Radiography Module

CONTENTS

CONTENTS

Introduction into radiography

Radiography is the use of X-rays to view unseen or hard-to-image objects. The use of radiography started in 1895 with the discovery of X-rays by **Wilhelm Conrad Roentgen**; he was the first man who described their properties in rigorous detail.

X-rays were found to be a type of electromagnetic radiation, other types of electromagnetic energy includes radio waves, microwaves, ultraviolet, infrared and visible light. The type of energy that is emitted and transferred through space is called *electromagnetic radiation* or, simply, **radiation.** The matter that intercepts with the radiation and absorbs a part or all of its energy is said to be **exposed** or **irradiated.** For example during a radiographic examination, the patient is exposed to the x-rays, and patient is said to be irradiated.

X-rays use during a radiographic examination is a special type of radiation called **ionizing radiation.** Ionizing radiation is any kind of radiation that is capable of removing an orbital electron from the atom with which it interacts. This type of interaction between radiation and matter is called **ionization**. Ionization occurs when an x-ray passes close to an orbital electron to remove it from the atom. The ionizing radiation may interact with and ionize additional atoms. Thus, any type of energy capable of ionizing matter is known as ionizing radiation. X-rays, gamma rays and ultraviolet light are the only forms of electromagnetic radiation with sufficient energy to ionize.

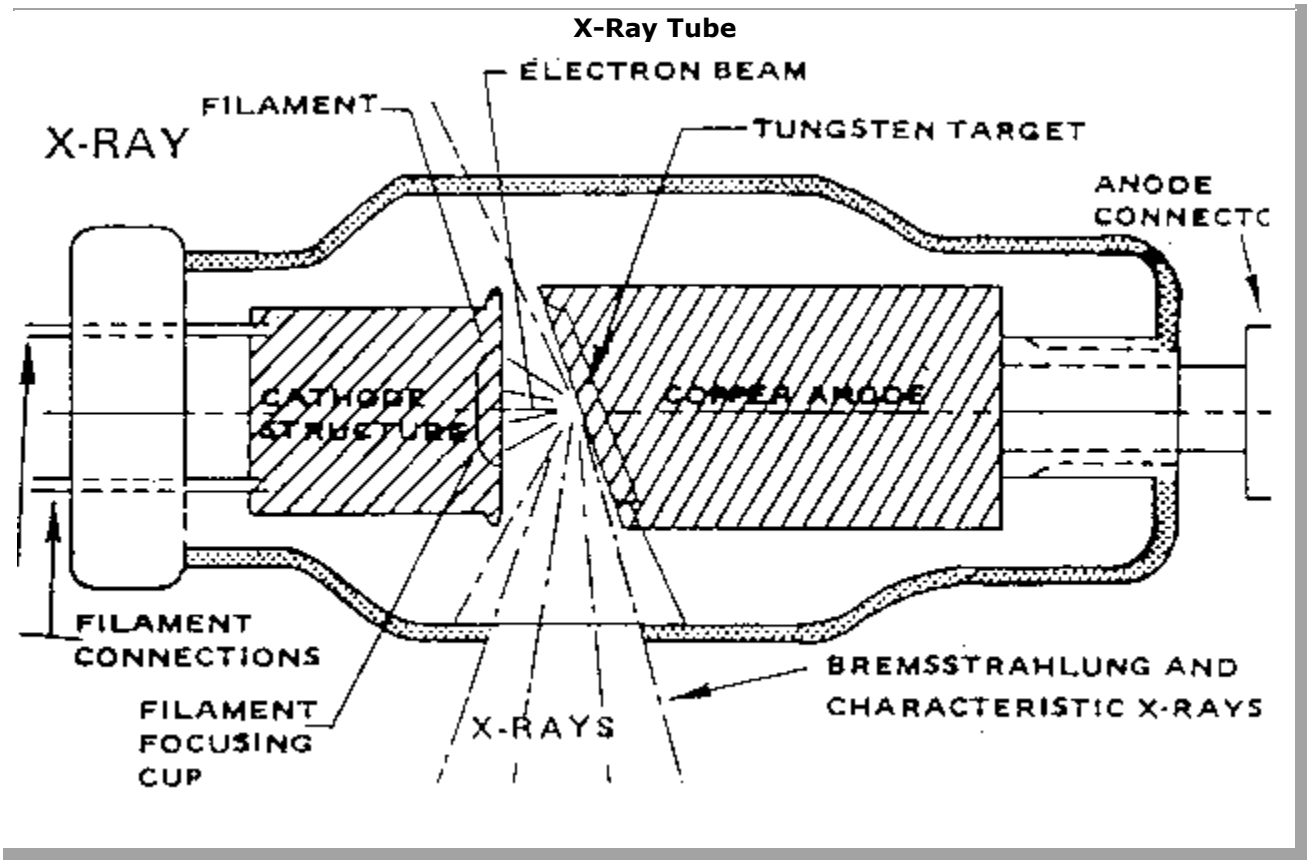
An x-ray machine produces x-rays in a particular manner that changes very little between the types of machines. For production of x-rays there has to be electricity that flows through the operating console, this is the location where the exposure techniques are chosen.

Once the exposure techniques are chosen the electricity goes toward the x-ray tube to heat the filament of tungsten. As the filament heats, it creates a cloud of electrons, this cloud of electrons is called a **thermionic emission.** There are two different sizes for the filament, the larger filament can create a bigger cloud of electrons and support higher energies. To keep all of the electrons concentrated in one area the filament is placed in a **focusing cup** which is charged negatively. The electrons produced are emitted towards an anode at the other end of the tube, they are called **projectile electrons**. The filament and the focusing cup create the **cathode** of the x-rays machine.

At the other end of the x-ray tube is the **anode.** The anode contains the **target** which is the location that the x-rays are produced. This target is made of tungsten and angled at a certain degree. From the point where the x-rays are created the beam diverges but not at a constant intensity. The reason for this is that the x-rays on the anode side can be absorbed by the heel of the anode. This creates the **anode heel effect,** which states that the intensity of the x-ray beam is stronger on the cathode side then of the anode side.

Both the anode and cathode are immersed in oil and protected by a glass tube. The oil acts as an insulator and helps to eliminate the heat that is produced while creating the x-rays. The glass tube is to hold the entire component in the oil bath but also to help eliminate any escaping radiation from the tube. Situated in the glass tube there is located a window under the anode, this window is the only location where the x-rays exit the x-ray tube.

The x-rays are produced by the projectile electrons interacting with the electrons in the tungsten atoms of the anode. The projectile electrons can ionize one of the inner-shell electrons of the target atom. To stabilize the atom, the electrons from outer-shell replace the electron missing and in doing so there is an emission of an x-ray. This type of interaction creates **characteristic radiation.** Another type of interaction creates a **bremsstrahlung x-rays**. This type of x-rays is created when the projectile electron completely avoids the orbital electrons as it passes through the target atom may come sufficiently close to the nucleus of the atom to come under the influence of its electric field. As the projectile electron passes by the nucleus, it is slowed down and changes course, leaving with a reduced kinetic energy in a different direction. This loss in kinetic energy reappears as an x-ray. The majority of all the x-rays produce are bremsstrhlung x-rays.



Dangers of x-rays

X-rays are a type of ionizing radiation that can be dangerous for the patients, their descendants and the operator. Ionizing radiation is dangerous because it may or may not cause changes to the molecular structures of the body's cells. To protect the public from these dangers the x-ray machine should only be used on a patient when the **benefits of a diagnosis outweigh the risks** related to the ionizing radiation that is being used. Once the benefices outweigh the risk, proper protection and proper use of the x-ray machine should be used to minimize the amount of radiation that the patient receives.

To protect the patient from exposure of excess ionizing radiation, the operator must limit the field for the x-ray beam to only include the affected area. This is achieved by **collimating the x-ray beam** as much as possible without compromising the image. Another way to protect the patient is to use **lead aprons** to cover the most sensitive parts of the body. The lead aprons should be used during every examination unless it covers the anatomical part that is being examined. The most sensitive part of the body that should be covered always is the reproductive organs, to help minimize the damages that could be transmitted to the patient's descendants. There are many other ways to reduce the exposure to the patient: reduce the amount of time for each exposure, use of a harder x-ray beam, create a bigger distance between the x-ray tube and the patient. All of these methods of reducing the exposure to the patient should never reduce the quality of the image that is being produced because if an image is not of a diagnostic quality the exposure will have to be retaken which elevates the patient's exposure to ionizing radiation.

The operator must always protect themselves against the ionizing radiation because over time they are exposed to more ionizing radiation then a patient for a single examination. To reduce the exposure of the operator during an examination, they should be as **far away from the source** (x-ray tube) of the ionizing radiation as possible. If they must be present in the room during the examination the operator must **wear a full body apron** to protect the entire body from the ionizing radiation but also to **reduce the amount of time** close to the source. The less time that is spent close to the ionizing radiation the less the operator is exposed. The operator should only be close to the source while the examination is if their **presence is necessary** to produce a radiograph of diagnostic quality.

Definition of basic terms

AP and PA Projection

AP and PA refer to the patient in accordance with the *anatomic position.* The anatomic position is a person standing erect with the face and eyes directed forward, arms extended by the sides with the palms of the hands facing forward, heels together, and toes pointing anteriorly. AP (antero-posterior) projection is achieved when the x-ray beam enters the anterior part of the body and exits the posterior part of the body. PA (posteroanterior) projection, are the opposite of an AP, the x-ray beam enters the posterior part of the body and exits the anterior portion of the body.

Lateral Projection

Lateral projections are produced when the x-ray beam passes from one side of the body part towards the other. There are two types of lateral projection: lateromedial and a mediolateral. **Lateromedial** is when the x-ray beam enters the lateral portion of the body part and exits the medial portion. **Mediolateral** is when the x-ray beam enters the medial portion of the body part and exits the lateral part.

Image Receptor

The image receptor (IR) is the device that receives the energy of the x-ray and forms the image of the body part. There are many types of image receptor, some uses film while others use x-ray detectors to form the image. A cassette with film is becoming an old technology that is slowly being replaced by the new technology. A cassette is a device that contains special intensifying screens that glow when struck by x-rays and imprint the x-ray image on the film. The light of the intensifying screens create a latent image on the film, this film must first be developed by special chemicals in a darkroom before the radiograph can be visualized under white light.

Collimation

Collimation is the term used to restrict the beam of radiation to irradiate only the area under examination. Narrowing the beam of radiation is possible by using a collimator or a specifically shaped diaphragm constructed of lead or other metal with high radiation absorption capacity. A collimator holds two purposes: first, it minimizes the amount of radiation to the patient and reduces the amount of scatter radiation that can reach the IR. Secondly, it produces radiographs that demonstrate excellent recorded detail and increased radiographic contrast.

Exposure technique

mAs

Milliampere-time (mAs) is the exposure technique that controls the **quantity** of x-rays produced by the x-ray tube by elevating the temperature of the filament creating a bigger thermoionic emission for a specific duration. Thus, when the mAs are double there is twice as much x-rays produced then initially. Calculating the amount of mAs is a multiplying the mA chosen by the time delay chosen (mAs = mA x Time). mAs has an affect of controlling the **optical density** (degree of blackening of the film) of the film, if the mAs are double the optical density on the radiograph is also doubled.

kVp

Kilovolt peak (kVp) is the exposure technique that controls the **quality** of the x-rays (energy of the x-rays). The higher the kVp the more energy each x-ray will possess which will create a harder x-ray beam. With a hard x-ray beam, the x-ray has more of a tendency of being transmitted through the body without any interaction then being absorbed by the body. With a higher kVp more x-rays reach the film that can blacken the film (elevating the optical density) but also helps to differentiate several structures. Therefore, kVp controls the **contrast** (difference in optical density) on the film (high kVp gives a low contrast) but also influences the optical density of the film.

Distance

There are two different type of distance used in radiography. The first is source-to-image-receptor distance (SID); this is the distance that separates the x-ray tube to the image receptor. The second distance is object-to-image-receptor distance (OID); this is the distance between the part anatomical part being examined and the image receptor. For exposure technique SID is an important factor to consider because the longer the distance of the source is to the image receptor the intensity of the beam covers a bigger surface. If the distance is doubled the intensity of the beam at one specific spot is four times less intense which in turn reduces the optical density of the film. To maintain the same optical density on the radiograph the mAs should be increased using the equation $(mAs_1/mAs_2) = (SID_1^2/SID_2^2)$.

For each radiographic imaging system, a guide or chart should be available that describes standard methods consistently producing high-quality images on an average size patient. The radiographic technique charts are tables that provide a means for determining the specific technical factors to be used for a given radiographic examination. For these charts to be successful the operator must understand its purpose and must know now to make adjustments for different body habitus and pathologic processes.

Points to analyze in a radiograph

Superimposition

Superimposition is produced when a three dimensional object is imaged in a two dimensional image as is the case in a radiograph of a body part. Superimposition is when one body part is imaged above another body part. In a radiograph, the relationship of the anatomic superimposition to size, shape, position, and angulation must be reviewed.

Adjacent Structures

To compare a structure, there must be another structure to compare their similarities and differences. On a radiograph each anatomic structure must be compared with that of the adjacent structures and reviewed to ensure that the structure is present and properly shown

Optical Density (OD)

Optical density is the degree of film blackening. A radiograph must have a proper optical density to be within a diagnostic range, if a radiograph is too light or to dark, an accurate diagnosis becomes difficult or impossible. Millianpere-sencond (mAs) is the factor that controls the density and must be considered when taking an x-ray.

Contrast

Contrast on a film is the difference in density between any two areas, the difference must be sufficient enough to allow radiographic distinction of adjacent structures with different tissue densities. A low-contrast image displays many density levels and a high-contrast display few density levels. The primary controlling factor of radiographic contrast is kilovoltage peak (kVp)

Recorded Detail

The recorded detail is the amount of detail that is visualized on a film. A radiograph must have sufficient recorded detail to clearly demonstrate the desired anatomic part. Recorded detail is primarily controlled by: geometry, film, Distance, screen, focal spot size and motion.

Magnification

Magnification is an enlarge representation of the anatomic part. Magnification must be evaluated in a radiograph, taking into account the controlling factors of *object-to-image-receptor distance* (OID), how far the body part is from the IR, and *source-to-image-receptor distance* (SID), or how far the x-ray tube is from the IR. All radiographs have some degree of magnification because all body parts are three dimensional.

Shape Distortion

Distortion is a misrepresentation of size or shape the anatomic part being examined. In a radiograph all anatomic part should be represented in its truest form and size to reduce the chances of a false diagnosis. The primary factors control shape distortions are: alignment of the body part, central ray, anatomic part, IR and angulation.

Projections

HAND

PA

Position of patient

- Seat patient at the end of the radiographic table or at the end of a table**.**

Position of part

- Rest the patient's forearm on the table and place the hand with the palmar surface down on the IR*
- Place the hand in the center of the IR
- Spread fingers apart slightly

Central ray

- Perpendicular to the third MCP joint*

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- No rotation of the hand
  - Equal concavity of the metacarpal and phalangeal shafts on both sides
  - Equal amount of soft tissue on both sides of the phalanges
  - Equal distance between the metacarpal heads
- Open MCP and IP joints, indicating that the hand was placed flat
- Slightly separated digits with no soft tissue overlap
- All anatomy distal to the radius and ulna
- Soft tissue and bony trabeculation

PA OBLIQUE

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table

Position of part

- Rest the patient's forearm on the table with the palm of the hand resting on the IR
- Adjust the obliquity of the hand so that MCP joints form an angle of approximately 45 degrees with the IR
- Place the hand in the center of the IR

Central ray

- Perpendicular to the third MCP joint

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Minimal overlap of the third-fourth and fourth-fifth metacarpal shafts
- Slight overlap of the metacarpal bases and heads
- Separation of the second and third metacarpals
- Open IP* and MCP joints
- Digits separated slightly with no overlap of their soft tissues
- All anatomy distal to the distal radius and ulna
- Soft tissue and bony trabeculation

LATERAL mediolateral or lateromedial

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table

Position of part

- Adjust the hand so that the palmar surface of the hand is perpendicular to the IR and the first digit forms a right angle to the palm
- The extension of the digits results in a superimposition of the phalanges. A modification of the lateral projection the *fan lateral position* eliminates the superimposition of all but the proximal phalanges. Place the digits in extension with the palmar surface perpendicular to the IR then separate the digits to eliminate the superimposition of the phalanges.

Central ray

- Perpendicular to the second digit MCP joint

Exposure technique

- kVp : 75
- mAs: 2.5
- SID: 48”

Evaluation criteria

- Hand is in a true lateral position if the following are seen:
  - Superimposed phalanges(individually demonstrated on a fan lateral)
  - Superimposed metacarpals
  - Superimposed distal radius and ulna
- Extended digits
- Thumb free of motion and superimposition
- Each bone outlined through the superimposed shadows of the other metacarpals

FINGERS (second through fifth digits)

PA

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table

Position of part

- Rest the patient's forearm on the table and place the hand with the palmar surface down on the IR
- Spread fingers apart slightly
- Center the digit under examination to the midline portion of the IR

Central ray

- Perpendicular to the PIP joint* of the affected digits
- Collimate to the digit under examination

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- No rotation of the digit
- Concavity of the phalangeal shafts and an equal amount of soft tissue on both sides of the phalanges
- Fingernails, if visualized and normal, centered over the distal phalanx
- Entire digit from fingertip to distal portion of adjoining metacarpal
- No soft tissue overlap from adjacent digits
- Open IP and MCP joint space without overlap of bones
- Soft tissue and bony trabeculation

LATERAL lateomedial or mediolateral

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table

Position of part

- Ask the patient to extend the digit to be examined and close the rest of the digits into a fist
- For the second and third digit have the patient's hand rest on the lateral, or radial, surface. For the fourth and fifth digit have the patient's hand rest on the medial, or ulnar, surface.
- Immobilize the extended digit by placing a strip of adhesive tape, a tongue depressor or other support against the palmar surface

- Adjust the anterior or posterior rotation of the hand to obtain a true lateral position of the digit

Central ray

- Perpendicular to the PIP joint of the affected digit
- Collimate to the digit under examination

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Entire digit in a true lateral position:
  - Fingernail in profile, if visualized and normal, in profile
  - Concave, anterior surface of the phalanges
  - No rotation of the phalanges
- No obstruction of the proximal phalanx or MCP joint by adjacent digits
- Open IP joint space
- Soft tissue and bony trabeculation

PA OBLIQUE

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table

Position of part

- Place the patient’s forearm on the table with the hand pronated and the palm resting on the IR
- Rotate the hand externally until the digits are separated and form an angle of 45-degree with the IR

Central ray

- Perpendicular to the PIP joint of the affected digit
- Collimate to the digit being examined

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Entire digit rotated at a 45-degree angle, including the distal portion of the adjoining metacarpal
- No superimposition of the adjacent digits over the proximal phalanx or MCP joint
- Open IP and MCP joint spaces
- Soft tissue and bony trabeculation

FINGERS (First digits)

AP

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table

Position of part

- Put the patient's hand in a position of extreme internal rotation. Have the patient hold the extended digits back with tape or the opposite hand. Rest the thumb on the IR

Central ray

- Perpendicular to the MCP joint
- Collimate to include entire first digit

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- No rotation of the digit
  - Concavity of the phalangeal and metacarpal shafts
  - Equal amount of soft tissue on both sides of the phalanges
  - Thumbnail, if visualized and normal, centered over the distal thumb
- Area from the distal tip of the thumb to the trapezium
- Open IP and MCP joint space without overlap of bones
- Overlap of soft tissue profile of the palm over the midshaft of the first metacarpal
- Soft tissue and bony trabeculation

LATERAL

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table with the relaxed hand placed on the IR

Position of part

- Place the hand in its natural arched position with the palmar surface down and fingers flexed
- Adjust the arching of the hand until a true lateral position of the thumb is obtained

Central ray

- Perpendicular to the MCP joint
- Collimate to include entire first digit

Exposure technique

- kVp : 70
- mAs: 2

- SID: 48”

Evaluation criteria

- First digit in a true lateral position:
  - Thumbnail in profile, if visualized and normal, in profile
  - Concave, anterior surface of the proximal phalanx
  - No rotation of the phalanges
- Area from the distal tip of the thumb to the trapezium
- Open IP and MCP joint spaces
- Soft tissue and bony trabeculation

PA OBLIQUE

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table with the palm of the hand resting on the IR

Position of part

- Place the palmar surface of the hand in contact with the IR. Ulnar deviate the hand slightly.

Central ray

- Perpendicular to the MCP joint
- Collimate to include entire first digit

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Proper rotation of phalanges, soft tissue, and first metacarpal
- Area from the distal tip of the thumb to the trapezium
- Open IP and MCP joint spaces
- Soft tissue and bony trabeculation

WRIST

PA

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table low enough to place the axilla in contact with the table

Position of part

- Have the patient rest the forearm on the table, and center the wrist to the IR area
- Slightly arch the hand at the MCP joints by flexing the digits to place the wrist in close contact with the IR

Central ray

- Perpendicular to the midcarpal area

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Distal radius and ulna, carpals and proximal half of metacarpals
- No rotation in carpals, metacarpals or radius
- Open radioulnar joint space
- Soft tissue and bony trabeculation
- No excessive flexion to overlap and obscure metacarpals with the digits

LATERAL lateromedial

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table low enough to place the axilla in contact with the table
- Have the patient rest the arm and forearm on the table to ensure the wrist is in a lateral position

Position of part

- Have the patient flex the elbow 90 degrees to rotate the ulna to the lateral position
- Adjust the forearm and hand so that the wrist is in a true lateral position

Central ray

- Perpendicular to the wrist joint

Exposure technique

- kVp : 75
- mAs: 2.5
- SID: 48”

Evaluation criteria

- Distal radius and ulna, carpals and proximal half of metacarpals
- Superimposed distal radius and ulna
- Superimposed metacarpals

- Radiographic density similar to PA and oblique radiographs, which requires increased exposure factors to compensate for greater part thickness

PA OBLIQUE lateral rotation

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table low enough to place the axilla in contact with the table

Position of part

- Rest the palmar surface of the wrist on the IR
- From the pronated position, rotate the wrist laterally (externally) until it forms and angle of approximately 45 degrees with the3 plane of the IR

Central ray

- Perpendicular to the midcarpal area. It enters just distal to the radius

Exposure technique

- kVp : 73
- mAs: 2
- SID: 48”

Evaluation criteria

- A well-demonstrated trapezium and the distal half of the scaphoid
- Distal radius and ulna, carpals and proximal half of metacarpals
- Open trapeziotrapezoid and scaphotrapezial joint space
- Usually, adequate amount of obliquity in the following circumstances:
  - Slight interosseus space between the third-fourth and fourth-fifth metacarpal shafts
  - Slight overlap of the distal radius and ulna
- Soft tissue and bony trabeculation

AP OBLIQUE medial rotation

Position of patient

- Seat the patient at the end of a radiographic table or at the end of a table
- Have the patient rest the forearm on the table in a supine position

Position of part

- Place the dorsal surface of the wrist against the IR
- Rotate the wrist medially (internally) until it forms approximately 45 degrees with the IR

Central ray

- Perpendicular to the midcarpal area. It enters the anterior surface of the wrist midway between its medial and lateral borders

Exposure technique

- kVp : 73
- mAs: 2
- SID: 48”

Evaluation criteria

- Carpals on medial side of wrist
- Triquetrum, hook of hamate and pisiform free of superimposition and in profile
- Distal radius and ulna, carpals and proximal half of metacarpals
- Radiographic-quality soft tissue and bony trabeculation

SCAPHOID SERIES ulnar deviation

Position of patient

- Seat the patient at the end of the radiographic table or at the end of a table low enough to place the axilla in contact with the table

Position of part

- Position the wrist on the IR for a PA projection
- Without moving the forearm, turn the hand outward until the wrist is in ulnar deviation

Central ray

- Perpendicular and with multiple cephalad* angle. With the hand and the wrist in the same position for each projection, four separate exposures are made at 0, 10, 20 and 30 degrees cephalad
- The central ray should directly enter the scaphoide bone
- Collimation should be close to improve image quality

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- No rotation of the wrist
- Scaphoid with adjacent articular area open
- Extreme ulnar deviation

FOREARM

AP

Position of patient

- Seat the patient close to the radiographic table and low enough to place the entire limb in the same plane

Position of part

- Supinate the hand, extend the elbow, and center the unmasked half of the IR to the forearm. Ensure that the joint of interest is included
- Have the patient lean laterally until the forearm is in a true supinated position
- Because the proximal forearm is commonly rotated in this position, palpate and adjust the humeral epicondyles to be equidistant from the IR

Central ray

- Perpendicular to the midpoint of the forearm

Exposure technique

- kVp : 75
- mAs: 4
- SID: 48”

Evaluation criteria

- Wrist and distal humerus
- Slight superimposition of the radial head, neck, tuberosity over the proximal ulna
- No elongation or foreshortening of the humeral epicondyles
- Partially open elbow joint if the shoulder was placed in the same plane as the forearm
- Open radioulnar space
- Similar radiographic densities of the proximal and distal forearm

LATERAL lateromedial

Position of patient

- Seat the patient close to the radiographic table and low enough that the humerus, shoulder joint and elbow lie in the same plane

Position of part

- Flex the elbow 90 degrees, and center the forearm over the IR
- Ensure that the entire joint of interest is included
- Adjust the limb in a true lateral position. The thumb side of the hand must be up

Central ray

- Perpendicular to the midpoint of the forearm

Exposure technique

- kVp : 75
- mAs: 4.5
- SID: 48”

Evaluation criteria

- Wrist and distal humerus
- Superimposition of the radius and ulna at their distal end
- Superimposition by the radial head over the coronoid process
- Radial tuberosity facing anteriorly
- Superimpose humeral epicondyles
- Elbow flexed 90 degrees
- Soft tissue and bony trabeculation along the entire length of the radial and ulnar shafts

ELBOW

AP

Position of patient

- Seat the patient close to the radiographic table and low enough that the humerus, shoulder joint and elbow lie in the same plane

Position of part

- Extend the elbow, supinate the hand and center the IR to the elbow joint
- Have the patient lean laterally until the humeral epicondyles and anterior surface of the elbow are parallel with the plane of the IR
- Supinate the hand to prevent rotation of the bones of the forearm

Central ray

- Perpendicular to the elbow joint

Exposure technique

- kVp : 75
- mAs: 2
- SID: 48”

Evaluation criteria

- Radial head, neck and tuberosity slightly superimposed over the proximal ulna
- Elbow joint open and centered to the central ray
- No rotation of the humeral epicondyles
- Soft tissue and bony trabeculation

LATERAL lateromedial

Position of patient

- Seat the patient close to the radiographic table and low enough that the humerus, shoulder joint and elbow lie in the same plane

Position of part

- From the supine position, flex the elbow 90 degrees and place the humerus and forearm in contact with the table
- Adjust the hand in the lateral position and ensure that the humeral epicondyles are perpendicular to the plane of the IR

Central ray

- Perpendicular to the elbow joint

Exposure technique

- kVp : 80
- mAs: 2
- SID: 48”

Evaluation criteria

- Open elbow joint centered to the central ray
- Elbow flexed 90 degrees
- Superimposed humeral epicondyles
- Radial tuberosity facing anteriorly
- Radial head partially superimposing the coronoid process
- Olecranon process seen in profile
- Bony trabeculation and any elevated fat pads in the soft tissue at the anterior and posterior distal humerus and the anterior proximal forearm

AP OBLIQUE medial rotation

Position of patient

- Seat the patient close to the radiographic table and low enough that the humerus, shoulder joint and elbow lie in the same plane

Position of part

- Extent the limb in position for an AP projection. Medially (internally) rotate or pronate the hand, and adjust the elbow to place its anterior surface at an angle of 45 degrees

Central ray

- Perpendicular to the elbow joint

Exposure technique

- kVp : 75
- mAs: 2.5
- SID: 48”

Evaluation criteria

- Coronoid process in profile
- Trochlea
- Elongated medial humeral epicondyle
- Ulna superimposed by the radial head and neck
- Olecranon process within the olecranon fossa
- Soft tissue and bony trabeculation

AP OBLIQUE lateral rotation

Position of patient

- Seat the patient close to the radiographic table and low enough that the humerus, shoulder joint and elbow lie in the same plane

Position of part

- Extent the patient’s arm in position for an AP projection. Rotate laterally (externally) the hand to place the posterior surface of the elbow at a 45 degree angle with the IR

Central ray

- Perpendicular to the elbow joint

Exposure technique

- kVp : 75
- mAs: 2.5
- SID: 48”

Evaluation criteria

- Radial head, neck and tuberosity projected free of the ulna
- Capitulum
- Open elbow joint
- Soft tissue and bony trabeculation

HUMERUS

AP

Position of patient

- Place the patient in the seated-upright or standing position facing the x-ray tube

OR

- With the patient in the supine position, adjust the IR to include the entire length of the humerus

Position of part

- Adjust the height of the IR to place its upper margin about 1 ½ inches (3,8cm) above the head of the humerus
- Abduct the arm slightly, and supinate the hand
- The coronal plane passing through the epicondyles should be parallel with the IR

Central ray

- Perpendicular to the midportion of the humerus and the center of the IR

Exposure technique

- kVp : 80
- mAs: 12
- SID: 48”

Evaluation criteria

- Elbow and shoulder joint
- Maximal visibility of epicondyles without rotation
- Humeral head and greater tubercle in profile
- Outline of the lesser tubercle, located between the humeral head and the greater tubercle
- Beam divergence possibly partially closing the elbow joint
- No great variation in radiographic densities of the proximal and distal humerus

LATERAL lateromedial

Position of patient

- Place the patient in the seated-upright or standing position facing the x-ray tube

OR

- With the patient in the supine position, adjust the IR to include the entire length of the humerus

Position of part

- Unless contraindicated by possible fracture, internally rotate the arm, flex the elbow approximately 90 degrees, and place the patient's anterior hand on the hip.
- A patient with a broken humerus or possible fracture, have the patient sit or stand while facing toward the IR. Oblique the thorax as necessary to align the humerus laterally. If the patient is not already holding the hand of the broken arm, have the patient do so.
- Suspend respiration while taking x-ray

Central ray

- Perpendicular to the midportion of the humerus and the center of the IR

Exposure technique

- kVp : 80
- mAs: 12
- SID: 48"

Evaluation criteria

- Elbow and shoulder joints
- Superimposed epicondyles
- Lesser tubercle in profile
- Greater tubercle superimposed over the humeral head
- Beam divergence possibly partially closing the elbow joint
- No greater variation in radiographic densities of the proximal and distal humerus

SHOULDER

AP external rotation

Position of patient

- Examine the patient in the upright or supine position

Position of part

- Adjust the position of the IR so that its center is 1 inch (2.5cm) inferior to the coracoid process
- Slightly rotate the patient enough to place the body of the scapula parallel with the plane of the IR
- Ask the patient to supinate the hand, unless contraindicated
- Abduct the arm slightly, and rotate it so that the epicondyles are parallel with the plane of the IR

Central ray

- Perpendicular to a point 1 inch (2.5cm) inferior to the coracoid process

Exposure technique

- kVp : 80
- mAs: 16
- SID: 48”

Evaluation criteria

- Superior scapula, lateral half of the clavicle and proximal humerus
- Soft tissue around the shoulder, along with bony trabecular detail
- Humeral head in profile
- Greater tubercle in profile on the lateral aspect of the humerus
- Scapulohumeral joint visualized with slight overlap of humeral head on the glenoid cavity
- Outline of lesser tubercle between the humeral head and greater tubercle

TRANSTHORACIC LATERAL

Position of patient

- Preferably have the patient in the upright position for this position is much easier to make adjustment. The patient can also be place in the supine position
- For the upright position, seat or stand the patient in the lateral position before a vertical grid

Position of part

- Have the patient raise the noninjured arm, rest the forearm on the head, and elevate the shoulder as much as possible.
- Center the IR to the surgical neck area of the affected humerus
- Use of a grid over the IR
- *Respiration:* Full inspiration.

Central ray

- Perpendicular to the IR, entering the midcoronal plane at the level of the surgical neck

Exposure technique

- kVp : 90
- mAs: 16
- SID: 48”

Evaluation criteria

- Proximal humerus
- Scapula, clavicle, and humerus seen through the lung field
- Scapula superimposed over the thoracic spine
- Unaffected clavicle and humerus projected above the shoulder closest to the IR

SCAPULAR Y (PA oblique)

Position of patient

- Radiograph the patient in the upright or recumbent body position; the upright position is preferred

Position of part

- Position the anterior surface of the shoulder being examined against the upright table
- Rotate the patient so that the midcoronal plane forms and angle of 45 to 60 degrees to the IR
- Palpate the scapula, and place its flat surface perpendicular to the IR
- Position the center of the IR at the lever of the scapulohumeral joint
- *Respiration:* Suspend

Central ray

- Perpendicular to the scapulohumeral joint

Exposure technique

- kVp : 80
- mAs: 16
- SID: 48”

Evaluation criteria

- Humeral head and glenoid cavity superimposed
- Humeral shaft and scapular body superimposed
- No superimposition of the scapular body over the bony thorax
- Acromion projected laterally and free of superimposition
- Coracoid possible superimposed or projected below the clavicle
- Scapula in lateral profile with lateral and vertebral borders superimposed

* ***Anterior dislocation***: humeral head projected under the coracoid process

***Posterior dislocation:** Humeral head projected under acromion

GLENOID CAVITY

Position of patient

- Achieve this position with the patient in the supine or upright position. The upright position is preferred.

Position of part

- Center the IR to the scapulohumeral join. The joint is 2inches (5cm) medial and 2 inches (5cm) inferior to the superolateral border of the shoulder
- Rotate the body approximately 35 to 45 degrees toward the affected side
- Adjust the degree of rotation to place the scapula parallel with the plane of the IR.
- *Respiration:* Suspend

Central ray

- Perpendicular to the IR. The central ray should be at a point 2 inches (5 cm) medial and 2 inches (5 cm) inferior to the superior lateral border of the shoulder

Exposure technique

- kVp : 80
- mAs: 16
- SID: 48”

Evaluation criteria

- Open joint space between the humeral head and glenoid cavity
- Glenoid cavity in profile
- Soft tissue at the scapulohumeral joint along with trabecular detail on the glenoid and humeral head

ACROMIOCLAVICULAR ARTICULATIONS

AP Bilateral

Position of patient

- Place the patient in a upright body position either seated or standing

Position of part

- Place the patient in the upright position before a vertical grid device, and adjust the height of the IR so that the midpoint of the IR lies at the same level as the AC joints*
- Center the midline of the body to the midline of the grid
- Ensure that the weight of the body is equally distributed on the feet to avoid rotation
- With the patient's arms hanging by the side, adjust the shoulders to lie in the same horizontal plane
- *Respiration:* Suspend

Central ray

- Perpendicular to the midline of the body at the level of the AC joints for a single projection; directed at each respective AC joint when two separate exposures are necessary for each shoulder in broad-shouldered patient
- Use a SID of 72 inches (183 cm) to reduce magnification

Exposure technique

- kVp : 80
- mAs: 30
- SID: 72"

Evaluation criteria

- AC joints visualized with some soft tissue and without excessive density
- Both AC joints, with and without weights, entirely included on one or two single radiographs
- No rotation of leaning by the patient
- Right or left and nonweight markers

CLAVICULE

AP

Position of patient

- Place the patient in the supine of upright position
- If clavicle is being examined for a fracture or a destructive disease or if the patient cannot be placed in the upright position use the supine position to reduce the possibility of fragment displacement or additional injury

Position of part

- Adjust the body to center the clavicle to the midline of the table or vertical grid device
- Place the arms along the sides of the body, and adjust the shoulders to lie in the same horizontal plane
- Center the clavicle to the IR
- *Respiration:* Suspend at the end of exhalation

Central ray

- Perpendicular to the midshaft of the clavicle

Exposure technique

- kVp : 80
- mAs: 12
- SID: 48”

Evaluation criteria

- Entire clavicle centered on the image
- Uniform density
- Lateral half of the clavicle above the scapula, with the medial half superimposing the thorax

AP AXIAL Lordotic position

Position of patient

- Stand or seat the patient 1 foot in front of the vertical IR device, with the patient facing the x-ray tube

Position of part

- Have the patient lean backward in the position of extreme lordosis, and rest the neck and shoulder against the vertical grid device. The neck will be in extreme flexion
- Center the clavicle to the center of the IR
- *Respiration:* Suspend at the end of a full inspiration

Central ray

- Directed to enter the midshaft of the clavicle
- For the *standing lordotic position*, 0 to 15 degrees cephalic is recommended
- For the *supine position*, 15 to 30 degrees cephalic is recommended

Exposure technique

- kVp : 80
- mAs: 12
- SID: 48”

Evaluation criteria

- Most of the clavicle projected above the ribs and scapula with the medial end overlapping the first or second rib
- Clavicle in a horizontal placement
- Entire clavicle along with the AC and SC joints*

***PA axial projection of the clavicle is similar to the AP axial projection. The differences are as follows:**

- The patient is prone or standing, facing the vertical grid device
- The central ray is angled 15 to 30 degrees caudad*

Structures shown and evaluation criteria are the same as for the AP axial projection described.

FOOT

AP

Position of patient

- Place the patient in the supine position
- Flex the knee of the affected foot enough to rest the sole of the foot firmly on the radiographic table or on the table

Position of part

- Position the IR under the patient's foot
- Ensure that no rotation of the foot occurs
- Take precautions against the IR slipping

Central ray

- Directed 10 degrees towards the heel entering the base of the third metatarsal

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- No rotation of the foot
- Equal amount of space between the adjacent midshafts of the second through fourth metatarsal
- Overlap of the second through fifth metatarsal base
- Visualization of the phalanges and tarsals distal to the talus, as well as the metatarsal
- Open joint space between medial and intermedial cuneiforms

AP OBLIQUE medial rotation

Position of patient

- Place the patient in the supine position
- Flex the knee of the affected foot enough to rest the sole of the foot firmly on the radiographic table or on the table

Position of part

- Position the IR under the patient's foot
- Rotate the patient's leg medially until the plantar surface of the foot forms an angle of 30 degrees to the plane of the IR

Central ray

- Perpendicular to the base of the third metatarsal

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- Third through fifth metatarsal base free of superimposition
- Lateral tarsals with less superimposition then in the AP projection
- Lateral TMT* and intertarsal joints
- Sinus tarsi
- Tuberosity of the fifth metatarsal
- Base of the first and second metatarsals
- Equal amount of space between the shafts of the second through fifth metatarsals
- Sufficient density to demonstrate the phalanges, metatarsal and tarsals

LATERAL mediolateral

Position of patient

- Have the patient lie on the radiographic table or table and turn toward t he affected side until the leg and foot are lateral
- Place the opposite leg behind the patient

Position of part

- Place the patella perpendiculare to the table, this is achieved by elevating the patient's knee or by flexing the knee approximately 90 degrees
- Dorsiflex the foot to form a 90 degree angle with the lower leg

Central ray

- Perpendicular to the base of the third metatarsal

Exposure technique

- kVp : 70
- mAs: 3
- SID: 48"

Evaluation criteria

- Metatarsals nearly superimposed
- Distal leg
- Fibula overlapping the posterior portion of the tibia
- Tibiotalar joint
- Sufficient density to demonstrate the superimposed tarsals and metatarsals

TOES

***The toes have the same projections as the fingers and also used the same positions as for the foot.**

CALCANEUS

AXIAL

Position of patient

- Place the patient in the supine or seated position with the legs fully extended

Position of part

- Place the IR under the patient's ankle, centered to the midline of the ankle
- Place a long strip of gauze around the ball of the foot. Have the patient grasp the gauze to hold the ankle in right-angle dorsiflexion
- If the patient;s ankle cannot be flexed enough to place the plantar surface of the foot perpendicular to the IR, elevate the leg on sandbags to obtain the correct position

Central ray

- Directed to the midpoint of the IR at a cephalic angle of 40 degrees to the long axis of the foot. The central ray enters the base of the third metatarsal

Exposure technique

- kVp : 75
- mAs: 6
- SID: 48"

Evaluation criteria

- Calcaneus and Subtalar joint
- No rotation of the calcaneus- the first or fifth metatarsals not projected to the sides of the foot
- Anterior protion of the calcaneus without excessive density over the posterior portion. Otherwise, two images may be needed for the two regions of thickness

LATERAL mediolateral

Position of patient

- Have the supine patient turn toward the affected side until the leg is approximately lateral

Position of part

- Adjust the calcaneus to the center of the IR

Central ray

- Perpendicular to the calcaneus. Center about 1 inch (2.5 cm) distal to the medial malleolus

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48"

Evaluation criteria

- No rotation of the calcaneus
- Density of the sustentaculum tali, lateral tuberosity, and soft tissue
- Sinus tarsi
- Ankle joint and adjacent tarsals

ANKLE

AP

Position of patient

- Place the patient in the supine position with the affected limb fully extended

Position of part

- Adjust the ankle joint in the anatomic position to obtain a true AP projection.

Central ray

- Perpendicular through the ankle joint at a point midway between the malleoli

Exposure technique

- kVp : 75
- mAs: 2
- SID: 48”

Evaluation criteria

- Tibiotalar joint space
- Ankle joint centered to exposure area
- Normal overlapping of the tibiofubular articulation with the anterior tubercule slightly superimposed over the fibula
- Talus slightly overlapping the distal fibula
- No overlapping of the medial talomaleolar articulation
- Medial and lateral malleoli
- Talus with proper density
- Soft tissue

LATERAL mediolateral

Position of patient

- Have the supine patient turn toward the affected side until the ankle is lateral

Position of part

- Ensure that the lateral surface of the foot is in contact with the IR
- Dorsiflex the foot, and adjust it in the lateral position. Dorsiflexion is required to prevent lateral rotation of the ankle

Central ray

- Perpendicular to the ankle joint entering the medial malleoli
-

Exposure technique

- kVp : 70
- mAs: 2
- SID: 48”

Evaluation criteria

- Ankle joint centered to the exposure area
- Tibiotalar joint well visualized, with the medial and lateral talar domes superimposed
- Fibula aver the posterior half of the tibia
- Distal tibia and fibula, talus and adjacent tarsal
- Fifth metatarsal should be seen to check for Jones fracture*
- Density of the ankle sufficient to see the outline of distal portion of the fibula

AP OBLIQUE lateral rotation

Position of patient

- Seat the patient on the radiographic table or a table with the affected leg extended

Position of part

- Place the plantar surface of the patient's foot in the vertical position and laterally rotate the *leg* and *foot* 45 degrees

Central ray

- Perpendicular, entering the ankle joint midway between the malleoli

Exposure technique

- kVp : 75
- mAs: 2
- SID: 48"

Evaluation criteria

- Subtalar joint
- Calcaneal sulcus (superior portion of calcaneus)

AP OBLIQUE medial rotation

Position of patient

- Place the patient in the supine position with the affected limb fully extended

Position of part

- Dorsiflex the foot enough to place the ankle at nearly right-ankle flexion
- Grasp the lower femur area with one hand and the foot with the other. Internally rotate the entire leg and foot together until a 45 degree position is achieved

Central ray

- Perpendicular to the ankle joint, entering midway between the malleoli

Exposure technique

- kVp : 75
- mAs: 2
- SID: 48"

Evaluation criteria

- Distal tibia, fibula and talus
- Distal tibia and fibula overlap some of the talus
- Talus and distal tibia and fibula adequately penetrated
- Tibiofibular articulation

LEG

AP

Position of patient

- Place the patient in the supine position

Position of part

- Adjust the leg so that the femoral condyles are parallel with the IR and the foot is vertical
- Flex the ankle until the foot is in the vertical position

Central ray

- Perpendicular to the center of the leg.

Exposure technique

- kVp : 75
- mAs: 5
- SID: 48”

Evaluation criteria

- Ankle and knee joint on one or more AP projections
- Ankle and knee joints without rotation
- Proximal and distal articulation of the tibia and fibula moderately overlapped
- Fibular midshaft free of tibial superimposition
- Trabecular detail and soft tissue for the entire leg

LATERAL mediolateral

Position of patient

- Place the patient in the supine position

Position of part

- Turn the patient toward the affected side with the leg on the IR
- Adjust the rotation of the body to place the patella perpendicular to the IR, and ensure that the line drawn through the femoral condyles is also perpendicular
- The knee may be flexed if necessary to ensure true lateral position

Central ray

- Perpendicular to the midpoint of the leg
- Use a SID of 48 inch (122 cm)

Exposure technique

- kVp : 75
- mAs: 5
- SID: 48”

Evaluation criteria

- Ankle and knee joint on one or more images
- Distal fibula lying over the posterior half of the tibia
- Slight overlap of the tibia on the proximal fibular head
- Ankle and knee joints not rotated
- Possibly to superimposition of femoral condyles because of the divergence of the beam
- Moderate separation of the tibial and fibular bodies or shafts (except at the articular ends)
- Trabecular details and soft tissue

KNEE

AP

Position of patient

- Place the patient in the supine position, and adjust the body so that the pelvis is not rotated

Position of part

- Place the IR under the patient's knee. Locate the apex of the patella and center the IR about ½ inch (1.3cm) below the patellar apex.
- Adjust the patient's leg by placing the femoral epicondyles parallel with the IR for a true AP projection

Central ray

- Directed to a point ½ inch (1.3cm) inferior to the patellar apex
- Variable, depending on the measurements between the anterior superior iliac spine (ASIS) and the tabletop.
  - <19cm 3 to 5 degrees *caudad* (thin pelvis
  - 19 to 24cm 0 degrees (perpendicular)
  - >24cm 3 to 5 degrees *cephalad*(large pelvis)

Exposure technique

- kVp : 75
- mAs: 4
- SID: 48"

Evaluation criteria

- Open femorotibial joint space, with interspaces of equal width on both sides if the knee is normal
- Knee fully extended if patient's condition permits
- Patella completely superimposed on the femur
- No rotation of the femur (femoral condyles symmetrical) and tibia (intercondylar eminence centered)
- Slight superimposition of the fibular head if the tibia is normal
- Soft tissue around the knee joint
- Bony detail surrounding the patella on the distal femur

LATERAL mediolateral

Position of patient

- Ask the patient to turn onto the affected side. Ensure that the pelvis is not rotated
- Have the patient bring the knee forward and extend the other limb behind it. The other limb may also be place in front of the affected knee.

Position of part

- A flexion of 20 to 30 degrees is usually preferred because this position relaxes the muscle and shows the maximum volume of the joint cavity
- To prevent fragment separation in new or unhealed patellar fractures, the knee should not be flexed more then 10 degrees
- Place a support under the ankle
- Grasp the epicondyles and adjust them so they are perpendicular to the IR. The patella with be perpendicular to the IR as well

Central ray

- Directed to the knee joint 1 inch (2.5cm) distal to the medial epicondyle at an angle of 5 to 7 degrees cephalic

Exposure technique

- kVp : 75
- mAs: 4
- SID: 48”

Evaluation criteria

- Femoral condyles superimposed
- Open joint space between femoral condyles and tibia
- Patella in a lateral profile
- Open patellefemoral joint space
- Fibular head and tibia slightly superimposed
- Knee flexed 20 to 30 degrees
- All soft tissue around the knee
- Femoral condyle with proper density

AP OBLIQUE lateral rotation

Position of patient

- Place the patient on the radiographic table or a table in the supine position, and support the ankles

Position of part

- Center the IR ½ inch (1.3cm) below the apex of the patella
- Externally rotate the limb 45 degrees

Central ray

- Directed to a point ½ inch (1.3cm) inferior to the patellar apex
- Variable, depending on the measurements between the anterior superior iliac spine (ASIS) and the tabletop.
  - <19cm 3 to 5 degrees *caudad* (thin pelvis
  - 19 to 24cm 0 degrees (perpendicular)
  - >24cm 3 to 5 degrees *cephalad*(large pelvis)

Exposure technique

- kVp : 75
- mAs: 4
- SID: 48”

Evaluation criteria

- Medial femoral and tibial condyles

- Tibial plateaus
- Open knee joint
- Fibula superimposed over the lateral half of the tibia
- Margin of the patella projected slightly beyond the edge of the lateral femoral condyle
- Soft tissue around the knee joint
- Bony detail on the distal femur and proximal tibia

AP OBLIQUE medial rotation

Position of patient

- Place the patient on the radiographic table or a table in the supine position, and support the ankles

Position of part

- Center the IR ½ inch (1.3cm) below the apex of the patella
- Medially rotate the limb 45 degrees

Central ray

- Directed to a point ½ inch (1.3cm) inferior to the patellar apex
- Variable, depending on the measurements between the anterior superior iliac spine (ASIS) and the tabletop.
  - <19cm 3 to 5 degrees *caudad* (thin pelvis
  - 19 to 24cm 0 degrees (perpendicular)
  - >24cm 3 to 5 degrees *cephalad*(large pelvis)

Exposure technique

- kVp : 75
- mAs: 4
- SID: 48”

Evaluation criteria

- Tibia and fibula separated at their proximal articulation
- Posterior tibia
- Lateral condyles of the femur and tibia
- Both tibial plateaus
- Open knee joint
- Margin of the patella projecting slightly beyond the medial side of the femoral condyle
- Soft tissue around the knee joint
- Bony detail on the distal femur and proximal tibia

CHEST

PA

Position of patient

- If possible, always examine patients in the upright position, either standing or seated, so that the diaphragm is at its lowest position and air or fluid levels are seen.

Position of part

- Place the patient, with arms hanging at sides, before a vertical grid device
- Adjust the height of the IR so that its upper border is about 1 ½ to 2 inches (3.8 to 5 cm) above the relaxed shoulders
- Center the midsagittal plane of the patient's body to the midline of the IR
- Have the patient stand straight, with the weight of the body equally distributed on the feet
- Ask the patient to flex the arms and to rest the *back of this hands* low on his hips, below the level of the costophrenic angles
- Depress the shoulders and adjust to lie in the same transverse plane. Rotate them forward to position them below the lung apices
- If a female patient's breasts are large enough to be superimposed over the lower part of the lung field, especially the costophrenic angles, ask the patient to pull the breast upwards and laterally. This is especially important when ruling out the presence of fluid. Have the patient hold the breast in place by leaning against the IR holder
- *Respiration:* Full inspiration. The exposure is made after the *second* full inspiration to ensure maximum expansion of the lungs. For certain conditions, such as pneumothorax and the presence of a foreign body, radiographs are sometimes made at the end of a full inspiration and expiration.

Central ray

- Perpendicular to the center of the IR. The central ray should enter at the lever of T7

Exposure technique

- kVp : 110
- mAs: 2.5
- SID: 72"

Evaluation criteria

- Entire lung fields from the apices to the costophrenic angles
- No rotation; sternal ends of the clavicles equidistant from the vertebral column
- Trachea visible in the midline
- Scapulae projected outside the lung field
- Ten posterior ribs visible above the diaphragm
- Faint shadow of the ribs and superior thoracic vertebrae visible through the heart shadow
- Lung markings visible from the hilum to the periphery of the lung
- With inspiration and expiration chest images, diaphragm demonstrated on expiration at a higher lever so that at least one less rib is seen within the lung field

LATERAL

Position of patient

- To show the heart and left lung, use the left lateral position with the patient's left side against the IR
- Use the right lateral position to best demonstrate the right lung

Position of part

- Adjust the position of the patient so that the midsagittal plane of the body is parallel with the IR and the adjacent shoulder is touching the grid device
- Center the thorax to the grid; the midcoronal plane should be perpendicular and centered to the midline of the grid
- Have the patient extend the arms directly upward, flex the elbows, and with the forearms resting on the elbows, hold the arms in position
- Place an IV stand in front of an unsteady patient. Have the patient extend the arms and grasp the stand as high as possible for support
- Adjust the height of the IR so that upper border is about 1 ½ to 2 inches (3.8 to 5cm) above the shoulders
- *Respiration:* Full inspiration. The exposure is made after the *second* full inspiration to ensure maximum expansion of the lungs

Central ray

- Perpendicular to the center of the IR. The central ray will enter the patient on the midcoronal plane at the level of T7 or the inferior aspect of the scapula

Exposure technique

- kVp : 120
- mAs: 2.5
- SID: 72"

Evaluation criteria

- Superimposition f the ribs posterior to the vertebral column
- Arm of its soft tissue not overlapping the superior lung field
- Long axis of the lung field demonstrated in vertical position, without forward or backward leaning
- Lateral sternum with not rotation
- Costophrenic angles and the lower apices of the lung
- Penetration of the lung fields and heart and intervertebral foramina, except in patient with scoliosis
- Sharp outlines of heart and diaphragm
- Hilum in the approximate center of the radiograph

ABDOMEN

AP

Position of patient

- Place the patient in the supine or upright position. The supine position is preferred for most initial examinations of the abdomen

Position of part

- Center the midsagittal plane of the body to the midline of the grid device
- Place the patient's arm where they will not cast shadows on the image
- For the *supine position*, center the IR at the level of the iliac crest to ensure that the pubic symphysis is included
- For the *upright position*, center the IR 2 inches (5 cm) above the lever of the iliac crest or high enough to include the diaphragm
- *Respiration:* Suspend at the end of expiration so that the abdominal organs are not compressed

Central ray

- Perpendicular to the IR at the lever of the iliac crest of the supine position
- Horizontal and 2 inches (5 cm) above the lever of the iliac crest to include the diaphragm for the upright position

Exposure technique

- kVp : 85
- mAs: 10
- SID: 48"

Evaluation criteria

- Area from the pubic symphysis to the upper abdomen (two radiographs may be necessary if the patient is tall)
- Proper patient alignment is ensured by the following:
  - Centered vertebral column
  - Ribs, pelvis, and hips equidistant to the edge of the radiograph on both sides
- No rotation of the patient, as indicated by the following:
  - Spinous processes in the center of the lumbar vertebrae
  - Ischial spine of the pelvis symmetric, if visible
  - Alae or wings of the ilia symmetric
- Soft tissue gray tones should demonstrate the following:
  - Lateral abdominal wall and properitoneal fat layer (flank stripe)
  - Psoas muscle, lower border of the liver, and kidneys
  - Inferior ribs
  - Transvers processes of the lumbar vertebrae
  - Right or left marker visible but not lying over the abdominal content

- Diaphragm without motion on upright abdomen examinations
- Density on upright abdomen examination, similar to supine examination. However, reduce density if pneumoperitoneum is suspected
- Upright abdomen identified with an appropriate marker

CAST

FIBERGLASS

- Increase mAs 25%

OR

- Increase kVp by 4

PLASTER MEDIUM

- Increase mAs 50%

OR

- Increase kVp by 7

PLASTER LARGE

- Increase mAs 100%

OR

- Increase kVp by 10

ABREVIATION

IR: image receptor
MCP: metacarpophalangeal joints
IP: interphalangeal joints
PIP: Proximal interphalangeal joint
TMT: Tarsometatarsal joint
Jones Fracture: Fracture of the base of the fifth metatarsal
AC joint: Acromioclavicular joint
SC joint: sternoclavicular joint
Cephalad: Central ray is directed towards the patient's head
Caudad: Central ray is directed towards the patient's feet
SID: source to image receptor distance

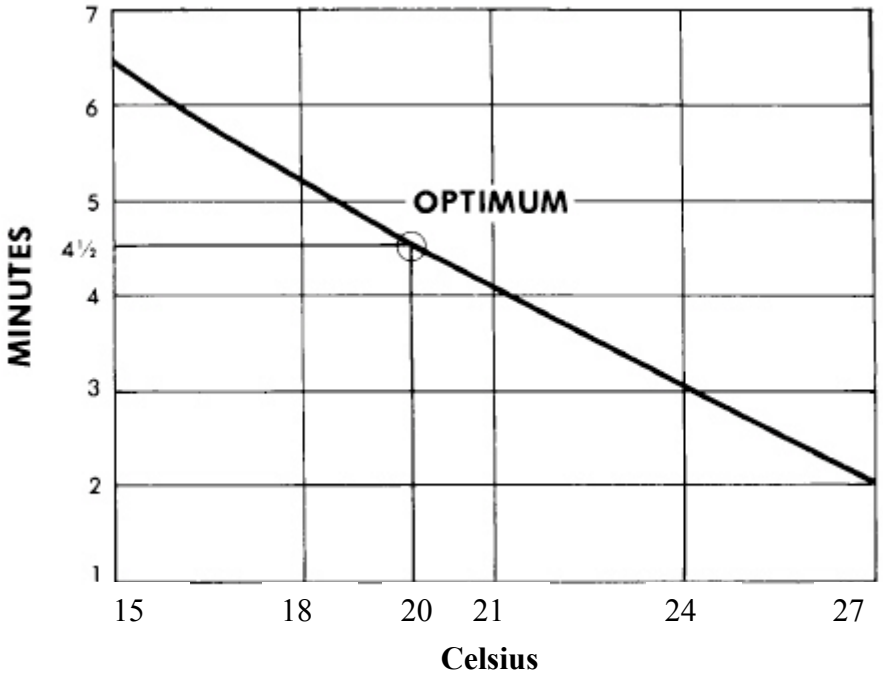
Film Developing

Wetting

The wetting process is the first step in developing a radiograph. This process consists of immersing the film in a solvent, water, to dissolve various solids and powders that are found on the film. The wetting process also swells the emulsion on the film to permit subsequent chemicals penetration. This process last around **15 seconds** enough time to get the entire film wet.

Developing

The principal action of developing is to change the silver ions of the exposed crystals into metallic silver. The developer is the chemical that performs this task. When manipulating the film, hands should be clean to avoid leaving finger marks on the film and place on a film holder. In this holder the film should be held lightly by its edges to avoid the appearance of smudges. A timer should be set and started when the film is immersed in the developer. The timer should be set for **4 ½ minutes** when the temperature of the developer is **20°C**. When 20°C cannot be obtained adjustment to the immersing time should be adjusted; if colder the film should be left in the developer longer. When the film is in the developer solution, the film should be moved up and down to break up any air bubbles that may have formed on the surface of the film. When the time expires take out the film and tilt it slightly for a few seconds to allow excess solution to drain into the developing section of the tank.



Rinsing

Some location has a **rinsing** station after developing, the film the rinse it in water for **20 seconds** to eliminate any access of developer that may be found on the film. Other locations have a **stop bath** which is an acidic solution to stop the action of the developer and removes excess chemical from the solution. When there is a stop bath in the dark room the film should be immersed in it for about **30 seconds** while moving the film to ensure no air bubble form on the surface of the film.

Fixing

The purpose of fixing is to remove the remaining silver halide from the emulsion and harden the gelatin. The film should be placed in the fixing solution for about **15minutes** while moving the film up and down to ensure no air bubbles are formed on the surface of the film. When the film is not immersed in the fixing solution long enough the film loses its archival quality because if there is any presence of developer solution on the film, the film will blacken under the white light and the image will be lost.

Washing

When the fixing process is complete, the film should be immersed in fresh, cool, circulating water for at least **20 minutes** to remove all of the fixing solution on the film. If the film is not washed properly, the radiograph will turn yellow and fade with time reducing its archival quality.

Drying

Drying is the final step in processing. After washing, the film should be hung carefully on a drying rack with a pan under the rack serves to catch water dripping from films. Drying is done by leaving the film suspended in the air until it is completely dry. Drying may be speeded up by directing a small electric fan directing a current of air. Drying time can vary, to determine when the film is dry is to touch and feel if all the water has been absorbed or removed from the film.

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