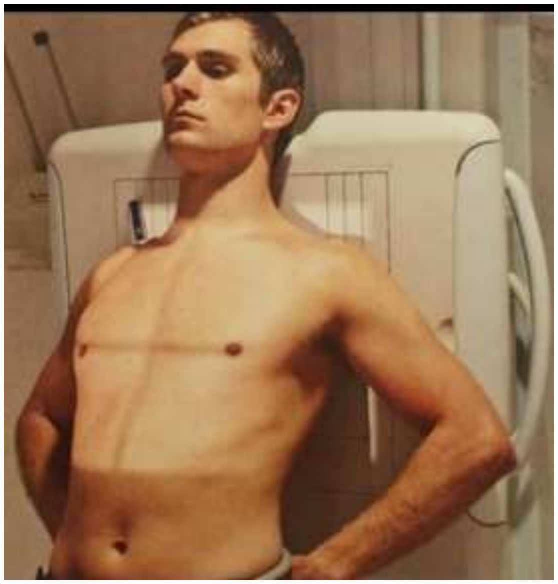


Fig: AP Lordotic View

Ribs (AP oblique view)

The **AP oblique rib** projection is performed to best demonstrate the axillary ribs. Oblique ribs may be conducted either as an anterior oblique or posterior oblique view.

Indications

The AP oblique view specifically focuses on the axillary ribs. The rib series is often considered to be an unnecessary, unjustified projection in many radiology departments. Indeed the Royal College of Radiologists (UK) iRefer guidelines state "Demonstration of a simple rib fracture does not usually alter management but if a complication such as pneumothorax or infection is suspected, chest radiograph would be appropriate" [3]. Thus if the projection might change the patient management it may still be considered pertinent and worthy of discussion.

Other indications for chest oblique views are assessing the pathology in the lung fields, trachea, mediastinal structures, contours of heart and large vessels [2].

Patient position

- the patient may be erect or supine with their right (RPO) or left posterior (LPO) side closest to the image receptor [2]
- affected side is rotated 45 degrees towards the IR [2]
- the patient's arm closest to the receptor is raised and placed on their head, with the other on their hip [2]

Technical factors

- **anteroposterior oblique projection**
- **respiration**
  - suspended inspiration
- **centering point**
  - above diaphragm: level of T7 (8 to 10 cm below the vertebral prominens.)
  - midway between the midsagittal plane and lateral margin of thorax [2]
- **collimation**
  - medially include 5 cm lateral to the sternoclavicular joint of the unaffected side
  - laterally to the lateral rib margin
  - superoinferiorly above diaphragm 5 cm above sterno-clavicular joint
  - superoinferiorly below diaphragm lower costal margin
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm [2]
- **exposure**
  - 110 – 125 kVp [2]
  - 12 – 20 mAs
- **SID**
  - 183 cm [2]
- **grid**
  - yes

Fig: Ribs AP oblique View

Image technical evaluation

- above diaphragm
  - 1^{st} – 10^{th} axillary ribs of the affected side are demonstrated without superimposition
  - thoracic vertebrae are included.

Ribs (AP view)

Indications

The AP view specifically focuses on the posterior ribs. The rib series is often considered to be an unnecessary, unjustified projection in many radiology departments. Indeed the Royal College of Radiologists (UK) iRefer guidelines state "Demonstration of a simple rib fracture does not usually alter management but if a complication such as pneumothorax or infection is suspected, chest radiograph would be appropriate" [2]. Thus if the projection might change the patient management it may still be considered pertinent and worthy of discussion.

Patient position

- the patient is erect facing the x-ray tube, posterior portion resting on the upright detector
- the chin is raised as to be out of the image field
- hands are placed by the patient's side

Technical factors

- **anteroposterior projection**
- **suspended inspiration (ribs above the diaphragm)**
- **suspended inspiration (ribs below the diaphragm)**
- **centering point (above the diaphragm)**
  - 10 cm below the jugular notch at the midsagittal plane
- **centering point (below the diaphragm)**
  - midway between the xiphoid process and the 12^{th} rib
- **collimation (ribs above the diaphragm)**
  - superior to the 1^{st} rib
  - inferior to the extent of the detctor
  - laterally to the skin borders
- **collimation (ribs below the diaphragm)**
  - superior to T9
  - inferior to the 12^{th} rib (above illiac crest)
- **orientation**

  - portrait
- **detector size**
  - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
  - 60-70 kVp
  - 30-40 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

The entire rib cage should be visible from the 1^{st} to the 12^{th}.

- the chin should not be superimposing any structures
- minimal to no superimposition of the scapulae borders on the lung fields
- sternoclavicular joints are equal distant apart
- the clavicle is in the same horizontal plane
- a minimum of ten posterior ribs is visualized above the diaphragm
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible.

▪ Ribs above diaphram

▪ Ribs below diaphram

Fig: Ribs AP view

Ribs (PA view)

Indications

The PA view specifically focuses on the anterior ribs. The rib series is often considered to be an unnecessary, unjustified projection in many radiology departments. Indeed the Royal College of Radiologists (UK) iRefer guidelines state "Demonstration of a simple rib fracture does not usually alter management but if a complication such as pneumothorax or infection is suspected, chest radiograph would be appropriate" [2]. Thus if the projection might change the patient management it may still be considered pertinent and worthy of discussion.

Patient position

- the patient is erect facing the upright image receptor, the superior aspect of the receptor is 5 cm above the shoulder joints
- the chin is raised as to be out of the image field
- shoulders are rotated anteriorly to allow the scapulae to move laterally off the lung fields, and this can be achieved by either:
  - hands placed on the posterior aspect of the hips, elbows partially flexed rolling anterior or
  - hands are placed around the image receptor in a hugging motion with a focus on the lateral movement of the scapulae
- shoulders are depressed to move the clavicles below the lung apices

Technical factors

- **posteroanterior projection**
- **suspended inspiration**
- **centering point**
  - the level of the 7th thoracic vertebra, approximately the inferior angle of the scapulae
- **collimation**
  - superiorly 5 cm above the shoulder joint to allow proper visualization of the upper airways
  - inferior to the inferior border of the 12th rib
  - lateral to the level of the acromioclavicular joints
- **orientation**
  - portrait *or* landscape
- **detector size**
  - 35 cm x 43 cm *or* 43 cm x 35 cm
- **exposure**
  - 60 - 70 kVp
  - 30 - 40 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

The entire rib cage should be visible from the 1st to the 12th.

- the chin should not be superimposing any structures
- minimal to no superimposition of the scapulae borders on the lung fields
- sternoclavicular joints are equal distant apart
- the clavicle is in the same horizontal plane
- a minimum of ten posterior ribs is visualized above the diaphragm
- the ribs and thoracic cage are seen only faintly over the heart
- clear vascular markings of the lungs should be visible.

Sternum (lateral view)

Indication

This view is invariably undertaken for one of two reasons, to assess for a fracture or metastasis. It may also rarely be performed to assess for osteomyelitis or concerns related to median sternotomy wires.

Patient position

- patient is erect with the left *or* right side of the thorax adjacent to the image receptor
- patient's hands are behind their back
- chin is raised as to be out of the image field
- arms are brought together behind their back so the chest is pushing outwards (pigeon chest)
- patient is standing upright
- midsagittal plane must be parallel to the image receptor

Technical factors

- **lateral projection**
- **suspended inspiration**
- **centering point**
  - midway between the jugular notch and the xiphoid process
- **collimation**
  - superiorly above the jugular notch
  - inferior to the xiphoid process
  - anteroposterior from the skin border to 2 cm behind the sternum
- **orientation**
  - portrait
- **detector size**

    - 24 cm x 30 cm
- **exposure**
    - 75 -85 kVp
    - 20 -25 mAs
- **SID**
    - 100 cm
- **grid**
    - yes

Image technical evaluation

- there should be no superimposition of structures over the sternum
- the entire length of the sternum can be seen in profile; the image is exposed enough that it is possible to trace the bony cortex the whole way around.

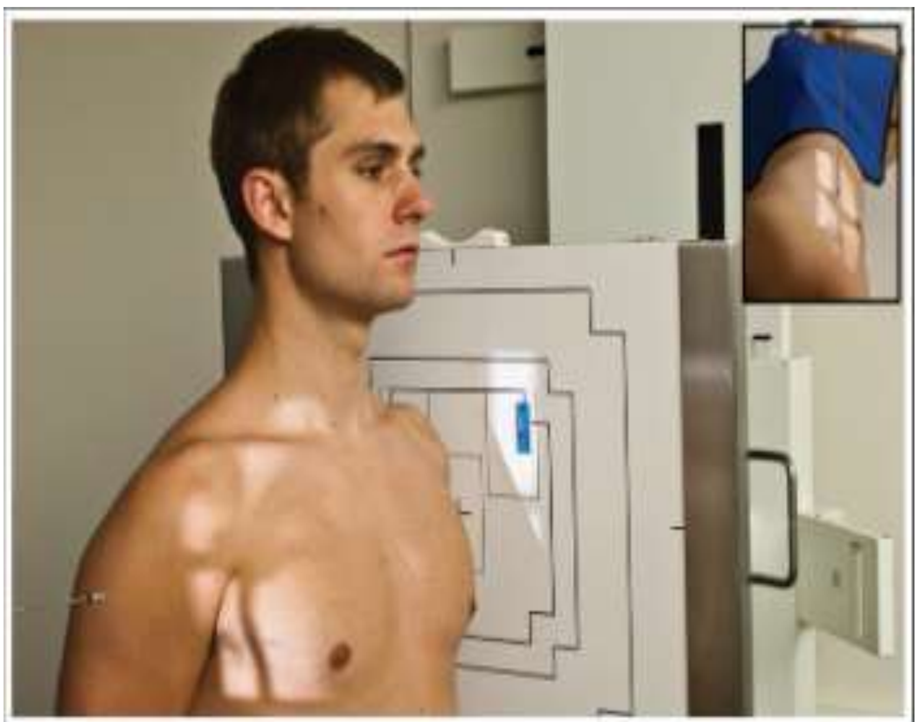


Fig: Sternum lateral view

Sternum (oblique view)

Indications

The oblique view will show the sternal body in the AP plane, it is used to query fractures or infection [1].

Patient position

- the patient is RAO facing the upright detector; the projection is performed RAO to project the sternum over the homogenous heart
- RAO is 20-30 degrees larger patients require less rotation

Technical factors

- **posteroanterior right oblique projection**
- **respiration**
  - suspended respiration *or* breathing technique if possible
- **centering point**
  - midway between the jugular notch and the xiphoid process
  - dependent on rotation around 2.5-3.0 cm left of the midline
- **collimation**
  - laterally around 15 cm to include the body of the sternum
  - superoinferiorly to include the jugular notch and the xiphoid process
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 65 – 75 kVp
  - 35 – 45 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- the body of the sternum should be superimposed over the ribs and the heart shadow with a clear bony outline.

Fig: Sternum Oblique View

ABDOMEN

Related radiological anatomy

Radiological anatomy of the abdomen involves the study of the structures and organs within the abdominal cavity as visualized through imaging techniques like X-rays, ultrasound, CT (computed tomography), and MRI (magnetic resonance imaging). Here's an overview of the key anatomical features typically assessed in abdominal radiology:

Organs

1. **Liver**
   - **Location**: Upper right quadrant
   - **Radiological Features**: Homogeneous texture, right lobe larger than left, identifiable hepatic veins and portal vein.
2. **Gallbladder**
   - **Location**: Underneath the liver
   - **Radiological Features**: Fluid-filled structure, visible on ultrasound, may show stones or inflammation.
3. **Pancreas**
   - **Location**: Behind the stomach, extends horizontally across the posterior abdominal wall.
   - **Radiological Features**: Head, body, and tail can be identified; ductal structures visible on imaging.
4. **Spleen**
   - **Location**: Upper left quadrant
   - **Radiological Features**: Homogeneous texture, usually crescent-shaped.
5. **Stomach**
   - **Location**: Upper central to left side
   - **Radiological Features**: Can be seen filled with air or contrast material; rugae folds visible.
6. **Small Intestine**
   - **Sections**: Duodenum, jejunum, ileum
   - **Radiological Features**: Coiled appearance, visible with contrast studies, distinct mucosal patterns.
7. **Large Intestine (Colon)**
   - **Sections**: Cecum, ascending, transverse, descending, sigmoid, rectum
   - **Radiological Features**: Haustral markings, visible with air or contrast

enema.

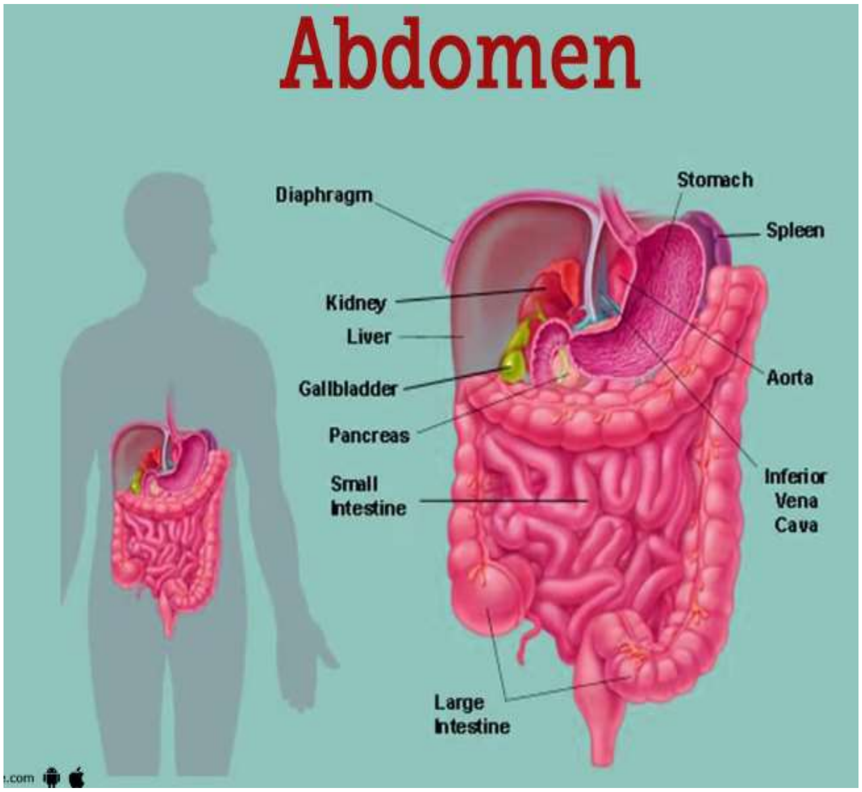
8. **Kidneys and Ureters**
    - **Location**: Retroperitoneal space on either side of the spine
    - **Radiological Features**: Renal cortex, medulla, and collecting system can be differentiated, ureters trace down to the bladder.
9. **Adrenal Glands**
    - **Location**: On top of each kidney
    - **Radiological Features**: Small, triangular or Y-shaped structures.
10. **Bladder**
    - **Location**: Pelvic cavity
    - **Radiological Features**: Visible when filled with urine, smooth-walled structure.

Vascular Structures

1. **Aorta**
    - **Location**: Runs along the spine
    - **Radiological Features**: Visible as a pulsatile structure, can be assessed for aneurysms or dissection.
2. **Inferior Vena Cava (IVC)**
    - **Location**: Right side of the aorta
    - **Radiological Features**: Large vessel returning blood to the heart, assessable for patency.
3. **Mesenteric Vessels**
    - **Radiological Features**: Superior and inferior mesenteric arteries and veins supply the intestines, visible with contrast studies.

Additional Structures

1. **Peritoneum and Mesentery**
    - **Radiological Features**: Double-layered structures, can show signs of inflammation (peritonitis) or masses.
2. **Abdominal Wall**
    - **Muscles**: Rectus abdominis, external oblique, internal oblique, transverse abdominis
    - **Radiological Features**: Muscular structures, can be assessed for hernias or trauma.



Abdomen (AP supine view)

The **AP supine abdominal radiograph** can be performed as a standalone projection or as part of an acute abdominal series, depending on the clinical question posed, local protocol and the availability of other imaging modalities.

Indications

This view is useful in assessing abdominal pathologies, including bowel obstructions, calcifications and neoplastic changes. It is also used as a scout/baseline image for contrast studies of the abdomen (i.e. small bowel follow-through).

Patient position

- the patient is supine, lying on his or her back, either on the x-ray table (preferred) or a trolley
- patients should be changed into a hospital gown, with radiopaque items

removed (e.g. belts, zippers, buttons)
- the patient should be free from rotation; both shoulders and hips equidistant from the table/trolley
- the x-ray is taken on suspended breathing to prevent motion

Technical factors

- **AP projection**
- **centering point**
  - the midsagittal plane, equidistant from each anterior superior iliac spine (ASIS) at the level of the iliac crest
- **collimation**
  - laterally to the lateral abdominal wall
  - superior to the diaphragm
  - inferior to the inferior pubic rami
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 30-120 mAs; AEC should be used if available
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- if possible, the diaphragm should be included superiorly
- the abdomen should be free from rotation with symmetry of the:
  - ribs (superior)
  - iliac crests (middle)
  - obturator foramen (inferior)
- no blurring of the bowel gas due to respiratory motion

Fig: Abdomen AP supine

Abdomen (PA erect view)

The **PA erect abdominal radiograph** is often obtained in conjunction with the AP supine abdominal view in the acute abdominal series of radiographs.
The erect abdominal radiograph has virtually disappeared from clinical practice in the United Kingdom, with studies dating back to the 1980s affirming that the erect projection rarely changes management.

Indications
This view is valuable in visualizing gas-fluid levels and free gas in the abdominal cavity as it allows the assessment of ascites, perforation, intra-abdominal masses, ileus, or postoperative complications.
Patient position

- the patient is standing, with ventral abdomen toward the image detector
- no rotation of shoulders or pelvis
- should include the entire transverse width of the patient (if possible; if not, two radiographs may be obtained)
- hands can be placed around the detector or on top

Technical factors

- **posteroanterior projection**
- **suspended inspiration (departmentally dependent)**
- **centering point**
  - 5 cm above the iliac crest at the midsagittal plane

- **collimation**
  - superiorly to include the hemidiaphragms
  - to include as much of the abdomen as possible
  - lateral to the skin margins
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm or 43 cm x 35 cm
- **exposure**
  - 70-80 kVp
  - 30-50 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- lateral abdominal wall should be included
- inferior pubic rami should be included inferiorly
- the diaphragm must be included superiorly
- the abdomen should be free from rotation with symmetry of the:
  - ribs (superior)
  - iliac crests (middle)
  - obturator foramen (inferior)
- no blurring of the bowel gas due to respiratory motion

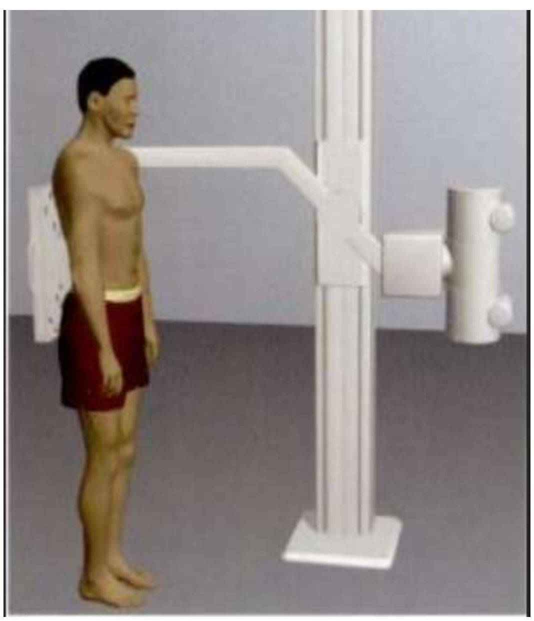


Fig : Abdomen (AP erect view)

Abdomen (PA prone view)

The **PA prone radiograph** is rarely performed and is often utilized when a patient is unable to lay supine. The projection is adequate for the examination of the abdominal cavity, however, not as practical for the renal structures due to magnification.

Indications

This view is useful in visualizing bowel obstruction, neoplasms, calcifications, ascites and as scout images in contrast medium studies of the abdomen (i.e. intravenous urography).

It is not ideal if the kidneys are the primary interest as there is magnification from an increased object to image distance.

Patient position

- the patient is prone, either on the x-ray table (preferred) or on a trolley
- patients should be changed into a hospital gown, with radiopaque items (e.g. belts, zippers) removed
- the patient should be free from rotation; both shoulders and hips equidistant from the table/trolley
- the x-ray is taken in full inspiration

Technical factors

- **PA projection**
- **centering point**
  - the midsagittal place (equidistant from each PSIS) at the level of the iliac crest
- **collimation**
  - laterally to the lateral abdominal wall
  - superior to the diaphragm
  - inferior to the inferior pubic rami
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 30-120 mAs; AEC should be used if available
- **SID**
  - 100 cm
- **grid**

    - yes

Image technical evaluation

- lateral abdominal wall should be included
- inferior pubic rami should be included inferiorly
- if possible, the diaphragm should be included superiorly
- the abdomen should be free from rotation with a symmetry of the:
    - ribs (superior)
    - iliac crests (middle)
    - obturator foramen (inferior)
- no blurring of the bowel gas due to respiratory motion

Fig: Abdomen PA prone view

Abdominal (lateral view)

The **lateral view abdominal radiograph** is a less common projection of the abdomen, it is different from the lateral decubitus view of the abdomen and looks more like a lateral lumbar spine view.

Indications

This projection is often requested as a useful problem-solving view that can complement frontal views of the abdomen, often utilized in the context of foreign bodies, to visualize soft tissue masses, umbilical hernia, or prevertebral pathology such as aortic aneurysm or calcifications [2].

This view also better visualize lines such as a shunt (or a part of a dedicated shunt series).

Patient position

- the patient may be either erect or recumbent, with her or his side against the detector
- legs may be flexed for balance [2]
- arms raised [2]

- lower bound of the field of view should contain the inferior pubic ramus
- the x-ray is taken in full expiration [2]

Technical factors

- **supine lateral projection**
- **centering point**
  - the midcoronal plane at the level of the iliac crest
- **collimation**
  - anterior-posterior to the skin margins
  - superior to the diaphragm
  - inferior to the level inferior pubic rami
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm [2]
- **exposure**
  - 70-80 kVp
  - 30-120 mAs; AEC should be used if available
- **SID**
  - 100 cm [2]
- **grid**
  - yes

Image technical evaluation

- the projection can be confirmed lateral via the lateral appearance of the vertebral bodies
- skin border is not burnt out (a filter may be required to address this)
- no blurring of the bowel gas due to respiratory motion.

Fig: Abdomen Lateral view

Abdomen (KUB view)

The **kidneys, ureters, bladder (KUB) radiograph** is optimized for assessment of the urogenital system, and should not be confused with the AP supine abdomen view. However, in cases where the patient may have both gastrointestinal and urogenital abnormalities, all pathologies will still be reported.

Indications

This view is useful in visualizing calcifications anywhere along the renal tract (i.e. kidneys, ureters, bladder, urethra). It is also used as baseline/interval images in contrast studies (i.e. intravenous urography).

Patient position

- the patient is supine, lying on their back, either on the x-ray table (preferred) or a trolley
- patients should be changed into a hospital gown, with radiopaque items removed (e.g. belts, zippers, buttons, ECG electrodes)
- the patient should be free from rotation; both shoulders and hips equidistant from the table/trolley
- the x-ray is taken on full inspiration
    - this causes the diaphragm to contract, hence compressing the abdominal organs, allowing all renal contents to be visualized on a single image

Technical factors

- **AP projection**
- **centering point**
    - the midsagittal point (equidistant from each ASIS) at the level of the iliac crest
- **collimation**
    - laterally to the lateral abdominal wall
    - superior to the upper kidney pole
    - inferior to the inferior pubic rami
- **orientation**
    - portrait
- **detector size**
    - 35 cm x 43 cm
- **exposure**
    - 70-80 kVp
    - 30-120 mAs; AEC should be used if available
- **SID**
    - 100 cm

- **grid**
  - yes

Image technical evaluation

- ensure visualization of the upper poles of both kidneys even if the diaphragm was not imaged
- the abdomen should be free from rotation with symmetry of the:
  - ribs (superior)
  - iliac crests (middle)
  - obturator foramen (inferior)

Fig: KUB AP Supine

Abdomen (lateral decubitus view)

The **lateral decubitus abdominal radiograph** is used to identify free intraperitoneal gas (pneumoperitoneum). It can be performed when the patient is unable to be transferred to, or other imaging modalities (e.g. CT) are not available. The most useful position for detecting free intraperitoneal air is the **left lateral decubitus** position.

Indication

To assess for a pneumoperitoneum when other imaging modalities are unfeasible for technical or availability reasons.

Patient position

- the patient is lying on either the left (left lateral decubitus) or right (right lateral decubitus) side
  - the left lateral decubitus is preferred as any free intraperitoneal gas will be contrasted by the liver
  - having a radiolucent sponge to elevate the patient's downside may ensuring the entire abdominal region is captured well
- the detector can be placed anteriorly or posteriorly

- patient's hands should be raised to avoid superimposing on the region of interest; legs may be flexed for balance
- rotation of shoulders or pelvis should be minimized, but not as critical as on other abdominal radiographic views
- patients should be changed into a hospital gown, with radiopaque items (e.g. belts, zippers) removed
- x-ray is often performed on expiration however this will depend on department protocols

Technical factors

- **lateral decubitus**
- **centering point**
  - midsagittal place (xiphisternum) just superior to the iliac crest
- **collimation**
  - laterally to the elevated lateral abdominal wall (e.g. right side for a left lateral decubitus x-ray)
  - superior to the diaphragm
  - inferior to the inferior pubic rami
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70 - 80 kVp
  - 30 - 120 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Fig: Abdomen (lateral decubitus view)

Image technical evaluation

- it is essential that the elevated lateral abdominal wall is included on the image to detect any free intraperitoneal gas.
- there should be no blurring of the bowel gas due to respiratory motion.

Abdomen (dorsal decubitus view)

The **dorsal decubitus view** is a supplementary projection often replacing the lateral decubitus view in the context of an unstable patient who is unable to roll nor stand. Used to identify free intraperitoneal gas (pneumoperitoneum). It can be performed when the patient is unable to be transferred to, or other imaging modalities (e.g. CT) are not available.

This projection is not a lateral projection.

Indications

Used to identify free intraperitoneal gas (pneumoperitoneum). It can be performed when the patient is unable to safety lay in the lateral decubitus position or to be transferred to, or other imaging modalities (e.g. CT) are not available.

Patient position

- the patient is supine
- the detector is placed landscape of at the patient's left-hand side running parallel to the long axis of the abdomen
- patient's hands should be raised to avoid superimposing on the region of interest; legs may be flexed for balance
- patients should be changed into a hospital gown, with radiopaque items (e.g. belts, zippers) removed
- x-ray is taken in full inspiration

Technical factors

- **horizontal beam dorsal decubitus view**
- **centering point**
  - 5 cm above the iliac crests at the midcoronal plane of the patient
- **collimation**
  - anteriorly to include soft tissue boundaries
  - posterior to include soft tissue
  - inferior to the level of the pubic rami
  - superior to the diaphragmatic domes
- **orientation**
  - landscape
- **detector size**

    - 35 cm x 43 cm
- **exposure**
    - 70 - 80 kVp
    - 30 - 120 mAs
- **SID**
    - 100 cm
- **grid**
    - yes

Image technical evaluation

- it is essential that the anterior abdominal wall and the diaphgrams are included on the image to detect any free intraperitoneal gas.
- there should be no blurring of the bowel gas due to respiratory motion.

Fig: Abdomen Dorsal Decubitus

KUB

Related radiological anatomy

The KUB radiograph is a plain X-ray of the abdomen that focuses on the **Kidneys, Ureters, and Bladder**. It is commonly used to evaluate these structures for stones, obstructions, or other abnormalities. Here's a detailed overview of the radiological anatomy relevant to a KUB:

Kidneys

- **Location**: Retroperitoneal, between T12 and L3 vertebrae.
- **Size and Shape**: Bean-shaped; usually about 10-12 cm in length.
- **Radiological Features**:
    - Outline and position: Kidneys are visible on either side of the spine.
    - Renal shadows: The borders of the kidneys should be smooth and well-

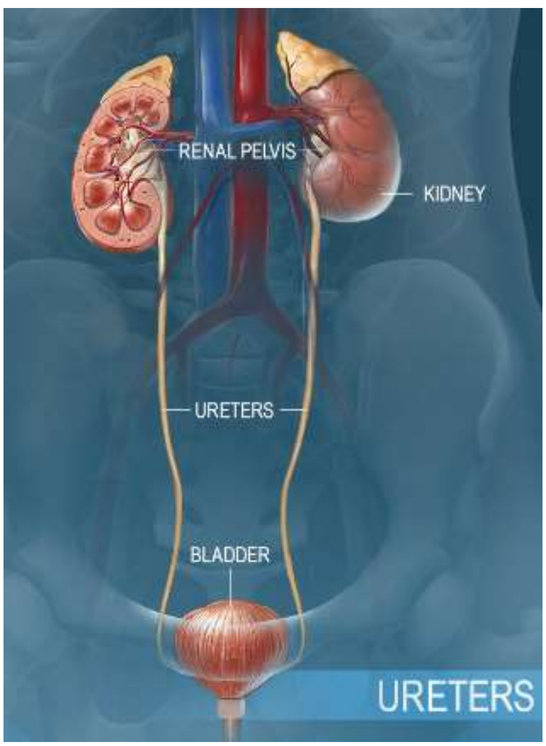
defined.
  - Calcifications: Stones or nephrocalcinosis may appear as radiopaque densities within the renal outline.

Ureters

- **Location**: Extend from the renal pelvis of each kidney, travel inferiorly, and enter the bladder.
- **Radiological Features**:
  - Not usually visible unless dilated or filled with contrast.
  - Stones: Can cause obstruction and may be visible as radiopaque densities along the course of the ureters.
  - Peristalsis: May cause ureters to have transient changes in diameter.

Bladder

- **Location**: Pelvic cavity, posterior to the pubic symphysis.
- **Shape**: When filled, it appears as a rounded, smooth-walled structure.
- **Radiological Features**:
  - Bladder outline: Should be smooth and well-defined.
  - Bladder stones: Radiopaque densities within the bladder.
  - Bladder distension: Assess the size and degree of filling.



Additional Structures on KUB

- **Bones**:
  - Lumbar vertebrae: Visible in the midline.

    - Pelvis: Iliac bones, sacrum, and coccyx.
    - Ribs: Lower ribs may be partially visible.
- **Soft Tissues**:
    - Psoas muscles: Should be visible as vertical soft tissue densities on either side of the spine.
    - Fat pads: Properitoneal fat stripe should be visible and smooth.
- **Gas Patterns**:
    - Stomach and intestines: Normal gas patterns are seen; abnormal dilatation can suggest bowel obstruction or ileus.
    - Air-fluid levels: Can indicate bowel obstruction.

CERVICAL SPINE

Related radiological anatomy

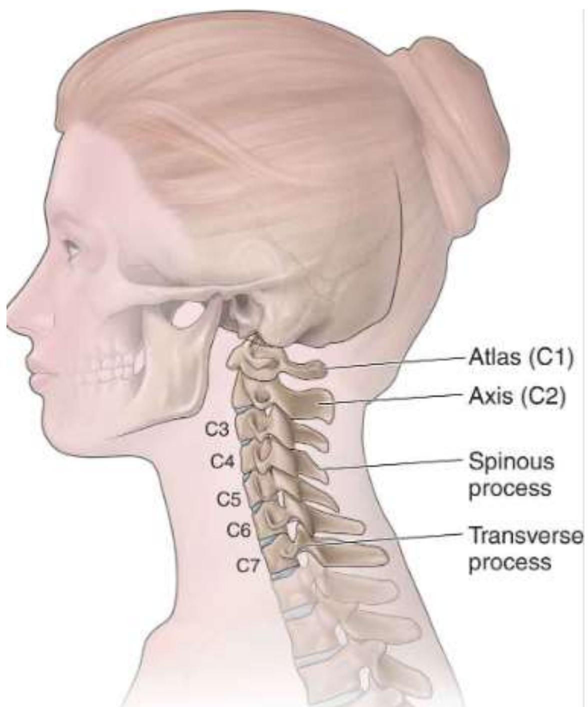
The cervical spine, or the neck portion of the spine, is composed of seven vertebrae, labeled C1 through C7, and it supports the skull, protects the spinal cord, and provides mobility and stability to the head and neck. Radiological anatomy of the cervical spine involves understanding the structures as they appear on various imaging modalities, including X-rays, CT scans, and MRI. Here's an overview of the key anatomical landmarks and their radiological appearances:

Cervical Spine Vertebrae

1. **C1 (Atlas):**
    - **Characteristics:** Ring-like structure with no body or spinous process.
    - **Radiological Features:**
        - On lateral X-ray: Appears as a ring.
        - On AP (anteroposterior) X-ray: Shows the lateral masses and the anterior and posterior arches.
        - On CT/MRI: Detailed visualization of the arches and the transverse foramen.
2. **C2 (Axis):**
    - **Characteristics:** Presence of the odontoid process (dens), which acts as a pivot for rotation.
    - **Radiological Features:**
        - On lateral X-ray: Dens is visible.
        - On AP open mouth (odontoid) view: Clear view of the dens and lateral masses.
        - On CT/MRI: Dens and its articulation with C1 are well-

demonstrated.

3. **C3-C6:**
   - **Characteristics:** Typical vertebrae with a vertebral body, transverse processes, and a bifid spinous process.
   - **Radiological Features:**
     - On lateral X-ray: Vertebral bodies, intervertebral discs, and spinous processes are visible.
     - On AP X-ray: Vertebral bodies, pedicles, and spinous processes.
     - On CT/MRI: Detailed visualization of vertebral bodies, intervertebral discs, and neural foramina.
4. **C7 (Vertebra Prominens):**
   - **Characteristics:** Long, prominent spinous process, easily palpable.
   - **Radiological Features:**
     - On lateral X-ray: Long spinous process is evident.
     - On AP X-ray: Prominent spinous process.
     - On CT/MRI: Similar to C3-C6, but with a more prominent spinous process.



Cervical spine (AP view)

The anteroposterior (AP) cervical spine projection is part of the cervical spine series.

Indications

This projection helps to visualize pathology relating to C3-C7 in the anatomical position, demonstrating any compression fractures, clay-shoveler fractures and herniated nucleus pulposus (HNP).

Patient position

- patient positioned erect in AP position (unless trauma when the patient will be supine)
- patient shoulders should be at equal distances from the image receptor to avoid rotation
- chin should be raised to align the lower margin of the upper incisors to the mastoid tips/base of the skull (unless trauma when the patient is placed in a cervical collar)

Technical factors

- **anterior-posterior projection**
- **centering point**
  - the central ray is midline centered at the level of C4 to enter immediately below the hyoid bone
  - 15° cephalad [2]
- **collimation**
  - laterally to include the entire cervical spine
  - superiorly to include C2 and inferiorly to include T2
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 65-75 kVp
  - 8-12 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- cervical spine intervertebral disk spaces should be open [2]
- spinous processes should be midline, equidistant to the pedicles, indicating that there is no rotation

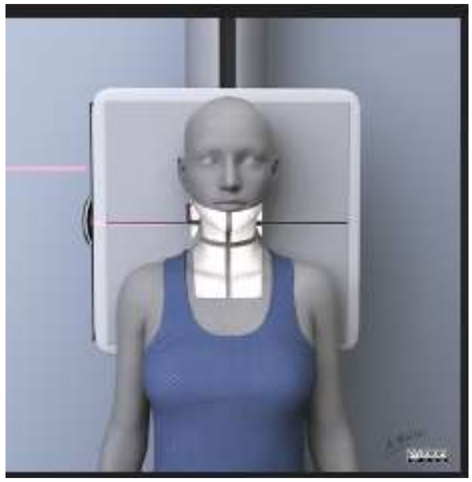


Fig: Cervical spine (AP view)

Cervical spine (lateral view)

Cervical spine lateral view is a lateral projection of the cervical spine.
As technology advances, computed tomography (CT) has replaced this projection, yet there remain many institutions (especially in rural areas) where CT is not readily available.

Indications

This projection helps to visualize pathology involving the entire cervical spine orthogonal to the AP view and is often performed in the trauma setting. It also helps to demonstrate any adjacent soft tissue structure, osteoarthritis and spondylosis.

Patient position

- the patient is supine or erect, depending on trauma or follow up
- the detector is placed portrait, running parallel to the long axis of the cervical spine on the patients left the side
- inform the patient that the image will be taken on suspended expiration

Technical factors

- **lateral projection**
- **centering point**
  - 2.5 cm above the jugular notch at the level of C4
- **collimation**
  - superior to C1
  - inferior to T1
  - anterior to include soft tissue
  - posterior to the soft tissue
- **orientation**

  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-75 kVp
  - 20-40 mAs
- **SID**
  - 150-180 cm
- **grid**
  - yes

Image technical evaluation

- there should be a clear visualization of C1 to T1 (T1 minimum)
- the vertebral bodies are superimposed laterally
- the articular pillars and zygapophyseal joints are superimposed

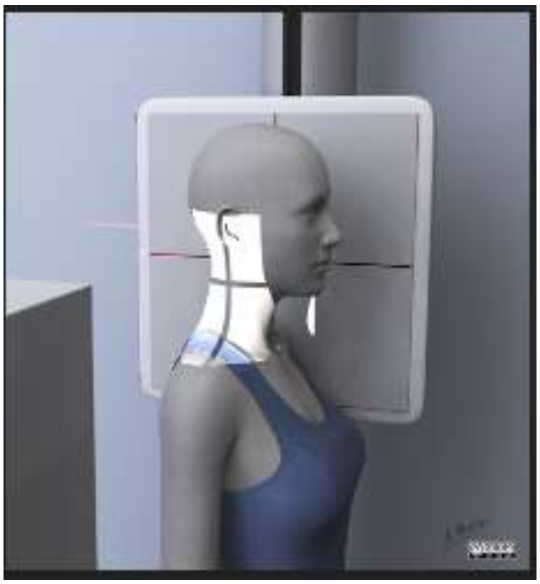


Fig: Lateral Cervical

Cervical spine (odontoid view)

The **odontoid** or **'peg'** projection, also known as the **open mouth AP projection** (or **radiograph**), is an AP projection of C1 (atlas) and C2 (axis) with the patient's mouth open.

Indications

This view focuses primarily on the odontoid process of C2, and is useful in visualizing odontoid and Jefferson fractures.

Patient position

- patient positioned erect in AP position unless trauma the patient will be supine
- patient's shoulders should be at equal distances from the image receptor to avoid rotation, the head facing straight forward.
- at the last instant, the patient is instructed to open their mouth as wide as possible
- the head should be positioned so the lower margin of the upper incisors and the base of the skull are perpendicular to the image receptor
    - do not move the head in trauma, angle the central accordingly

Technical factors

- **anterior-posterior projection**
- **centering point**
    - the central ray is centered at the center of the open mouth
    - angle accordingly; see 'patient positioning'
- **collimation**
    - laterally to include the mandible
    - superior-inferior to include the upper incisors and lower incisors
- **orientation**
    - landscape
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 70-75 kVp
    - 8-12 mAs
- **SID**
    - 100 cm
- **grid**
    - yes

Image technical evaluation

- the dens is free from superimposition of the adjacent atlas lateral masses or other tissues [2]
- the zygapophyseal joint space between C1 and C2 is symmetrical

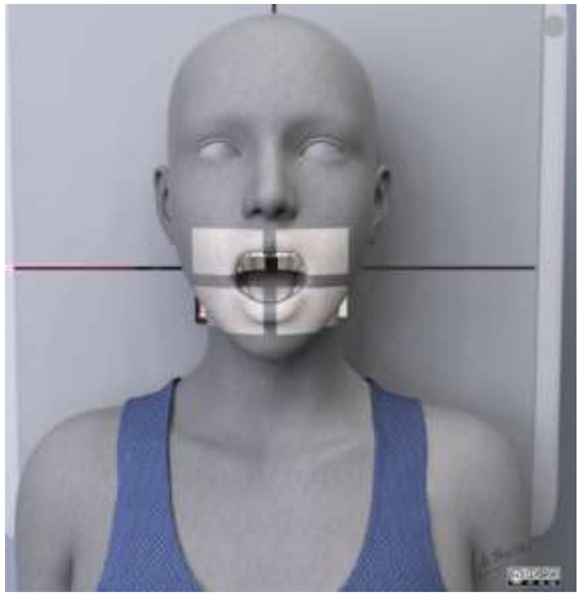


Fig : Open Mouth AP projection

Cervical spine (AP oblique view)

The **AP oblique cervical spine projections** are supplementary views to the standard AP, odontoid and lateral images in the cervical spine series and are always done bilaterally for comparison purposes. However, the PA oblique projection is preferred as it reduces radiation dose to the thyroid [1] compared to the AP oblique projection.

Clinical Indications

This projection can be used to visualize pathology involving the adjacent soft tissue structures or cervical spine, especially stenosis of the intervertebral foramina.

Note: Such views should not be performed on trauma patients without the strict instructions of a qualified clinician who has reviewed the lateral cervical spine image or CT of the cervical spine. Moving the patient's head or neck, or removing a cervical collar could be detrimental.

Patient position

- patient is standing erect with either the left or right posterior side closer to the image receptor
- the thorax and cervical spine is at 45° to the image receptor
- the face is in a lateral position with the interpupillary line perpendicular to the image receptor

Technical factors

- **anteroposterior oblique**

- **centering point**
  - C4 at or just above the level of the hyoid bone
  - 15° cranial tilt of the central ray
- **collimation**
  - laterally to include the entire cervical spine and its spinous processes
  - anteriorly to include the soft tissue of the neck
  - superiorly to include all of C1/base of skull
  - inferiorly to include to at least T1 (EAM to sternal notch)
- **orientation**
  - portrait
- **detector size**
  - 18 cm x 24 cm
- **exposure**
  - 75 kVp
  - 12.5-16 mAs
- **SID**
  - 150-180 cm
- **grid**
  - yes

Image technical evaluation

- all of the cervical spine should be included from C1-T1
- patient's head should be in a lateral position to prevent mandibular superimposition over the vertebral bodies of the cervical spine
- intervertebral foramina of the side positioned further from the image receptor should be demonstrated open

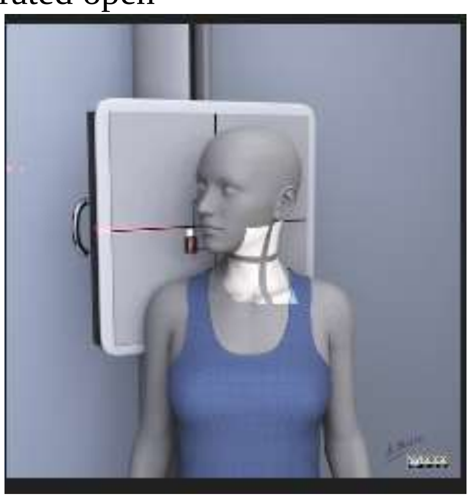


Fig: Cervical spine (AP oblique view)

<u>Cervical spine (PA oblique view)</u>

The **PA oblique cervical spine projections** are supplementary views to the standard AP, odontoid and lateral images in the cervical spine series and are always done bilaterally for comparison purposes. The PA oblique projection is preferred as it reduces radiation dose to the thyroid [1], compared to the AP oblique projection.

Clinical Indications

This projection can be used to visualize pathology involving the adjacent soft tissue structures or cervical spine, especially stenosis of the intervertebral foramina.
Note: Such views should not be performed on trauma patients without the strict instructions of a qualified clinician who has reviewed the lateral cervical spine image or CT of the cervical spine. Moving the patient's head or neck, or removing a cervical collar could be detrimental.

Patient position

- patient is standing erect with either their right or left anterior side closer to the image receptor
- the thorax and cervical vertebral column at 45° to the image receptor
- head in a lateral position

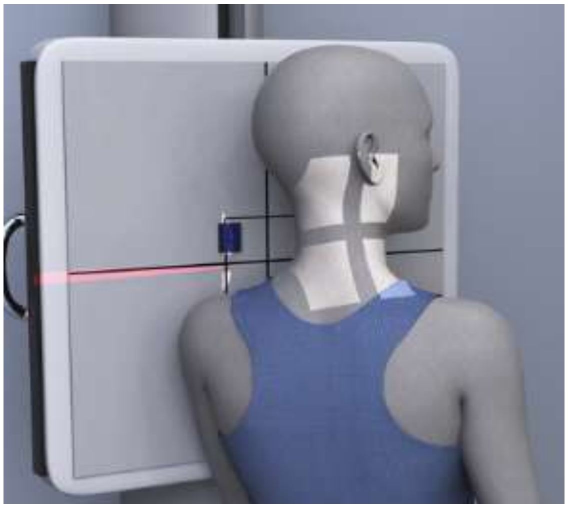
Technical factors

- **posteroanterior oblique projection**
- **centering point**
    - C4
    - central ray has a 15° caudal tilt
- **collimation**
    - laterally to include the entire cervical spine and its spinous processes
    - anteriorly to include the soft tissue of the neck
    - superiorly to include all of C1
    - inferiorly include to at least T1 (EAM to vertebral prominence of C7 and/or T1)
- **orientation**
    - portrait
- **detector size**
    - 18 cm x 24 cm
- **exposure**
    - 75 kVp
    - 12.5-16 mAs
- **SID**
    - 150-180 cm
- **grid**

  - yes

Image technical evaluation

- all of the cervical spine should be included from C1-T1
- patient’s head should be in a lateral position to prevent mandibular superimposition over the vertebral bodies of the cervical spine. To ensure this ensure that the interpupillary line is perpendicular to the image receptor but also parallel to the floor
- intervertebral foramina of the side positioned closer to the image receptor should be demonstrated open



Cervical spine (swimmer's lateral view)

Cervical spine swimmer's lateral view is a modified lateral projection of the cervical spine to visualize the C7/T1 junction.

As technology advances, computed tomography has replaced this projection, yet there remain many institutions (especially in rural areas) where computed tomography is not readily available.

Indications

This view is most often performed when a standard lateral view cannot image the cervicothoracic junction due to patients having a dense, muscular shoulder. It can help to visualize subluxation and fractures involving the inferior cervical spine, superior thoracic spine and adjacent soft tissue.

Patient position

- the patient is supine or erect, depending on trauma or follow up
- the detector is placed running parallel to the long axis of the cervical spine
- the arm closest to the detector is placed above the patient's head, resting on the head for support

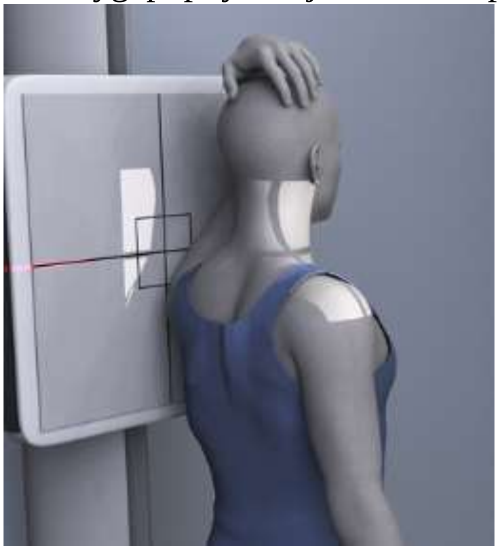
- the opposite arm is placed by the patient's side, as posterior to the patient as possible (maintaining spinal precautions if they are in place)
- image is taken on suspended expiration

Technical factors

- **lateral projection**
- **centering point**
  - 2.5 cm above the jugular notch at the level of T1
- **collimation**
  - superior to C1
  - inferior to T3
  - anterior to the extent of the vertebral bodies
  - posterior to the spinous process
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 80-90 kVp
  - 120-150 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- there should be a clear visualization of C7 to T1
- the vertebral bodies are superimposed laterally
- the articular pillars and zygapophyseal joints are superimposed



Cervical spine (flexion and extension views)

The **cervical spine flexion and extension views** demonstrate the seven vertebrae of the cervical spine when the patient is in a lateral position.

Indications

These views are specialized projections often requested to assess for spinal stability.

Note, such functional views should not be performed on trauma patients without the strict instructions of a qualified clinician.

Patient position

- the patient is erect, left side against the upright detector
- the detector is placed portrait, parallel to the long axis of the cervical spine on the patients left side
- the patient will have the neck in the extended (chin up) or flexion (chin down) position depending on the projection

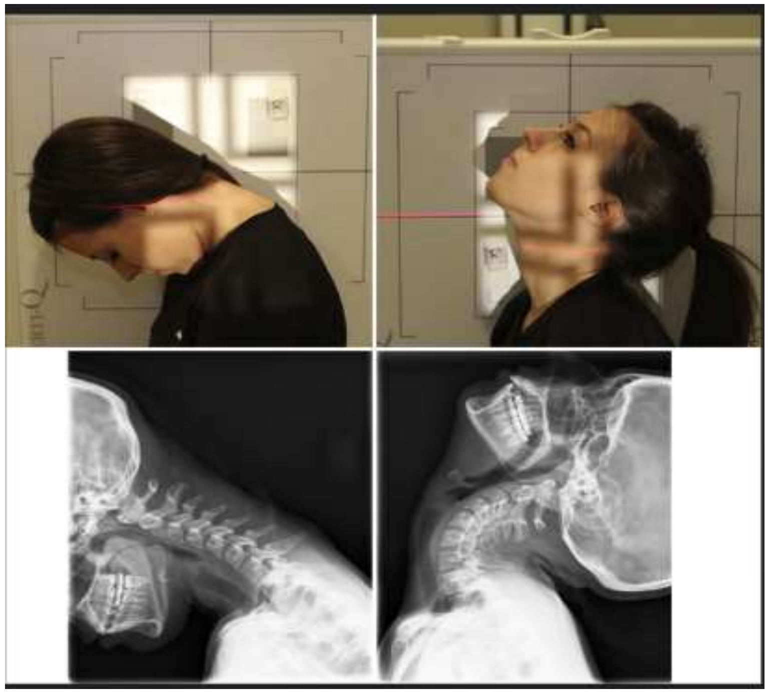
Technical factors

- **lateral projection**
- **centering point**
  - 2.5 cm above the jugular notch at the level of C4
- **collimation**
  - superior to C1
  - inferior to T1
  - anterior to include soft tissue
  - posterior to the soft tissue
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 50-75 kVp
  - 20-50 mAs
- **SID**
  - 150-180 cm
- **grid**
  - yes

Image technical evaluation

- there should be clear visualization of C7 to T1
- the image is labeled as 'flexion' or 'extension'
- flexion images should demonstrate well separated spinous process

- extension images should demonstrate crowding of the spinous process



Cervical spine (Fuchs view)

The **closed mouth odontoid AP view (Fuchs view)** is a non-angled AP radiograph of C1 (atlas) and C2 (axis).

Indications

This view focuses primarily on the odontoid process, and is useful in visualizing odontoid and Jefferson fractures. The standard Fuchs view (Figure 1 and 3) should not be used in a trauma setting and the modified Fuchs view (Figure 2) may be used instead.

Patient position

- supine or erect
- head placed against the image detector
- chin angled up 35-40°

Technical factors

- **anteroposterior projection**
- **centering point**
  - the beam is aimed just underneath the chin
- **collimation**
  - superior to the TMJ
  - inferior to include C2/3
  - lateral to include the skin margin

- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 75-80 kVp
  - 20-25 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

The entire odontoid process should be visibly to avoid obscuring anatomy.

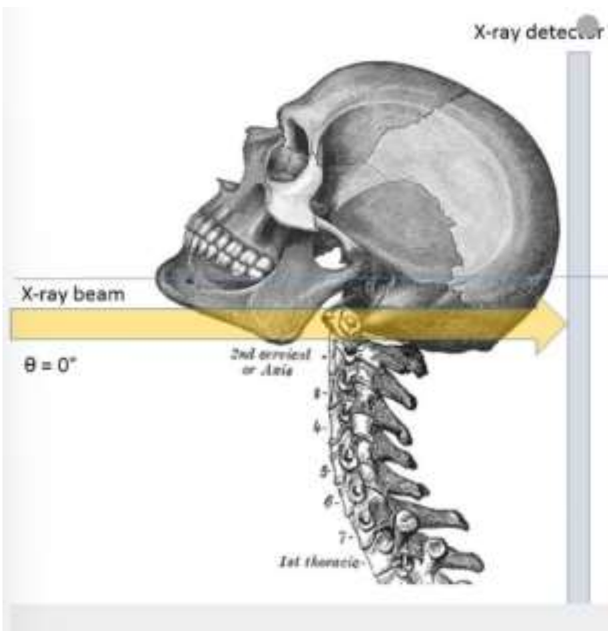


Figure 1: standard Fuchs view

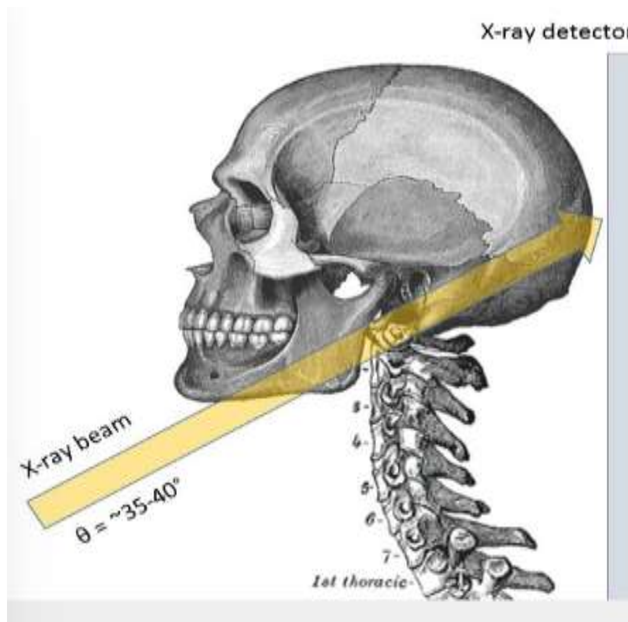
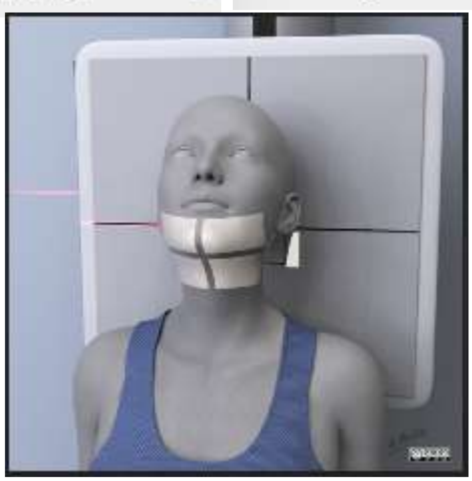


Figure 2: modified Fuchs view



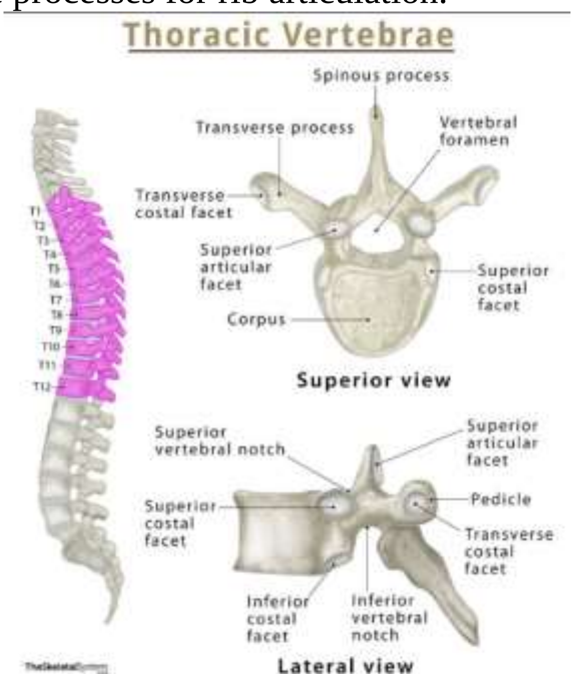
THORACIC SPINE

Related radiographic anatomy

The thoracic spine consists of twelve vertebrae labeled T1 through T12. It connects with the cervical spine above and the lumbar spine below, and articulates with the ribs to form part of the thoracic cage. Understanding the radiographic anatomy of the thoracic spine is essential for diagnosing and managing various spinal and thoracic conditions. Here's an overview of the key anatomical landmarks and their radiographic appearances:

Thoracic Spine Vertebrae

1. **General Characteristics:**
   - Each thoracic vertebra has a vertebral body, pedicles, laminae, spinous process, transverse processes, and superior and inferior articular processes.
   - The spinous processes are long and slope downward, especially in the mid-thoracic region.
   - Transverse processes have facets for articulation with ribs (costal facets).
2. **Radiographic Features:**
   - **Vertebral Body:** Heart-shaped, increases in size from T1 to T12.
   - **Pedicles:** Robust and project posteriorly.
   - **Laminae:** Form the posterior part of the vertebral arch.
   - **Spinous Process:** Long and sloped, overlapping the next vertebra's level.
   - **Transverse Processes:** Extend laterally and have costal facets for rib articulation.
   - **Costal Facets:** Present on the sides of the vertebral bodies and transverse processes for rib articulation.



Thoracic spine (AP view)

The **thoracic spine anteroposterior (AP) view** images the thoracic spine, which consists of twelve vertebrae.

Indications

This projection is utilized in many imaging contexts including trauma, postoperatively, and for chronic conditions. It can help to visualize any compression fractures, subluxation or kyphosis.

Patient position

- the patient is erect or supine, depending on clinical history
  - ideally, spinal imaging should be taken erect in the setting of non-trauma to give a functional overview of the thoracic spine
  - all imaging of patients with a suspected spinal injury must occur in the supine position without moving the patient
- hands are placed by the patient's side

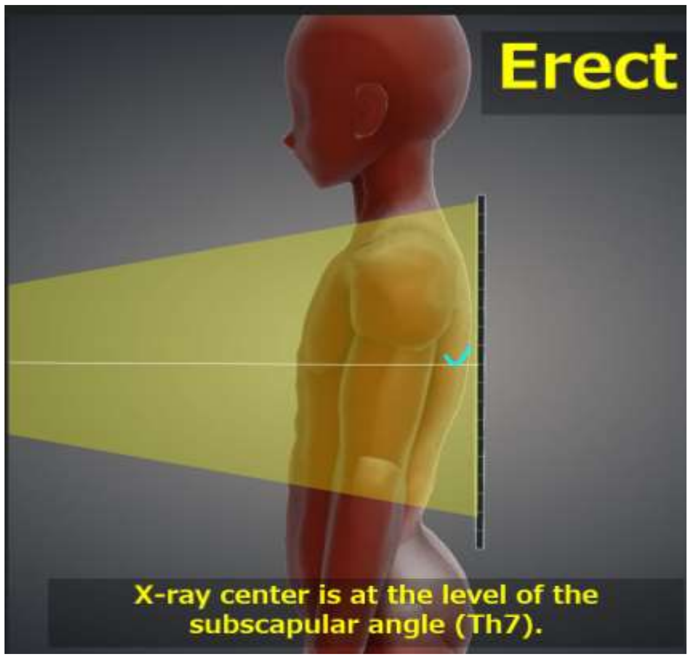
Technical factors

- **anteroposterior projection**
- **arrested inspiration (**to push the diaphragm downwards over the upper lumbar vertebra)
- **centering point**
  - the level of the 7th thoracic vertebra at the MSP
  - the central ray is perpendicular to the image receptor
- **collimation**
  - superiorly to include the C7/T1 junction
  - inferiorly to include the T12/L1 junction
  - lateral to include the costotransverse joints and left and right paraspinal lines
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 25-40 mAs
- **SID**
  - 110 cm
- **grid**
  - yes (ensure the correct grid is selected if using focused grids)

Image technical evaluation

The entire thoracic spine should be visible from T1 to T12:

- no patient rotation as evident by central spinous processes with sternoclavicular joints appearing equidistant
- intervertebral joints are seen in profile
- adequate image penetration and image contrast is evident by clear visualization of thoracic vertebral bodies, with both trabecular and cortical bone demonstrated.



Thoracic spine (lateral view)

The **thoracic spine lateral view** images the thoracic spine, which consists of twelve vertebrae.

Indications

This projection is utilized in many imaging contexts including trauma, postoperatively, and for chronic conditions. It can help to visualize any compression fractures, subluxation or kyphosis, and is used in conjunction with the AP view to complete a thoracic spine series.

Patient position

- the patient is erect, supine or lateral decubitus depending on clinical history
  - ideally, spinal imaging should be taken erect in the setting of non-trauma to give a functional overview of the thoracic spine
  - all imaging of patients with a suspected spinal injury must occur in the supine position without moving the patient
  - the lateral projection requires the upper limbs to be removed from the

  - path of the direct x-ray beam, minimizing the superimposition of the proximal humeri over the thoracic vertebrae
  - in all variations of positioning, the humeri are extended 90º to the thorax, with the elbows flexed so that the forearms are parallel to the thorax

Technical factors

- **lateral projection**
- **suspended expiration** (or breathing technique if possible)
- **centering point**
  - the level of the 7th thoracic vertebra, which correlates to the inferior border of the scapula, centered directly over the thoracic spine (most commonly equates to the posterior third of the thorax)
  - the central ray is perpendicular to the image receptor
- **collimation**
  - superiorly to include the C7/T1 junction
  - inferiorly to include the T12/L1 junction
  - anterior and posterior to include the anterior margin of all thoracic vertebrae and posterior to include the posterior column elements.
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 80-100 kVp
  - 40-80 mAs
- **SID**
  - 110 cm
- **grid**
  - yes (ensure the correct grid is selected if using focussed grids)

Image technical evaluation

The entire thoracic spine should be visible from T1 to T12:

- intervertebral joints and neural foramen are open, with the superimposition of the posterior spinous processes and posterior rib articulation indicating a true lateral has been achieved
- adequate image penetration and image contrast is evident by clear visualization of thoracic vertebral bodies, with both trabecular and cortical bone demonstrated
- visualization of the upper thoracic spine is often difficult given the patient thickness at this region. If clinical concern for injury in this area is strong, the cervical spine: swimmer's lateral view can be included, or referral to CT

can be made.

LUMBAR SPINE, SACRUM AND COCCYX:

Related radiographic anatomy

The lumbar spine, sacrum, and coccyx are important parts of the human vertebral column, each with distinct anatomical features that can be observed through radiographic imaging. Here is an overview of their related radiographic anatomy:

Lumbar Spine

1. **Vertebral Bodies**:
    - Five lumbar vertebrae (L1-L5) are the largest and bear the most weight.
    - The vertebral bodies are large and kidney-shaped in the lumbar region.
2. **Intervertebral Discs**:
    - Located between the vertebral bodies.
    - Act as shock absorbers.
3. **Spinous Processes**:
    - Thick, broad, and project horizontally.
4. **Transverse Processes**:
    - Long and slender, projecting laterally.
5. **Facet Joints**:
    - Superior and inferior articular processes that form the facet joints.
    - Oriented to allow flexion and extension while limiting rotation.

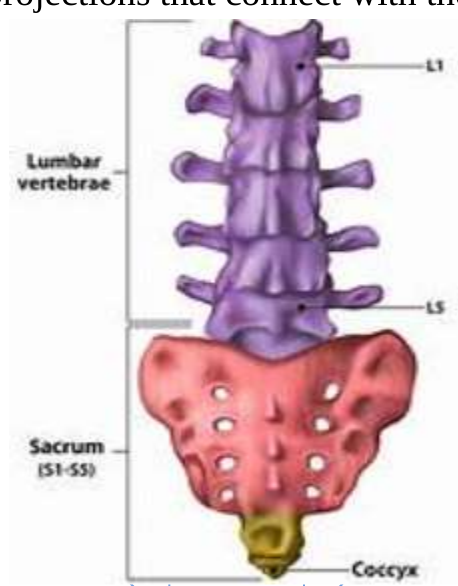
6. **Laminae**:
    - Connect the spinous process to the transverse processes.
7. **Pedicles**:
    - Connect the vertebral body to the transverse processes.
8. **Intervertebral Foramina**:
    - Openings between adjacent vertebrae for nerve roots to exit the spinal column.

Sacrum

1. **Sacral Vertebrae**:
    - Five fused vertebrae (S1-S5) form a single bone.
2. **Sacral Promontory**:
    - The anterior projecting edge of the first sacral vertebra.
3. **Ala (Wings)**:
    - The lateral parts of the sacrum that articulate with the ilium of the pelvis.
4. **Sacral Canal**:
    - Continuation of the vertebral canal, terminating at the sacral hiatus.
5. **Sacral Foramina**:
    - Four pairs of openings on each side for the exit of sacral nerves.
6. **Auricular Surface**:
    - Articulates with the ilium of the pelvis to form the sacroiliac joint.

Coccyx

1. **Coccygeal Vertebrae**:
    - Typically consists of four fused vertebrae (Co1-Co4).
2. **Base and Apex**:
    - The base is the superior part that articulates with the sacrum.
    - The apex is the inferior tip.
3. **Cornua**:
    - Small bony projections that connect with the sacrum.



Lumbar spine (AP/PA view)

The **lumbar spine anteroposterior or posteroanterior view** images the lumbar spine in its anatomical position. The lumbar spine generally consists of five vertebrae (see: lumbosacral transitional vertebra).

Indications

This projection is utilized in many imaging contexts including trauma, postoperatively, and for chronic conditions. Ideally, spinal imaging should be taken erect in the non-trauma setting to give a functional overview of the lumbar spine. Otherwise, patients with a suspected spinal injury must remain in the supine position without any movement.

Patient position

- the patient is erect or supine, depending on clinical history
- in the supine projection, hands are placed by the patient's side
- if performing erect, position the patient in the PA position; this has numerous advantages including reduced dose to the gonadal region and utilization of beam divergence; arms can be placed by the side, or the handlebars of the erect Bucky can be held for patient stability. The weight bearing PA view can be called the Ferguson technique.

Technical factors

- **anteroposterior projection**
- **suspended expiration** (for a uniform density)
- **centering point**
    - the level of the iliac crests at the MSP
    - the central ray is perpendicular to the image receptor
- **collimation**
    - superiorly to include the T12/L1 junction
    - inferior to include the sacral region
    - lateral to include the transverse processes and sacroiliac joints
- **orientation**
    - portrait
- **detector size**
    - 35 cm x 43 cm
- **exposure**
    - 70-80 kVp
    - 40-60 mAs
- **SID**
    - 110 cm
- **grid**

  - yes (ensure the correct grid is selected if using focused grids)

Image technical evaluation

- the entire lumbar spine should be visible, with demonstration of T11/T12 superiorly and the sacrum inferiorly.
- no patient rotation as evident by central spinous processes and the symmetrical appearance of the sacroiliac joints and iliac wings
- intervertebral joints are visualized
- adequate image penetration and image contrast is evident by clear visualization of lumbar vertebral bodies, pedicles, and facet joints, with both trabecular and cortical bone demonstrated

Fig: Lumbar spine (AP/PA view)

Lumbar spine (lateral view)

The **lumbar spine lateral view** images the lumbar spine which generally consists of five vertebrae (see: lumbosacral transitional vertebra).

Indications

This projection shows an orthogonal view of the AP/PA view and is utilized in many imaging contexts including trauma, postoperatively, and for chronic conditions. This view is also ideal in characterizing spinal alignment.

Note: Ideally, spinal imaging should be taken erect in the non-trauma setting to give a functional overview of the lumbar spine. Otherwise, patients with a suspected spinal injury must remain in the supine position without any movement.

Patient position

- the patient is positioned erect, supine or lateral recumbent, depending on clinical history
- in the lateral decubitus position, position the patient so that the humeri are extended 90 degrees to the thorax, with the elbows flexed so that the forearms are parallel to the thorax. Spinal curvature in the AP projection will determine if a right lateral or a left lateral is performed.
- when implementing horizontal beam technique, ensure the distal upper limbs are not overlying the region of interest. Ask the patient to cross their arms over their upper thorax, or to extend them in a similar position to that achieved in the lateral decubitus position

Technical factors

- **lateral projection**
- **expiration** (to minimize superimposition of the diaphragm over the upper lumbar spine)
- **centering point**
  - the level of the iliac crest
  - coronal centering point is directly over the lumbar vertebra, which corresponds to the posterior third of the abdomen
  - the central ray is perpendicular to the image receptor
- **collimation**
  - superiorly to include the T12/L1
  - inferior to include the sacrum
  - anterior to include the anterior border of the lumbar vertebral bodies
  - posterior to include all elements of the posterior column, particularly the spinous processes
- **orientation**
  - portrait
- **detector size**
  - 35 cm x 43 cm
- **exposure**
  - 70-80 kVp
  - 60-80 mAs
- **SID**
  - 110 cm
- **grid**
  - yes (ensure the correct grid is selected if using focussed grids)

Image technical evaluation

- the entire lumbar spine should be visible from T12/ L1- L5/S1

- superimposition of the greater sciatic notches, the superior articulating facets and the superior and inferior endplates. This indicates a true lateral has been achieved
- adequate image penetration and image contrast is evident by clear visualization of lumbar vertebral bodies, with both trabecular and cortical bone demonstrated

Fig: Lumbar spine (lateral view)

Sacrum (AP view)

The **sacrum anteroposterior (AP) view** is used to demonstrate the sacrum and its articulations. The efficacy of this radiographic projection is debatable, with radiographers encouraged to follow department protocol when imaging this region

Indications

This view can be utilized in the event of trauma, or for evaluating degenerative changes [2] of the sacrum and/or sacroiliac joints.

Patient position

- the radiograph is performed with the patient in a supine position, hands placed comfortably by the patient's side, with the legs extended
- ensure the patient is not rotated - anterior superior iliac spine must be equidistant from the IR/table.

Technical factors

- **AP view**
- **centering point**

  - at the MSP, midway between the ASIS and the symphysis pubis [3]
- **central ray**
  - angled 15° cephalic [3]
  - this angle allows the CR to be perpendicular to the sacrum as it is curved with an anterior concavity and convex posteriorly
- **collimation**
  - must adhere to the ALARA principle given the region exposed via the primary beam
  - superior to include the L5/S1 articulation
  - inferior to include the S5 (the articulation of the sacrum and coccyx will not be demonstrated clearly given the orientation of the coccyx in this projection)
  - lateral to include the SI joints
- **orientation**
  - portrait
- **detector size**
  - 24x30 cm
- **exposure**
  - 70 kVp
  - 20-30 mAs
- **SID**
  - 110 cm
- **grid**
  - yes (ensure the correct grid is selected if using focused grids)
  - when using table bucky, ensure the CR and the IR are correctly aligned, given the use of an angled tube

Image technical evaluation

- the entire sacrum should be visible from S1-S5
- not patient rotation as demonstrated by the symmetrical appearance of the SI joints and the iliac crests
- adequate penetration as evident by the clear visualization of the sacral foramen
- the sacral foramen should appear open, which is achieved using the correct tube angle.

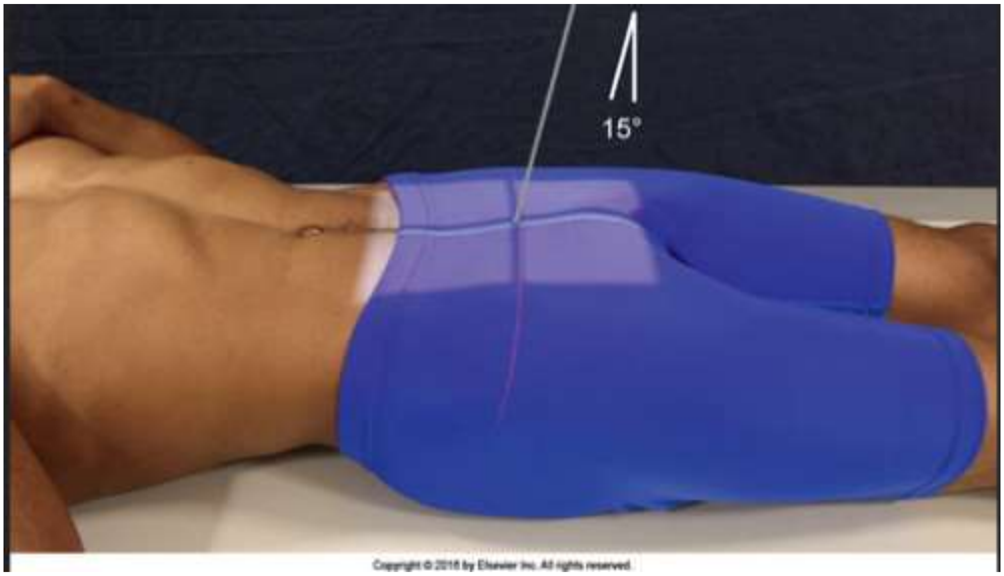


Fig: Sacrum X-rays

Coccyx (AP view)

The **coccyx anteroposterior (AP) view** is used to demonstrate the coccyx, in conjunction with the sacrum and coccyx (lateral view). Follow departmental protocol in relation to imaging this region.

Indications

This projection helps to visualize the pathology of the coccyx, especially fractures. To minimize superimposition of structures over the coccyx region, the urinary bladder and large colon should ideally be emptied before this examination [1].
Given that management of coccygeal fractures is nearly always non-operative, some radiology literature suggests that x-ray evaluation for coccygodynia is a waste of resources and exposes patients to unnecessary ionizing radiation, without having a measurable impact on clinical outcome. Thus, in some territories (e.g. the UK), the usual practice is to not perform routine imaging of the coccyx [2].

Patient position

- the patient is supine, with arms placed comfortably by their side, legs extended [1]

Technical factors

- **anteroposterior view**
- **centering point**
  - 5 cm superior to the pubic symphysis at the mid-sagittal plane [1]
- **central ray**
  - angled 10° caudal [1]

- **collimation**
  - must adhere to the ALARA principle given the radiosensitive region exposed via the primary beam
  - close collimation to the area of interest
- **orientation**
  - portrait
- **detector size**
  - 24 x 30 cm
- **exposure**
  - 80 kVp
  - 15 mAs
- **SID**
  - 110 cm
- **grid**
  - yes

Image technical evaluation

- adequate penetration should clearly demonstrate the coccyx region
- the coccyx is free of superimposition from the pubic rami
- lateral margin of the coccyx is equidistant from the pelvic brim indicating no patient rotation.

Fig: Coccyx (AP view)

Sacrum and coccyx (lateral view)

The **sacrum and coccyx lateral view** is utilized to demonstrate the most distal region of the spine in a lateral position.

Indications

This projection is commonly used in conjunction with the AP projection or can be used as a sole projection, depending on department protocols. It helps to visualize pathology of the sacrum and coccyx, and investigates the cause of sacral and coccyx pain in both acute and chronic conditions.

Patient position

- the patient is in a lateral recumbent position [1]
  - the patient can be either on the left or right lateral recumbent position, depending on which is more comfortable
  - flex the knees
  - a cushion under the waist can aid patient comfort
  - ensure the patient is in a true lateral position

Technical factors

- **lateral view**
- **centering point**
  - 8-10 cm posterior to the ASIS
- **central ray**
  - angled perpendicular to the IR (90°)
- **collimation**
  - superior to include the L5/S1 articulation
  - inferior to include the distal coccyx
  - anterior to include the entire anterior margin of the sacrum
  - posterior to the skin margin
- **orientation**
  - portrait
- **detector size**
  - 24 x 30 cm
- **exposure**
  - 80 kVp
  - 30-40 mAs
- **SID**
  - 110 cm
- **grid**
  - yes

Image technical evaluation

- the entire sacrum and coccyx should be visible from L5/S1 to terminal coccyx
- no patient rotation as demonstrated by superimposition of the greater sciatic notches and femoral heads
- adequate penetration should clearly demonstrate the sacrum and coccyx region.

Fig : Sacrum and coccyx (lateral view)

PEDIATRIC RADIOGRAPHY

When performing X-rays on babies, special care and attention are required to ensure accurate imaging while minimizing radiation exposure. Here are key considerations for X-ray positioning care and radiation protection for infants:

X-Ray Positioning Care

1. **Preparation**:
   - Explain the procedure to the parents or guardians and gain their cooperation.
   - Ensure the baby is calm and comfortable. Use soothing techniques or allow a parent to hold and comfort the baby if possible.
2. **Immobilization**:
   - Use gentle immobilization techniques to prevent movement and obtain clear images.
   - Immobilization devices like Velcro straps, sandbags, or foam sponges can be helpful.
   - For chest X-rays, a Pigg-O-Stat or similar pediatric immobilizer can be

used.

3. **Positioning Aids**:
    - Use positioning aids such as lead markers, sponges, or rolled towels to help achieve the correct positioning.
    - Ensure the baby is properly aligned to avoid repeat exposures.
4. **Proper Positioning**:
    - Follow standard positioning guidelines for the specific anatomical area being imaged (e.g., AP or lateral views for chest or abdomen).
    - Verify correct positioning before exposure using alignment lights or markers.

Radiation Protection

1. **Minimize Exposure**:
    - Use the lowest possible exposure settings (kVp and mAs) to achieve diagnostic-quality images.
    - Limit the field size to the area of interest using collimation.
2. **Lead Shielding**:
    - Use lead shielding to protect the baby's gonads and other sensitive areas from unnecessary radiation.
    - Ensure the lead shields are properly placed and do not obscure the area of interest.
3. **Distance**:
    - Maintain as much distance as possible between the X-ray source and the baby to reduce exposure.
    - Use a long cone or collimator to keep the X-ray beam focused and minimize scatter.
4. **Parental Involvement**:
    - If a parent is required to hold the baby during the procedure, provide them with a lead apron and thyroid shield to protect them from radiation.
    - Encourage parents to step back and avoid the direct beam path whenever possible.
5. **ALARA Principle**:
    - Follow the ALARA (As Low As Reasonably Achievable) principle to ensure radiation exposure is minimized.
    - Regularly review and update protocols to incorporate new techniques and technologies that reduce exposure.

SKULL & CRANIAL BONES AND FACIAL BONES:

Related radiological anatomy

Here's an overview of the skull, cranial bones, and facial bones, highlighting their radiological anatomy. Including images for reference, we'll describe key features visible in X-ray and other radiographic modalities.

Skull and Cranial Bones

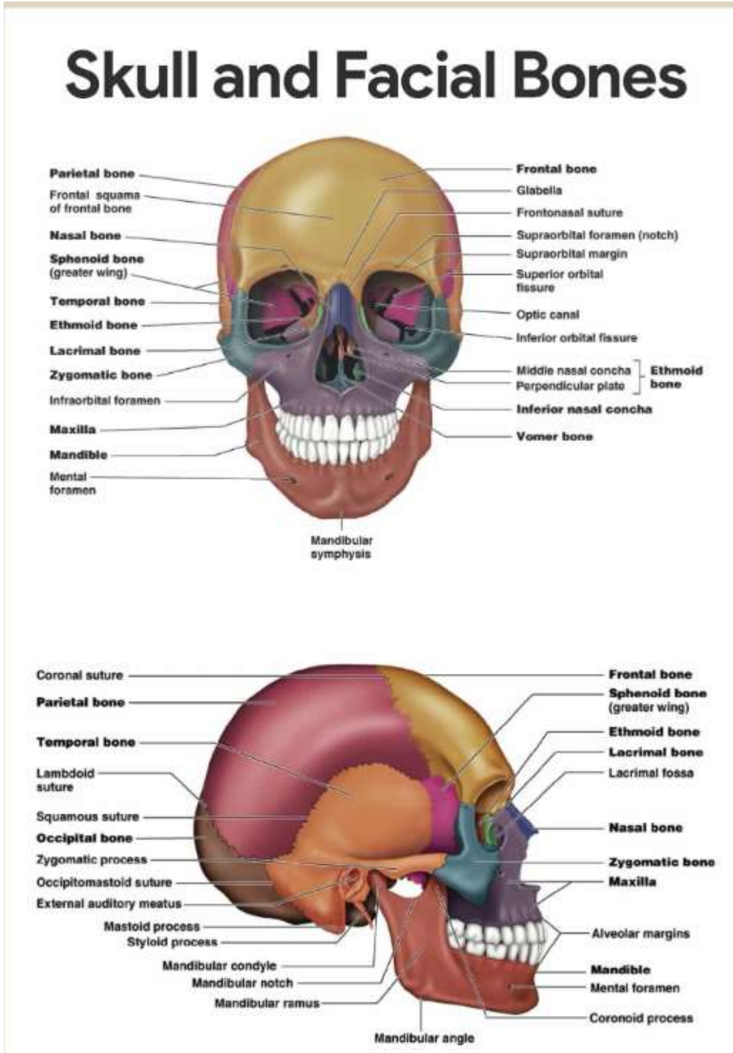
The skull comprises the cranium (which encases the brain) and the facial bones. The cranial bones include:

1. **Frontal Bone**: Forms the forehead and the superior part of the orbital cavity.
2. **Parietal Bones**: Paired bones forming the superior and lateral aspects of the cranium.
3. **Temporal Bones**: Located on the sides of the skull, containing the structures of the ear.
4. **Occipital Bone**: Forms the posterior part of the skull and the base of the cranium.
5. **Sphenoid Bone**: A butterfly-shaped bone at the base of the skull, contributing to the floor of the cranium and the sides of the orbit.
6. **Ethmoid Bone**: Located between the eyes, forming part of the nasal cavity and the orbits.

Facial Bones

The facial bones include:

1. **Maxilla**: Paired bones forming the upper jaw and the majority of the hard palate.
2. **Zygomatic Bones**: Cheekbones, forming part of the orbit.
3. **Nasal Bones**: Form the bridge of the nose.
4. **Lacrimal Bones**: Small bones forming part of the medial wall of each orbit.
5. **Palatine Bones**: Form part of the hard palate, nasal cavity, and orbit.
6. **Inferior Nasal Conchae**: Thin bones forming part of the lateral walls of the nasal cavity.
7. **Vomer**: Forms the inferior part of the nasal septum.
8. **Mandible**: The lower jawbone, the only movable bone of the skull.



Skull (AP view)

The **skull anteroposterior (AP) view** is a non-angled radiograph of the skull. This view provides an overview of the entire skull rather than attempting to highlight any one region.

Indications

This examination is able to assess for medial and lateral displacements of skull fractures, in addition to neoplastic changes and Paget disease.

Note: As this view results in higher radiation dose to the radiosensitive lens of the eyes compared to the PA view, it should only be used in situations where the patient is unable to face the detector, like in trauma settings and patients with poor mobility.

Patient position

- the back of patient's head is placed against the image detector

Technical factors

- **anteroposterior projection**
- **centering point**
  - the central ray is centered at the nasion
- **collimation**
  - laterally to include soft tissue
  - superiorly soft tissue
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 75 kVp
  - 8-10 mAs
- **SID**
  - 100 cm
- **grid**
  - yes

Image technical evaluation

- ensure the image is symmetrical and free from any rotation
- assess the orbital margins and ensure they are similar in appearance
- the petrous ridge will overlap the orbits

Fig: Skull (AP view)

Skull (PA view)

The **skull posteroanterior (PA) view** is a non-angled radiograph of the skull. This view provides an overview of the entire skull rather than attempting to highlight any one region.

Indications

This examination is able to assess for medial and lateral displacements of skull fractures, in addition to neoplastic changes and Paget disease.

Patient position

- the patient is erect
- the patient's forehead is placed against the image detector allowing for the nose to be in contact as well

Technical factors

- **posteroanterior projection**
- **centering point**
  - the beam is exiting at the nasion
- **collimation**
  - superior to the skin margins
  - inferior to include the most inferior aspects of the skull
  - lateral to include the skin margin
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 75-80 kVp
  - 20-25 mAs
- **SID**
  - 100 cm
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

The petrous ridge will overlap the orbits, and the innominate lines should be equal distance from the lateral borders of the orbits.

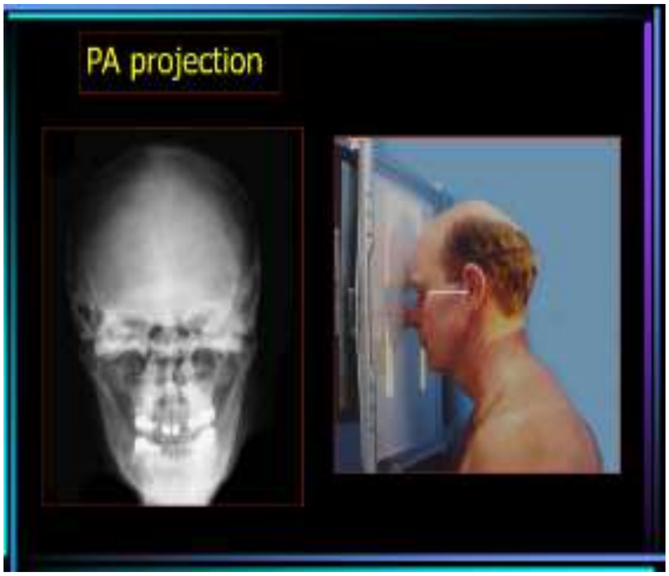


Fig : Skull (PA view)

Skull (lateral view)

The **skull lateral view** is a non-angled lateral radiograph of the skull. This view provides an overview of the entire skull rather than attempting to highlight any one region.

Indications

This projection is used to evaluate for skull fractures, in addition to neoplastic changes and Paget disease. In the trauma setting, a horizontal beam lateral projection may demonstrate air-fluid levels in the sphenoid sinus [1], an indication of basal skull fracture.

Patient position

- the sagittal midline of the patient's head is parallel to the image detector
- sella turcica in profile
- temporomandibular joints are superimposed

Technical factors

- **lateral projection**
- **centering point**
  - the beam travels laterally, with 0° of angulation, through a point ~4 cm above the external auditory meatus
- **collimation**
  - superiorly to include skin margins
  - inferiorly to include base of skull
  - anteriorly to include frontal bone

- posteriorly to the skin margins
- **orientation**
  - landscape
- **detector size**
  - 24 cm x 30 cm
- **exposure**
  - 60-70 kVp
  - 10-20 mAs
- **SID**
  - 100 cm
- **grid**
  - no

Image technical evaluation

- the sagittal midline of the patient's head is parallel to the image detector
- sella turcica in profile
- temporomandibular joints are superimposed

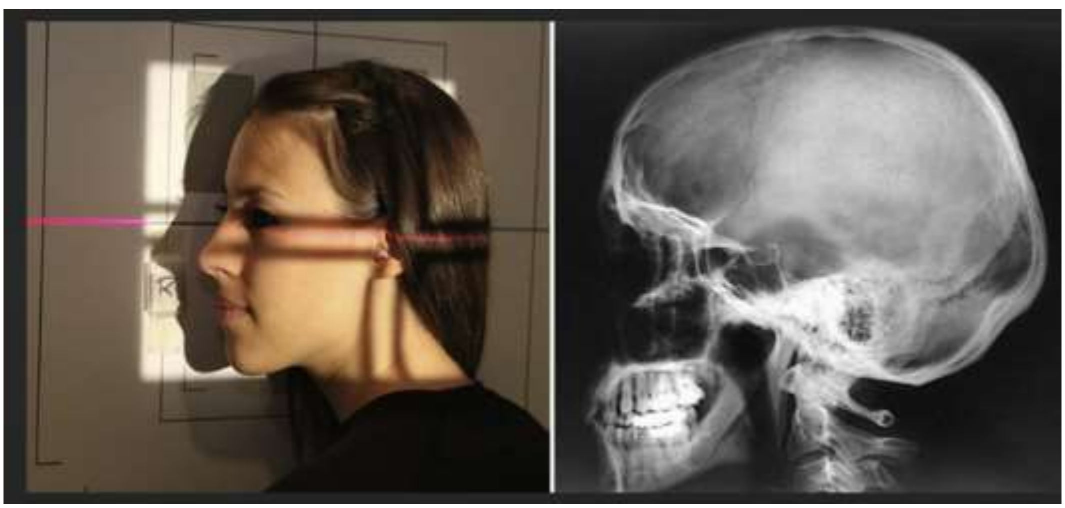


Fig: Skull (lateral view)

Skull (Towne view)

The **Towne view** is an angled anteroposterior radiograph of the **skull** and visualizes the petrous part of the pyramids, the dorsum sellae and the posterior clinoid processes, which are visible in the shadow of the foramen magnum.

Indications

This projection is used to evaluate for medial and lateral displacements of skull fractures, and radiopaque foreign bodies [2].

Patient position

- supine position. Remove all foreign bodies around the head [2]
- nuchal ridge is placed against the image detector
- the infraorbitomeatal line perpendicular to the image receptor
- the beam travels 30° caudad to the orbitomeatal line [2] or 37° caudad to the infraorbital meatal line [2]

Technical factors

- **anteroposterior axial projection**
- **centering point**
  - midway between the external auditory meatuses and exits the foramen magnum [2]
- **collimation**
  - superior to include skin margins
  - inferior to include base of skull
  - lateral to the skin margins
- **orientation**
  - portrait [2]
- **detector size**
  - 24 cm x 30 cm [2]
- **exposure**
  - analog at 75-85 kVp, digital at 80-90 kVp [2]
  - 10-20 mAs
- **SID**
  - 100 cm [2]
- **grid**
  - yes [2]

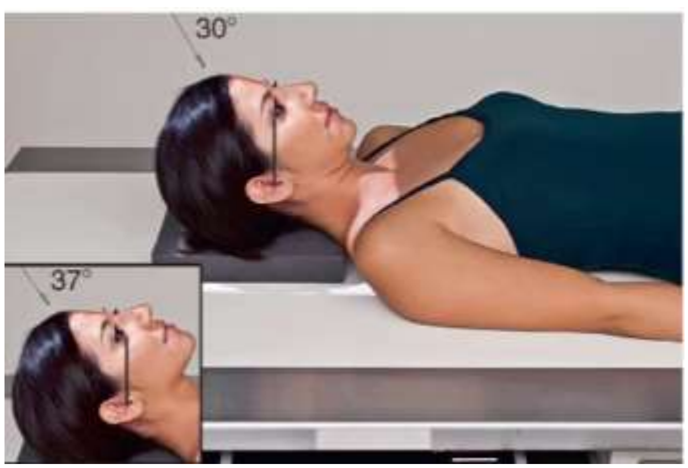


Fig: Skull (Towne view)

Image technical evaluation

- dorsum sella overlies the foramen magnum [2]
- petrous ridges are symmetrical.

Skull (Caldwell view)

The **Caldwell view** is a caudally angled radiograph, with its posteroanterior projection allowing for minimal radiation to the orbits. This view may be used in imaging of the skull or facial bones depending on the clinical indications.

Indications

This view aids in visualizing the paranasal sinuses, especially the frontal sinus. It can help to assess inflammatory conditions such as sinusitis and secondary osteomyelitis, and sinus polyps or cysts.

Additionally, skull fractures, neoplastic processes, or Paget disease may also be visualized via this view.

Patient position

- the patient is seated in front of the upright detector
- the patient's forehead is placed against the image detector [4]
- forehead and nose are both touching the detector
- the orbitomeatal line (OML) is running perpendicular to the detector
- petrous ridge is below orbits

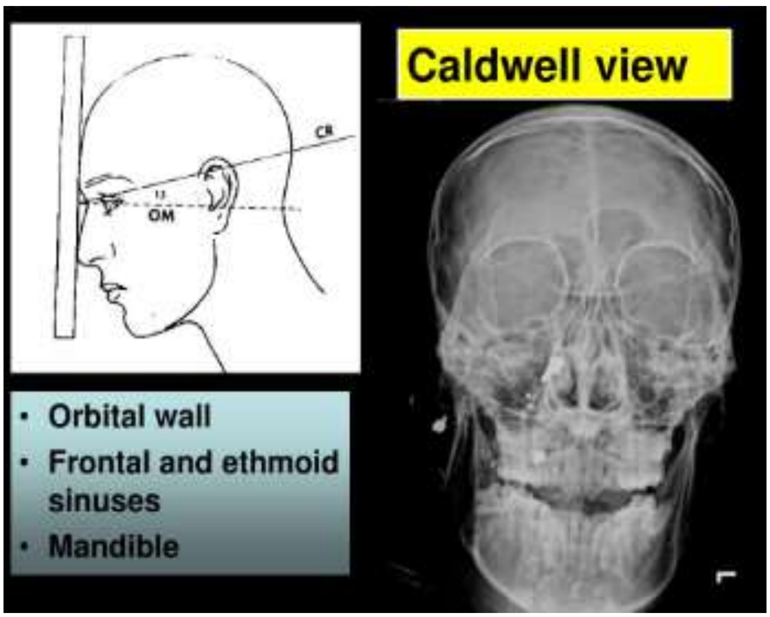
Technical factors

- **posteroanterior (PA) projection**
- **centering point**
  - angled caudad around 15° to exit at the nasion
- **collimation**
  - lateral to the skin margins
  - superior and inferior to the borders of the sinus cavities
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm [4]
- **exposure**
  - 70-80 kVp [4]
  - 20 mAs
- **SID**

    - 100 cm [4]
- **grid**
    - yes [4]

Image technical evaluation

- no rotation evident via the symmetrical nature of the orbits
- the innominate lines should be equidistant from the lateral borders of the orbits
- petrous ridges are projected in the lower third of the orbits
- no tilting should be evident; an imaginary line through the petrous ridges should be horizontal.



Facial bones (Waters view)

The occipitomental (OM) [4] or Waters view or parietoacanthial projection is an angled PA radiograph of the skull, with the patient gazing slightly upwards.

Indications

It can be used to assess for facial fractures, as well as for acute sinusitis. In general, radiographs of the skull and facial bones are rapidly becoming obsolete, being replaced by much more sensitive CT scans.

Patient position

- the patient is erect facing the upright detector
- the chin is raised until the mento-mandibular line (MML) is perpendicular to the receptor (orbitomeatal line (OML) will be 37° from receptor) [2]

- ensure patient's head is straight

Technical factors

- **posteroanterior projection**
- **centering point**
  - the beam is exiting at the acanthion [2]
- **collimation**
  - superior to the skin margins
  - inferior to include the most inferior aspects of the skull
  - lateral to include the skin margin
- **orientation**
  - portrait
- **detector size**
  - 24 cm x 30 cm [2]
- **exposure**
  - 75-80 kVp
  - 20-25 mAs
- **SID**
  - 100 cm [2]
- **grid**
  - yes (this can vary departmentally)

Image technical evaluation

- the petrous ridge should be inferior to the maxillary sinuses
- assess for rotation via the assessments of the coronoid process symmetry
- generally, the base of the mandible and the occiput will be superimposed

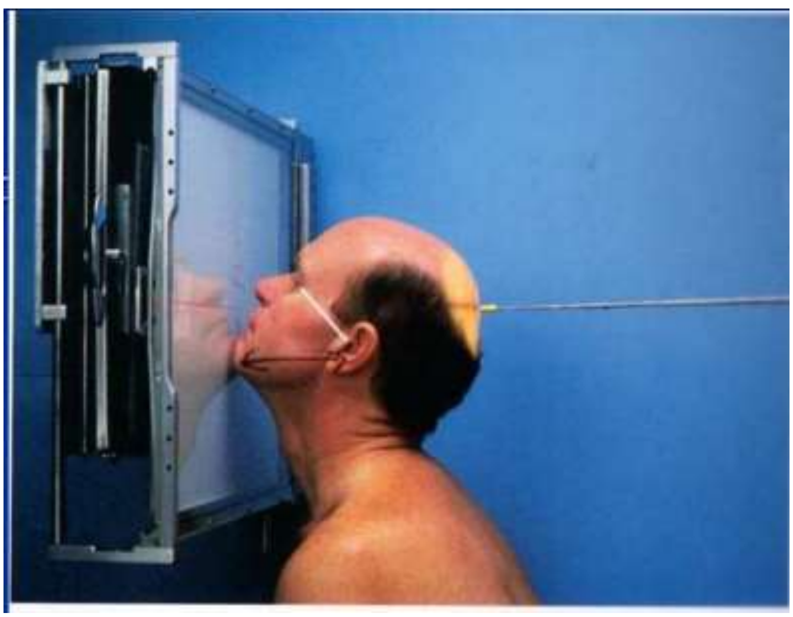


Fig: Facial bones (Waters view)

DENTAL RADIOGRAPHY

Dental radiographs, commonly known as X-rays, are radiographs used to diagnose hidden dental structures, malignant or benign masses, bone loss, and cavities.

Periapical view

Periapical radiographs are taken to evaluate the periapical area of the tooth and surrounding bone

For periapical radiographs, the film or digital receptor should be placed parallel vertically to the full length of the teeth being imaged.

The main indications for periapical radiography are

- Detect apical inflammation/ infection including cystic changes
- Assess periodontal problems
- Trauma-fractures to tooth and/or surrounding bone
- Pre/ post apical surgery/extraction. Pre extraction planning for any developmental anomalies and root morphology. Post extraction radiographs for any root fragments any other co-lateral damages.
- Detect any presence or position of unerupted teeth
- Endodontics. For any endodontic treatment, a pre-treatment radiograph is taken to measure the working length of the canals and this measurement is confirmed with electronic apex locator. A 'cone fit' radiograph is used when Master Apical Cone is placed in wet canal to correct working length to achieve frictional fit apically. Next, obturation verification radiograph is indicated after the canal space is fully filled with master cone, sealer and accessory cones. In the end, a final radiograph is taken after a definitive restoration is placed to check the final outcome of root canal treatment.
- Evaluation of implants.

Intraoral periapical radiographs are widely used for the preoperative due to its simple technique, low cost and less radiation exposure and widely available in clinical settings.

Bitewing view

The bitewing view is taken to visualize the crowns of the posterior teeth and the height of the alveolar bone in relation to the cementoenamel junctions, which are the demarcation lines on the teeth which separate tooth crown from tooth root. Routine bitewing radiographs are commonly used to examine for interdental caries and recurrent caries under existing restorations. When there is extensive bone loss, the films may be situated with their longer dimension in the vertical axis so as to better visualize their levels in relation to the teeth. Because bitewing views are taken from a more or less perpendicular angle to the buccal surface of the teeth, they more accurately exhibit the bone levels than do periapical views. Bitewings of the anterior teeth are not routinely taken.

The name *bitewing* refers to a little tab of paper or plastic situated in the center of the X-ray film, which when bitten on, allows the film to hover so that it captures an even amount of maxillary and mandibular information.

Occlusal view

The occlusal view reveals the skeletal or pathologic anatomy of either the floor of the mouth or the palate. The occlusal film, which is about three to four times the size of the film used to take a periapical or bitewing, is inserted into the mouth so as to entirely separate the maxillary and mandibular teeth, and the film is exposed either from under the chin or angled down from the top of the nose. Sometimes, it is placed in the inside of the cheek to confirm the presence of a sialolith in Stenson's duct, which carries saliva from the parotid gland. The occlusal view is not included in the standard full mouth series.

1. Anterior oblique occlusal mandible – 45°

Technique: the collimator is positioned in the midline, thru the chin aiming an angle of 45° to the image receptor which is placed centrally into the mouth, on to the occlusal surface of the lower arch.

Indications:

1) Periapical status of lower incisor teeth for patients who cannot tolerate periapical radiographs.

2) Assess the size of lesions such as cyst or tumours at anterior area of mandible

2. Lateral oblique occlusal mandible – 45°

Technique: The collimator is positioned from below and behind the angle of mandible and parallel to the lingual surface of the mandible, aiming upwards and forwards at the image receptors which is placed centrally into the mouth, on to the occlusal surface of lower arch. Patients must turn their head away from the side of investigation.

Indications:

1) Detection of any sialoliths in submandibular salivary glands

2) Used to demonstrate unerupted lower 8's

3) Assess the size of lesions such as cyst or tumours in the posterior of body and angle of mandible

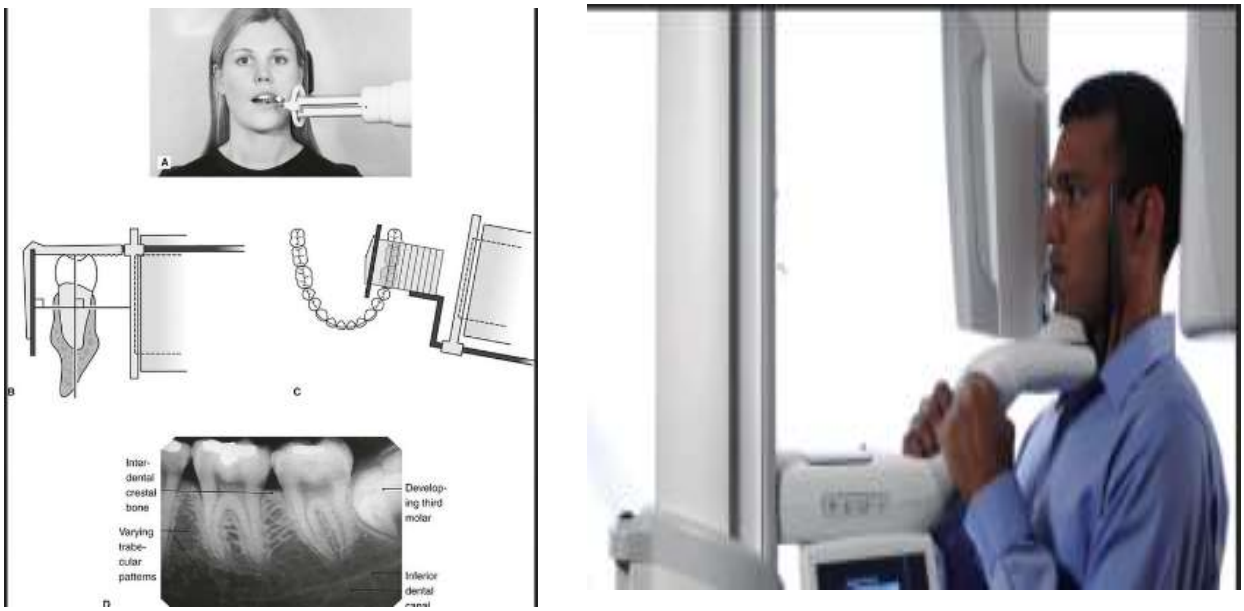


Fig: Dental Radiography

MIDNAPORE CITY COLLEGE

Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

Second Year

Paper Title: Radiobiology & Radiation Safety In Radiodiagnosis (Practical)

Paper Code: Paper –III

Syllabus

A. Time, Dose, Shielding, Measurement of HVT & TVT
B. Familiarization of Radiation Survey meters and their functional performance checks.
C. Radiological Protection Survey of Diagnostic X-Ray installation
D. Diagnostic Imaging: Quality Assurance - M. M Rehani
E. AERB safety requirements- Atomic Energy Act, Radiation protection rules.

Time, Dose, Shielding, Measurement of HVT & TVT

There are three factor that control the amount, or dose, of radiation received from a source. Radiation exposure can be managed by a combination of these factor :

Time- Reducing the time of an exposure reduces the effective dose proportionally.

An example of reducing radiation doses by reducing the time of exposure might be improving operator training to reduce the time they take to handle a source.

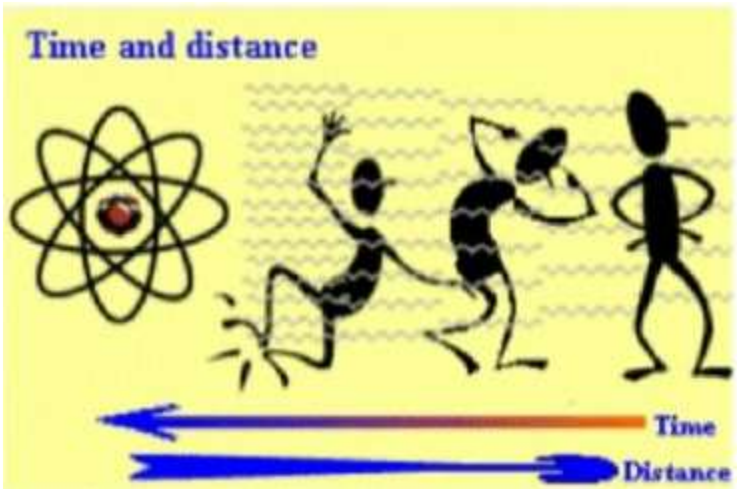
Distance – Increasing distance reduces dose due to the **inverse square law.** Distance can be as simple as handling a source with **forceps** rather than fingers.

Shielding – The term 'biological shield' refers to a mass of absorbing material placed around a reactor, or other radioactive source, to reduce the radiation to a level safe for humans. The effectiveness of a material as a biological shield is related to its **Cross-section for scattering and absorption.**

What are the basic measures in radiation protection?

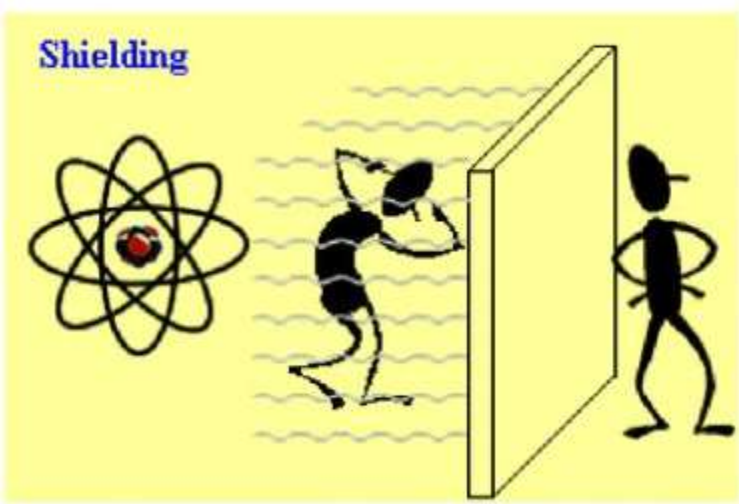
Shortening the time of exposure, increasing distance from a radiation source and shielding are the basic countermeasures (or protective measure) to reduce doses from external exposure.

Time : The less time that people are exposed to a radiation source, the less the absorbed dose.



Distance : The farther away that people are from a radiation source, the less the absorbed dose.

Shielding : Barriers of lead, concrete or water can stop radiation or reduce radiation intensity.



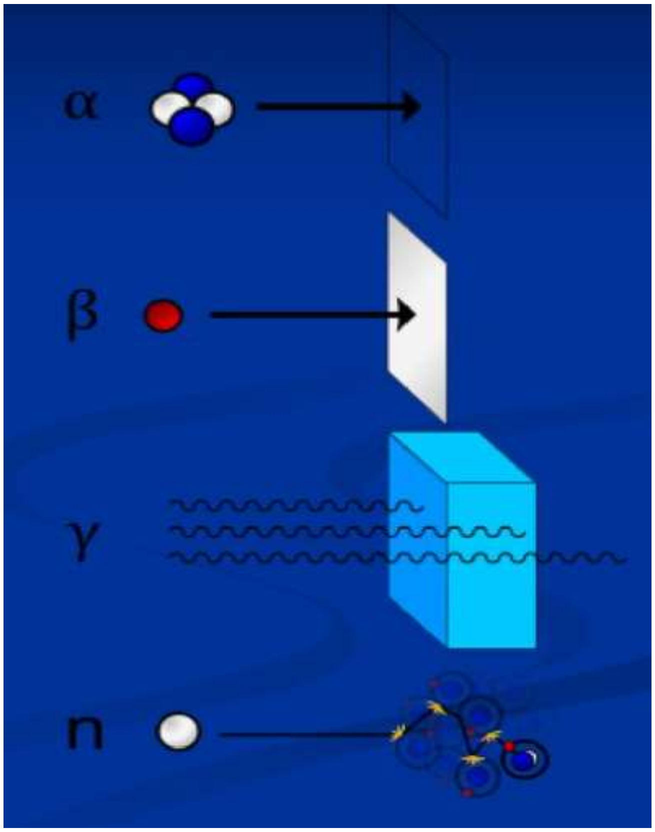
To reduce doses from intake of radioactive substances, the following basic countermeasures can be considered:

1. Shortening time of exposure to contaminants;
2. Preventing surface contamination;
3. Preventing inhalation of radioactive materials in air; and
4. Preventing ingestion of contaminated foodstuffs and drinking water.

Interaction of Radiation with Shielding

Diagram showing various forms of **ionizing radiation,** and the sort of material that is used to stop or reduce that type.

Different types of **ionizing radiation** interact in different ways with shielding material. The effectiveness of shielding is dependent on the **Stopping power of radiation particles,** which varies with the type and energy of radiation and the shielding material used. Different shielding techniques are therefore used dependent on the application and the type and energy of the radiation.



Half-Value Thickness (HVT)

1. **Definition**:
    - Half-Value Thickness (HVT) is the thickness of a specific material that reduces the intensity of radiation by 50%.
2. **Application**:
    - It is used to evaluate the effectiveness of shielding materials in reducing radiation exposure.
3. **Formula**:

$$I = I_0 \times (0.5)^n$$

Where:

- I = Final intensity of radiation after passing through material.
- I_0 = Initial intensity of the radiation.
- n = Number of half-value layers (HVTs).

Tenth-Value Thickness (TVT)

1. **Definition**:
    - Tenth-Value Thickness (TVT) is the thickness of material required to reduce the radiation intensity to 1/10th of its original value.
2. **Relation to HVT**:
    - Approximately, TVT is equivalent to 3.32 times the HVT.

$$TVT \approx 3.32 \times HVT$$

3. **Application**:
    - It is used in designing barriers or shields in medical, industrial, or nuclear settings.

Measurement of HVT and TVT

1. **Procedure**:
    - The initial radiation intensity (I_0) is measured without any shielding.
    - Various thicknesses of the shielding material are then placed between

the radiation source and the detector.
- The intensity after passing through the material is measured.
- The HVT is determined by identifying the thickness that reduces the intensity to 50%, and TVT by the thickness that reduces it to 10%.

2. **Materials**:
    - Common materials used for measuring HVT/TVT include lead, steel, and concrete.
3. **Instruments**:
    - Radiation detectors like Geiger counters, ionization chambers, and scintillation detectors are used to measure radiation intensity.

Familiarization of Radiation Survey meters and their functional performance checks.

Background

Radiation survey meters are portable, hand-held radiation detectors that can be used by emergency responders: law enforcement, fire fighters, hazmat team members, and healthcare professionals, during interdiction or response to radiological incidents. Survey meters are physically larger and heavier than radiation pagers and are not intended to be worn by a person. However, they may be carried in emergency vehicles (e.g., fire trucks, squad cars, or ambulances). Survey meters have bigger internal radiation detectors and therefore, they offer more detection sensitivity than radiation pagers. Some survey meters have a read-out unit with interchangeable probes for detecting different types of ionizing radiation (e.g., alpha, beta, and gamma). In the hands of emergency responders, survey meters would be primarily used to verify and confirm the readings of radiation pagers, locate radioactive source or material, or provide numerical value of the measured quantities to estimate the scale of the radiological problem. In the absence of radiation pagers, survey meters equipped with alarming capabilities can provide an early warning of the presence of radiation, reducing the risk of harmful health effects or radiation exposure.

Fundamentals

Ionizing radiation produces charged particles (i.e., ionization), or produces micro flashes of light (i.e., scintillations) that can be detected by measuring these charges or scintillations with specialized instrumentation. Different types of radiation carry different amounts of energy and penetrating powers. Alpha radiation can travel 2 inches in air and can be stopped by a piece of paper, but can cause the most damage to human organs if alpha-emitting radioactive substances enter the human body. Beta radiation can travel several hundred feet in air and can be stopped by most protective clothing. Skin contamination and inhalation are the primary paths of exposure from beta radiation.

Gamma is the most penetrating radiation and can be stopped only by several inches of lead or several feet of concrete and other high-density materials. More information on radiation and radiation protection basics can be found on the Health Physics Society (HPS) or Environmental Protection Agency (EPA) home pages listed at the end of this note. There is no detection system that can detect all forms of ionizing radiation. As gamma is the most penetrating form of radiation, most early detection devices are optimized to detect gammas first. Radiation detection is based on measuring the electric signal produced by radiation in gases using Geiger-Muller (G-M) tubes; semiconductors, such as Cadmium-Zinc-Telluride (CdZnTe) and high purity germanium (HPGe); or scintillating crystals, such as Sodium Iodide (NaI) and Cesium Iodide (CsI). Alpha radiation is detected with Zinc-Sulphide (ZnS) scintillator, with a measuring window protected by a very thin mylar sheet. Beta radiation probes are energycompensated G-M tubes.

Typical survey meters may consist of

• Read-out unit that contains a power source for external probes, handles the display and alarms, and sometimes is equipped with internal radiation detectors.

• Specialized smart probes for exposure rate measurements and/or contamination detection.

Ludlum Response Kit (left to right): Gamma Scintillator probe, energy-compensated G-M probe, survey meter, G-M pancake probe

Types of Radiation Survey Meters

There are several types of radiation survey meters, each designed to detect specific types of radiation and different ranges of intensity:

- **Geiger-Mueller (GM) Counters**:
  - Widely used for detecting beta and gamma radiation.
  - Provide an audible signal when radiation is detected.
- **Ionization Chambers**:
  - Used for measuring high-dose rates.
  - Typically used in medical and nuclear power applications to assess gamma and X-ray radiation.
- **Scintillation Detectors**:
  - Highly sensitive and can detect low levels of radiation.
  - Used to measure gamma radiation and sometimes alpha and beta particles.
- **Neutron Detectors**:
  - Detect neutron radiation.
  - Used in specific nuclear applications.

Applications

Radiation survey meters are primarily used as follow-up to alarms from radiation pagers or portal monitors to localize radioactive sources or to detect the presence of radioactive contamination.

If equipped with gamma sensitive probes (internal or external), a survey meter is useful for the following:

• Establishing control zone boundaries.
• Controlling personnel exposure.
• Assessing package integrity.
• Locating sources of radiation.

The purpose of a contamination survey is to locate radioactive material in unwanted locations. A survey meter with alpha/beta probe is useful for the following:

• Locating contamination on personnel and equipment.
• Determining the effectiveness of decontamination.
• Verifying contamination control boundaries.
• Determining the extent and magnitude of a contaminated area. For additional applications, see the EPA's Radiation Protection Basics or the HPS's Radiation Basics.

Radiation Survey Meter – How it Works

Detecting Radiation

Radiation can be detected using a variety of instruments and methods that read out in exposure or count rate. The measuring device used is dependent upon the type of radiation and the measurement needed. The three basic methods employed involve the use of survey instruments, liquid scintillation counters and dosimetry. This section discusses the operation of the two most common types of survey instruments used for the detection of ionizing radiation.

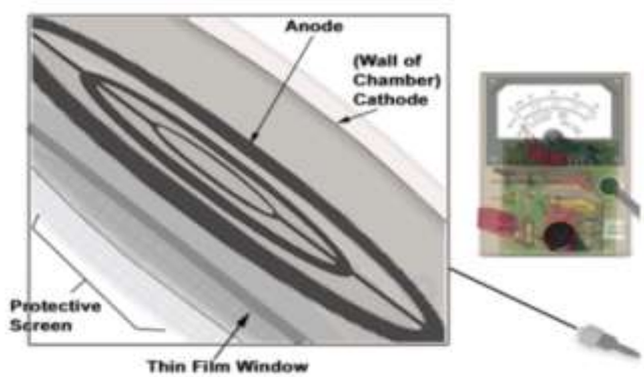
Survey Instruments

Survey instruments locate contamination or detect radioactive material. Radioactive material detected in the attached probe causes electronic pulses that move the meter needle and make an audio response. The meters read out in counts per minute (cpm) and can be calibrated to report mR/hr. There is a large selection of survey instruments available, designed for the detection of a specific type of radiation. One of the most common survey meters, shown here, can be used with various probes, depending on your needs and radionuclide. Before using a survey meter, make sure you have the right probe, such as pancake (Geiger Mueller) or scintillation (Sodium-Iodide) Probe.

General Purpose Survey Meter (Scaler)

GM Probe with Survey Meter

The GM Probe has a simple construction. Just under the surface, you can see a gas filled chamber connected to a simple circuit. Radiation interacts in the chamber and is changed into an electronic pulse.
The screen protects the thin-film window from breakage, scratches, or puncture.

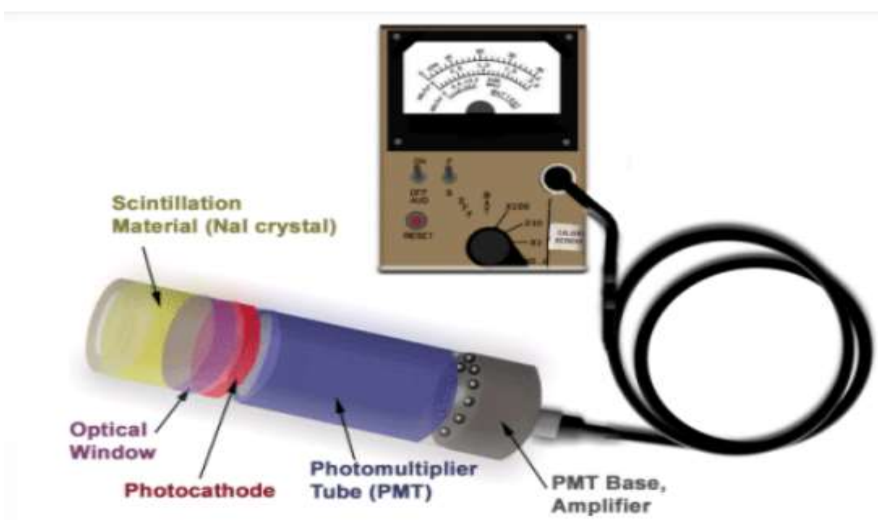


Inside the chamber, you can see a "target" shaped electrode called an anode. This electrode collects the charge created by ionization from incident radiation. The electric circuit is completed by using the chamber wall as the cathode. The chamber is filled with a special gas that amplifies the signal after the ionization. The amplification means that an interaction is counted but does not directly relate to the radiation dose.

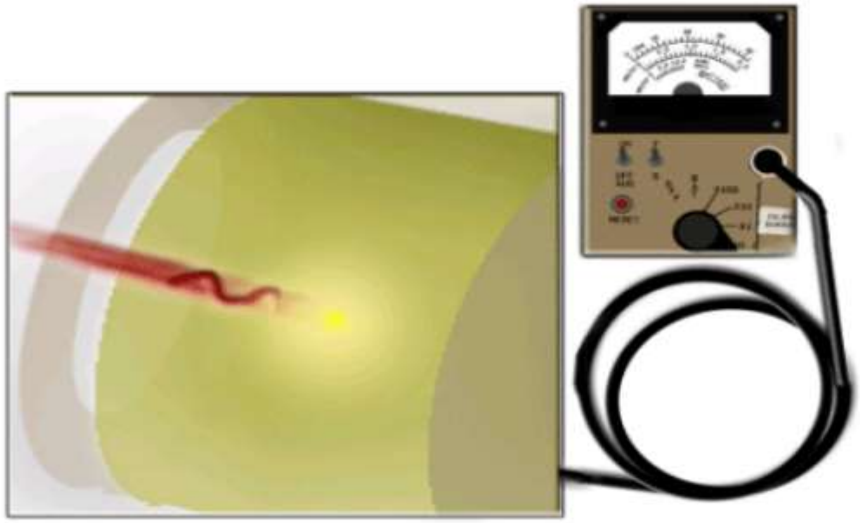
- Looking closer, we can see the interior chamber where the interaction will occur.
- Incident radiation, shown as a beta particle, passes through the thin window of the probe and into the gas filled chamber.
- The two charges created by the ionization continue to move towards the electrodes as the beta keeps going through the chamber. The two charges then strike the electrodes and a potential forms.
- The ionization creates an electric current in the circuit. The chamber's quench gas stops the amplification from an interaction (approximately 80 microseconds) and prepares the chamber for another interaction.
- The electric current is processed in the scaler and sorts out the radiation interaction current pulses from the system current from the batteries.
- Inside the scaler, the signals are reported visually by a meter (needle) and audibly by clicks.

Scintillation (NaI) Probe w/ Survey Meter

A scintillation probe is based on the light emission by substances (i.e. a crystalline sodium-iodide salt called NaI) that emits light or "scintillates" when struck by ionizing radiation). These light flashes are collected by a photomultiplier tube, which also amplifies the signal. These sensitive components are all encased in a magnetically shielded, light tight aluminum shell. This probe is used to primarily detect low energy photons (125I) and low energy x-rays.

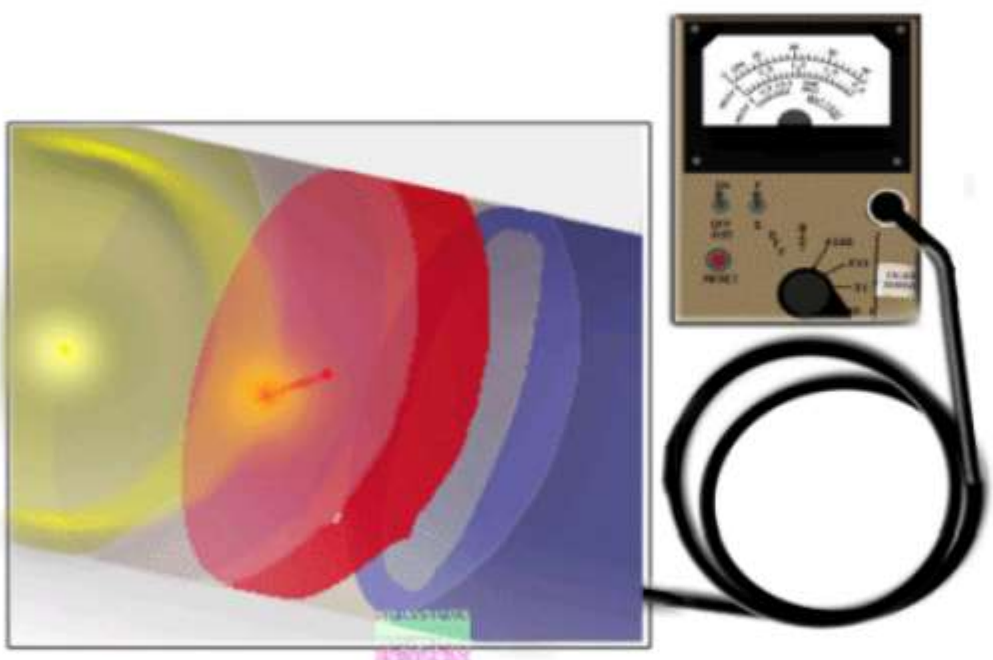


The probe contains a scintillation material (a NaI crystal), an optical window, a photocathode, a photomultiplier, and an amplifier.

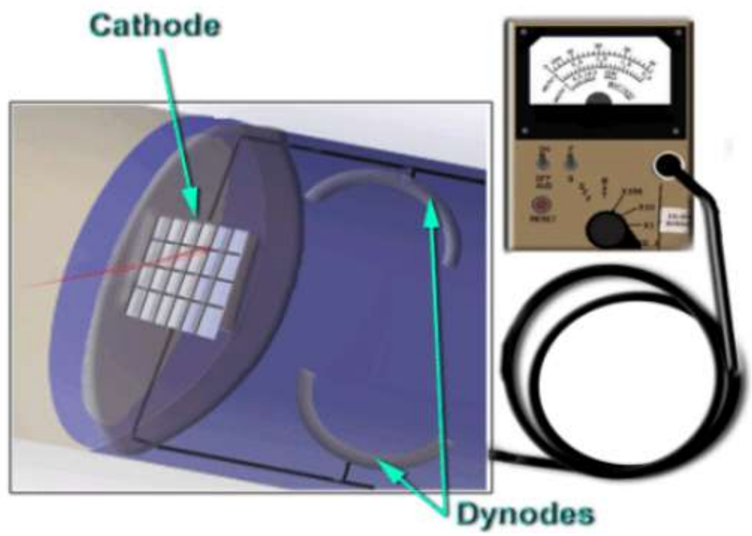


An incident X-ray or gamma ray passes through the probe window depositing energy in the scintillation crystal. The scintillation material converts the energy into light (scintillates).

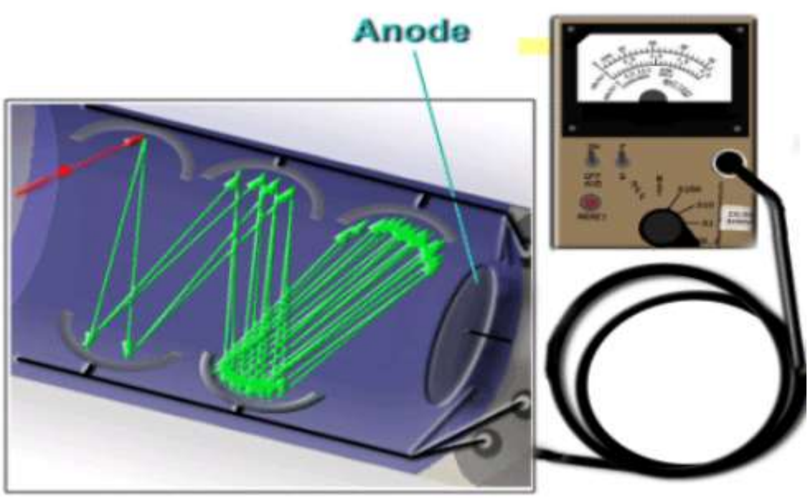
The emitted light spreads out and strikes the optical window and is transferred to the photomultiplier (PMT).
At the front of the (PMT) is a window of special material called the photocathode (shown in red). When light strikes the photocathode, it produces electrons. One electron is shown ejected. The electron is pulled towards the PMT.



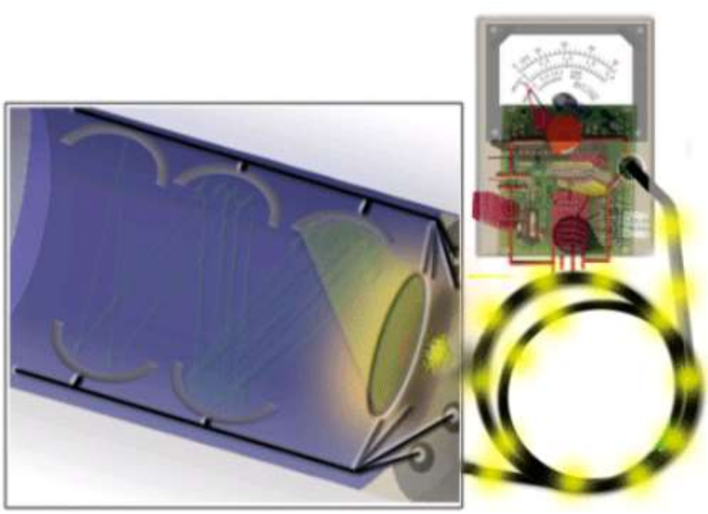
The electron ejected from the photocathode passes into the photomultiplier.



The ejected electron hits the PMT's dynodes and multiplies the number of electrons. This essentially causes an "**avalanche**" of electrons that result in an amplification of the original interaction.



The avalanche ends at the last dynode, where an electron pulse that is millions of times larger than it was at the beginning. The electrons are then collected by an anode at the end of the tube.
The anode collects the electrons and forms an electronic pulse.
The pulse is directed along the circuit to the scaler as a series of pulses.



Inside the scaler, the signals are reported visually by a meter (needle) and audibly by clicks.

Functional Performance Checks

Before using a radiation survey meter, it's crucial to ensure its accuracy and reliability by conducting performance checks. These checks help to ensure the meter is functioning correctly and providing accurate measurements.

Daily/Pre-use Checks:

1. **Battery Check**:
   - Ensure that the battery is fully charged or in good condition. A low battery may cause incorrect readings.
2. **Self-Test**:
   - Most modern survey meters have a self-test function to check internal electronics. Run this before using the meter.
3. **Background Radiation Measurement**:
   - Measure the background radiation level to ensure the device is properly calibrated.
   - The background radiation should be within the normal range (typically around 0.05 to 0.2 μSv/h depending on location).
4. **Source Check**:
   - Use a known radiation source (e.g., a check source of Cesium-137) to ensure the meter detects radiation and gives expected readings.
   - Verify that the readings correspond to the known activity of the check source.

Routine/Periodic Performance Checks:

1. **Calibration**:
    - Survey meters must be calibrated at regular intervals (typically every 6-12 months) using a traceable calibration source.
    - Calibration ensures that the readings are accurate across different ranges and radiation types.
2. **Operational Checks**:
    - Check the instrument's response to different types of radiation (alpha, beta, gamma) if it is a multi-functional meter.
    - Ensure the range selector functions correctly across its range.
3. **Detector Integrity**:
    - Inspect the detector for physical damage or contamination.
    - Any cracks, dents, or contamination can affect the meter's performance.
4. **Response Time**:
    - Check the response time of the meter. It should respond quickly (typically within seconds) when exposed to radiation.
5. **Alarm Functionality**:
    - Test the alarm threshold and ensure it is set correctly for the desired radiation levels. Verify the alarm triggers at the correct dose rate.

Radiological Protection Survey of Diagnostic X-Ray Installation

A radiological protection survey of a diagnostic X-ray installation is critical to ensure the safety of staff, patients, and the public from unnecessary radiation exposure. The survey involves inspecting the installation, measuring radiation levels, evaluating shielding effectiveness, and confirming that all safety regulations are followed.

Purpose of a Radiological Protection Survey

The main objectives of a radiological protection survey in a diagnostic X-ray installation are:

- Ensuring that radiation exposure is within safe limits.
- Verifying the effectiveness of shielding in walls, doors, and windows.
- Checking that X-ray equipment is operating safely and within regulatory standards.

- Ensuring that radiation warning signs and safety protocols are in place.

Key Components of the Survey

- **Evaluation of X-ray Equipment**

Type of Equipment:
Identify the X-ray equipment (e.g., general radiography, fluoroscopy, or dental X-ray units).

Equipment Inspection:
- Check that the X-ray machine is properly installed and functioning.
- Ensure the control panel, exposure buttons, and radiation indicators are working correctly.

Performance Checks:
- Measure the output radiation of the X-ray tube to verify it's within safe limits.
- Ensure the collimator is functioning and limiting the X-ray beam to the desired area.

- **Shielding Evaluation**

- **Primary and Secondary Barriers**:
  Primary barriers (walls, floors) are designed to block direct X-ray beams, while secondary barriers (doors, ceilings) protect against scattered radiation.

- **Shielding Material**:
  Lead, concrete, or equivalent materials are commonly used for shielding in diagnostic X-ray rooms.

- **Shielding Adequacy**:
  - Measure radiation levels around the installation (behind walls, doors, windows, and ceilings) to ensure they conform to safety limits.
  - Use Half-Value Thickness (HVT) and Tenth-Value Thickness (TVT) measurements to check the thickness of shielding materials.

➢ Radiation Dose Rate Measurement

- **Dose Rate at Different Locations:**
    - Measure the dose rates at various points inside and outside the X-ray room, including:
        - Control area
        - Operator's position
        - Areas adjacent to the X-ray room (corridors, offices)
        - Public access areas
- **Instruments Used:**
    - Survey Meters: Geiger-Mueller counters, ionization chambers, or scintillation detectors.
    - Personal Dosimeters: Used for staff to monitor cumulative exposure over time.
- **Action Limits:**
    - Ensure that the measured dose rates are below regulatory limits, typically set by national standards (e.g., 1 mSv/year for the public and 20 mSv/year for radiation workers).

➢ Scatter and Leakage Radiation

Scatter Radiation:

- Check scatter radiation at the operator's position and other areas in the room where people may be present during X-ray procedures.

Leakage Radiation:

- Measure leakage radiation from the X-ray tube housing to ensure it is within acceptable limits (typically 1 mGy per hour at 1 meter from the source).

➢ Safety Features and Protocols

Warning Signs and Lights

- **Radiation Warning Signs:**
    - Ensure that warning signs indicating the presence of radiation are placed at the entrance of the X-ray room and other relevant areas.
- **Warning Lights:**
    - Verify that operational warning lights are activated when the X-ray machine is in use.
    - These lights should be visible both inside and outside the room.

Safety Interlocks and Emergency Controls

Door Interlocks:

- Inspect door interlock systems that automatically stop radiation exposure when the door is opened.

Emergency Shut-off:

- Ensure that emergency stop buttons are functioning and can immediately terminate the X-ray exposure.

Administrative Controls

Staff Training and Personal Protective Equipment (PPE)

- **Staff Training:**
  - Verify that all staff members operating the X-ray machine are properly trained in radiological safety.
- **Personal Protective Equipment (PPE):**
  - Ensure that appropriate PPE, such as lead aprons, thyroid shields, and lead glasses, is available and used by staff during X-ray procedures.

Dose Monitoring and Record Keeping

Personal Dosimeters:

- Ensure that radiation workers are equipped with personal dosimeters to track their radiation exposure over time.

Records:

- Maintain proper records of radiation dose measurements, equipment calibration, and any corrective actions taken to mitigate excessive exposure.

Regulatory Compliance

International Standards:

- Ensure the installation complies with guidelines from organizations like the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA).

Local Regulations:

- Adhere to national and local regulations for diagnostic X-ray installations, which may include specific requirements for shielding, dose limits, and safety protocols.

Reporting and Recommendations

Final Report:

- After the survey, a detailed report is prepared that includes:
    - Measured radiation levels
    - Shielding evaluation results
    - Compliance with dose limits
    - Safety protocols in place
    - Recommendations for improvements or corrective actions

DIAGNOSTIC IMAGING: QUALITY ASSURRANCE

Congruence Of Radiation And Optical Field And Beam.

Optical field in the equipment is used for defining the radiation field and limit the area of interest.
If optical field and radiation field are not congruent there may be loss of information and repeat the examination.
Collimator test tool is used for testing the congruence.
It consist of a glass fiber board 24 X 27 cm with a rectangular area 22- 16 cm marked on it by coating of X-Ray Opaque material.
The rectangular divided into four equal segment.

FFD =100

Central Beam Alignment

• If the x-ray beam is not perpendicular to the image receptor, the image may be distorted.

If grid is used, the distortion will be magnified resulting in complete loss of minute

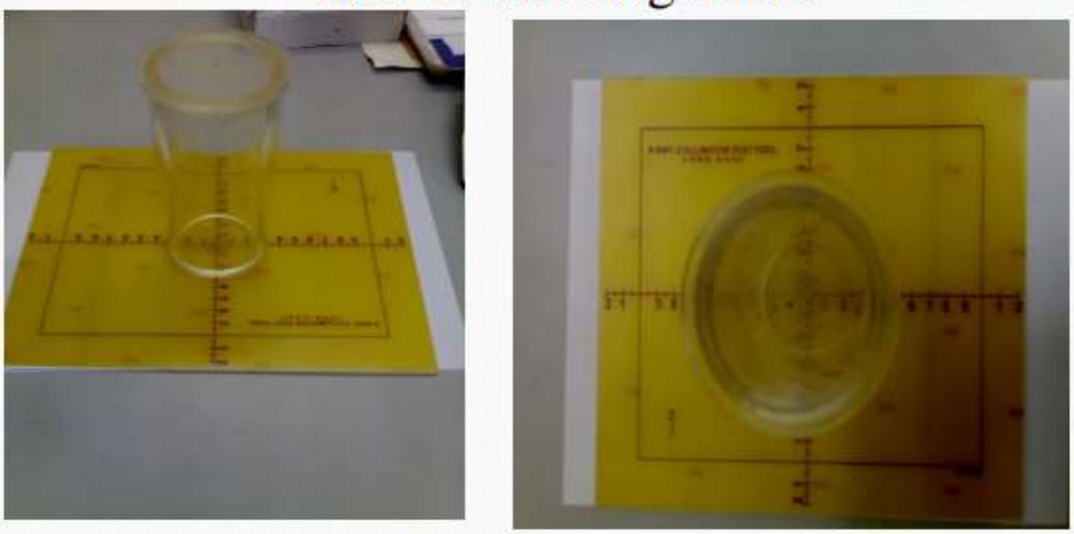
details.

• Beam alignment test can be done simultaneously with the test for congruence of optical

and radiation field

• Tolerance Central beam alignment < 1.5°

Congruence of Radiation and Optical Fields and Beam Alignment



Beam alignment test tool

Effective Focal Spot Size measurements:

Focal Spot size is defined in two ways:

The actual focal spot size is the area on the anode that is struck by electrons and it is primarily determined by the length of cathode filament and the width of the focusing cup slot.

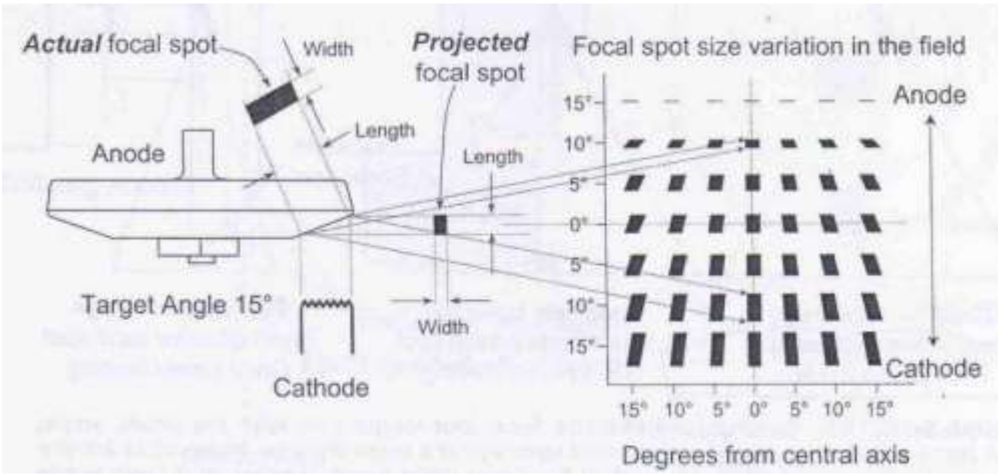
The effective focal spot size is the length and width of the focal spot as projected down the central ray in the x-ray field.

The effective focal width is equal to the actual focal width and therefore is not affected by the anode angle.

However, the anode angle causes the effective focal spot length to be smaller than the actual focal spot length.

Effective focal length = Actual focal length x Sin Ø

Here, Ø is the anode angle

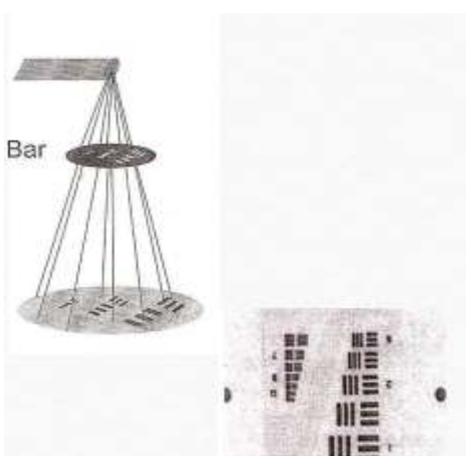


Effective Focal Spot Size Measurements:

Tools used for effective focal spot size measurements:
• Pinhole camera
• Slit camera
• Star pattern
• Resolution bar pattern Tolerance:

for f < 0.8 mm	+0.5 f
for 0.8 ≤f≤1.5 mm	+0.4 f
for f > 1.5 mm	+0.3f

Bar pattern images demonstrate the effective resolution parallel and perpendicular to the A-C axis for a given magnification geometry.

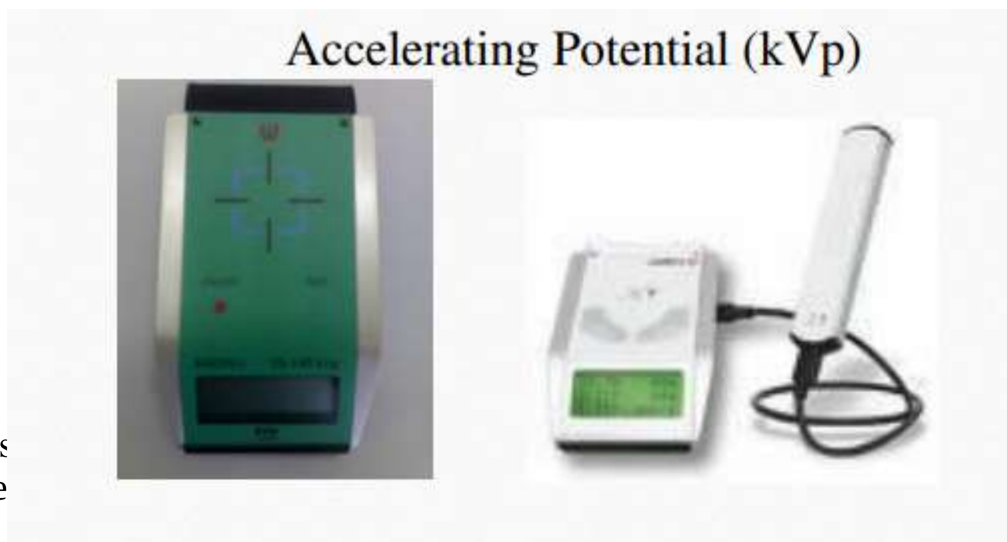


K.V. And Exposure Time Testing.

Accelerating Potential (kVp)

• The peak potential of the x-ray generator affects quality of the x-ray beam and exposure to the patient.

• Presently solid – state detectors, which employ non-invasive method for peak tube potential measurement are quite handy for this test.



• Assess … that set on the e

Tolerance : ± 5kV

Accuracy of Exposure Timer

• If the exposure time of the x-ray unit is not in order, the radiograph can be under exposed or overexposed.

• For this, absolute timer method is adopted by measuring set and measured time with digital timers.

Tolerance: Accuracy of exposure timer % Error ± 10 %

Linearity of mA loading stations

• The tube current (mA) is equal to the number of electrons flowing from the cathode to the anode per unit time.

• The exposure of the beam for a given kVp and filtration is proportional to the tube current.

• This test is carried out to check the linearity of radiation output with respect to change in tube current (mA) stations by keeping timer station constant at a particular kV station.

FFD=100 cm **Radiation field size = 20 cm x 20 cm**

• Keeping exposure time and kVp constant, radiation output is measured at different mA stations.

• Measurement for mA loading station is to be repeated for a number of times each to eliminate statistical errors.

• Radiation output readings of each mA loading station readings are averaged and the coefficient of linearity (CoL) is evaluated from average mR/mAs or mGy/mAs as follows:

Coefficient of linearity = $(X_{max} - X_{min}) \div (X_{max} + X_{min})$

Tolerance: Coefficient of Linearity < 0.1

Linearity of timer loading stations

- The exposure time is the duration of X-ray production.
- Keeping the kVp and mA constant, radiation output is measured at different timer stations and Coefficient of Linearity is evaluated.

- This test is carried out to check the linearity of radiation output with respect to change in timer stations by keeping mA station constant at a particular kV station.
- Tolerance: Coefficient of timer linearity < 0.1

Consistency Of Radiation Output

• To check the constancy of radiation output

• Keeping fixed mA and time, radiation output is measured at various available kV stations. Average(X) of (mR/mAs) or (mGy/mAs) is calculated.

• Consistency at each kV station is checked by evaluating the coefficient of variation.

Coefficient of variation

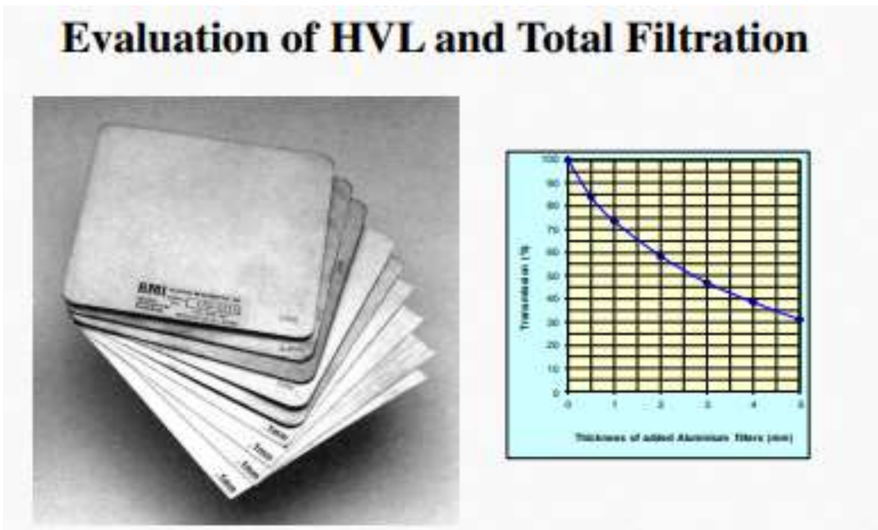
• COV = $1/ X \times [(\sum (Xi- X)^2) /(n-1)]$ ½

• Tolerance : Coefficient of Variation < 0.05

Total Filtration of X-ray tube

- To cutoff low energy components from X-ray beam, which do not contribute to diagnostic image formation but result in unnecessary patient exposure.

- If the filtration is too high, image contrast will be poor and unit will be overloaded.
- Therefore it is necessary that the total filtration (inherent + added) provided for the X-ray tube be as per the recommended value.
- The determination of half value thickness (HVT) of the X-ray beam is the method of evaluation of total aluminum equivalent filtration of the X-ray tube.
- Total aluminum equivalent filtration of the x-ray tube is evaluated by determining the half value thickness of the beam.



- Transmission curve of the x-ray beam can be prepared by plotting a graph between the absorber thickness and corresponding percentage transmission.
- The absorber thickness for 50 % transmission will be the half value thickness of the x-ray beam.
- Total aluminum filtration could be determined from HVT using calibration tables.
- Presently, new solid state detectors directly gives the values of HVT and total filtration used in diagnostic X-ray equipment.

Minimum Filtration for X-ray tubes

For ensuring radiation quality of the x-ray beam, the total filtration in the x-ray source assembly shall comply with the Half- Value Layer requirements.
Material Used : Aluminum filters of purity 99.99% or higher and density 2.70 g cm-3

Tolerance : 1.5 mm Al for kV ≤ 70
2.0 mm Al for 70 ≤ kV ≤ 100
2.5 mm Al for kV > 100

Aluminum Equivalence of table top (Couch) ≤ 1.2 mm Al

Radiation leakage through tube housing

The radiation leakage measurement is carried with an ionization chamber/semiconductor based radiation survey meter. For checking the leakage radiation, the collimator of the tube housing should be fully closed and the tube should be energized at maximum rated tube potential and tube current at that kVp.

- The exposure rate at one meter from the focal spot is measured at different locations (anode side, cathode side, front back and top) from the tube housing and collimator.

- From the maximum leakage rate (mR/h) from both tube housing and collimator, leakage radiation in one hour is computed on the basis of the workload of the unit.

- Work load = 180 mA-min in one hour (for Radiography/Radiography & Fluoroscopy/C-Arm/Interventional Radiology/ dental OPG and dental CBCT equipment)

• Work load = 20 mA-min in one hour for dental (Intra- oral) equipment

• Work load = 40 mA-min in one hr for mammography unit

Radiation leakage from tube housing

Max leakage from tube housing

$$= \frac{\text{mA– min in one hour X ————Max.leakage radiation level (mR/hr)}}{\text{60 min X ————— mA used for measurement}}$$

Tolerance limit:
1. Radiation Leakage at 1 m distance from the focus < 1 mGy in one hour (for Radiography/Radiography & Fluoroscopy/C-Arm/Interventional Radiology/ dental OPG and dental CBCT equipment)
2. Radiation Leakage limit at 5cm from the external surface of mammography unit < 0.02 mGy in one hour
3. Radiation Leakage limit at 1m distance from the focus of dental (intra-oral) unit < 0.25 mGy in one hour

Table Top Dose Rate (Fluoroscopy)

The air kerma rate, measured in air at the position where the central of the useful beam enters the patient, shall be less than 5cGy/min for units without automatic brightness control (ABC) and less than 10 cGy/min for units with ABC.

The focus-to-table top distance shall be not less than 30 cm for fluoroscopy equipment.

Fluoroscopic Image Quality Parameters High Contrast Resolution or Spatial Resolution

High Contrast or Spatial resolution refers to the ability of imaging system to visualize small detail, and an imaging system has higher spatial resolution if it can demonstrate the presence of smaller objects in the image.

Tolerance: Mesh pattern of 30 lines/inch or bar pattern of 1.5 lp/mm must be resolved.

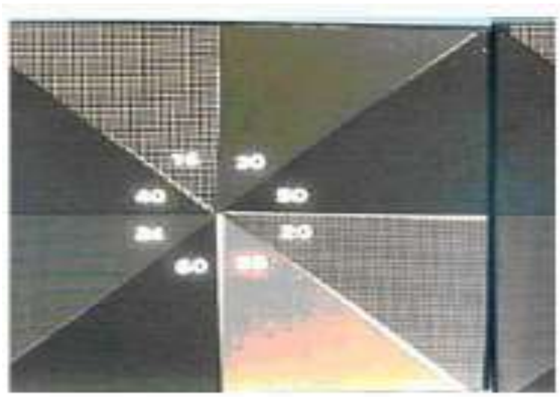


Figure 1. Resolution test tool.

Fluoroscopic Image Quality Parameters Low Contrast Resolution

Contrast in a radiographic image is the difference in the gray scale of the image.

Low contrast sensitivity refers to the ability of a imaging system to visualize low-contrast objects or structures that differ slightly in radio opacity from the surrounding area.

Tolerance: Minimum diameter of 3 mm hole size of test pattern must be resolved.

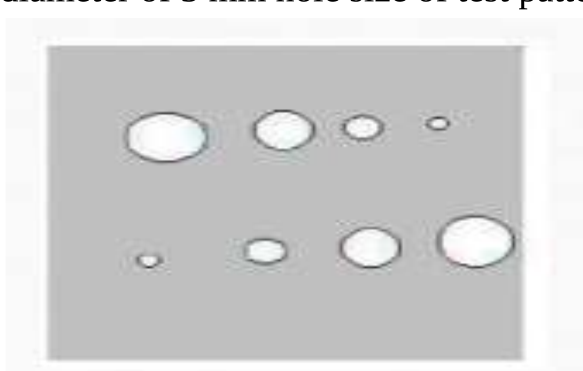


Fig: Contrast Resolution tool

"AERB" SAFETY REQUIREMENTS- ATOMIC ENERGY ACT, RADIATION PROTECTION RULES.

The acts, rules and regulations that are basis of the constitution of AERB and govern the regulatory process and functions are listed here for reference.
Activities concerning establishment and utilisation of nuclear facilities and use of radioactive sources are carried out in India in accordance with the relevant provisions of the Atomic Energy Act, 1962.
The environment protection aspects are governed by the Environmental Protection Act, 1986.
The regulations for radiation protection aspects are as governed by the Radiation Protection Rules, 1962. Safety aspects in mining and milling of prescribed substances are governed by the Mines Minerals Prescribed Substance Rules, 1984. Safe waste disposal is ensured by implementation of the Atomic Energy Safe Disposal of Radioactive Waste Rules, 1987.

ATOMIC ENERGY ACT :

Atomic Energy Act provides for the development, control and use of atomic energy for the welfare of the people of India and for other peaceful uses and for matters connected with. It provides the basic regulatory framework for all activities related to atomic energy programme and use of ionising radiation in India. Of the 32 sections of the Atomic Energy Act those related to safety are Sections 3 (e) (i), (ii) and (iii), 16, 17 and 23.
Pursuant to the Atomic Energy Act, the Atomic Energy Regulatory Board (AERB) designated by the Central Government, is the Competent Authority as the Regulatory Body for granting, renewal, withdrawal and revocation of consents for Nuclear and Radiation Facilities. The Regulatory Body also exercises control over nuclear installations and the use of radioactive substances and radiation generating plants outside such installations..
Section 16 and 17 of the Atomic Energy Act refers to control over radioactive substance and special provisions for safety. Section 23 empowers the Regulatory Body with administration of Factories Act 1948, including enforcement of its provisions, appointment of inspection staff and making of rules in the installations of Department of Atomic Energy (DAE).

Note

- AERB is also empowered to perform the functions under sections 10(1) (powers of entry) and 11(1) (powers to take samples) of Environmental

Protection Act, 1986 and Rule 12 (agency to which information on excess discharge of pollutants to be given) of the Environmental Protection (Amendment)Rules, 1987 with respect to radioactive substances.

- Section 52 of Air (Prevention and Control of Pollution) Act, 1981 states that in relation to the radioactive air pollution the provisions of Atomic Energy Act will apply.

RADIATION PROTECTION RULES.

The Central Government has appointed Chairman, ATOMIC ENERGY REGULATORY BOARD (AERB) as the 'Competent Authority' to exercise the powers conferred on the Competent Authority in the following rules:

1. Atomic Energy (Radiation Protection) Rules, 2004
2. Atomic Energy (Factories) Rules, 1996
3. Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987
4. Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substance) Rules, 1984

Note

- Hazardous wastes (Management and Handling) Rules, 1989 state that these rules will not apply to radioactive wastes (Rule 2 (e)). The radioactive wastes are covered under the provisions of Atomic Energy Act and rules made there under.
- Rules 2(b) and 3 of Manufacture, Storage and Import of Hazardous Chemical Rules (1989) under the Environmental Protection Act, 1986 has notified AERB as the authority to enforce directions and procedures as per Atomic Energy Act with respect to radioactive substances.

MIDNAPORE CITY COLLEGE

Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

Second Year

Paper Title: Contrast & Special Radiography Procedures (Practical)

Paper Code: Paper –IV

Syllabus:

A. Non-contrast Special radiography-

i. **Paediatric Imaging:** special needs of patient and radiographer- use of dedicated equipment and accessories-modified technical considerations - selection of exposure factors-image quality considerations radiation protection of the patient - special techniques in children for contrast studies.

ii. **Geriatric radiography:** Equipment and accessories - exposure factor considerations in special care. Elderly patients profile - difficulties during radiography - technical considerations-projections with unconventional special positioning.

iii. **Trauma/Emergency Radiography**

iv. Selection of suitable X-ray equipment-patient position -radiographic projections and sequence for each patient - modification of routine positioning- radiation protection - patient care.

v. **Operation theatre radiography:** 0.T procedures cholangiography - orthopedic procedures -maintenance of asepsis - preparation of radiographer and equipment/accessories - careful safe use of mobile andfluoroscopic equipment - radiation protection - patient care - rapid availability of radiographic image-cooperation with OT staff-type of studies done -clinical applications - clinical applications- per operative radiographs- preoperative fluoroscopy studies -patient care-radiation protection of all staff.

B. Contrast radiography

i. **Radiological contrast media:** classification -need for radiological contrast media -methods of administration-dosage-reactions to contrast media- role of radiographer in management of patient with contrast reaction.

ii. **For all contrast investigations:** patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used and dosage-alternative contrast used-side effects and its identification-treatment of complication during the procedure - pathological conditions- indications and contraindications- injection procedure -techniques for radiographic projections -radiographic appearances- radiation protection.

Syllabus:

C. Sialogram

D. Barium studies: different types - Barium swallow Barium meal study of upper GIT, Barium meal follow through, Barium enema, small bowel enema, distal colography, defaecography.

E. Percutaneous Transbepatic Cholangiogram, ERCP, T-Tube cholangiography, per-operative cbolangiography.

F. IVP-rapid sequence-infusion pyelography-high dose urography, Cystogram, Anterior Uretbrogram RGU, MCU, RCP

G. Angiography, Diagnostic & therapeutic, venography, Lym phangiogram

H. Orthography, Discography

I. Myelogram

J. Hysterosalphingography

K. Sinography

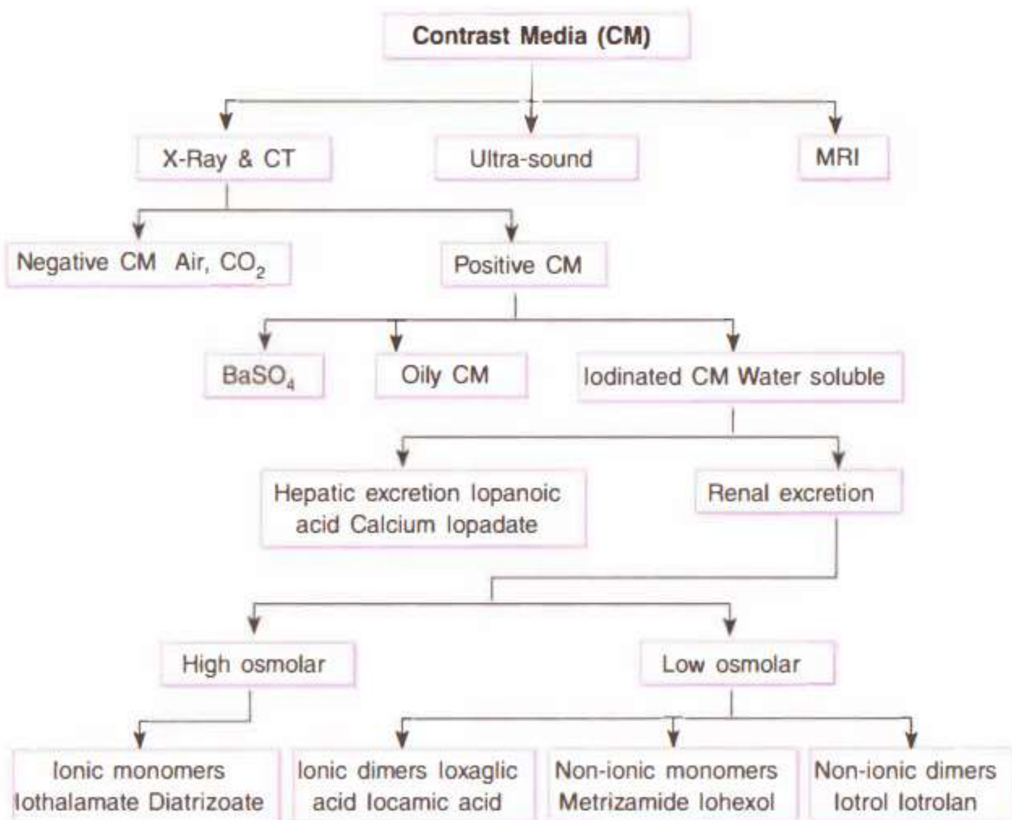
L. Fistulogram

M. Ductogram

Radiological contrast media

Contrast media (or contrast agents) are substances used in medical imaging to enhance the visibility of internal structures and fluids. They work by altering the way that X-rays, magnetic resonance imaging (MRI), or ultrasound waves interact with tissues, making specific areas of the body stand out more clearly.

Classification



Types of Contrast Media

1. **Iodine-Based Contrast Media:**
   - **Use:** Primarily used in X-ray and CT scans.
   - **How It Works:** Iodine has a high atomic number, meaning it effectively absorbs X-rays. When injected into the body, it enhances the contrast of blood vessels, organs, and other structures by making them appear brighter on the image.

- **Forms:** Can be administered intravenously (IV) or orally.
- **Applications:** Often used for angiography (imaging blood vessels), urography (imaging the urinary tract), and contrast-enhanced CT scans.

2. **Barium-Based Contrast Media:**
   - **Use:** Mainly used in gastrointestinal (GI) studies, such as barium swallows, barium meals, and barium enemas.
   - **How It Works:** Barium sulfate is a radiopaque substance that coats the lining of the GI tract, making it visible on X-ray images.
   - **Forms:** Usually administered orally or rectally as a liquid suspension.
   - **Applications:** Used to examine the esophagus, stomach, intestines, and colon for conditions like blockages, tumors, ulcers, and other abnormalities.
3. **Gadolinium-Based Contrast Agents (GBCAs):**
   - **Use:** Commonly used in MRI scans.
   - **How It Works:** Gadolinium is a rare earth metal that affects the magnetic properties of nearby hydrogen atoms, enhancing the contrast of tissues on MRI images.
   - **Forms:** Typically administered intravenously.
   - **Applications:** Used for imaging the brain, spine, joints, and blood vessels, as well as for detecting tumors, inflammation, and vascular abnormalities.
4. **Microbubble Contrast Agents:**
   - **Use:** Used in ultrasound imaging.
   - **How It Works:** Microbubbles filled with gas enhance the reflection of ultrasound waves, increasing the contrast of blood flow and other structures.
   - **Forms:** Administered intravenously.
   - **Applications:** Used to enhance echocardiograms (ultrasound of the heart) and other vascular imaging studies.

Safety and Side Effects

While contrast media are generally safe, they can cause side effects in some individuals, ranging from mild to severe:

- **Mild Reactions:** Nausea, vomiting, headache, itching, or a metallic taste.
- **Moderate Reactions:** Urticaria (hives), swelling, or shortness of breath.
- **Severe Reactions:** Anaphylaxis, a rare but life-threatening allergic reaction, or nephrogenic systemic fibrosis (NSF) in patients with kidney problems (specifically with gadolinium-based agents).

Considerations and Precautions

- **Allergies:** Patients with a history of allergic reactions to contrast media should inform their healthcare provider, as premedication may be required.
- **Kidney Function:** Patients with kidney disease need to be carefully evaluated before receiving certain contrast agents, particularly iodine-based and gadolinium-based agents, as these can potentially worsen kidney function.
- **Pregnancy and Breastfeeding:** Special considerations are needed, as some contrast agents can cross the placenta or be excreted in breast milk.

SIALOGRAM

This is the study to demonstrate the parotid or submandibular glands by injection of contrast medium into the duct system.

INDICATIONS

1. Calculi.
2. Chronic inflammatory disease.
3. Mass lesion.
4. Obstructive lesion.
5. Penetrating trauma.
6. Strictures.
7. Fistula.
8. Prior to CT evaluation of salivary glands.

CONTRAINDICATIONS

1. Allergy to iodine.
2. Acute Sialadenitis.

EQUIPMENT

1. Contrast medium-water soluble, ionic contrast media like -Triovideo 280,Conray 280 or non-ionic contrast medium such as omnipaque-350.
2. Lacrimal cannula or disposable 22 G (Gelco/Venflon).
3. Lacrimal dilator. Liebreich's double ended lacrimal probe.
4. 2 cc syringe. Four grades (00/0, 1/2, 3/4 & 5/6) 00/0 and ½ are required for sialography. Outer diametre of cannula 1.02 mm. Rabinov sialography catheter obtainable in a sterile pack and is recommonded.
5. Lemon/vitamin C tablet.

PREPARATION OF THE PATIENT

Removal of false teeth, if any.

PROCEDURE

l. Preliminary radiograph

Plain radiograph should be taken before embarking on sialography because a considerable pathology is associated with opaque calculi within the glands themselves or their ducts, particularly in the submandibular gland.

2. Locating duct openings

(a) Parotid duct opens opposite 2nd upper molar tooth on the buccal surface of the cheek.

(b) Submandibular duct opens at the base of the frenulum of the tongue.

(c) In case the ostium is not visible, apply pressure on the gland or give a sialogogue like lime. Then saliva will be seen pouring through the punctum.

3. Dilate the punctum with lacrimal dilator.
4. Technique
Two techniques for cannulating the ducts are by using:
(a) Intracath technique.
(b) Lacrimal cannula technique.
• If we are using an intracath, we should cut enough plastic tubing from the tip of intracath with fine scissors such that 2 mm of the inner wire stilette is still protruding. Now the punctum is cannulated for 5 mm. Now withdraw the stiletto such that it no longer protrudes the outer tube.
• The inner stilette produces stiffness during introduction of catheter. The stilette is removed and outer tube is attached to polythene tube.
• Now the contrast is injected.
• In the lacrimal cannula method, contrast is injected into the cannula which is introduced through the duct opening.
• Contrast is injected till the patient complains of pain by a prearranged signal.
• About 0.5-1.0 cc of contrast is required.

5. Film exposure
Positioning for parotids:
• Frontal view is taken with face rotated 5-10 degrees towards the side of study.
• Lateral view is taken with 15-20 degrees cranial tube tilt. Positioning for submandibular gland
• Lateral view is taken with 15-20 degrees cranial tube tilt.
Films are taken during injection. The catheter is left in place till the adequacy of films is ensured.

6. Aftercare: none
If sialadenitis occurs after the procedure, it should be treated with antibiotics and anti-inflammatory drugs.

7. Complications
• Sialadenitis and abscess
• Stricture of the ducts.

8. Disadvantages of sialogram
• Masses less than 1cm may not be detected.
• Contrast does not always penetrate the deep lobe of parotid gland.

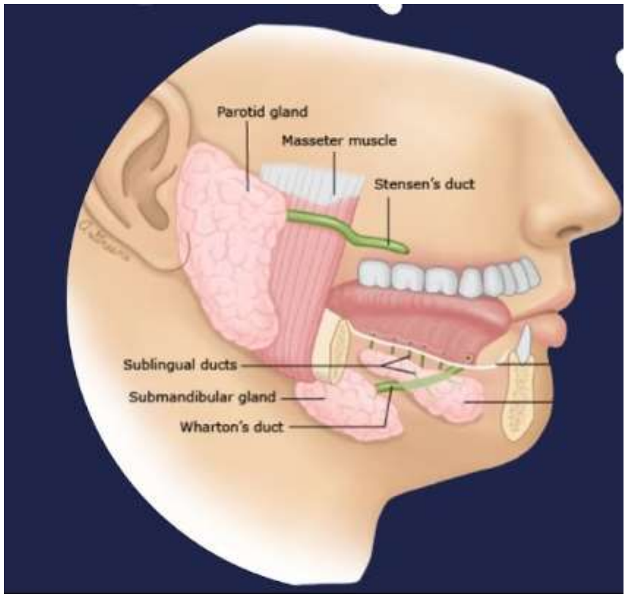


Fig: Sialography

BARIUM SWALLOW

Barium swallow is the contrast study from oral cavity upto the fundus of the stomach.

INDICATIONS

1. Dysphagia and obstruction.
2. Pain during swallowing.
3. Assessment of mediastinal masses.
4. Assessment of left atrial enlargement.
5. Pre-op assessment of carcinoma bronchus and oesophagus.
6. Motility disorders of oesophagus, E.g.: Achalasia and diffuse oesophageal spasm, scleroderma.
7. Assessment of site of perforation.
8. Zenker's diverticulum and cricoid webs. In these cases water soluble contrast media are used. E.g. : Gastrograffin or dionosil aqueous.

RELATIVE CONTRAINDICATIONS

• Tracheo oesophageal fistula.
• Perforation.

CONTRAST

- 100% Barium sulphate paste.
- 80% Barium sulphate suspension.
- 30% Barium sulphate suspension for high kV technique.
- 200-250% high density, low viscosity for double contrast study.

TECHNIQUE

Pharynx

One mouthful (about 10-15 ml) of contrast media (Barium sulphate paste) is given and fluoroscopic observation of the act of deglutition is observed in frontal and lateral view with the patient erect. To get optimum distension of the pharynx, exposure is triggered at the time when the hyoid bone is at the highest point during swallowing. For this, a string is tied just above the level of the larynx. The rotor is kept running and patient is asked to swallow. Exposure is released when the larynx comes above the string. Lateral film is taken in erect and frontal film in supine position.

To Get Optimum Mucosal Coating

One mouthful of contrast media (Barium sulphate paste) is given to the patient and the patient is instructed to swallow once and stop swallowing there after. Spot films are taken in frontal and lateral projections (better way is to ask patient to keep mouth open or say eee .... eee .... after one swallow) or patient performs valsalva maneuver in erect position with nose closed. Frontal and lateral spots are taken to show distended pyriform sinuses and valecullae.

Oesophagus

Single Contrast

Multiple mouthfuls of 80% w /v Barium suspension are given. Follow the barium bolus down the oesophagus and observe the peristalsis always in supine position. Films are exposed in erect position-RAO, LAO, frontal and lateral views when the oesophagus is well distended. In RAO position esophagus is projected clear of the spine.

The escape of contrast at the level of the diaphragmatic hiatus should not be confused for reflux. Mucosal film is taken in RAO after the oesophagus is empty. Then the fundus of the stomach, & G-O junction are assessed with spot films in different obliquities in erect and recumbent positions.

Double Contrast

Barium contrast should be high density, low viscosity (200 to 250%). 15-20 ml Barium is given in the mouth and the patient is asked toswallow. Then effervescent powder is given with another mouthful ofbarium. In erect position, gas tends to stay up, resulting in adequate distension which stays for longer time as compared to supine position. Prone position also retains more gas within the oesophagus and gives adequate distension.

Hypotonia using Buscopan or Glucagon keeps the esophagus distended for a longer time (Inj. Buscopan 2ml LV. given just before the procedure). Filming is done in frontal, lateral, RAO and LAO. Introduction of gas for double contrast studies can also be done through a tube passed into the upper oesophagus.

COMPLICATION

1. Leakage of barium from an unsuspected perforation-granuloma formation.
2. Aspiration.

Present status of Ba. Swallow in comparison with the following:

Oesophageal Endoscopy

• It is a gold standard for diagnosis of oesophagitis, Barret's oesophagus & varices.

• It is also useful to take biopsy for confirmation.

Ultrasound

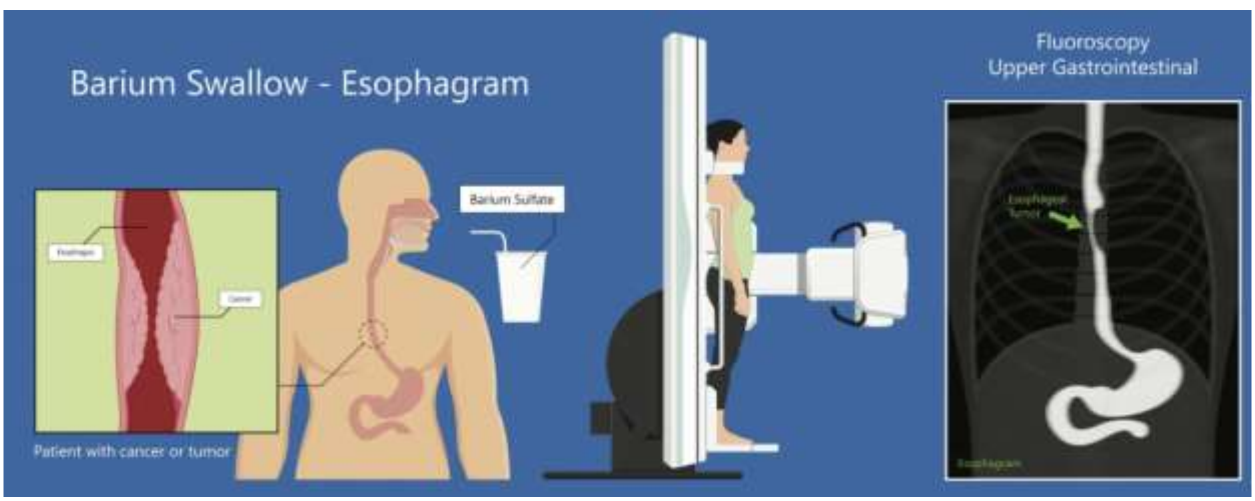
• At present, endoscopic ultrasound provides the most accurate estimation of the depth of penetration in malignancy, the length of esophagus affected, and the extent of lymph node involvement in a patient of ca. esophagus.

• Fine needle aspiration of suspicious lymph nodes can also be taken.

• It is also useful in a patient of esophageal tear. Computed Tomography

• Computed tomography is the standard tool for regional and distant staging of esophageal cancer.

• It may detect thickened esophagus, enlarged lymph nodes, and involvement of the mediastinum, lung or liver.



BARIUM MEAL

Barium meal is the radiological study of oesophagus, stomach, duodenum and proximal jejunum. It is done by oral administration of contrast media (Barium sulphate).

INDICATIONS

1. Symptoms which prompts Barium meal study are :
(a) Epigastric pain suggestive of peptic ulceration.
(b) Anorexia.
(c) Weight loss.
(d) Vomiting.
(e) Anaemia.
(f) Heart burn.
(g) Dyspepsia.
2. Upper abdominal mass.
3. Castro-intestinal haemorrhage.
4. Gastric or duodenal obstruction.
5. Malignancies of oesophago-gastric junction, stomach and duodenum.
6. Systemic diseases like Tuberculosis affecting the upper gastrointestinal tract.
7. Motility disorders of gastro-intestinal tract.
8. In children to identify a cause for vomiting due to : (i) Gastroesophageal reflux; (ii) Pyloric obstruction; (iii) Malrotation.

CONTRAINDICATIONS

Suspected cases of gastro-duodenal perforation
• History or suspicion of aspiration, where alternative contrast medium should be considered.
• Large bowel obstruction (Barium inspissation occurs in these cases)
• Fistulous communication with any organs other than parts of G.I.T.
• Recent biopsy from GIT, as barium granuloma may form at biopsy site.

PREPARATION

Patient should not eat or drink for atleast 6 hours before examination. Patients who are undergoing a routine study during a morning session are usually told to fast overnight.
• As cigarette smoking may interfere with optimum coating of the mucosa, patients should restrain from smoking.
• As prolonged fasting is harmful for patients with diabetes, early morning appointment should be arranged.

• In patients with gastric outlet obstruction, prolonged fasting or intravenous Metacloprarnide and sometimes nasogastric intubation and aspiration of the contents may be necessary.

CONTRAST MEDIA

Single Contrast Study

Low density barium suspension (80-100% w /v) is used. 30% w /v suspension is used for high kV single contrast study. Water soluble contrast media are indicated when a gastro-duodenal perforation is suspected. Use of newer non-ionic water soluble contrast media have to advocated for the detection of upper GI perforation, when there is risk of aspiration.

Double Contrast Study

A high density (approximately 250% w /v), low viscosity barium suspension produces best mucosal coating and hence detail. Between 100 and 150 ml of barium suspension is usually necessary to achieve adequate double contrast studies.

BIPHASIC STUDY OF UPPER GIT

Introduction

Gives good anatomic & physiologic information & has accuracy comparable to endoscopy.

Goal

• To have both mucosal delineation in double contrast phase & full column distention in single contrast phase.

Contrast Medium

60-100% low viscosity, 200-250 ml of Barium is given orally with gas forming powder in the last few mouthfuls.

Filming

Duodenal spot filming is done first to avoid flooding of the bowel

(a) Prone oblique Rt.side down	:Duodenal cap, C-loop
(b) Supine with Rt. side up oblique	: Duodenum
(c) Erect	:Gastric fundus
(d) Supine with 60° head up	: Upper body of Stomach
(e) Supine	: Lower body of Stomach,Pyloric antrum
(f) Supine with Rt. side up oblique	: Pyloric antrum & Canal.

Note: Biphasic examination has to be performed quickly, without wasting time. More gas and barium may be given as required.

AFTER CARE

• The patient should be warned that his bowel motion will be white for few days after the examination and to keep his bowel open with laxative to avoid barium impaction which can be painful.

• The patient must not leave the department until any blurring of vision produced by Buscopan has resolved.

COMPLICATIONS

1. Leakage of barium from an unsuspected perforation-peritonitis.
2. Aspiration pneumonia.
3. Barium impaction-converts a partial large bowel obstruction into a complete obstruction.
4. Side effects from the pharmacological agents used alongwith barium.
5. Acute gastric dilatation.
6. Barium embolisation if a bleeding ulcer is present.

Comparison of barium studies with other modalities like

Endoscopic Ultrasound

1. It is,..ideal to assess the extent of growth & its extension into the wall of oesophagus.
2. It is useful in early detection of lymph nodes.
3. Biopsy can also be taken for confirmation of diagnosis.

Computed Tomography

1. Main role of C.T. is in staging the malignant disease process.
2. It is the modality of choice to assess the structure outside stomach wall.

BARIUM MEAL FOLLOW THROUGH (BMFT)

Barium studies are still the mainstay for evaluating patients with suspected small bowel abnormalities.
The major methods used for the barium examination of the small bowel are:
1. Small bowel follow through examination.
2. Dedicated small bowel follow through examination.
3. Enteroclysis (or) small bowel enema.
4. Peroral pneumocolon.
5. Retrograde small bowel examination.

It is the radiographic examination of the GIT-oesophagus, stomach, duodenum, small bowel and ileocaecal junction by oral administration of contrast media. It is so called because it is performed following a barium meal examination of the oesophagus, stomach and duodenum.

INDICATIONS
1. Patients who have low suspzcwn of small bowel disease abdominal pain and diarrhoea.
2. Patients with suspected complete (or) near complete small bowelobstruction.
3. Patients who are suspected of suffering from Crohn's disease.
4. Patients who refuse placement of nasogastric tube/failed intubation.

If enteroclysis is the routine method, the barium follow through will only be used for
1. Elderly patients with suspected jejunal diverticulosis who present with malabsorption.
2. In patients who are unwilling or in whom it is not possible to perform intubation.

CONTRAINDICATIONS
1. Colonic obstruction.
2. Suspected perforation.
3. Paralytic Ileus.

PREPARATION
Before any small intestinal study
1. The colon should be cleaned by the administration of a suitable purgative. (Purgative should be avoided in patients with suspected obstruction, acute exacerbation of Crohn's disease or an Ileostomy).
2. A low roughage diet and a high fluid intake is also maintained for 48 hours prior

to the investigation
3. No food or fluid should be taken for 12 hours before the investigation. If the patient is taking tranquilizers, antispasmodics and codeine, they should be stopped for 24-48 hours before the examination.

SMALL BOWEL FOLLOW THROUGH
Initially 150 ml of high density barium and effervescent agents are used to evaluate oesophagus, stomach and duodenum by means of double contrast examination. Later 200 ml of barium (20-25%) (to decrease the high density effect from double contrast study of Upper GI study) followed by 250 ml of barium (40-45%) is given. Once this is completed, a series of overhead radiographs are obtained at halfhourly intervals till terminal ileum is reached.

DEDICATED SMALL BOWEL FOLLOW THROUGH
- Single contrast technique.
- Double contrast technique.

COMPLICATIONS
1. Leakage of barium from an unsuspected perforation.
2. Aspiration.
3. Conversion of partial large bowel obstruction into a complete obstruction by the impaction of barium.
4. Barium appendicitis, if barium impacts in the appendix.
5. Side effects of pharmacological agents used.

Fig: BMFT

BARIUM ENEMA

DEFINITION

It is the radiographic study of the large bowel by administration of the contrast medium through the rectum.

CONTRAST

Pure crystals of Barium sulphate are formed by milling of the mined raw mineral barytes, precipitation with sulphuric acid, followed by washing and drying. Particle size varies from 0.6-1.4 microns (fine and uniform) to 4-50 microns (large crystal in more heterogeneous form). Particles are coated with various agents to achieve rapid flow, good mucosa! adhesion, adequate radiographic density, an even coating which is plastic and does not crack and absence of artifact or foaming.

Additives - Carboxy Methyl Cellulose
- Simethicone, Gum acaeeae, Pectin
- Dimethyl Polysilicone (anti foaming agent)

PREPARATION

There are different regimes of bowel preparation and most regimes rely on a combination of dietary restriction, purgation and overhydration with the possible addition of cleansing water enema.

Diet

Patient should be given a low residue (low fibre) diet for 2 days prior to the examination. Patient should not have any fatty fried foods. He should not have vegetables and fruits. Patient can have egg, meat, dal and soups. Patient should drink plenty of clear fluids on the day preceding the examination. Iron containing medication should be stopped 2 days before the examination because they make stools adhere to mucosa.

Laxatives

(For removal of most solid material)

Castor Oil (30 ml)

- irritant cathartic.
- cheap, though unpleasant to take, is gentle in effect.
- has dual action, being broken down in the small bowel into : (i) Ricinoleic acid, which inhibits water reabsorption; (ii) Mineral oil residue that probably has a direct motor action causing contractions in the distal small bowel and proximal colon.

Bisacodyl (15-20 mg)

- irritant cathartic
- contact laxative belonging to polyphenolic group of compounds

• hydrolysed by intestinal enzymes in the small and large bowel into desacetyl bisacodyl which has a direct motor action on the bowel and also a slight secretory effect.
E.g.: Dulcolax.

Magnesium Citrate (5-10 mg)
• saline type cathartic is more pleasant to take than magnesium sulphate.
• magnesium and the sulphate or citrate radicals are poorly absorbed from the gut, leading to osmotic retention of fluid and increased peristalsis.
E.g.: Picolax (one sachet contains 10 mg of sodium picosulphate, 3.5 g of magnesium oxide and 12 g of citric acid).
• It is a contact and osmotic laxative.
• Headache is its most common side effect. E.g.: Citramag (Magnesium citrate equivalent to 5 g of Mg Oxide).

Bowel Wash
• Previous night.
• In the morning, 2 hours prior to the procedure.
• Pass the tube beyond the rectosigmoid junction and infuse about 1.5-2 litres of fluid allowing evacuation. Repeat this till efflux is clear of any faecal matter. This is done for removal of smaller particles.
• Patient lies: Left lateral position -receiving first 500 ml.
Prone position -receiving second 500 ml.
Right lateral position -receiving third 500 ml.

Preparation of Patient in our Department
1. Tab. dulcolax 2 HS - 2 Days.
2. Tap water enema on previous night and 7 a.m. on the day of investigation.
3. Low residue diet - 2 Days.
4. To come on empty stomach on the of investigation.

Preparation of the Patient should not be done in
1. Diarrhoea.
2. Total obstruction.
3. Paralytic ileus.
4. Children less than 8 yrs. of age

DOUBLE CONTRAST BARIUM ENEMA (DCBE)
First modern double contrast barium enema with air insufflation wus performed by Fischer in 1923 and later popularized by Welin in 1960s.

Preliminary Films

Plain radiograph of the abdomen is essential and helps in assessing any abnormalities of gas filled bowel loops. In the presence of residual faecal matter, double contrast examination should be cancelled. In many centres, barium enemas are performed after an excretory urogram. This not only reduces the time of hospitalization but also gives relationship of the urinary system to the colon. It also helps in visualization of the bladder in frontal and lateral projections and this permits the study of the space between bladder and rectum.

Indications

1. Preferred method for routine examination.
2. High risk patients - rectal bleeding, previous H/ o carcinoma or polyp, family H/o colorectal cancer or polyposis.
3. Demonstration of sinuses or fistulas.
4. Patient with severe diverticulosis, polyposis or diarrhoea.
5. Presence of obstruction.
6. Reduction of an intussusception.

Contraindication

1. Allergy to barium suspension.
2. Peritonitis.
3. Acute or fulminating inflammatory colon disease.
4. Debilitated, unconscious, inability to cooperate.
5. History of recent rectal/ colonic biopsy

Procedure

Barium suspension : High density (slower flowing, better coating) 75% to 95% w/v. The patient is in prone position with left side down oblique and high density low viscosity barium suspension is allowed to flow upto splenic flexure. Now air is introduced with patient prone. Air should push the barium column and never pass beyond the column. The role of IV muscle relaxant before or after the double contrast barium study had found to have no effect on the mucosa! coating. Frontal view of rectum is taken in prone position and then the patient is turned left lateral to take the lateral view. Then oblique right side down view for rectosigmoid junction is taken. The patient is taken back in prone position with right side dependent and air is pumped into left sided colon. Once barium comes into transverse colon tum the patient left side up - barium enters right sided colon and reaches the ileocaecal junction. Now with the right side up, more air is pumped till air outlines the ileocaecal junction. Take spot films for flexures and ileocaecal junction. Now proceed with full films in supine, both decubitus and erect as required.

Advantages of Double Contrast Over Single Contrast

- Better surface details.
- Surface lesions can be demontrated to the best effect.
- Easy unraveling of the colon as it is possible to look through loops.

Disadvantages of Double Contrast Over Single Contrast

- Difficult in uncooperative patients.
- Fistulae/sinuses can be missed.
- Effacement of submucosal detail of the colon and overlooking of annular /polypoid lesion is possible.

SINGLE CONTRAST BARIUM ENEMA (SCBE)

Indications

1. Uncooperative, very debilitated or immobile patient.
2. Evaluation of acute obstruction or volvulus.
3. Reduction of intussusception.
4. Show configuration of colon.
5. Where only gross pathology is to be excluded.

Contraindications

1. Allergy to barium suspension.
2. Risk of perforation.
3. Peritonitis.
4. Suspicion of acute/fulminating ulcerative colitis.
5. Following a recent deep biopsy

Procedure

Barium suspension : Low density (to promote see through effect with a high kV or compression) 15% to 20% w /v. Tube is placed in the rectum with the patient in left lateral position. The height of the enema should not be more than 1 metre above the table top. In case there is gas in the rectum, the patient is kept supine and infusion is started. Otherwise the patient is kept in left lateral position. As soon as the entire rectum is full, the tube is clamped and a lateral view is taken. Then the patient is put prone and with the infusion running, the frontal view film of the rectum is exposed. In the prone position, pelvis tilts forward, sacrum lies parallel to the film and foreshortening of rectum is prevented. The patient is kept prone with right side down

oblique position. This position helps in the opening up the curve of rectosigmoid junction. Spot views of rectosigmoid junctions with barium flowing are taken.
Now the patient is kept prone oblique with left side down. Splenic flexure opens out and spot view of splenic flexure is taken. As barium flows towards hepatic flexure, patient is turned right side down oblique and spot films of hepatic flexure. With continuous flow of barium caecum fills up. As soon as the reflux across ileocaecal junction takes place, the tube is clamped and ileocaecal spot films are exposed. A full film is now exposed to show entire colon. After evacuation, mucosal relief film is exposed. Polyposis and diverticulosis can be better visualized on post-evacuation films.
Pelvic outlet view for rectum : Give 30° cranial angulation to the tube with the patient supine so that pubic symphysis and sacral promontory overlap. Pelvic inlet view for sigmoid : Should be taken before the transverse colon is filled with barium. 30° caudal tilt is given to the X-ray tube with patient supine.

Absolute Contraindications for Both DCBE and SCBE

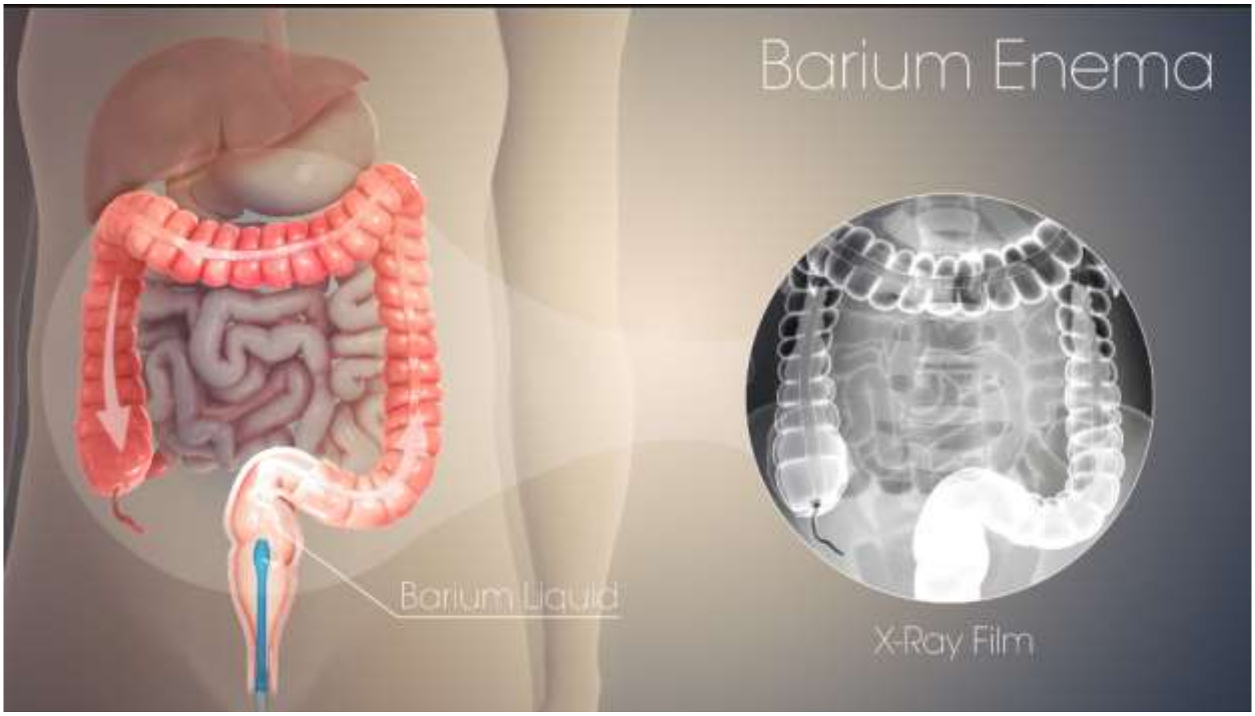
- Toxic megacolon.
- Pseudomembranous colitis.
- If rectal biopsy has been done in the previous 5 days, it is preferable to wait for 7 days.
- Paralytic ileus.
- Difficulty to pass tube in rectum. For example, inflammed piles, growth etc.

COMPLICATIONS

Can result from:
- Preparation of patient
- Pharmacological agents
- Procedure

AFTERCARE

1. The patient should be warned that his bowel motion will be white for a few days after the examination.
2. Laxatives should be used to avoid barium impaction in patients with constipation.



T-TUBE CHOLANGIOGRAPHY

A type of direct cholangiography, which allows study of the CBD in the post-operative period prior to removal of T-tube, determining the patency of CBD. If there are no post-operative complications, a T-tube cholangiogram should be obtained 8-10 days after operation. It is estimated that approximately 5% of post-operative T-tube cholangiograms will show retained calculi (Glenn, 1974). If retained stones are detected, percutaneous removal through T-tube tract, as popularized by Mazzariello (1978) and Bushenne (1980) is the treatment of choice.

INDICATIONS

1. Exploration of the bile ducts at operation.
2. Poor or absent drainage of bile from the T-tube after operation to determine whether the T-tube is blocked or is no longer present in the CBD.
3. Haemorrhage from the T-tube.
4. Demonstration of residual hematoma or abscess formation within the liver parenchyma after partial hepatectomy or liver laceration.

TECHNIQUE

• No patient preparation is required. The examination is done on fluoroscopy unit with image intensifier and a tilting table, 7-10 days after operation/ earlier if there is indication for this such as haemorrhage from T-tube/failure of T-tube drainage.

The patient is placed supine on the X-ray table with the left side slightly raised. All dressings and metal objects are removed from the liver area. A preliminary film of right upper quadrant should be obtained before injection to establish the position of tube and identify unusual air collections. Sterile technique is used, and a syringe connected to a No. 21 or No. 23 scalp vein needle is filled with contrast material and closely scrutinized to eliminate air bubbles. The I-tube is then punctured and gently aspirated to withdraw air bubbles lodged in the tube. The I-tube should then be clamped just beyond the point of insertion of the needle to prevent distal air bubbles from being mobilized during injection. Dilute contrast medium should be used so that stones are not obscured. If bile ducts are markedly dilated, more dilute contrast medium (CM) should be injected, but overdistension should be avoided. Care should be taken not to introduce air bubbles into biliary tree as they may mimic stones on cholangiogram. Approximately 5 cc of CM is injected under fluoroscopic control and a spot film is obtained in AP projection. Patient is then rotated into the left posterior oblique position and the procedure repeated with an additional 5 cc injection. A further injection is made when the patient is placed in RPO and finally a film is taken with patient supine once again in straight AP. Normally a total of 20-25 cc of CM is sufficient to obtain these special views. After final injection, a right lateral film may be obtained if required. If desired, films are taken at 15min / 30 min intervals depending upon degree of delay in emptying of biliary tract until patency of biliary tract is determined. If obstruction is encountered, it is best to withdraw as much of contrast media as possible prior to removal of the syringe. With a slow injection rate, the patient should experience no pain. A sense of fullness will occasionally be noted. Marked discomfort indicates that either the I-tube is malpositioned or the normal flow of bile is obstructed. If explanation is not evident fluoroscopically, it is best to pause and review the available films before proceeding.

PITFALLS

Differentiation between air bubbles and calculi may be made by placing the patient in Trendelenburg and Semierect positions. Not everything that is round and rises to float is an air bubble. Gall stones do not have to be faceted and cholesterol stones may float in CM. Elseny and Jacobs showed that specific gravity of cholesterol stone is 1.04, which is the greatest specific gravity that native bile reaches, which means stones can hardly float in native bile, but may float after the dilution by contrast. Air bubbles fortunately are never faceted, never sink in bile/ contrast medium and typically appear as tiny, perfectly round, smooth, and often multiple lucent defects.

INTERPRETATION

Normal T-tube cholangiogram

Normally there is free drainage of the CM into the duodenum and there may be reflux of CM into the pancreatic duct. Using this technique, the entire biliary tract is outlined, including any cystic duct remnant. Oblique/lateral views or both are necessary to demonstrate the latter.

Abnormal T-tube cholangiogram

1. Failure of CM to enter the duodenum may be due to :
(a) Rapid injection of CM resulting in the spasm of sphincter of Oddi.
(b) Organic obstructive lesion such as tumor or calculus. When obstructive lesion is encountered, spot films of the area should be taken.

2. Failure of CM to pass into the IHD may result either from concretions obstructing the lumen or orifice of proximal limb of T-tube or CM following the path of least resistance distally.

3. Failure of T-tube drainage after operation may be due to :
(a) Occlusion of T-tube by debris. This is sometimes overcome by injection of CM.
(b) Malposition of T-tube in CBD. This happens when upper limb of T-tube lies against wall of right or left hepatic duct, usually because the upper limb is too long, which may lead to obstruction of bile flow leading to jaundice.
(c) Kinking of the T-tube within the abdomen.
(d) One or both limbs of T-tube may lie outside the CBD. Clinically this is suspected when there is failure of drainage, leakage of bile around the tube or a biliary fistula.

4. Haemorrhage from a I-tube post-operatively
It may be due to
(a) Erosion of small vessel by the tube.
(b) Vitamin K deficiency in patient with obstructive jaundice of long duration.

5. Residual calculi in CBD
These usually pass down from the intrahepatic ducts more commonly from the left hepatic duct and are found in the upper CBD or rarely at its lower end.

6. Lower CBD obstruction at I-tube cholangiography
This is most commonly due to spasm of sphincter of Oddi, owing to rapid injection of CM. It may also be due to :
1. A neoplasm at head of pancreas.
2. Chronic pancreatitis with fibrosis of the lower CBD.
3. A benign stricture after passage of a calculus.
4. Primary carcinoma of the papilla or CBD.
5. A calculus impacted at the sphincter of Oddi.

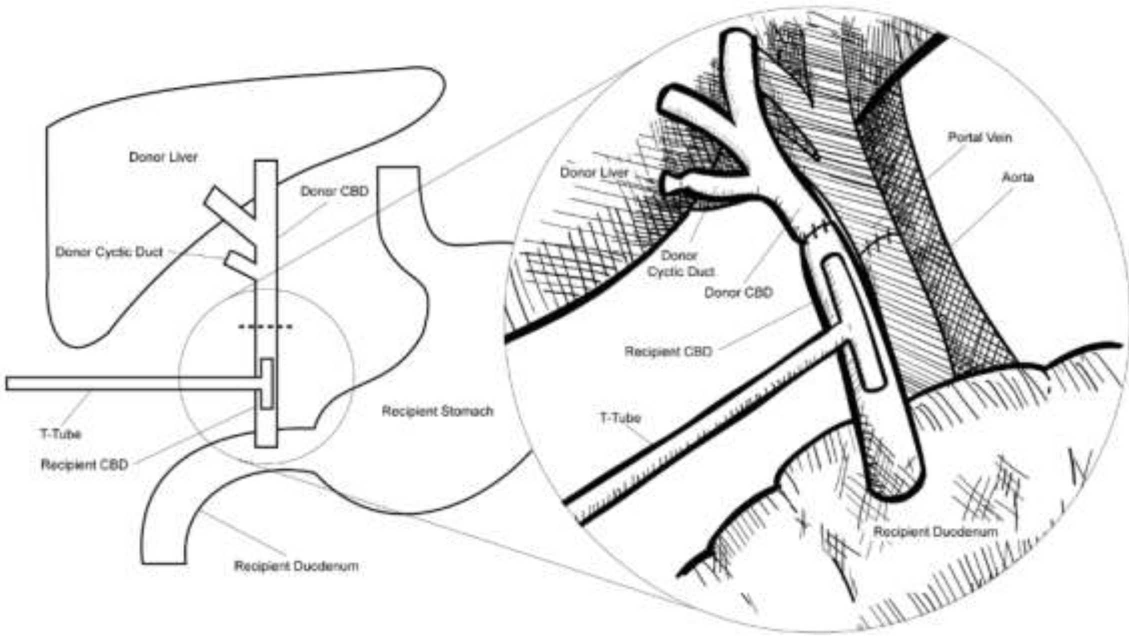


Fig: T-tube cholangiogram

PERCUTANEOUS TRANSHEPATIC CHOLANGIOGRAPHY

It is a method of direct cholangiography and provides the most complete and detailed radiographic demonstration of biliary duct system.

INDICATIONS

- In presence of bile duct obstruction which has been demonstrated by US/CT where information provided by these studies is insufficient for diagnostic purposes/for planning treatment.
- Prior to biliary drainage procedures/stenting.
- Undiagnosed jaundice.
- Extrahepatic bile duct obstruction due to calculi, strictures and malignancies.
- Biliary diseases.
- Sclerosing cholangitis.
- Chronic pancreatitis.
- Post operative fistula.

CONTRAINDICATIONS

• Ascites-difficulty in puncturing and applying compression, possibility of haemorrhage is high.
• Biliary sepsis-appropriate antibiotic cover, use small volume contrast and establish drainage.
• Hydatid disease.
• Bleeding diathesis.
• Contrast hypersensitivity.

PREREQUISITES

Patient Preparation

1. US /CT must be performed prior to PTC, which provides useful information regarding not only to the level of obstruction but also to the assessment of tumor resectability and planning of the most appropriate approach to biliary decompression.
2. Check clotting profile and platelet count.
3. Xylocaine sensitivity test.
4. HIV and HBsAg be tested for.
5. Fasting 4 hours prior to procedure.
6. Start I.V. line and broad spectrum antibiotics (in view of high incidence of bacterial colonization of obstructed biliary system).
7. Premedication 30 minutes prior to procedure.
8. Informed consent.

Equipment

1. Fluoroscopy unit with image intensifier and a tilting table
2. Chiba needle-22/23 G, 15-20 cm long with short bevel, stainless steel needle.

TECHNIQUE

PTC is performed as a sterile procedure with the patient on a fluoroscopic table which preferably is able to tilt. This is done under local anaesthesia with i.v. sedation and analgesia with appropriate patient monitoring.
Two approaches: Right flank approach (Lateral) and epigastric approach.

Right Flank Approach

A flexible chiba needle is inserted, usually from the right side. The puncture site is slightly anterior to midway between the tabletop and the xiphisternurn; inferior to the right lateral costophrenic angle on fluoroscopy on full inspiration and superior to the hepatic flexure of the colon on full expiration. The needle is inserted medially through the liver while screening, angulated slightly anteriorly to the coronal plane and directed craniad towards a point midway between the right cardiophrenic angle and the first part of the duodenum which can usually be identified by luminal gas.

• Specific vertebral bodies are not appropriate for guidance as their relationship to the liver is variable. Needle movement should be during suspended respiration, end-expiration or end-inspiration, and the different phases of respiration can be used to help direct the needle.

• Needle tip is advanced to approximately over the right margin of the spine and then withdrawn incrementally with intermittent suction applied with a syringe connected via a short tubing.

• Needle entry into a bile duct is identified by aspiration of bile or injection of contrast medium.

• It is important to inject only sufficient contrast media to establish diagnosis, as injecting more in high-grade obstruction will increase risk of septic shock.

• Injection of contrast media outside bile ducts should be minimum as it tends to obscure the region of interest, may be painful and can produce pseudo-obstruction of IHBD.

• Injection into portal or hepatic veins is recognised by rapid flow of contrast media away from the needle tip.

• Injection into lymphatics - narrow irregular channels passing downwards and medially but without typical branching of bile ducts. These have a characteristic fine beaded appearance.

• Injection into liver parenchyma - persistent amorphous stain.

• Injecting periportally - static branching stain.

• Injection into bile ducts - slow 'oil like' flow of contrast medium away from needle tip. With multiple needle passes it is common to produce haemobilia, when this occurs blood stained bile is aspirated which is more viscous than frank venous blood and drips like oil rather than water.

• If biliary radicle is punctured in first pass, repeated attempts are made with slight variation in craniocaudal angulation but without withdrawing tip from liver substance.

• If gall bladder is punctured accidentally, continue by injecting contrast till gall bladder lumen and CBD are opacified and appropriate films are taken (frontal, 45 degrees, LPO, lateral, Trendelenberg).

After filming, contrast and bile are aspirated out of gall bladder to decompress system. • The success rate using fine needle PTC increases with number of passes and increase in number of passes does not increase the incidence of serious complications.

• As movement in biliary radicles is gravity dependent, various positional manoeuvres are done. LPO and Prone positions are used to opacify left lobe ducts.

• Following successful duct entry, bile samples should be obtained for bacteriological and if malignant obstruction is suspected for cytological examination.

• Water-soluble contrast medium (200-300 mg I/ml) is then injected in sufficient quantities to obtain as much filling as possible of the intrahepatic and extra hepatic duct system without using undue pressure. As much bile as possible is aspirated, but if aspiration is difficult without loosing needle position then undiluted CM is used (bile itself produces some dilution).

• In very dilated systems or if stones are suspected more dilute CM is needed so that stones or ductal anatomy is not obscured.

• With needle in position, patient can be carefully moved into a LPO position, which helps to fill the more anterior left lobe ducts and feet down table tilt us used to fill the EHBD completely. Films are checked prior to needle withdrawal and then further films are taken in different projections to ensure complete visualization of biliary system. A prone film may be needed to fill left ducts

Epigastric Approach

It is preferred when: 1. If only left lobe cholangiogram is required or if right sided PTC has failed to produce left lobe cholangiogram. 2. If there is right lobe atrophy or previous right hepatectomy which results in gall bladder or bowel lying deep to right lateral wall where they are at risk of puncture with a right flank approach.

Pitfalls

l. False localization of level of obstruction: Failure to inject sufficient CM or use table tilt and patient positioning can lead to false localization of obstruction recognized by presence of hazy margin at level of appc1rent obstruction.

2.Incompletes cholangiogram. Opacification of only right ducts is often mistaken for a complete cholangiogram. The left ducts lie usually over spine if not opacified even with patient rotation and table tilt then direct epigastric approach is used.

AFfER CARE

1. Ask the patient to lie down on right lateral position, as this gives compression to puncture site.
2. Check pulse and BP ½ hourly for 12-24 hours.
3. Observe for increase in abdominal girth.
4. Observe for signs and symptoms of peritonitis and intraperitoneal haemorrhage.

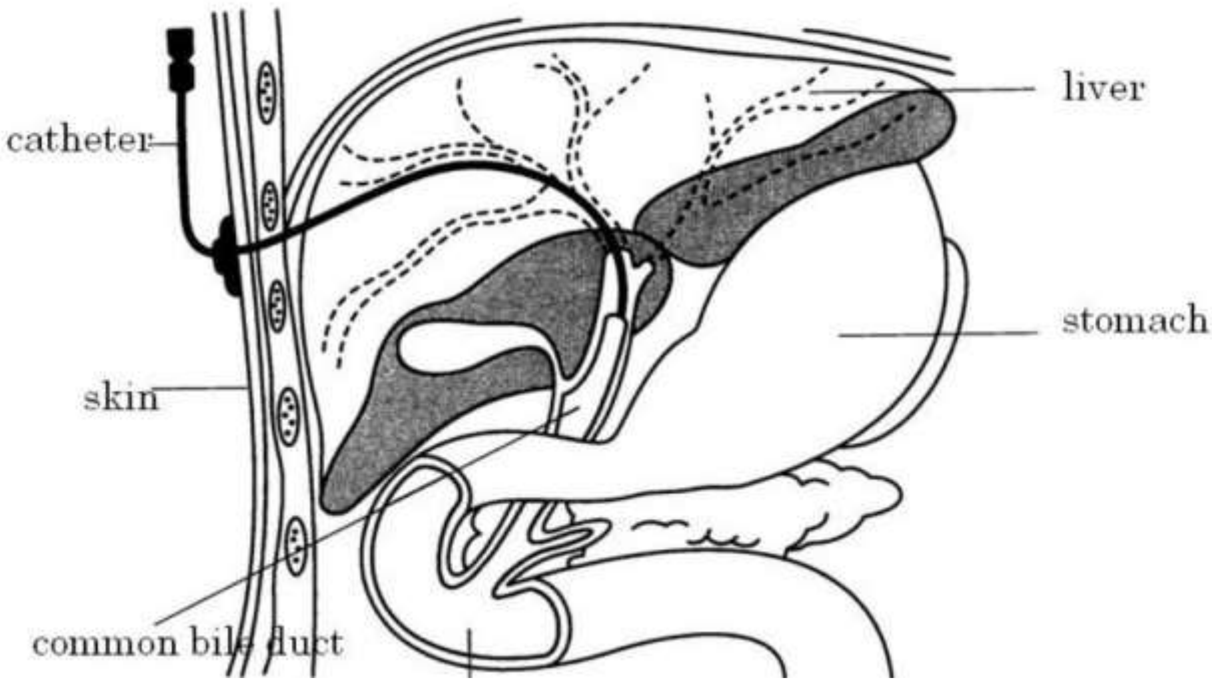


Fig: Percutaneous Transhepatic Cholangiography

BILIARY SYSTEM PROCEDURES (PTBD/ERCP/PTC)

PTBD (Percutaneous Transhepatic Biliary Drainage)

Percutaneous Transhepatic Biliary Drainage (PTBD) is a procedure used to relieve biliary obstruction. It is typically performed when endoscopic methods (like ERCP) are not feasible. Here's an overview of the procedure and its details:

Indications:

1. **Malignant Biliary Obstruction:** Often due to cholangiocarcinoma, pancreatic cancer, or metastatic disease.
2. **Benign Biliary Strictures:** Resulting from surgical injury, chronic pancreatitis, or primary sclerosing cholangitis.
3. **Biliary Leaks:** Post-surgical or traumatic.
4. **Infectious Conditions:** Such as cholangitis when other methods fail.

Procedure Details:

Pre-procedure Preparation:

1. **Patient Assessment:** Including history, physical examination, and review of imaging studies like ultrasound, CT, or MRCP.
2. **Laboratory Tests:** Blood tests to assess coagulation status (INR, platelets), liver function tests, and renal function.
3. **Informed Consent:** Detailed explanation of the procedure, risks, and benefits.

Technique:

1. **Imaging Guidance:** The procedure is usually performed under ultrasound and fluoroscopic guidance.
2. **Anesthesia:** Local anesthesia with or without conscious sedation. Sometimes general anesthesia may be required.
3. **Accessing the Biliary Tree:**
    - A needle is inserted through the skin and liver into a bile duct.
    - Contrast dye is injected to visualize the biliary tree (cholangiogram).
4. **Guidewire and Catheter Placement:**
    - A guidewire is passed through the needle into the bile duct.
    - The needle is removed, and a drainage catheter is placed over the guidewire into the bile duct.
    - The catheter may be internal (draining into the duodenum) or external (draining outside the body into a bag).

Post-procedure Care:

1. **Monitoring:** Vital signs, pain management, and monitoring for complications.
2. **Catheter Care:** Regular flushing to maintain patency and prevent infections.
3. **Follow-up Imaging:** To assess the position of the catheter and the resolution of biliary obstruction.

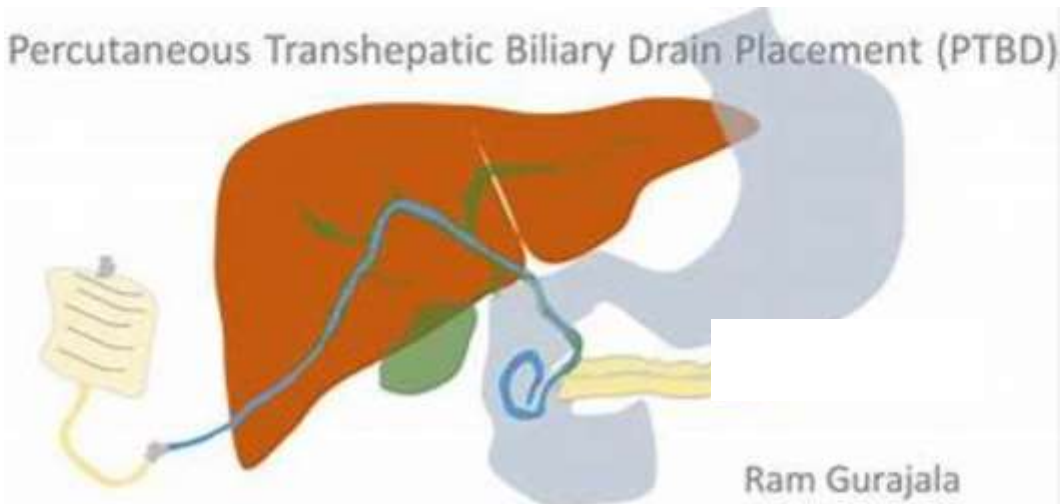
Complications:

1. **Bleeding:** From liver puncture or bile duct injury.

2. **Infection:** Cholangitis or abscess formation.
3. **Catheter Displacement:** Leading to bile leakage or ineffective drainage.
4. **Peritonitis:** Due to bile leak into the abdominal cavity.
5. **Liver Damage:** Rare but possible.

Advantages:

- **Minimally Invasive:** Compared to surgical options.
- **Effective Relief:** Of biliary obstruction, reducing symptoms like jaundice and pruritus.
- **Bridge to Surgery:** Can be used as a temporary measure before definitive surgical treatment.



<u>ERCP(Endoscopic Retrograde Cholangiopancreatography)</u>

Endoscopic Retrograde Cholangiopancreatography (ERCP) is a procedure used to diagnose and treat conditions of the biliary and pancreatic ducts. It combines endoscopy and fluoroscopy to provide both diagnostic and therapeutic capabilities. Here are the details of the procedure:

Indications:

1. **Biliary Obstruction:** Due to stones (choledocholithiasis), strictures, or tumors.
2. **Cholangitis:** Infection of the bile ducts.

3. **Pancreatitis:** Especially when caused by bile duct stones.
4. **Biliary Leaks:** Often post-surgical.
5. **Sphincter of Oddi Dysfunction:** Problems with the muscle controlling bile and pancreatic juice flow.

Procedure Details:

Pre-procedure Preparation:

1. **Patient Assessment:** Medical history, physical examination, and review of imaging studies such as ultrasound, CT, or MRCP.
2. **Laboratory Tests:** Liver function tests, coagulation profile, and renal function.
3. **Informed Consent:** Explanation of the procedure, risks, and benefits.

Technique:

1. **Sedation/Anesthesia:** Usually performed under conscious sedation, but general anesthesia may be used.
2. **Endoscope Insertion:**
   - A duodenoscope is passed through the mouth, esophagus, and stomach into the duodenum.
3. **Cannulation of the Ampulla of Vater:**
   - A catheter is inserted through the endoscope to cannulate the ampulla of Vater (opening of the bile and pancreatic ducts).
4. **Contrast Injection:**
   - Radiopaque contrast dye is injected into the bile and pancreatic ducts.
5. **Fluoroscopy:**
   - X-ray images are taken to visualize the ducts and identify any obstructions, stones, or abnormalities.

Therapeutic Interventions:

1. **Sphincterotomy:** Incision of the sphincter of Oddi to facilitate stone removal or improve bile flow.
2. **Stone Extraction:**

    - Stones are removed using baskets or balloons.

3. **Stent Placement:**
    - Plastic or metal stents are placed to relieve obstructions or leaks.
4. **Dilation of Strictures:**
    - Balloon dilation of narrowed areas in the ducts.
5. **Biopsy:** Tissue samples may be taken for further pathological examination.

Post-procedure Care:

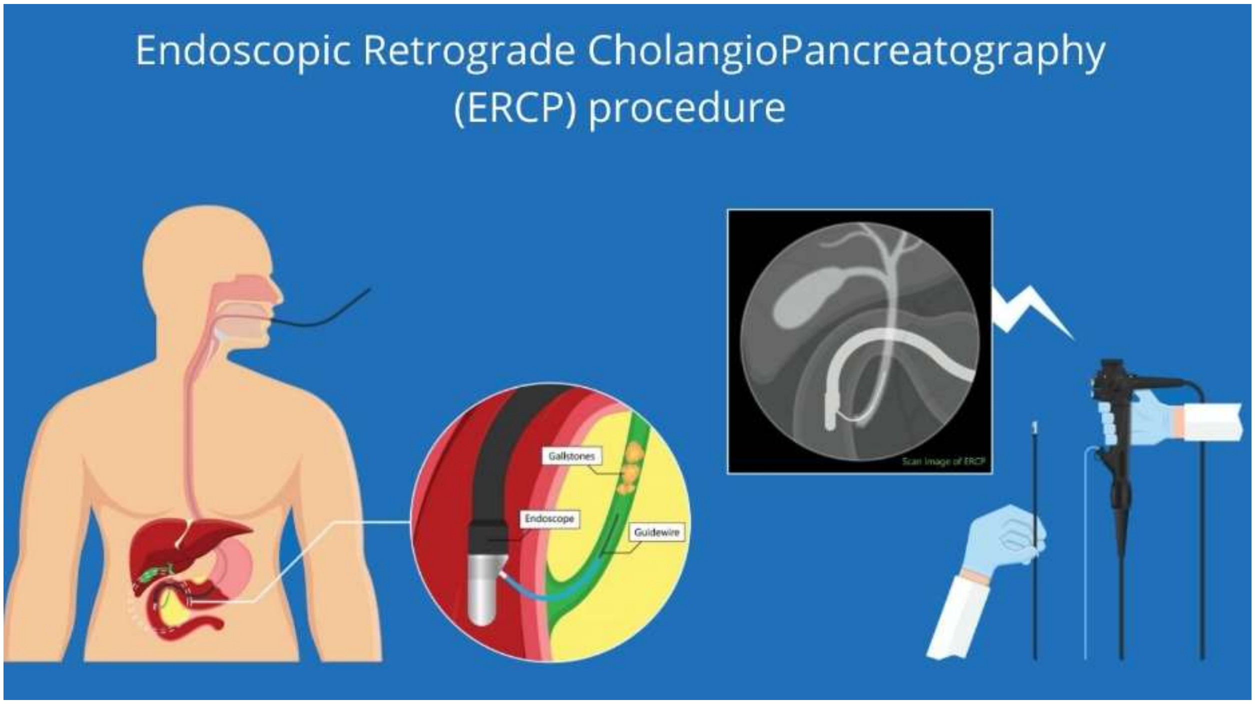
1. **Monitoring:** Vital signs, monitoring for complications like pancreatitis or bleeding.
2. **Diet:** Gradual reintroduction of diet, starting with clear liquids.
3. **Medications:** Pain management and antibiotics if needed.
4. **Follow-up:** Additional imaging or procedures if necessary, especially if stents are placed.

Complications:

1. **Pancreatitis:** The most common complication.
2. **Infection:** Cholangitis or sepsis.
3. **Bleeding:** From sphincterotomy or biopsy sites.
4. **Perforation:** Of the duodenum or ducts.
5. **Adverse Reactions:** To sedation or contrast dye.

Advantages:

- **Minimally Invasive:** Compared to open surgical procedures.
- **Diagnostic and Therapeutic:** Can identify and treat issues in one session.
- **Quick Recovery:** Faster recovery time compared to surgery.



INTRAVENOUS UROGRAM (IVU/NP):

It is the radiographic examination of urinary tract including renal parenchyma, calyces and pelvis after intravenous injection of contrast media. Intravenous pyelogram (IVP) is a misnomer as it implies visualisation of the pelvis and calyces without the parenchyma. The term pyelogram is reserved for retrograde studies visualising only the collecting system.

There has been a decline in the intravenous urograms done over the last 10 years. This is because of

1. Development of newer imaging modalities like CT Scan, Ultrasound etc.
2. Cost--containment.
3. Adverse effects of contrast media.

INDICATIONS

In Adults

1. Screening of entire urinary tract especially in cases of haematuria or pyuria.
2. Diseases of renal collecting system and renal pelvis.
3. Differentiation of function of both kidneys.
4. Abnormalities of the ureter.
5. Obstructive uropathy-IVU is the gold standard.
6. TB of the urinary tract.
7. Calculus disease.
8. Potential Renal Donors.
9. Prior to endo-urological procedures and surgery of urinary tract.

10. Suspected renal injury.
11. Renal colic or flank pain.

In Children

Besides the indications mentioned above other indications are

1. VATER anomalies: These patients have vertebral, anal, tracheoesophageal, and renal anomalies. Renal anomalies are seen in about 90% of patients.
2. Malformation of urinary tract, e.g., polycystic disease, PUJ obstruction etc.
3. Neurological disorders affecting urinary tract.
4. Malformation of genitalia like bilateral cryptorchidism, III degree hypospadiasis, family history of urinary tract anomalies, urinary tract infection.
5. Enuresis in the presence of bacteriuria, abnormal urinary sediment, adolescents, diurnal/ nocturnal incontinence and history of recurrent urinary tract infection.
6. In girls with constant or intermittent dampness which suggests an ectopically inserted ureter, IVU is mandatory.
7. Anorectal anomalies.
8. Not recommended for evaluation of UTI unless preliminary voiding cystourethrogram reveals reflux or some other compelling indication.

CONTRAINDICATIONS (RELATIVE)

1. Iodine sensitivity.
2. Pregnancy
3. Severe history of anaphylaxis previously carries 30% risk of similar reaction on a subsequent occasion. The risk is lower with low osmolar contrast media.

Contrast Media

Dose

In adults	In children
Non-ionic contrast media	
Iohexol—Omnipaque	*240 mg I/ml 300mg I/ml*
300 mg I/ml—40-80 ml or	< 7 kg 4 ml/kg 3 ml/kg
350 mg I/ml 40-80ml	> 7 Kg 3 ml/kg 2 ml/kg
Ionic media	
300 to 600 mg Iodine equivalent/kg body weight. Maximum of 40 gm of Iodine.	Meglumine iothalamate or diatrizoate 60% containing equivalent of 280 mg I/ ml of iodine. Dose is 1-2 ml /kg body weight < 6 months : 10 ml 6 months-2 yrs : 20 ml 2-10 yrs : 20-40 ml.

Mode of injection Contrast media is usually given as a LV. bolus injection within 30-60 seconds. The density of the nephrogram is directly proportional to the plasma concentration of contrast media. More iodine increases the density of the nephrogram. Large doses of contrast media increase diuresis which distends the collecting system thus increasing the diagnostic information from the urogram.

PREPARATION

For Adults

1. Ask for any history of Diabetes mellitus, Pheochromocytoma, Renal disease, or allergy to drugs and any specific foods.
2. Fasting for 4 hours.
3. Do not dehydrate the patient.
4. Bowel preparation:

• Low residue diet like Dal-chapati/Non-vegetation food and plenty of oral fluids.

• Bowel wash is given till bowel is clear of faecal matter on the previous night. Conventional enema is not desirable because it is inadequate for colon cleansing and leave residual air and fluid in the bowel. However, distal colon enemas can be used to clean the distal bowel and can be utilised in the place of 'he suppository.

• Laxatives is recommended to eliminate faecal matter from the colon and to reduce amount of gas in the bowel.

Dulcolax (Biscodyl) is given 2-4 tablets at bedtime for 2 days prior to the I.V.U. If this does not cause adequate bowel cleansing then give castor oil. Castor oil is an effective catharsis when administered in the dose of 30-60 ml. Castor oil is contraindicated in cases of abdominal pain of unknown cause, old and debilitated patients. In older patients it is advisable to use a suppository in the morning in addition to oral laxatives.

For Children

1. No paediatric patient should ever be purposely dehydrated as it is hazardous to do so.
2. Colon should be empty for I.V.U. For this, laxatives can be given. However, results of laxatives are unpredictable and the compliance in their administration by parents is erratic. Suppositories are better for this purpose. Cleansing enemas are used in children older than 2 years. A preliminary film is taken. If it shows undue gas or faeces in colon the nurse can administer a cleansing enema using soap suds.
3. The child posted for urography must not have a full stomach to avoid vomiting. So the child should not be given anything by mouth for 3-4 hours prior to the procedure.

PROCEDURE

• Patient is placed in supine position with pelvis at cathode side of the tube.

• A support is placed under patient's knees to reduce lordotic curvature of lumbosacral spine and provide comfort.

• A scout film is taken including the kidneys, ureters, bladder and urethral regions on a large size film.

Contrast media is injected intravenously into a prominent vein in the arm. Test injection of 1ml of contrast is given and patient is observed for 1 min to look for any contrast reactions. Then the rest of the contrast is rapidly injected within 30-60 seconds.

Cortical nephrogram is seen within 20 seconds of contrast injection. This depicts the renal parenchyma opacified by contrast. The nephrogram is made up of cortical phase due to vascular filling and a tubular phase due to contrast within the lumen of renal tubule. Density of the nephrogram depends on the dose of contrast and the peak plasma level.

The appearance of pyelogram (contrast in calyces) is seen 2 minutes after contrast injection. During its transit, it may be concentrated as much as 50 times producing a dense pyelogram.

If a kidney fails to excrete detectable amount of contrast media into collecting system, it is termed as non-visualising kidney. This does not necessarily mean that the kidney is not functioning.

In Children

• Equipment should be capable of short exposures to avoid motion blurring.
• Usually a moving grid is used.
• Source to image distance- 40 inches or 1 metre.
• Contrast - non-ionic best
• Dose 1-2 ml/kg.
• Filming: The concentrating ability of the kidney is not fully developed in neonates, so delay is given for initial films. First film is taken 15 min after. Adequate collimation should be used so as to reduce total absorbed dose and effect of scattered radiation on film quality. Fast film-screen combinations and minimum number of films should be taken.
• Gonadal protective shields should be used.
• If bowel gas obscures the renal region, either paddle compression technique should be used or place the child in prone position as it displaces bowel away from the kidneys or use post compression release technique.

FILMING TECHNIQUE

Low KV (65-75) high mA (600-1000) and short exposure should be used to get optimum image contrast.

Standard Films Taken

• Plain X-ray KUB /Scout film-14" x 17"
• 1 minute film-10" x 12"
• 5 minute film-10" x 12"

• 10 minute film-15" x 12"
• 15 minute film-15" x 12"
• 35 minute film-14" x 17"
• Post void film-10" x 8"

Plain X-ray KUB /Scout film provides valuable information and sometimes indicates probable diagnosis. Useful in assessing

• Calculus
• Intestinal abnormalities
• Intestinal gas pattern
• Calcification
• Abdominal mass
• Foreign body 1 minute film shows nephrogram. This radiograph is often omitted as the renal outlines are usually adequately visualised on 5 minute film.

5 minute film shows nephrogram, renal pelvis, upper part of ureter. Compression band is now applied on patient's abdomen and the balloon is positioned on anterior superior iliac spine where ureters cross pelvic brim. This is to produce better pelvicalyceal distension.

Special films in IVU

l. Oblique view: To project the ureter away from spine and to separate overlying radio opaque shadows mimicking calculi. Oblique views are also used for visualisation of posterolateral aspects of bladder; differentiation of extrinsic or intrinsic renal, ureteral or bladder masses and for doubtful urethral masses.

2. Erect film is used to • Provoke emptying of urinary tract; • Demonstrate layering of calculi in cysts and abscesses; • Detect urinary tract gas not seen in other films; • Have optimum demonstration of renal ptosis, bladder hernia, cystocele and areas of obstruction in ureter.

3. Prone film is used for • Viewing of ureteral areas not seen in supine films, • Demonstration of renal ptosis and bladder hernia.

4. Delayed films in IVU are taken 1-24 hours after injection. Patients should always be instructed to void prior to delayed films so that a calculus in the distal ureter is seen well. Usual sequence of delayed films is after 1 hr, 3hrs, 6 hrs, 12 hrs and 24 hrs.

Delayed films are used in

• Cases of obstruction where early nephrogram is seen but collecting system is not seen.
• Long standing hydronephrosis in which renal parenchyma is seen but collecting system is not visualised until many hours later.
• Congenital lesions like non-visualised upper calyceal system with ectopic or obstructed ureter.

NEPHROTOMOGRAM

This consists of rapid injection of contrast media followed by tomography. Indications

1. Mass lesion of renal parenchyma--cysts/tumours.
2. Demonstrate damage to renal parenchyma from infection or infarct.
3. Exact localization of the mass.
4. Detection of parenchymal scars.
5. Adrenal tumours.
6. Anomalies-horse shoe kidney, pelvic kidney.
7. Poor contrast concentration.
8. Renal trauma

Technique Patient is placed supine on X-ray table. Preliminary tomograms are taken 6 cm and 9 cm from table top and contrast is injected rapidly. For nephrotomogram body sections are taken at 1cm intervals, 60-90 seconds after end of injection. The tomograms should be taken at the period of maximum intensity of nephrogram.

Tomogram levels

8, 9, 10 cm from table top for normal adult.
9, 10, 11 cm in heavier patient.
7, 8, 9 cm in thin patient.
5, 6, 7 cm for children.

• Linear tomogram is superior to complex motion tomography. 40- 50 tube arc gives the best tomographic effect.

• Since upper poles of the kidneys are located more posteriorly than the lower poles, upper poles are seen better in posterior tomograms and lower poles on anterior tomograms.

• A nephrotomogram at 12-20 seconds after commencement of contrast injection (Arm-Kidney time) may demonstrate a vascular phase with delineation of renal vascularity.

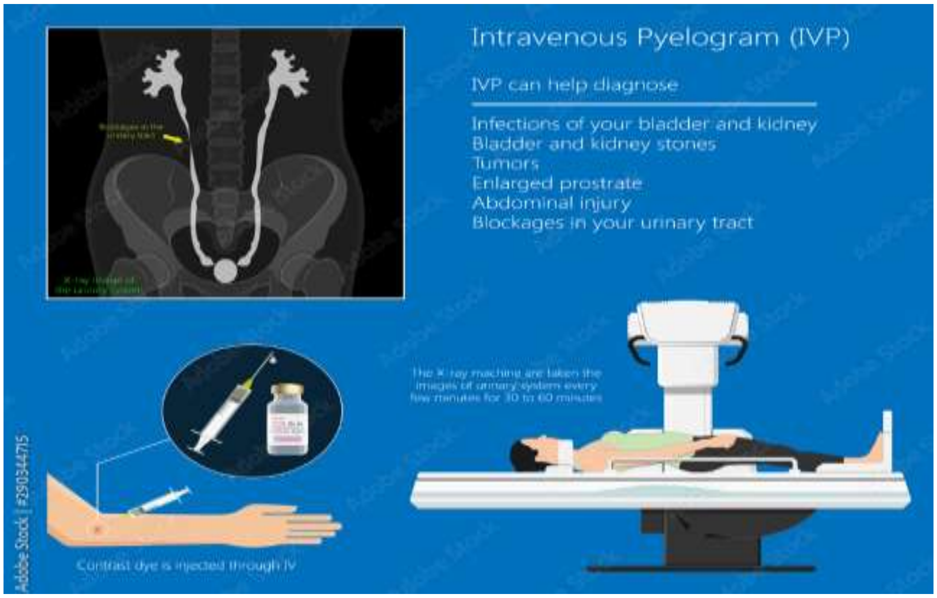
• A tomogram at 30-45 seconds shows dense parenchymal opacification, delineation of cortex, medulla, corticomedullary junction and also lobar anatomy of kidney.

• A series of tomograms (1-4 minute) shows homogeneous uniform, increased density of parenchyma and no delineation of cortex and medulla.

For obliteration of bowel gas, 8-10 degrees tube arc (Zonogram) is used.

AFTER CARE

1. Observation for 6 hours.
2. Watch for late contrast reactions.
3. Prevention of dehydration.
4. In high risk patients-renal function tests should be done to watch for deterioration.



ANGIOGRAPHY

It is the study of the blood vessels by injection of a contrast medium into the vessel. This can be done in two ways:

• Direct injection of contrast with needle insitu
• Injection of contrast with catheter insitu (catheter angiogrărn)

INDICATIONS

1. Primary vascular diseases like :
(a) Vasa-occlusive deseases.
(b) Vasospastic disease.
(c) Aneurysms.
(d) AVM Arteriovenous Malformations.
(e) AVF Arteriovenous Fistulas.
2. Vascularity assessment of a tumour.
3. Investigating source of haemorrhage.
4. Congenital vascular condition.
E.g.: coarctation, abnormal origin of vessels etc.
5. Pre-operative definition of vascular anatomy.
E.g. : Organ transplantation, Vascular tumour excision.

6. Percutaneous interventional vascular procedures.

CONTRAINDICATIONS

1. Bleeding tendencies or anticoagulant therapy leading to a prothrombin time above 30% of the control values.
2. Pulse not palpable at the vascular access site.
3. Thrombogenic tendency.
4. Skin infections or swelling at site of entry. In case of this, alternate entry site is selected.
5. Abnormal renal function. If patient is in CRF then it is better to put the patient on dialysis after doing the angiogram.
6. Cardio Vascular diseases like recent MI, overt CCF. Contrast injection may exacerbate cardiac failure.
7. Hepatic failure.
8. History of allergy, skin rashes or asthma.
9. Pregnancy.
10. Residual barium from previous studies.

PATIENT PREPARATION AND PRECAUTIONS

1. Careful history and clinical examination.
2. Informed consent.
3. Patient should be well hydrated.
4. Fasting 4 hours prior to procedure.
5. Shave and clean the arterial puncture site.
6. Xylocaine sensitivity test.
7. Following investigations to be done :

- Hb% and Haematocrit and platelet count
- ESR
- PT, PTT, BT and CT
- HBsAg and HN
- Pulse chart
- General examination and bruits, if any, should be noted
- If patient is on Warfarin, it should be stopped 4-6 days before Procedure
- If any H/ o heparinization, heparin should be stopped 4-6 hours before procedure
- PTT 1.2 x control, is acceptable
- Any history of drug intake
- History of diabetes mellitus
- History of coronary heart disease

LOCAL ANAESTHESIA

1 %-2% xylocaine without adrenaline is used.

After intradermal and subcutaneous infiltration, needle is advanced at 45 degree angle to the skin surface, with the femoral artery fixed with 3 fingers, 3-4 ml is infiltrated medial to the artery. Care should be taken not to inject in the femoral vessels, by aspirating prior to the injection. Then 3-4 ml of xylocaine is injected lateral to the artery. This large quantity of local anaesthesia helps in stabilising the artery and to minimise local vasospasm.

DIRECT NEEDLE PUNCTURE + INJECTION OF CONTRAST WITH NEEDLE IN SITU

For the Femoral Artery

- Feel the inguinal ligament.
- Feel the artery and fix it with three fingers of left hand below the inguinal ligament.
- Inject the local anaesthetic agent at the site of the puncture as described above.
- Make a hole in skin using a thick needle 2½ cm (1 inch) below the inguinal ligament or give a stab incision.

Various anatomical descriptions are given regarding the site of puncture:

- In the author's experience the best place is where the artery can be most easily palpated, irrespective of the relationship of this point to the inguinal skin crease. Since this is usually the point where the artery crosses the head of the femur it is also the easiest point to achieve haemostasis afterwards.
- Introduce the needle through the skin hole maintaining an angle of 45 degrees to the skin surface and go along the course of artery. After traversing the subcutaneous tissue, feel the pulsations of the artery with the needle tip and puncture the artery with a sharp jab at 45 degrees to the skin surface and stop.
- If needle moves side to side it means that artery has not been punctured. Needle should move up and down to be quite certain about arterial puncture.
- Remove the stillete and slowly withdraw the needle till blood freely spurts out.
- To stabilise the needle, the needle is advanced about 1 to 2 cm into the vessel with the help of a short guide wire.
- Connect the tubing to the hub of the needle through a 2 way stop cock making sure that there is no air inside it.
- Suck and withdraw blood in the syringe and discard it and flush with another syringe. Then inject contrast and do filming.
- Flush the system once every minute. The stopcock should be closed during flushing and not after stopping the injection to prevent reflux of blood into the needle tip

where a thrombus may form.

• Post procedure hemostasis is achieved by compression using 3 fingers; most distal finger on puncture site on the wall of the artery, other 2 fingers to compress the proximal vessel and pull out the needle. Do not allow spurting of blood after withdrawing needle if catheter is not used. Compress just enough till a bruit is felt on the finger and distal pulsations are just felt. Hold for 10 minutes, release in a graded manner (never leave suddenly as a thrombus may get washed away) and watch for rebleeding.

Complications of Direct Arterial Puncture Technique Using Needle

1. Due to local anaesthesia

(a) Allergic
(b) Toxic-due to injection in the vein, e.g., convulsions and cardiac arrhythmias.

2. Due to contrast media

(a) Allergic and idiosyncratic reactions are much less common with intra arterial injections than with intravenous injections.
(b) Feeling of warmth localised to the region supplied by the injected artery.
(c) Pain may follow injection of contrast material into the vessel.
(d) Chemotoxic effects: If contrast media containing pure sodium ions is used, the chances of these reactions are high. Meglumine salts are less toxic.

3.Due to technique

(a) Haemorrhage/haematoma formation at puncture site.
(b) Arterial thrombosis and embolization due to trauma to the vessel wall or if the puncture is made on an atherosclerotic plaque.
(c) Sub intimal dissection.
(d) Infection at puncture site (late).
(e) Damage to local structures: For example, Brachia! Plexus damage during axillary artery puncture.

4. Distant complications

(a) Peripheral embolism can result from atherosclerotic plaque damage or dislodgement of a thrombus formed at puncture site.
(b) Air embolism can be prevented by :
• ensuring that all taps and connectors are tight.
• always sucking back when a new syringe is connected.
• ensuring that all bubbles are excluded from the syringe before injecting.
(c) Cotton fibre embolus occurs when syringes are filled from bowls containing

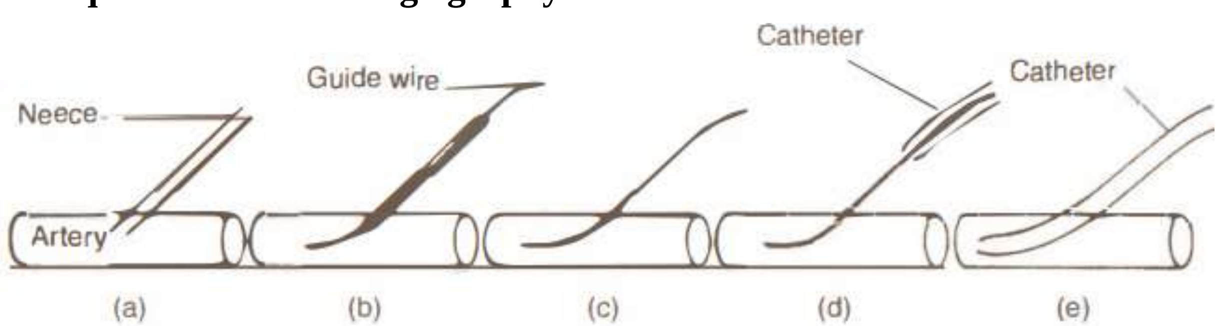
cotton swabs. This can be prevented by :
• Using separate bowls for flushing and for wet swabs.
• A closed system of perfusion.

CATHETER ANGIOGRAPHY (Injection of contrast media with catheter in situ)

Site of Entry
1. **Femoral artery** : Most common and preferred route of entry.
2. **Axillary artery** : Site of entry, in case of femorals are not palpable.
3**. Brachial**: Midarm is preferred for the catheterisation. Antecubital fossa is not the first choice because the artery is smaller than at the midarm.
4. **Direct carotid** : Percutaneous entry into the common carotid artery is done at the lower border of the thyroid cartilage.
5. **Direct vertebral** : Only historical now. The vertebral artery was punctured by a special needle which had only a side hole without any end hole.
6**. Radial artery** : The advantage is that if the artery is thrombosed the limb still survives because of the palmar and dorsal arches. 4F or smaller caliber catheters have to be used.
7. **Popliteal artery** : This artery is punctured in the popliteal fossa and has been used primarily for angioplasty.

Seldinger Needle for Arterial Puncture
• The classic Seldinger's needle is a 3 piece needle, outer one is the 16G cannula, middle is the needle with a lumen inside which is a stillete.
• The length is 7 ems. This needle now is no longer in use.
• The recent needle consists 2 parts, outer is the lumen (18 gauge) inside is the stillete (diameter more than 1 mm).
• The needles of this type are modified COOK' s and modified POTT' s needles.

Technique for Catheter Angiography



Seldinger technique for catheterizing blood vessels.

• After injecting local anaesthetic, with all aseptic precautions as described earlier, a stab incision is made 2.5 cm below the inguinal
ligament. The fascia is separated using fine artery forceps to make a track for passing the catheter.
• Artery is punctured using the above needle by the usual technique of transfixing the vessel.
• The guide wire is advanced gently for 20-25 cm. Do not advance, if there is resistance. Do not use force for any maneuver. The needle is removed while holding the guide wire in place and firm compression is applied to the puncture site to prevent bleeding.
• The guide wire is cleaned of all blood by a wet gauze piece while maintaining compression at puncture site to prevent blood loss.
• Now the catheter is threaded over guide wire till end of guide wire should come outside catheter. Then catheter is advanced holding guide wire firmly.
• The guide wire is removed and immediately suction is applied with a syringe to which a stopcock has already been fitted. This syringe is then discarded and a fresh syringe filled with heparinised saline. (1000 units of Heparin in 540 ml of normal saline) is used to flush the catheter.
• Once the catheter is in the vessel, Heparin may be injected in a bolus.
• Some give low dose, i.e., 3000 units in adults. Some give high doses, i.e., 10,000 units, in which case, before catheter withdrawal appropriate dose of protamine sulfate is given to reverse the hepariza tion.
• In our institution we do not give bolus dose of Heparin as a routine.
• Flushing of the catheter should be done every one minute. While flushing always check for the backflow into the syringe so that injection of any thrombus formed within the catheter can be avoided.
• All air must always be excluded from the system.
• In certain cases, continuous flushing of the catheter is done with the help of a pump. This, however, could give rise to fluid overload.

Contrast Used for Angiography

3 basic types of contrast material are used:
(a) High density (more than 70%)-e.g., Conray 420, Trivideo 400, Urograffin 76%, Trazograf 76%, Urovideo 370)
(b) Medium Density (60%)-e.g., Conray 280, Urograffin 60%, Trazograf 60%, Triovideo 280, Angiograffin 65%.
(c) Low density (30%)-e.g., No preparation available in India. For this, dilute medium density contrast by 50%.
• High density contrast (76%) is used for Global injections.
• All selective angiographies need medium density (60%) contrast material.
• Low density contrast material can be used wherever Digital Subtraction

Angiography is available and for test injections.

Special points for contrast injection

• In the ventricle and in the aortic root we do not inject a pure sodium contrast as high concentration of Sodium in coronary arteries can lead to arrythmias. Sodium concentration should be isotonic to the plasma sodium. These conditions are met by Sodium meglumine combinations like Urograffin, Trazograff and Urovideo.
• Pure meglumine salts should also not be injected as they do not contain any sodium.
• Pure Sodium salts are more painful than meglumine salts.
• Pure Sodium salts should not be used for any selective angiograms.
• Pure Sodium salts can cause damage to spinal cord if large volumes are injected in the descending thoracic aorta close to the artery of Adamkiewicz.
• Sodium salts are never used in cerebral circulation. Use pure meglumine for cerebral angiograms. Avoid sodium and meglumine combinations for cerebral studies.
• Injection in the aorta away from the root can be done by any contrast agent.

Rates of Contrast Injection and Volume of Contrast Media

(a) Heart and Arch of aorta:
20-25ml/ sec.
Total volume 30-40 ml in heart and 40-80 ml in arch.
(b) Abdominal aorta:
15-20 ml/sec (with occlusive disease)
20-25 ml/sec (without occlusive disease)
Total volume: 40-80 ml.
(c) Infrarenal segment:
8-10 ml/sec
Total volume 40 ml
In step motion angios the volume increases to 80-100 ml.
(d) Innominate:
8-10 ml/ sec
Total volume 20 ml.
(e) Other arteries:
(i) Carotids: 10 ml rapidly with hand
(ii) Internal carotid: 8 ml rapidly with hand
(iii) Vertebral: 6 ml rapidly with hand
(iv) External carotid: 5 ml rapidly with hand
(v) Coeliac axis: 6-8 ml/ s (total of 40 ml)

(vi) S.M.A.: 6-8 ml/ s (total of 40 ml)] too h' 1g h vo 1 umes
(vii) I.M.A: 4 ml/ s (20 ml total)
(viii) Renal: 8-10 rapid injection with hand
(ix) Femorals : 20-40 ml (hand injection with static serial)
: 50 ml (6-8 ml/s in step motion angio)
* Before removal of catheter assure that peripheral pulses are palpable. If peripheral pulses are not palpable then do a pull out Angio. Withdraw the catheter to a point 10 cm above the puncture site and do an angiogram to see if any
thrombus is present or if vasospasm exists. If it does, then the vascular surgeon should be consulted before removing the catheter.
* If no complications exist, pull out the catheter.
* When withdrawing feel the artery proximal to the catheter and the entry site. After removing the catheter let the blood spurt out three times and then compress the artery at and proximal to the puncture site with 3 fingers.
* Also suck with a syringe as the catheter is being withdrawn to remove any microemboli.
* Compress with just enough force so as to feel a bruit under the fingers and ensure that the distal pulses are just felt without any local bleeding. Grade the compression accordingly.
More complications occur due to over compression than the procedure itself

Post Procedure Care

- Bed rest
- Keep the puncture part without moving for atleast 6-8 hrs.
- Watch for any recurrence of bleeding.
- Peripheral pulses should be monitored/Vitals monitored.
- Hydrate the patient well.
- Deterioration of renal function should be watched for.

Complications of Femoral artery catheterisation
(A) Due to contrast medium

Most of them have been dealt with earlier. A few extra and important ones are:

1. **Allergic and Idiosyncratic**: Non-fatal reactions are much less common with intra-arterial injections than with intravenous injections.
2. **Chemotoxic effect**

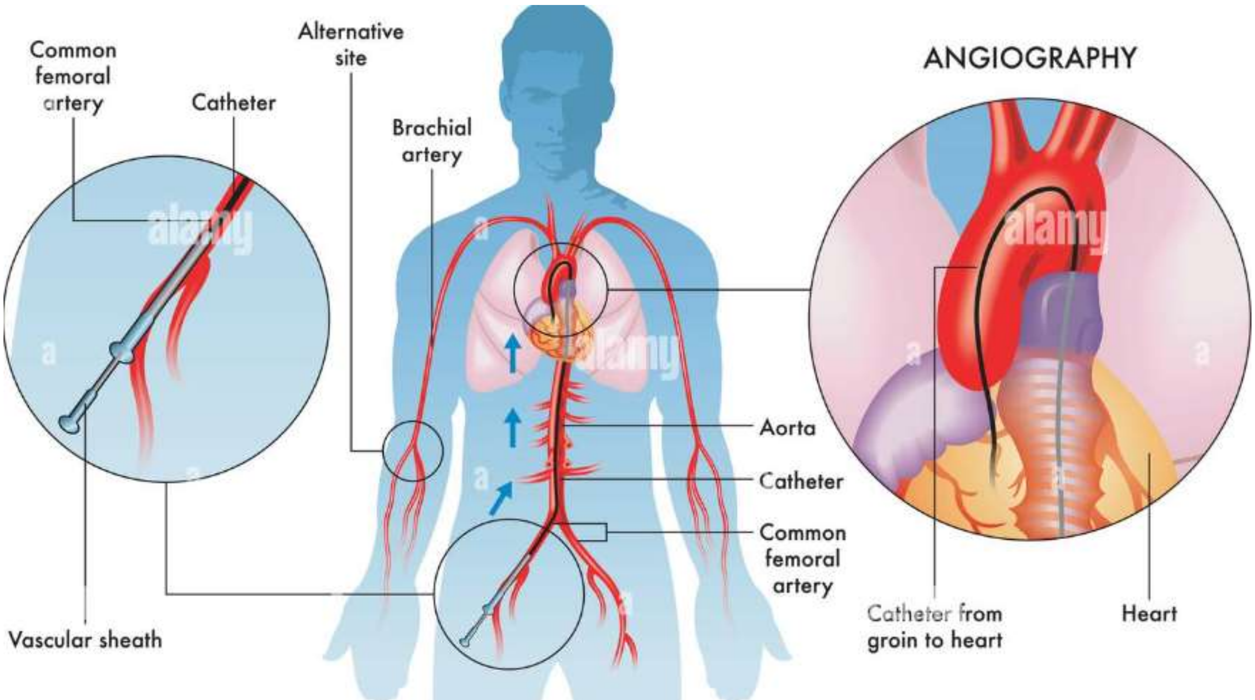
- Coronary arteries:

Pure sodium or pure meglumine salts produce impaired myocardial contractility and ECG changes.
Addition of calcium improves the contractility.
• Cerebral arteries:
Sodium salts are highly neurotoxic
• Spinal cord:
Direct injection into a lumbar or an intercostal artery which feeds the artery of ADAMKIEWICZ or diversion of large volume of contrast into the spinal vascular bed can result in spinal cord damage. Large volume contrast injection in thoracic aorta can also cause spinal cord damage. Treatment is by replacing CSF with (N) isotonic saline in 10 ml aliqouts.
• Kidneys:
Acute renal failure is a rare complication

(B) Due to the technique

(a) Local
1. Haemorrhage/Haematoma.
2. Arterial thrombus: This can be minimised by Heparin bonded catheters and guide wires and meticulous flushing with heparinised saline.
3. Infection at puncture site.
4. Damage to local structures, i.e., brachia! plexus in axillary artery puncture.
5. False aneurysm.
6. A.V. fistula.
(b) Distant
1. Peripheral embolus
2. Atheroembolism-J tip guide wires should be preferred to minimise this possibility.
3. Air embolus: Prevented by ensuring
• All taps and connectors are tight
• Always sucking back when a new syringe is attached
• Ensuring all bubbles are removed before injecting
• Keeping the syringe vertical with plunger up while Injecting
4. Cotton fibre embolus : prevented by
• separate bowls of saline for flushing and wet swabs
• closed system of perfusion
5. Artery dissection : Ri"sk is reduced by
• floppy, J shaped guide wires
• Pigtail catheters
• Test injection prior to pressure injection
• Careful and gentle manipulation of catheters and guide wires.

6. Catheter knotting
7. Catheter impaction
8. Catheter and guide wire breakage
9. Bacteremia/Septicaemia.



PERCUTANEOUS TRANSLUMIN ANGIOPLASTY

Definition

Encompasses both dilatation of stenotic lesions and the recanalisation of occluded vessels.

Technique

Basic method consists of passing a guiding catheter to a site from which a guidewire can be negotiated through the region to be dilated.

• An injection of contrast delineates the exact length and position of the lesion and its proximal and distal limits.

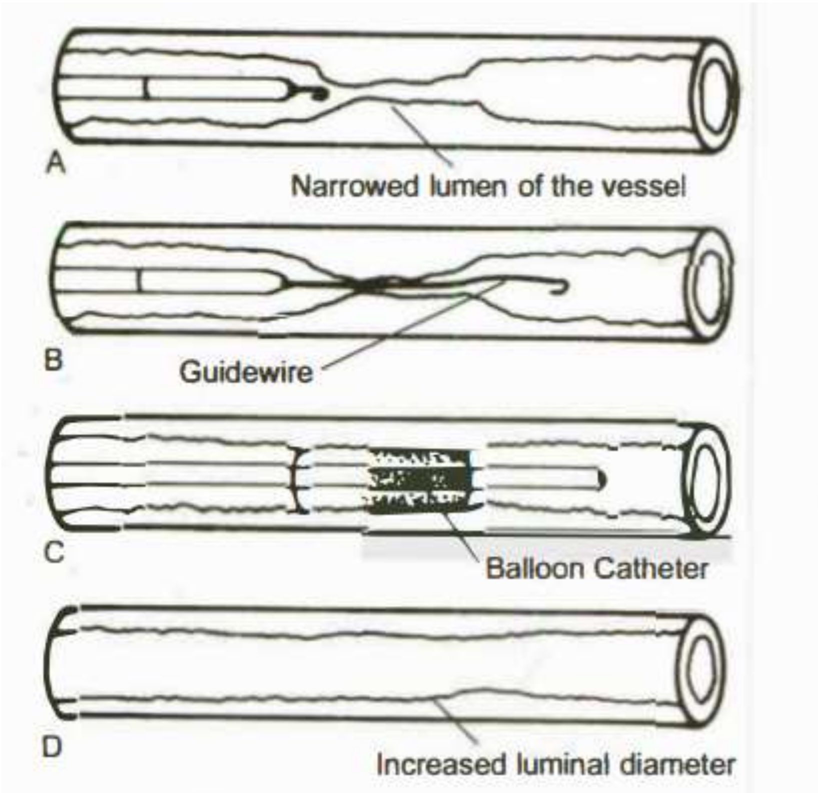
• The guidewire and catheter are manipulated through the stenosis, the wire is withdrawn and an injection of contrast is made to show that the lesion has been safely negotiated and that runoff remains intact.

• The guidewire is then replaced so that its tip lies well distal to the abnormal segment and the original catheter is replaced by a balloon catheter of appropriate dimensions without altering the position of the wire.

• The balloon is then manipulated into the area of stenosis and inflated.
• The balloon should be fully deflated before any attempt is made to alter its position.
• The balloon is inflated manually with a 10cc syringe loaded with dilute contrast medium.

Precautions and Preparations

Anticoagulant, fibrinolytic and antispasmodic drugs are essential in the preparation of the patient before the procedure.



Balloon catheter angioplasty

COMPLICATIONS

(1) Puncture site

- haemorrhage
- thrombosis
- pseudoaneurysms

(2) Target vessel and its distribution territory

- embolisation

- thrombosis
- dissection
- perforation
- occlusion

(3) Catheter related

- balloon rupture \ embolization

CT-ANGIOGRAPHY

CT angiography is a three-dimensional technique that provides information about the imaged vessels and adjacent structures.

Advantages of CT angiography

• It is a non invasive, outpatient examination with minimal risk.
• It can demonstrate eccentric stenosis, which can be missed on , conventional angiography.
• It can also demonstrate retrograde filling of vessels distal to an occlusion by collaterals with high origin.
• Aneurysms can be best diagnosed by CT angiography.

Disadvantages of CT angiography

• Short segment stenoses may be missed.
• Differentiation between tight stenosis and occlusion can be difficult in patients with heavy vascular calcification.
• Radiation exposure.
• Risk of contrast reaction.

MR-ANGIOGRAPHY

• MR- angiography is defined as the MR technique that selectively displays the flowing blood in the vessels.
• There are different techniques based on either the flow effect or on the use of contrast agent.
• MRI technique creates soft tissue contrast between blood vessels and surrounding tissues.

The three main types of MR-ANGIOGRAPHY

1. Time of flight angiography (TOF).
2. Phase contrast angiography (PCA).

3. Contrast enhanced magnetic resonance angiography (CE-MRA).
All angiography techniques differentially enhance vascular MR signal. TOF and PCA reflect the physical properties of flowing blood that were exploited to make the vessels appear bright. CE-MR Angiography creates the angiographic effect by using an intravenously administered MR contrast agent which selectively shorten the Tl Wt images. MR- Angiography images optimally display area of contrast blood-flow-velocity. Loss of streamline flow occurs at all vessel junctions and stenosis, and in regions of mural thrombosis resulting in a loss of signal.

Disadvantages of MR-Angiography

1. Overestimation of stenosis.
2. Low flow velocity can create regions with signal loss and the wrong diagnosis of a stenosis of a vessel.
3. Ghost images which can be overcome by changing the phase encoding direction.

MYELOGRAM

A **myelogram** is a diagnostic imaging procedure used to visualize the spinal cord, nerve roots, and surrounding structures.

Purpose

- **Diagnose Spinal Disorders**: Identifies conditions such as herniated discs, spinal stenosis, tumors, infections, or congenital abnormalities.
- **Evaluate Nerve Root Compression**: Assesses the compression of nerve roots that might be causing pain, weakness, or numbness.
- **Pre-Surgical Planning**: Provides detailed anatomical information to aid in surgical planning.

Indications

1. Evaluation of Spinal Disorders
2. Assessment of Nerve Root Compression
3. Pre-Surgical Planning
4. Evaluation of Spinal Cord Abnormalities
5. Follow-Up of Previous Spinal Procedures

Contraindications

1. Allergy to Contrast Medium

2. Active Spinal Infection
3. Severe Spinal Stenosis or Abnormalities
4. Coagulation Disorders
5. Pregnancy
6. Recent Spinal Surgery
7. Kidney Dysfunction

1. **Preparation**:
    - **Pre-Procedure Instructions**: The patient may be instructed to avoid eating or drinking for a few hours before the procedure. Inform the healthcare provider about any allergies, especially to contrast materials, and any current medications.
    - **Consent**: The patient will provide informed consent after discussing the procedure, risks, and benefits with the healthcare provider.
2. **Positioning**:
    - **Patient Position**: The patient is typically positioned on an X-ray or CT table, usually in a prone (face down) or lateral (side) position, depending on the specific area of the spine being examined.
3. **Contrast Injection**:
    - **Spinal Puncture**: A needle is inserted into the lumbar region of the spine, usually between two vertebrae, to access the spinal canal. This is performed under sterile conditions and may be guided by fluoroscopy or ultrasound.
    - **Contrast Medium Injection**: A radiopaque contrast medium is injected into the spinal canal, where it flows around the spinal cord and nerve roots. This enhances the visibility of these structures on subsequent imaging.
4. **Imaging**:
    - **X-ray or CT Scanning**: After the contrast medium is injected, X-ray or CT imaging is performed to visualize the spinal canal and its contents.

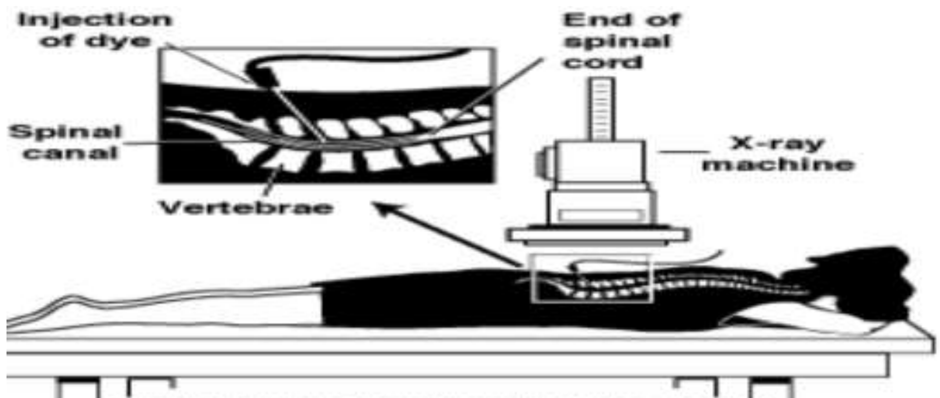
Multiple images may be taken in various positions to provide a comprehensive view.

- **Dynamic Imaging**: The patient may be asked to move or change positions to capture images from different angles.

5. **Completion**:
    - **Needle Removal**: The needle is carefully removed after the imaging is complete.
    - **Post-Procedure Monitoring**: The patient is monitored for a short period to ensure there are no immediate adverse reactions.
6. **Post-Procedure Care**:
    - **Hydration**: Patients are encouraged to drink plenty of fluids to help flush the contrast medium from their system and reduce the risk of headache.
    - **Rest**: Patients may be advised to rest and avoid strenuous activities for a short period following the procedure.

Risks and Considerations

- **Headache**: A common side effect is a headache, which can occur due to the puncture in the spinal canal. Drinking fluids and lying flat can help alleviate this.
- **Allergic Reactions**: Although rare, some patients may have allergic reactions to the contrast medium.
- **Infection**: There is a small risk of infection at the site where the needle is inserted.
- **Spinal Fluid Leakage**: In rare cases, there may be leakage of spinal fluid, which can cause headaches or other symptoms.
- **Contrast Reaction**: Adverse reactions to the contrast medium, such as nausea or a rash, are possible but uncommon.



A myelogram requires the injection of dye into the spinal canal under x-ray guidance. The dye is usually injected in the lower back region (lumbar) and in some cases, in the neck (cervical) area.

HSG (HYSTEROSALPINGOGRAPHY)

It is the procedure in which the contrast is injected into the uterus to study the uterine cavity and fallopian tubes.

INDICATIONS

1. Infertility:

   - To demonstrate patency of the fallopian tubes and their communication with the peritoneal cavity. The causes of tubal blockage are obstruction following tubal infection, fimbrial adhesions, tubal pregnancy, tumour and sterilization procedures. Poor operative technique and tubal spasm may give false appearance of tubal blockage.

   - Prior to artificial insemination.

2. Recurrent abortions: To demonstrate congenital abnormalities of the uterus or incompetence of the internal os of the uterus.
3. Following tubal surgery: To monitor the effect of tubal surgery. For example, to confirm tubal occlusion in a sterilization procedure or to demonstrate patency and length of falloplan tubes after surgical intervention to restore patency of pathologically obstructed tubes.
4. Migrated IUCD.
5. Uterine and tubal lesions like tuberculosis, submucous fibroids, polyps, synechiae.

CONTRAINDICATIONS

- Active Pelvic Sepsis.
- Sensitivity to contrast media.
- Recent dilatation and currettage.
- Pregnancy.

- The week prior to and the week following onset of menstruation.
- Severe renal or cardiac disease.
- Cervicitis/purulent vaginal discharge.

EQUIPMENT

- Contrast Media: Water soluble. For example, Urograffin 60%, Conray 280, Trivideo 280. Volume 10-20 ml. (Average volume 5-6 ml, in nulliparous women 3-4 ml, if there is hydrosalphyx > 10 ml).
- 20 cc syringe.
- Canula: Leech Wilkinson, Jarcho type, Spackman.
- Uterine sound and dilator.
- Sims speculum.
- Tenaculum: Trauma is less, so ideal for nulliparous women. (Vulsellum forceps can also be used but trauma is more).
- Fluoroscopy unit with spot film devices.

PROCEDURE

Ideal Time of Procedure: Between 8th and 10th day of menstrual cycle, i.e., 2-3 days after stoppage of menstruation so that menstruation tissue or fluid is not carried either into the oviduct or the peritoneal cavity and the incidence of intravasation of contrast is low. Done before 12th day because oocyte undergoes meiosis during this time and is radiosensitive. Thus radiation exposure during this time should be avoided.

Patient Preparation: The patient should be advised to abstain from intercourse between booking the appointment and the time of examination unless a reliable method of contraception is used to avoid the possibility of irradiating an early pregnancy. Patient should be fasting 4 hours prior to the procedure.

Premedication: Premedication is not required in majority of the cases. When the patient is very anxious, 5-10 mg of I.V. diazeparn 30 minutes before procedure is helpful to prevent the tubal spasm which can be provoked by anxiety. Morphine and Pethidine should not be given as they stimulate the contraction of the fallopian tubes. However Baralgan, which contains analgin and pitafemone HCl in 2 ml ampoule or 0.6 mg atropine sulphate in 1 ml ampoule can be given I.V. 10 to 15 minutes before starting the procedure.

The bladder should be emptied prior to HSG. A full bladder will elevate the fallopian tubes and may cause apparent tubal blockage with the spurious radiological appearance of a hydrosalpinx.

TECHNIQUE

• Using a canula.
• Using Foley's catheter.

Using a Canula

The patient is placed in lithotomy position at the edge of the X-ray table. A speculum is introduced into the vagina and the anterior lip of the cervix is held with tenaculurn and gentle traction is applied. The canula is inserted into the cervical canal under direct vision. The speculum is then removed and patient is carefully moved up the X-ray table in supine position. Care must be taken to remove all the air bubbles from the syringe and canula before injecting, as these may mimic polyps or fibroids.
Under fluoroscopic control, 2 ml of the contrast media is injected to outline the uterine cavity. To prevent leak from the cervix, a downward traction should be kept on the tenaculurn while keeping an upward pressure to the canula.
The injection is then continued slowly governed by the patient's tolerance until the oviducts have been outlined and free intraperitoneal spill of the dye is visualised.

Filming:

• As the tubes begin to fill.
• When peritoneal spill has occurred.

Maximum X-ray screening time must not exceed 30 seconds using an image intensifier and only two X-ray plate exposures are permitted in order to minimize radiation to female gonads. (70-90 kV range)

Using Foley's Catheter

Cameron et al have described a method using 8 F Foley's catheter. The cervix is exposed with a vaginal speculum and swabbed with an antiseptic solution with the patient in lithotomy position. After the lumen of the catheter is filled with the contrast (to prevent air bubbles) the catheter is inserted through the cervical os using a cervical forceps to guide it when the ballon lies within the uterine cavity, it is gently inflated with water (2-3 ml). Before the injection of contrast, the ballon is pulled downwards against the internal os. The speculum is withdrawn and the catheter is attached to the syringe. The patient assumes a more relaxed supine position. Contrast injection and filming is same as with using a canula.

Advantages

1. No need for tenaculum thus avoiding possible cervical trauma and bleeding.
2. Ability of a single operator to control both the injection and exposure of spot films on a conventional fluoroscopic machine.
3. Much easier to obtain spot radiographs because the patient is in more comfortable

position and there is no chance of obscuring anatomy with metal artefacts.
4. A "drainage" radiograph can be obtained at the end of the procedure to demonstrate the uterine cavity without the catheter creating artefacts.
5. Avoids false passage formation.
6. Avoids potential uterine perforation.

Disadvantages

1. The tip of the catheter sometimes blocks the tube on one side. This can be avoided by applying downward traction on the catheter while injecting the contrast.
2. 2. The part of the uterus adjacent to the bulb cannot be studied. For visualization of the lower uterine segment and the cervical canal which are obliterated by balloon catheter, the balloon may be deflated gradually while simultaneously injecting the radioopaque dye.

False positive result is seen in hydrosalpinx. False negative result is due to tubal spasm. Tubal spasm is seen in response to anxiety or injecting the contrast with pressure. To eliminate tubal spasm, sublingual nitroglycerine, general anaesthesia, narcotics, tranquillizers and adrenalin or glucagons may be given.

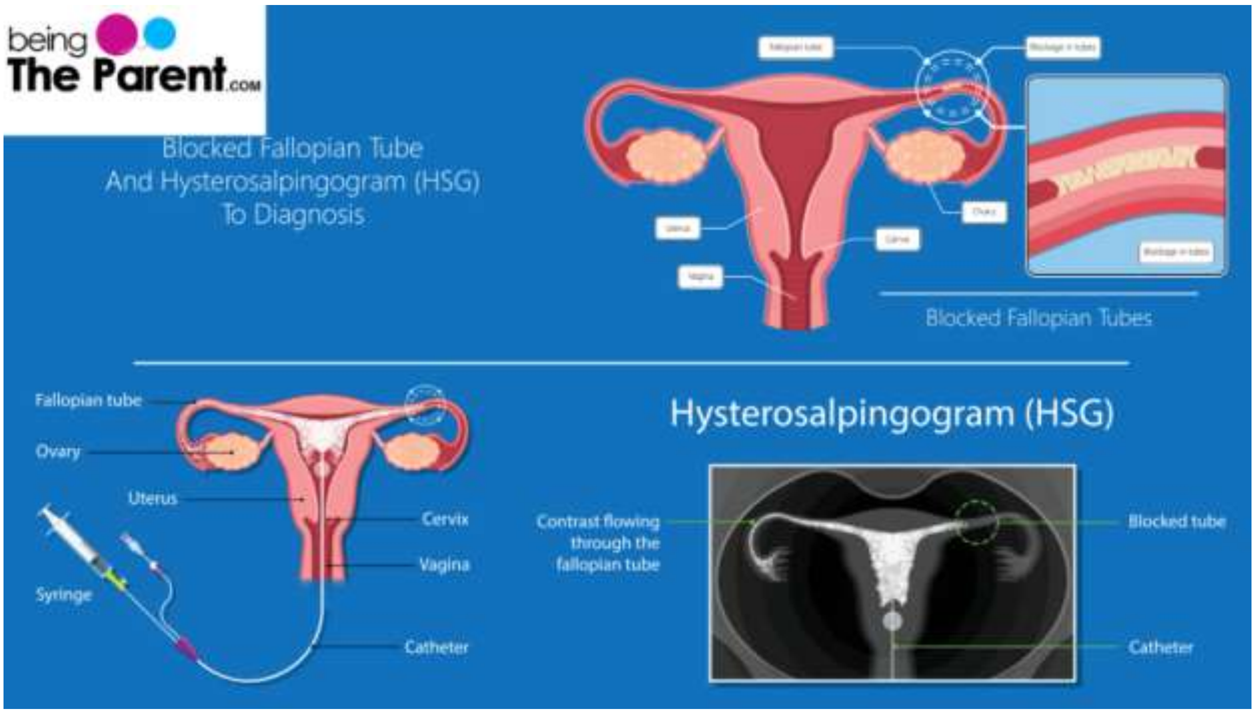
For peritubal adhesions HSG has high false positive rates.
Note: Lack of tubal fitting in a patient with no known tubal surgery (or) infection is a non-specific finding on HSG.
Differential Diagnosis
- Anatomic obstruction
- Technical problem
- Cornual spasm.
- Possibly mucosal plugging.

Contrast may loculate around fimbrial adhesions and mimic a hydrosalphinx.

COMPLICATIONS

1. Pain may occur at the following times :
• Using the vulsellum forceps.
• During insertion of canula.
• With tubal distension and distension of uterus.
• Generalised lower abdominal pain due to peritoneal irritation by the contrast media.
2. Venous intravasation due to: (0.6 to 3.7%)

• Excessive injection pressure.
• Traumatization of the endometrium by the tip of the cannula.
• The examination performed when the endometrium is deficient as after curettage (or) menstruation.
3. Trauma to the uterus due to canula causing perforation.
4. Exacerbation of Pelvic Infection. [over all infection rate 0.25 to 3% after procedure]



SINOGRAPHY

Sinography, also known as fistulography, is an imaging technique used to visualize and diagnose abnormal passages or cavities (sinuses or fistulas) within the body. Here are the key details of the procedure:

Purpose

- **Diagnosis**: To identify the presence, extent, and path of a sinus or fistula.
- **Pre-surgical Planning**: To guide surgical intervention or other treatments.
- **Post-surgical Evaluation**: To check for recurrence or complications.

Indications

- **Chronic Infections**: To evaluate chronic abscesses or infections.
- **Unhealed Wounds**: To assess non-healing wounds or ulcers.
- **Unknown Origin**: To identify the origin of unexplained discharge.

Procedure

1. **Preparation**
    - **Patient History**: Obtain detailed medical history.
    - **Consent**: Explain the procedure and obtain informed consent.
    - **Positioning**: Position the patient to best expose the area of interest.
2. **Injection of Contrast Medium**
    - **Sterilization**: Clean and sterilize the area around the sinus or fistula opening.
    - **Local Anesthesia**: Apply local anesthesia if necessary.
    - **Catheter Insertion**: Insert a small catheter or cannula into the opening.
    - **Contrast Injection**: Inject a water-soluble contrast medium through the catheter. The amount and type of contrast depend on the specific case.
3. **Imaging**
    - **Fluoroscopy or X-ray**: Use fluoroscopy or X-ray to visualize the flow of contrast through the sinus or fistula.
    - **Images Acquisition**: Acquire a series of images to track the path and extent of the abnormal passage.
    - **CT or MRI**: In some cases, a CT scan or MRI may be used for detailed imaging.

Post-Procedure Care

- **Observation**: Monitor the patient for any immediate reactions or complications.
- **Instructions**: Provide post-procedure care instructions, such as managing discomfort or signs of infection.
- **Follow-Up**: Schedule follow-up appointments for results and further management.

Risks and Complications

- **Allergic Reaction**: Risk of allergic reaction to the contrast medium.
- **Infection**: Risk of introducing infection during the procedure.
- **Discomfort or Pain**: Discomfort or pain at the injection site.
- **Radiation Exposure**: Minimal risk from radiation exposure during imaging.

Interpretation

- **Radiologist Review**: A radiologist reviews the images to determine the presence, extent, and path of the sinus or fistula.
- **Report**: A detailed report is prepared for the referring physician with recommendations for further treatment or intervention.

FISTULOGRAM

A fistulogram, also known as a fistulography, is a specialized imaging procedure used to evaluate abnormal connections between organs or vessels, known as fistulas. Here are the detailed steps and important information regarding the procedure:

Purpose

- **Diagnosis**: To identify the presence, extent, and path of a fistula.
- **Treatment Planning**: To guide surgical or medical treatment.
- **Post-treatment Evaluation**: To assess the success of treatment or detect recurrences.

Indications

- **Chronic Infections**: Evaluating chronic abscesses or infections.
- **Persistent Discharge**: Investigating unexplained or persistent discharge.
- **Post-Surgical Assessment**: Checking for fistulas after surgery.

Procedure

1. **Preparation**
    - **Medical History**: Review the patient's medical history and any previous imaging studies.
    - **Consent**: Explain the procedure to the patient and obtain informed consent.
    - **Preparation**: Position the patient appropriately based on the location of the fistula.
2. **Contrast Medium Injection**
    - **Sterilization**: Clean and sterilize the area around the fistula opening.
    - **Local Anesthesia**: Apply local anesthesia if necessary to minimize discomfort.
    - **Catheter Insertion**: Insert a small catheter or cannula into the external opening of the fistula.

- **Contrast Injection**: Inject a water-soluble contrast medium through the catheter. The contrast helps to visualize the fistula on imaging.

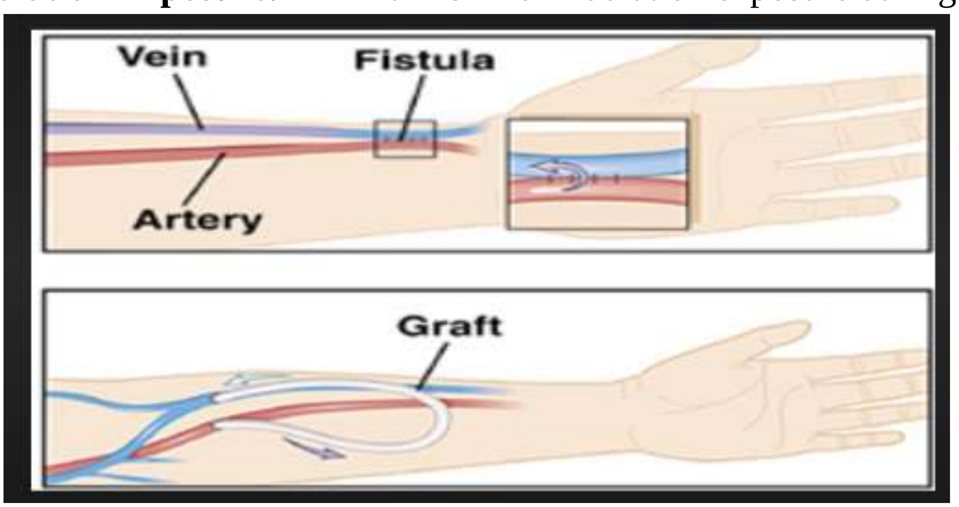
3. **Imaging**
   - **Fluoroscopy**: Use fluoroscopy (real-time X-ray) to monitor the flow of contrast medium through the fistula.
   - **X-rays**: Take a series of X-ray images to document the course and connections of the fistula.
   - **Additional Imaging**: In some cases, additional imaging like CT scan or MRI might be required for more detailed visualization.

Post-Procedure Care

- **Observation**: Monitor the patient for any immediate reactions or complications, such as allergic reactions to the contrast medium.
- **Instructions**: Provide the patient with post-procedure care instructions, including how to manage any discomfort or signs of infection.
- **Follow-Up**: Schedule a follow-up appointment to review the results and discuss further treatment options if needed.

Risks and Complications

- **Allergic Reactions**: Risk of allergic reactions to the contrast medium.
- **Infection**: Small risk of introducing infection during the procedure.
- **Discomfort**: Some discomfort or pain at the injection site.
- **Radiation Exposure**: Minimal risk from radiation exposure during imaging.



DUCTOGRAM

A ductogram, also known as a galactogram, is a specialized imaging procedure used to evaluate the breast ducts, particularly when there is abnormal nipple discharge. Here are the details of the procedure:

Purpose

- **Diagnosis**: To identify the cause of nipple discharge, such as intraductal papillomas, ductal ectasia, or breast cancer.
- **Treatment Planning**: To guide surgical or medical treatment based on the findings.

Indications

- **Nipple Discharge**: Unilateral, spontaneous, and persistent discharge, especially if it's clear or bloody.
- **Suspicion of Intraductal Lesions**: When there is a need to evaluate suspected intraductal lesions.

Procedure

1. **Preparation**
    - **Patient History**: Review the patient's medical history and any previous breast imaging studies.
    - **Consent**: Explain the procedure to the patient and obtain informed consent.
    - **Preparation**: The patient is asked to avoid squeezing the nipple before the procedure to avoid expressing the fluid that needs to be imaged.
2. **Duct Cannulation**
    - **Sterilization**: Clean and sterilize the nipple and surrounding area.
    - **Identification of Discharge Duct**: Identify the specific duct from which the discharge is originating by gently expressing the nipple.
    - **Cannula Insertion**: Insert a tiny, flexible cannula into the duct opening. This can be slightly uncomfortable but should not be painful.

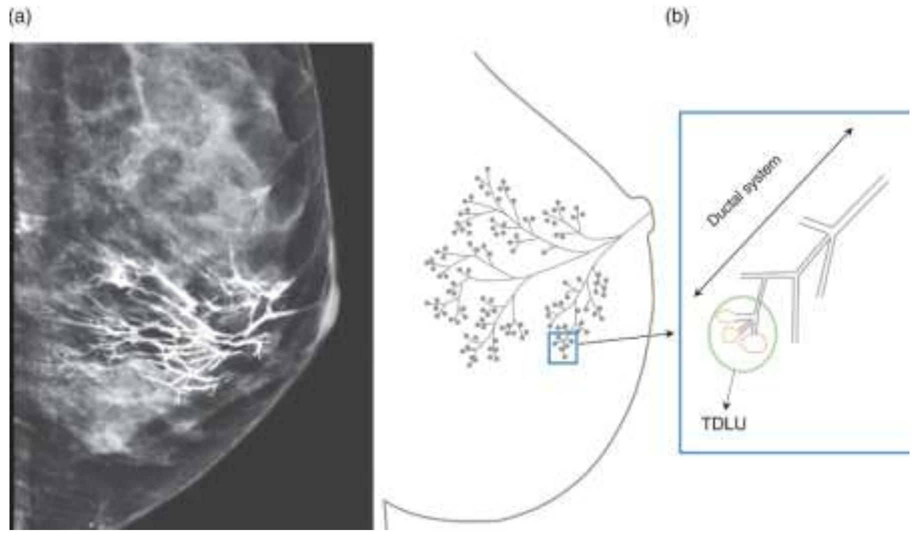
3. **Contrast Medium Injection**
    - **Contrast Injection**: Inject a small amount of water-soluble contrast medium through the cannula into the duct. The contrast medium will outline the ductal structures.
    - **Duct Distention**: Care is taken not to over-distend the duct, which can cause discomfort or rupture.
4. **Imaging**
    - **Mammography**: Perform mammographic imaging immediately after the contrast injection. Standard mammographic views, as well as specialized magnification views, are obtained to visualize the ductal system.
    - **Documentation**: Acquire images that clearly show the ductal structures and any abnormalities.

Post-Procedure Care

- **Observation**: Monitor the patient for any immediate reactions, such as discomfort or allergic reactions to the contrast medium.
- **Instructions**: Provide the patient with post-procedure care instructions, including how to manage any discomfort and what symptoms to watch for.
- **Follow-Up**: Schedule a follow-up appointment to review the results and discuss further diagnostic or treatment steps if needed.

Risks and Complications

- **Discomfort**: Mild discomfort or pain during cannulation and injection of contrast medium.
- **Infection**: Small risk of introducing infection during the procedure.
- **Duct Perforation**: Rare risk of duct perforation due to over-distention with contrast medium.
- **Allergic Reactions**: Rare risk of allergic reaction to the contrast medium.


(a)
(b)
Ductal system
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