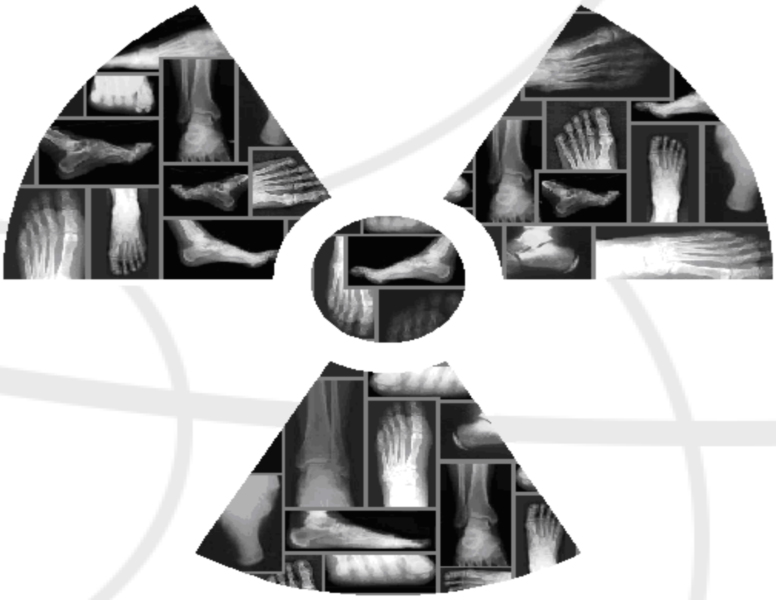
Florida Podiatric Medical Association

Radiation Safety and Training Manual
Fixed Length Podiatric Radiography Equipment



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Chapter 1. *Role of the Basic X-ray Machine Operator-Podiatry*

What types of certification for radiographers are offered in Florida?

Florida offers five types of certification: Basic X-ray Machine Operator, Basic X-ray Machine Operator-Podiatric Medicine, General Radiographer, Nuclear Medicine Technologist, and Radiation Therapy Technologist.

Certified Podiatric X-ray Assistant

Any Certified Podiatric X-ray Assistant may perform services only:

a. In the office(s) of the podiatric physician(s) to whom the Certified Podiatric X-ray Assistant has been assigned, in which office(s) such physician maintains his or her practice;
b. When the podiatric physician(s) to whom he or she is assigned is present;
c. Each podiatric physician or group of podiatric physicians utilizing Certified Podiatric X-ray Assistant's shall be liable for any act or omission of any Certified Podiatric X-ray Assistant acting under supervision and control.

Section 461.003(2), Florida Statutes, Definitions. "Certified podiatric x-ray assistant," means a person who is employed by and under the direct supervision of a licensed podiatric physician to perform only those radiographic functions that are within the scope of practice of a podiatric physician licensed under this chapter. For purposes of this subsection, the term "direct supervision" means supervision whereby a podiatric physician orders the X-ray, remains on the premises while the X-ray is being performed and exposed, and approves the work performed before dismissal of the patient.

What are the requirements for certification?

To become certified, each applicant must pass a test covering radiation protection, equipment operation and maintenance, image production and evaluation, procedures, and patient care.

Section 461.0135, Florida Statutes, Operation of X-ray machines by podiatric X-ray assistants. -- A licensed podiatric physician may utilize an X-ray machine, expose X-rays films, and interpret or read such films. The provision of part IV of chapter 461 to the contrary notwithstanding, a licensed podiatric physician may authorize or direct a certified podiatric X-ray assistant to operate such equipment and expose such films under the licensed podiatric physician's direction and supervision, pursuant to rules adopted by the board in accordance with s. 461.004, which ensures that such certified podiatric X-ray assistant is competent to operate such equipment in a safe and efficient manner by reason of training, experience, and passage of a board-approved course which includes an examination. The board shall issue a certificate to an individual who successfully completes the board-approved course and passes the examination to be administered by the training authority upon completion of such course.

Department inspectors verify the certification of each technologist during the inspection of medical x-ray machines, nuclear medicine facilities and radiation therapy facilities.

Chapter 2 *Radiobiology and Radiation Safety*

- **History of Radiation Protection**
- **Cells and Radiosensitivity**
- **Biological Effects**
- **Three Basic Protection Measures**
- **Patient Protection**
- **Occupational Protection**

Historyof Radiation Protection

- X-rays were discovered by Wilhelm Konrad Reontgen in 1895
- X-ray machine operators, not patients, are at a higher risk of the adverse affects of radiation exposure
- Non-threshold Response to Radiation Concept: Any exposure to ionizing radiation will result in some type of biological change or damage

Cells and radiosensitivity

- Reproductive cells (immature, rapidly dividing cells) and white blood cells (specifically lymphocytes) are the most radiosensitive
- Muscle, nerve, and cortical bone have highly specialized cells, and have a low sensitivity

Biological Effects

- Genetic effects – molecular effects; damage to DNA molecules can cause mutations in the offspring
- Somatic effects – cellular effects; describes biological damage to the individual (e.g. burns, hair loss, cancer) but is not passed to the offspring
- Embryologic effects – those that effect the embryo or fetus during its development
- First trimester – most radiosensitive period; the most severe effects occur during the first six weeks
- Sensitivity decreases during the second and third trimesters

Three Basic Protection Measures

- Time
- Distance
- Shielding

Time – keep the exposure time as short as possible; minimize the number of times exposed to radiation (radiation dose is cumulative!)

Distance – ***this is the most effective method of radiation protection***
The inverse square law:
The intensity of the beam is inversely proportional to the square of the distance.

Shielding – lead is the metal most commonly used in diagnostic radiology for radiation protection

Patient Protection

- Preparation and positioning
- Beam restriction
- Shielding for patients
- Exposure Factors
- Radiographic accessories
- Pediatric patients
- Female patients

Preparation and Positioning

Be sure to prepare the patient prior to bringing the patient to the x-ray machine. Decreasing retakes reduces patient exposure. Have the patent remove jewelry which may obscure anatomy (e.g. ankle bracelets, toe rings). Military radiographers use the MAPPS mnemonic when preparing the patient for the radiograph:

M – Measure
A – Adjust
P – Position
S – Shield
S – Shoot

Measure. Radiographers in training use calipers to measure the body part, and use a technique chart to choose exposure factors. Experienced radiographers, however, can simply observe the patient's body type to determine which exposure factors to use. For radiographs of the foot and ankle, simply observe if the patient has a small, medium, or large body type.

Adjust. After determining the patient's body type, adjust the exposure factors accordingly.

Position. After setting the exposure factors, position the x-ray tubehead and patient.

Shield. Shield ALL adults of childbearing age, and ALL pediatrics.

Shoot. After completing the above steps, you are ready to make the exposure.

Beam restriction

Beam restriction is another method of shielding. The collimator is the best device for restricting the size of the primary beam. **Always use the smallest exposure field possible when taking a radiograph!** Using the smallest field possible will decrease patient exposure by reducing secondary and scatter radiation.

Shielding

Lead is the metal most commonly used in diagnostic radiology for radiation protection. Shield ALL patients of childbearing age, and ALL pediatrics

Exposure Factors

- mA (milliamperes; current)
- S (time in seconds)
- kVp (kilovolt peak; difference in potential)
-

Also, remember that the x-ray beam is HETEROGENEOUS – it will consist of photons of different wavelengths
The shorter the wavelength and the higher the frequency of a photon, the greater it's penetrating power.

The mA, and/or the time (s), control the amount or QUANTITY of x-rays coming out of the tube. Think of the mA and the time as a product, or as the "mAs":

mAs

mA X s = mAs

5 X 1 = 5
10 X .5 = 5

The kVp controls QUALITY or PENETRATING POWER of the x-ray beam.

The exposure factors will be discussed in more detail in chapter 4. They are presented here to remind radiographers to choose the correct exposure factors in order to reduce retakes, and keep patient exposure to a minimum.

Pediatric Patients

Unruly or uncooperative children must be restrained by the parent, family member or friend for radiographs. Radiographers should NOT hold children for radiographs.

Pregnant Patients

The 10-day rule: x-rays should only be scheduled during the first 10 days after the beginning of menstruation, because it is unlikely that a woman will be pregnant during this time.

Elective radiographs should be delayed or rescheduled if pregnancy status is uncertain.

Occupational Protection

- ALARA concept: radiation workers are to keep exposures As Low As Reasonably Achievable
- Occupational dose equivalent (DE) limits are set by the National Council on Radiation Protection
- 5 rems per year is the total dose limit for radiation workers
- 0.5 rems per year is the total dose limit for the rest of the population
- The *cumulative* DE limit for radiation workers is 1rem times the worker's age.

For example, a 35 year old worker would have a cumulative dose limit of 35 rems.

Two types of monitoring devices are most commonly used:

- Film badges
- Thermoluminescent dosimeters

Film badges consist of a piece of film similar to that of dental film within a plastic holder. They should be worn at chest level (on the collar), and changed every 4 weeks.

The TLD contains small chips of lithium fluoride. They should also be worn at chest level, and these are changed every three months.

According to the Florida Bureau of Radiation control, film badges or TLD's are NOT required in podiatry offices, because these offices have such a low radiograph output. What the Bureau DOES require is that professionals in these offices practice radiation protection:

- Shield the patient
- Shield the radiographer
- Radiographer should stand at least six feet away from the tubehead when making an exposure

- Parents need to be shielded if holding a child
- Radiographers should NOT hold children for radiographs

Summary

- Reproductive and white blood cells are the most radiosensitive cells in the body
- Genetic effects: describe biological damage from radiation that is passed to the offspring
- Somatic effects: describe biological damage from radiation that affects the individual, but is not passed to the offspring
- The most severe biological effects occur during the first trimester
- Three basic protection measures: time, distance, shielding
- Distance is the MOST effective protection against radiation exposure
- The inverse square law: the intensity of the beam is inversely proportional to the square of the distance
- Lead is the most common metal used for shielding in radiology departments
- ALARA concept: keep radiation doses As Low As Reasonably Achievable
- 5 rems is the annual occupational radiation dose limit, 0.5 rems is the non-occupational annual dose limit
- Film badges/TLD's are commonly used for occupational exposure monitoring; they should be worn on the collar. Film badges are changed every four weeks, TLD's every three months

Chapter 3 *Introduction to Radiographic Equipment*

Components of the X-ray Machine:

- **Tube Head**
- **Beam Limitation Device (collimator)**
- **Arm**
- **Control Panel**

Tube Head

The tube head consists of a glass envelope, the cathode filament (negative charge) and the anode target (positive charge). The housing for the x-ray tube has a lead lining filled with oil. The lead absorbs off-focus radiation. The oil keeps the x-ray tube cool.

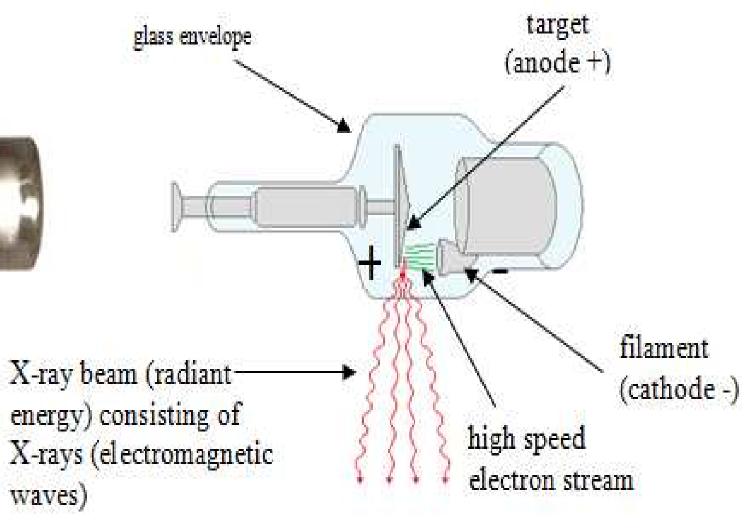


Figure 3-1. X-ray tube head.

Beam Limitation Device (collimator)

The beam limitation device shapes the dimensions of the x-ray beam (collimation). Always use the smallest exposure field possible to reduce patient exposure and to reduce scatter radiation. Examples include cones, diaphragms, and variable aperture. Variable aperture collimators consist of flat sheets of lead within the x-ray tube housing are the most commonly used.

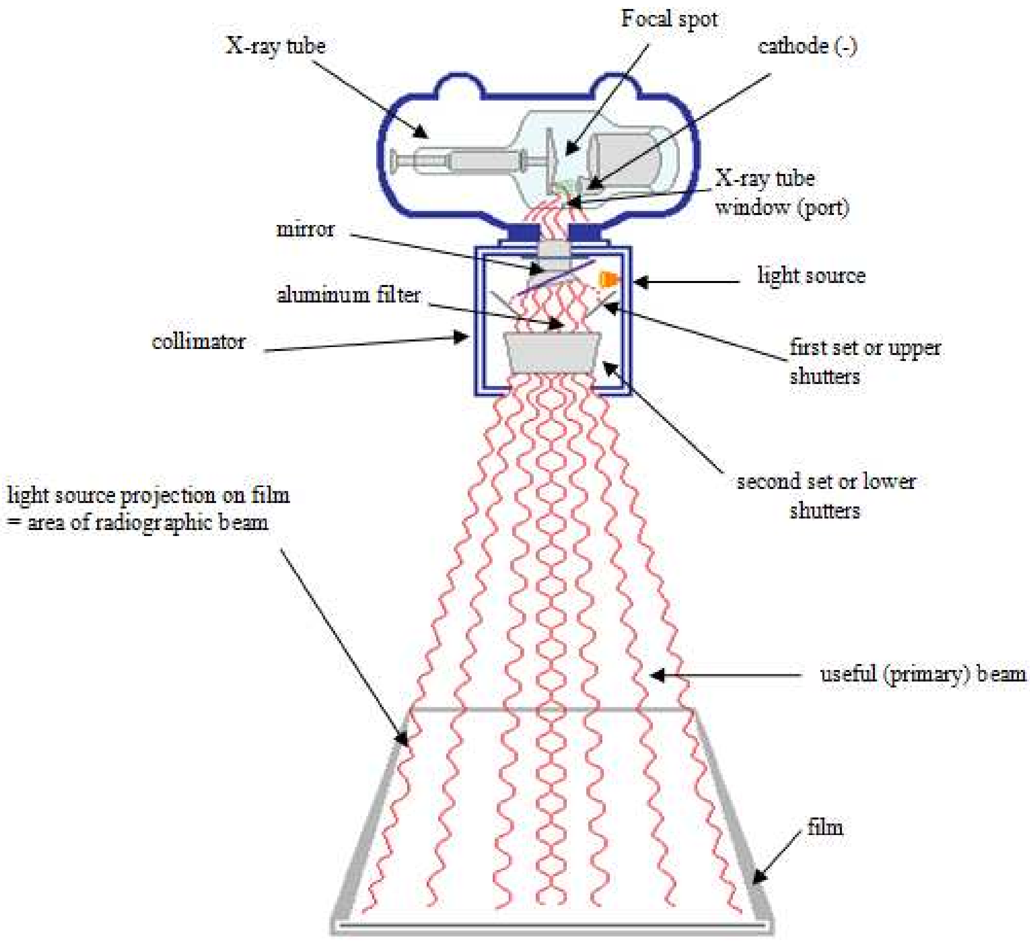


Figure 3-2. A, Variable rectangular collimator. B, Diagram of a typical collimator.

Arm

The function of the arm is to hold the tube head firmly in place. Movement of the tube head during exposure will blur the image

Control Panel

The three expose factors are:

- Milliamperage (mA)
- Timer (seconds)
- Kilovolt peak (kVp)

These factors are adjusted at the control panel

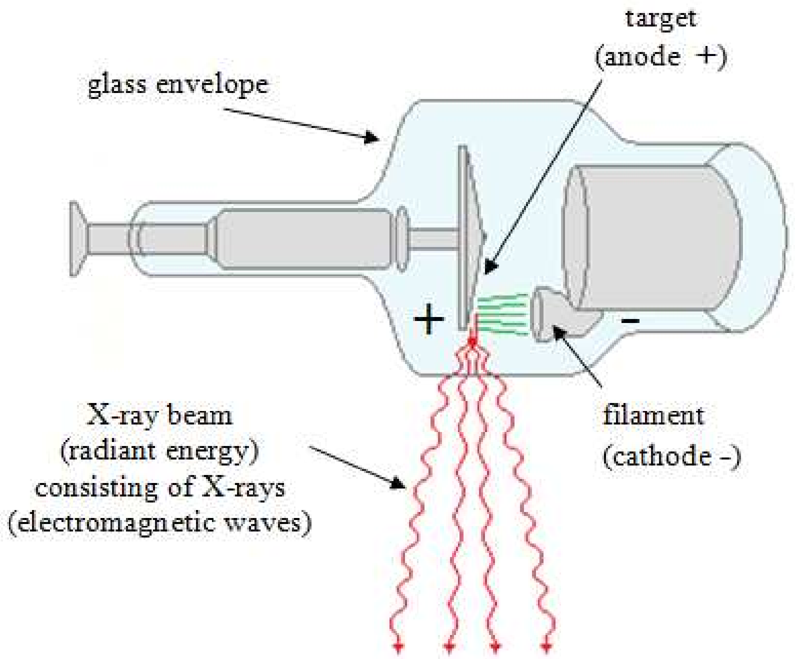


Figure 3-3. Diagram showing the cathode, anode, and resulting heterogeneous x-ray beam.

Milliamperage (mA)

- Controls the amount of current to the filament of the cathode side of the x-ray tube
- Current to the filament will produce electrons

- A higher current will produce a greater number of electrons to eventually bombard the anode target. Therefore, the mA controls the amount, or QUANITIY of x-rays coming out of the tube
- Timer (seconds)
- The timer controls the amount of time, in seconds, that the current is supplied to the filament
- The longer the exposure time, the greater the number of electrons produced at the cathode. Therefore, the time also controls the amount or QUANTITY of radiation
- Remember to think of the mA and time as a product; the “mAs” controls the quantity of radiation coming from the x-ray tube. 1 to 90 mAs is a common range for podiatric units.

Kilovolt Peak (kVp)

- Controls the voltage to the x-ray tube.
- Affects the QUALITY or PENETRATING POWER of the beam
- 50 to 70kVp is a common range for podiatry units
- Increasing the voltage will increase the difference in potential difference across the x-ray tube. As a result, the electrons will have a greater attraction to the positive anode target; the electrons will bombard the target with greater force; thus increasing the penetrating power of the beam.

The Source to Image Distance (SID) is 21 to 28 inch usually used for podiatry and extremity studies. Podiatric equipment has a fixed length (fixed SID).

Summary

- The tube head consists of a glass envelope, the cathode filament and the anode target.
- The beam limitation device shapes the dimensions of the x-ray beam. Always use the smallest exposure field possible to reduce patient exposure.
- The three primary exposure factors are: mA, time(s), and kVp.
- The three primary exposure factors are adjusted at the control panel.
- The mAs controls the QUANTITY or AMOUNT of x-rays produced
- The kVp controls the QUALITY or PENITRATING POWER of the x-ray beam

Chapter 4 *Basic Physics for Radiography and X-ray Production*

The credit for the discovery of x-rays is given to Wilhelm Konrad Roentgen in 1895

Radiography: using the x-ray beam, and its ability or inability to penetrate different types of tissues to produce an image to aid in the diagnoses and treatment of injury or disease.

- **Properties of x-rays**
- **X-ray Production**
- **Types of Radiation**
- **Units of Measure**

Properties of X-rays

- Electromagnetic radiation
- An x-ray photon is a packet of energy of a certain wavelength, which moves at the speed of light. It has electric and magnetic properties.
- Electromagnetic spectrum:

Radio MRI micro IR   ROYGBIV   UV X gamma

X-ray Production

- Electrons are formed (cathode side of the tube; controlled by mA and time (s))
- Electrons are accelerated across the tube (controlled by the kVp)
- Electrons hit the anode target where the x-ray photons are produced (the force with which the electrons hit the target will influence the penetrating power of the beam)

Types of Radiation

- Primary radiation – photons directed toward the object
- Remnant radiation – photons which pass through the object and reach the film
- Attenuated radiation – photons which are scattered or absorbed and do NOT reach the film
- Leakage radiation is that which escapes from the lead housing of the x-ray tube

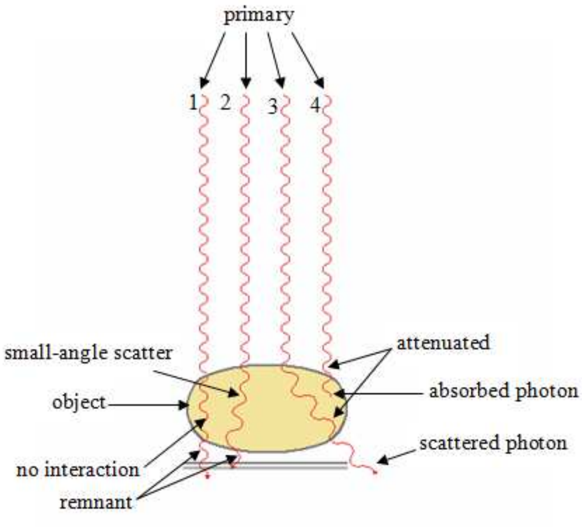


Figure 4-1. Primary, remnant, and attenuated radiation

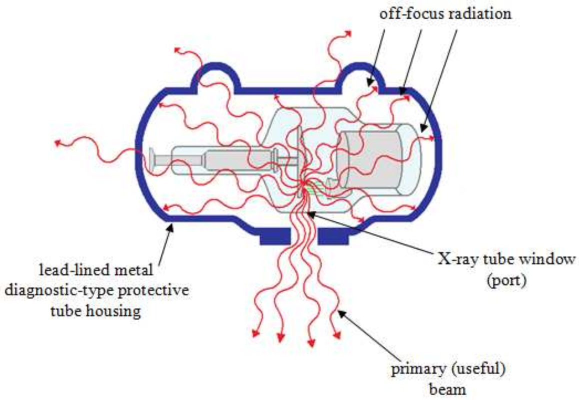


Figure 4-2. Leakage radiation.

Units of Measure

- R (roentgen) – the amount of radiation measured in dry air
- Rad (radiation absorbed dose) – the amount of energy transferred to an object by any type of radiation
- Rem (Rad equivalent man) – unit of measure to describe the biological effects on human body

For the purposes of diagnostic radiology:

R = rad = rem

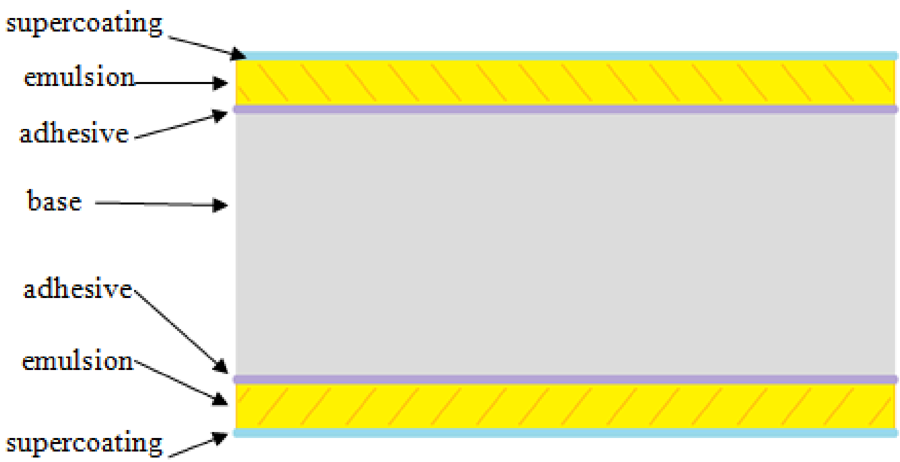
Summary

- The credit for the discovery of x-rays is given to Wilhelm Konrad Roentgen in 1895
- X-rays are a type of electromagnetic radiation
- Radiography: using the x-ray beam, and its ability or inability to penetrate different types of tissues to produce an image to aid in the diagnoses and treatment of injury or disease
- Remnant radiation is that radiation that passes through the object being radiographed and makes it to the film
- Leakage radiation is that which escapes from the lead housing of the x-ray tube
- Rem is the unit of measure to describe the biological effects on human body tissue

Chapter 5 *Principles of Exposure and Image Quality*

- **Film**
- **Latent image**
- **Screens; cassettes**
- **Density**
- **Tissue thickness**
- **Contrast**
- **Factors that affect image quality**

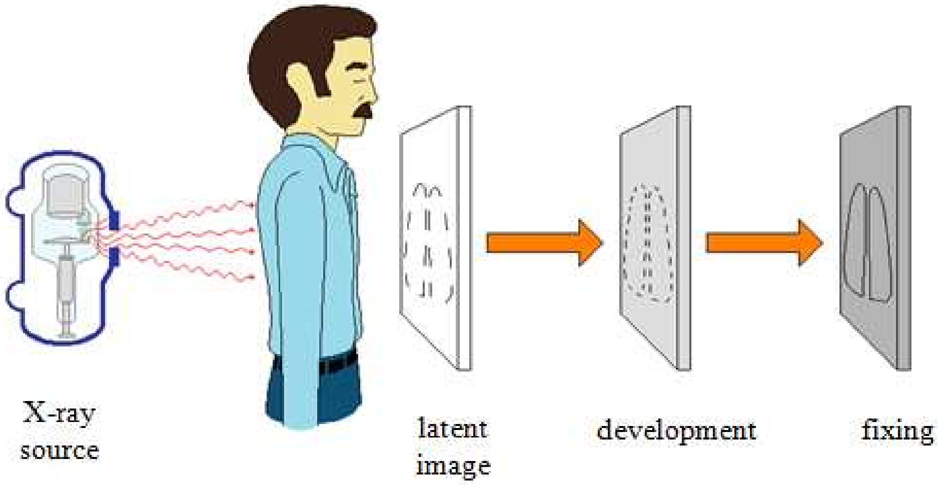
Film



Cross-section of Radiographic Film

The radiographic film has basically two major parts: the **base**, and the **emulsion**. The base is made of polyester, and is the support for the film emulsion. The emulsion is coated on both sides of the base, and is a mixture of gelatin and silver halide crystals. When the emulsion is exposed to x-rays, the silver halide crystals are converted to black metallic silver.

Latent image



Before the radiographic film is developed, the image, which cannot yet be seen, is known as the ***latent image***. The actual radiographic image that is visualized after the film is processed is called **the *manifest image***, or the visible image.

Screens; cassettes

Non-screen film – (direct exposure); cardboard cassette, increased patient exposure. Not recommended for use in Florida.

Screen film – used with cassettes with intensifying screens. The purpose of intensifying screens is to reduce the amount of radiation needed to make an exposure.

Screen film is sensitive to fluorescent light from crystals in the intensifying screens. **Slow speed screens** have smaller crystals, result in greater detail; commonly used for extremity work. Disadvantage: increased patient exposure. **High speed screens** have large crystals; therefore decreased patient exposure. Disadvantage: less detail.

Density

The amount of black metallic silver deposited on the radiographic film. It is also a measure of the quantity of radiation absorbed by the film.

Density is controlled by:

- mAs
- TFD
- kVp
- Film-screen combination
- Filtration
- Tissue thickness
- Processing
- Fog
- Artifacts

Tissue thickness

A thicker body part will need higher exposure factors for adequate film density. Also, a denser body part will need higher exposure factors.

Example: a wet cast is more dense than a dry cast due to its water content. For a wet cast increase kVp by 15; for a dry cast increase 10 kVp

Contrast

Refers to the degree of difference between light and dark areas on a film.
Long scale: many shades of gray. A HIGH kVp will give a long scale of contrast because of its ability to penetrate many types of body tissues.
Short scale: abrupt, black/white images; a low kVp will produce this type of image due to the beam's inability to penetrate.

Factors that affect image quality

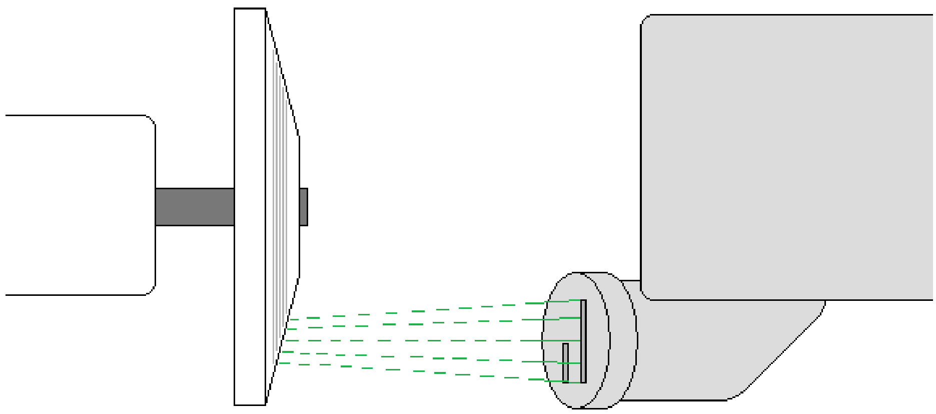
- Fog
- Motion
- Artifacts
- Focal spot size

Fog (film fog) is unwanted film density which can degrade the radiographic image. Causes include: exposure of film to light or secondary/scatter radiation, and improper film development.

Motion of the body part during the exposure produces a blurred image. It can be controlled with a short exposure time, or by immobilizing the patient.

Artifacts are foreign or unwanted marks that show up on a radiograph because of improper film handling, improper processing, or faulty equipment. They can cause either increased or decreased radiographic density. A "crescent mark" is a type of film artifact caused by mishandling film.

The focal spot is the area on the anode which is bombarded by electrons, and the x-rays produced.



- Smaller focal spot = greater detail; but lessens the life of the x-ray tube
- Large focal spot = less detail, but prolongs the life of the tube

Summary

- Latent image: the radiographic image, before it is developed and cannot yet be seen
- Non-screen film, though providing excellent detail, results in a SIGNIFICANT increase in patient exposure and is NOT recommended for use in the state of Florida
- The purpose of intensifying screens is to reduce the amount of radiation needed to make an exposure
- Increase exposure factors when imaging a thicker body part (increase either mAs, kVp or both), because the thickness of the body part DOES affect radiographic density
- kVp controls the penetrating power of the x-ray beam; increase kVp by 15 if x-raying a wet cast; 10 kVp for a dry cast
- If a film is underexposed (lacks adequate density) you should increase the mAs or kVp
- Radiographic density is a measure of the amount of blackness on the film
- Radiographic contrast refers to the degree of difference between light and dark areas on a film
- A light leak in the darkroom would produce “film fog” artifact
- Patient motion would cause “blurring of the radiographic image
- Small focal spot: better image detail
- Large focal spot: longer x-ray tube life
- Crescent mark: a film artifact caused by mishandling the film

Chapter 6 X-ray Darkroom and Film Processing

- **Darkroom**
- **Film Storage**
- **Manual Processing**
- **Automatic Processing**

Darkroom

In the darkroom, light proofing is a necessity to prevent fogging of the radiographic film. The film bin is a light proof storage cabinet for film. Lighting should consist of a white light, and a safe light.

The white light is for non-developing duties (e.g., replenishing chemicals). For developing film a safe light must be used. The safe light should be no more than 15 watts; and one must also use a Wratten 6B filter. The safe light CAN cause film fog, therefore one must limit the time the film is exposed to it

Film Storage

Pressure, temperature, humidity chemicals, and static electricity can cause unwanted artifacts or film fog. Pressure: can cause changes in the emulsion; which will be manifested as artifacts on the developed film. Store films on edge; never stack boxes on top of one another.

Temperature and humidity: the temperature at which film is stored will determine how long it will last. The cooler the storage temperature, the longer the film will last. The ideal storage conditions:
Temperature: 60-75’
Relative humidity: 50-60

Film must be protected from unwanted radiation; should not be stored in exposure rooms. Open boxes of film should be stored in a film bin

Static electricity may also cause film artifacts. Low humidity, too cold temperatures, rough handling, or ungrounded electrical equipment can cause static marks on the film

Manual Processing

- Developer
- Stop bath (water)
- Fixer
- Wash (water)
- Dry
- Processing time can take up to one hour

The **developer** is an alkaline solution that converts the latent image into a visible image. 5 minutes at 68'F is ideal; too long developer time or too high temperature will result in film fog.

The **stop bath** is clean water, or water with 1-5% acetic acid. Its' function is to stop the action of the developer; usually 30 seconds.

The **fixer** is composed of a fixing agent, acidifier, hardener, and preservative. The function of the fixer is to neutralize the developer, remove the undeveloped silver, and harden the emulsion to make the visible image permanent.

The wash is clean water, to rinse the remaining chemicals from the film.

Drying – either drip dry, or use a film dryer.

When using the developer continually, the chemicals become exhausted and the level of solution in the tank drops. The replenisher solution will make up for the loss in strength and volume. Fixer can also be replenished by discarding an equal volume of old fixer and adding new fixer.

Automatic Processing

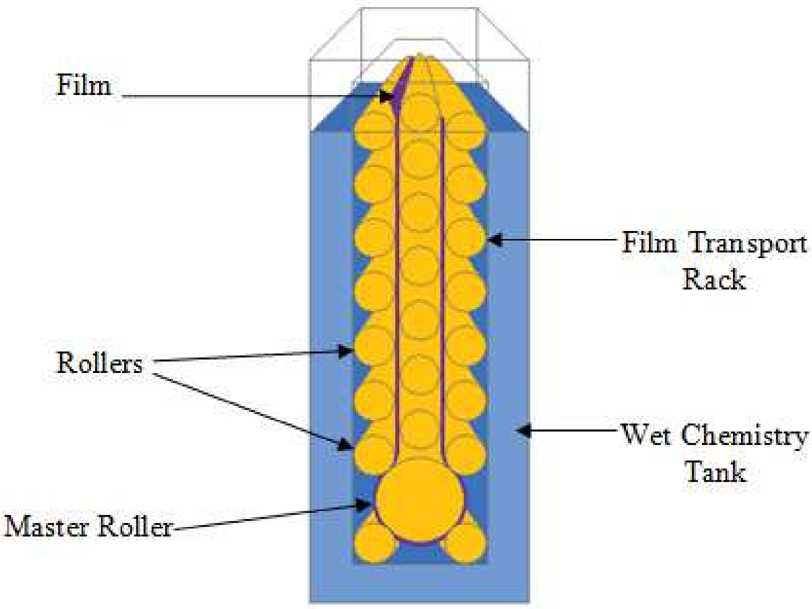
- Developer
- Fixer
- Washer
- Dryer
- Processing time: 90 seconds

The chemicals for automatic processing are the same as those discussed for manual processing.

The components of the automatic processor:

- Transport system
- Replenishment system
- Temperature regulation system
- Re-circulation system
- Water system
- Drying system

The **transport system** consists of the feed tray, rollers, and main drive motor. It moves the film through the developer, fixer, washer, and dryer.



Just as in manual processing, the developer and fixer volumes decrease and weaken; the **replenishment system** restores the volume and strength of the chemicals. The size of the film determines the amount of replenisher added.

The **temperature regulation system** heats the chemicals so that less time is required than that of manual processing.

The **re-circulation system** consists of the processor tanks, filters, pumps, and drains. It continually mixes the replenisher solutions.

The **water system** circulates water through the wash tank to remove all residual processing chemicals.

The **dryer system** is composed of a blower, ventilation ducts, drying tubes, and an exhaust system. It can dry the film in a very short period of time.

Summary

- The maximum wattage for a safelight is 15 watts
- Manual processing time can take up to one hour
- Automatic processing time is 90 seconds
- Wratten 6B filter is recommended for use in the darkroom

Chapter *7* Radiography of the Lower Extremity:

- Positioning Terminology
- Foot
- Digits
- Sesamoids
- Calcaneus
- Ankle
- Lower Leg
- Stress Inversion
- Anterior Drawer
- Harris-Beath

Positioning Terminology

Central Ray (CR): an imaginary photon at the exact center of the x-ray beam. The collimator light usually displays a circle, or crosshairs which will indicate the central ray. The central ray is used in positioning to aim the x-ray beam.

Position: Pertains to that aspect of the body closest to the film. It is used to name the oblique and lateral (not true lateral but a side) positioning techniques.

Projection: The direction that the x-ray beam travels through the body. This direction is described as being anteriorposterior (AP) or posterioranterior (PA), dorsoplantar (DP) or plantardorsal (PD), or lateromedial or mediolateral. The term *projection* is used to describe a positioning technique; it does not refer to the radiographic image.

View: Pertains to the radiographic image only. The terminology used to describe the positioning technique will simply be applied to the image, but the word *view* will replace the term *position* or *projection*. For example, the dorsalplantar (DP) projection produces a dorsalplantar (DP) view, and a medial oblique (MO) position produces a medial oblique (MO) view.

Positioning Technique: The actual method of performing the study, including the position of the patient, Tubehead, and film and the projection of the x-ray beam.

Angle of Gait: The angle formed between the feet and a line of progression while walking; approximately 10 to 15 degrees of abduction in the normal individual.

Base of Gait: The distance between both medial malleoli when walking (approximately 2 inches).

Midline of the Foot: The imaginary line that enters the center of the heel and exits through the second digit.

Normal Anatomical Position: The patient is facing you; erect, arms at the side, and palms facing forward.

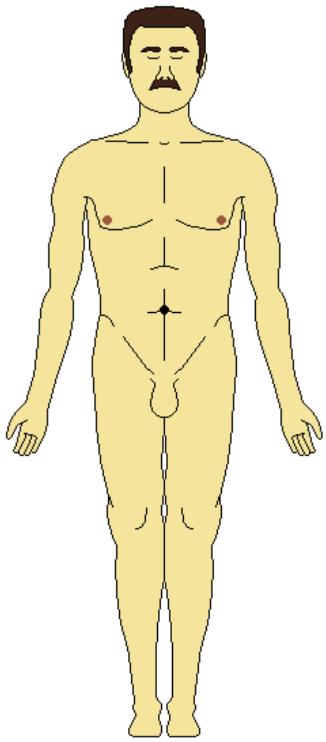


Figure 6-1 Normal anatomical position

Anterior or Ventral: the front of the body

Posterior or Dorsal: the back of the body (except in the foot, dorsal is the top of the foot, the anterior surface).

Plantar: In reference to the bottom (sole) of the foot.

Lateral: Away from the midline of the body.

Medial: Toward the midline of the body.

Supine: Lying face up.

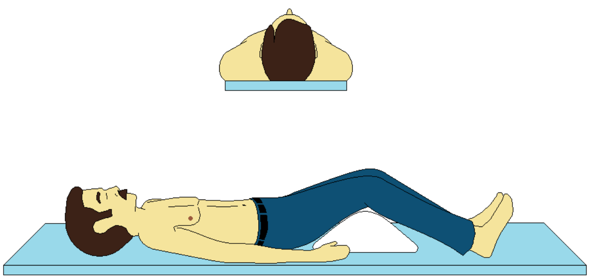


Figure 6-2 Supine position

Prone: Lying face down.

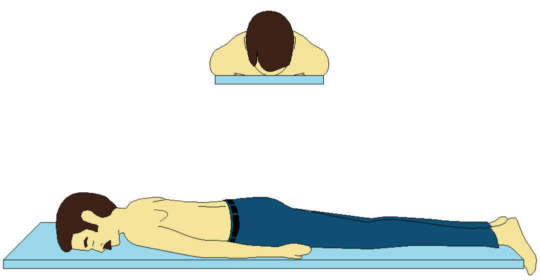


Figure 6-3 Prone position

Extension: The process of straightening a joint.

Flexion: The process of bending the joint in an angle.

Proximal: near the attachment of a limb or closest to the point of origin.

Distal: far from the attachment of a limb or farthest from the point of origin.

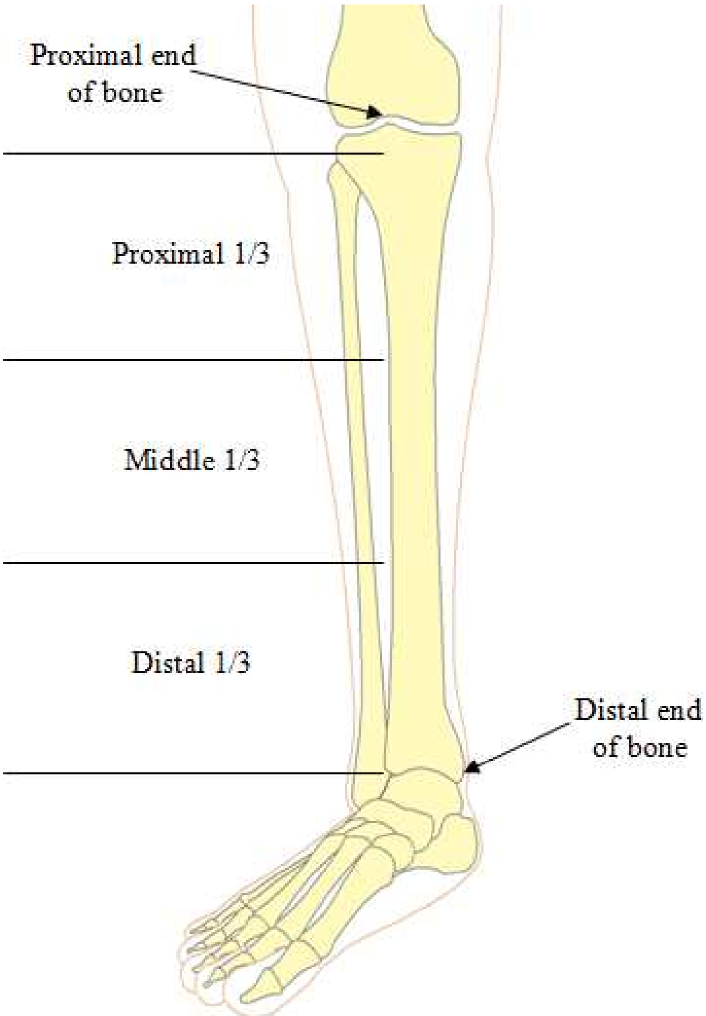


Figure 6-4 The proximal, middle, and distal parts of a long bone.

When taking radiographs, patient identification information, a right or left marker, and exam date must be permanently recorded on all radiographs to be medico-legally acceptable.

Additionally, always collimate! Use the smallest exposure field to reduce patient exposure to secondary and scatter radiation.

Foot Radiography - Standard radiographs:

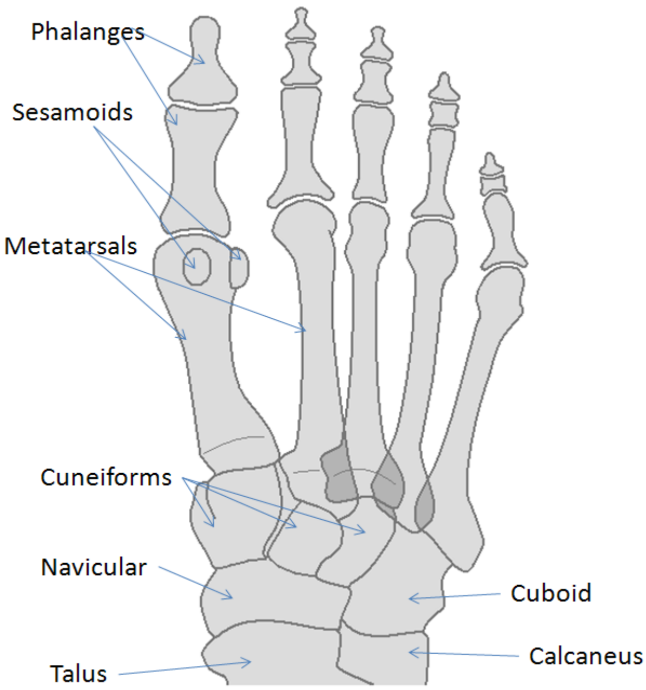
- DP
- Oblique (medial oblique or lateral oblique)
- Lateral

Dorsoplantar Radiograph:

- Tube angulation is 15 degrees from vertical (toward patient)
- Central ray at 2nd metatarsocuneiform joint
- Anatomy visualized:
  - Forefoot and rearfoot
  - Talo-navicular
  - Calcaneo-cuboid joints

Figure 6-5a Dorsoplantar projection

Figure 6-5b Dorsoplantar view.



Medial Oblique Radiograph - Method 1:

- Film cassette is flat
- Tube angulation is 0 degrees
- Position: the foot is rotated medially 45 degrees
- Central ray is aimed at the 3rd metatarsocuneiform joint.

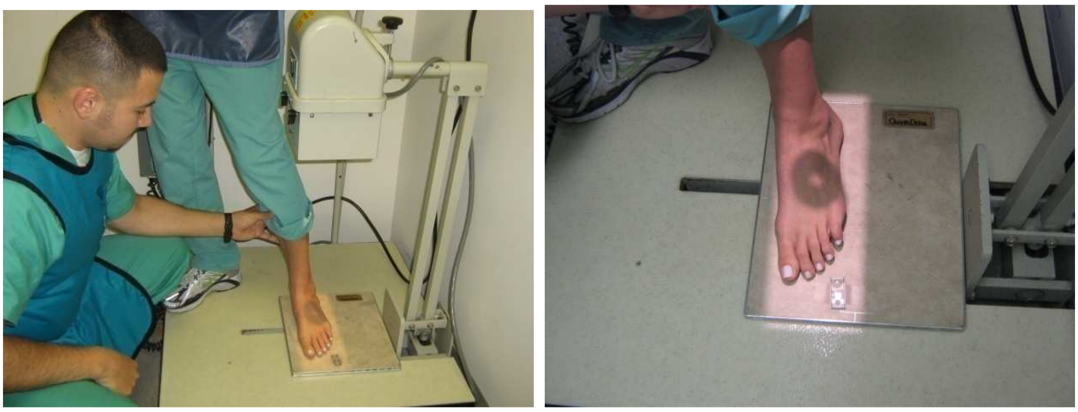
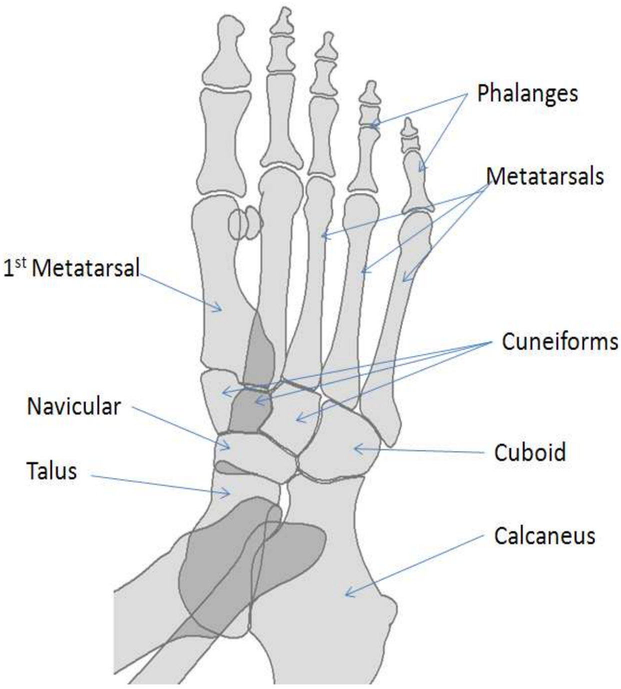


Figure 6-6a Medial oblique position – method 1.

Figure 6-6b Medial oblique view – method 1.



Medial Oblique Radiograph - Method 2:

- Film cassette is flat
- Tube angulation is 45 degrees
- Central ray is aimed at 3rd metarsocuneiform joint

Figure 6-7a Medial oblique position – method 2.

Figure 6-7b Medial oblique view – method 2.

Lateral Oblique Radiograph - Method 1:

- Film cassette is flat
- Tube angulation is 0 degrees
- Position: The foot is rotated 45 degrees laterally.
- Central ray aimed at 1st metatarsocuneiform joint

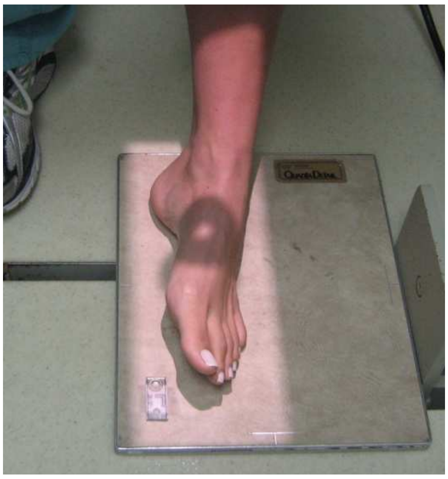
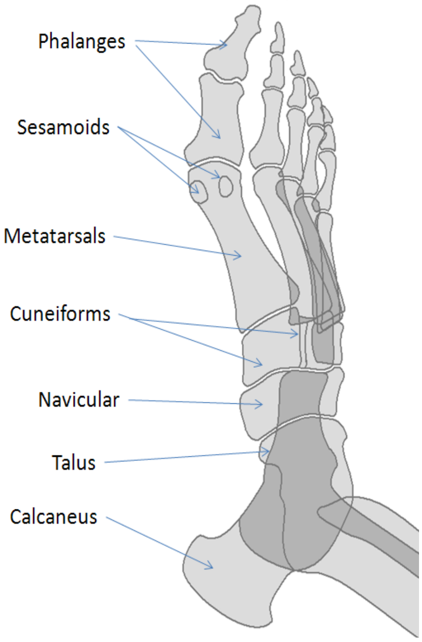



Figure 6-8a Lateral oblique position – method 1.

Figure 6-8b Lateral oblique view – method 1.



Lateral Oblique Radiograph - Method 2

- Film cassette is flat
- Tube angulation is 45 degrees
- Central ray aimed at first metatarsal cuneiform joint

Figure 6-9a Lateral oblique position – method 2.

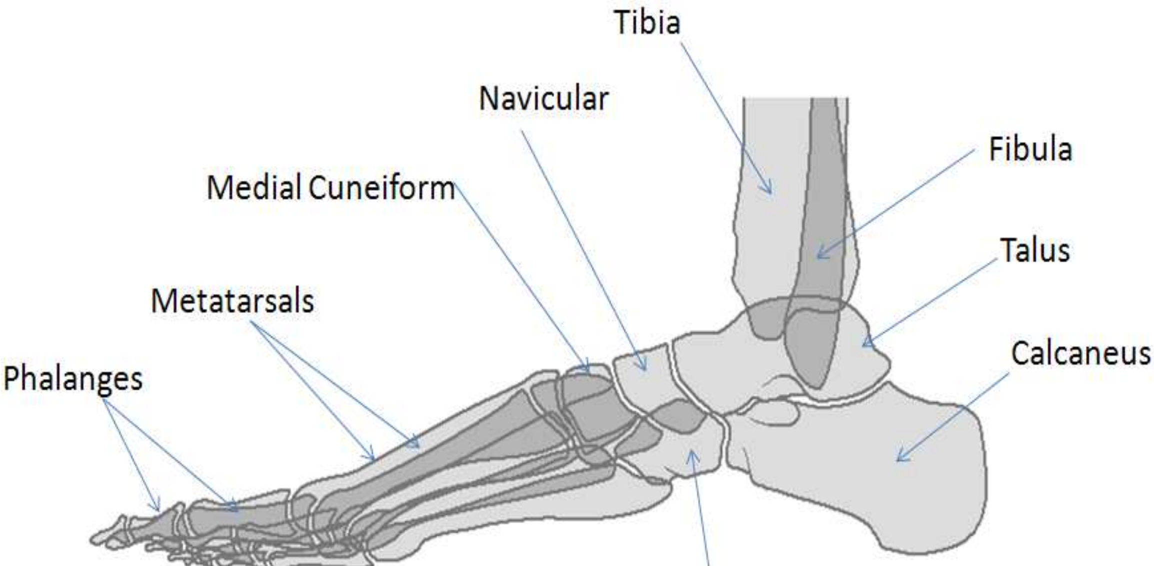
Figure 6-9b Lateral oblique view – method 2.

Lateral Foot:

- Projection is either: Mediolateral or Lateromedial
- Cassette is vertical
- Tube angulation is 90 degrees from vertical
- Central ray is aimed the lateral cuneiform/cuboid

Figure 6-10a Lateral foot position.

Figure 6-10b Lateral foot view.



Toe Radiography: Standard radiographs:

- DP
- Oblique
- Isolated lateral

(use less kVp than with regular foot series)

Dorsoplantar Radiograph:

- Tube angulation is 0 degrees (vertical)
- Central ray at the 2nd digit proximal phalanx if viewing all digits, or to the proximal phalanx of the particular digit in question if viewing only one digit.

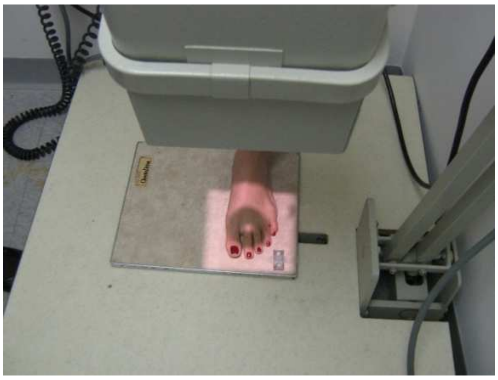


Figure 6-11a DP toes position.

Figure 6-11b DP toes view.

Medial Oblique Radiograph - toes:

- Film cassette is flat
- Tube angulation is 0 degrees
- Position: the foot is rotated medially 45 degrees
- Central ray is aimed at the 3rd proximal phalanx.

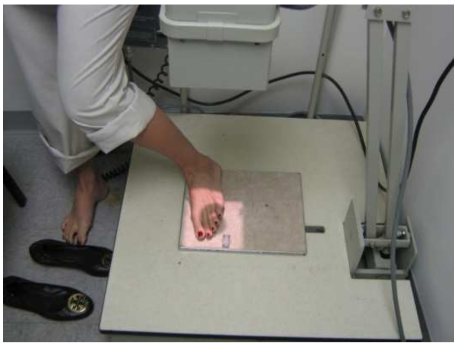
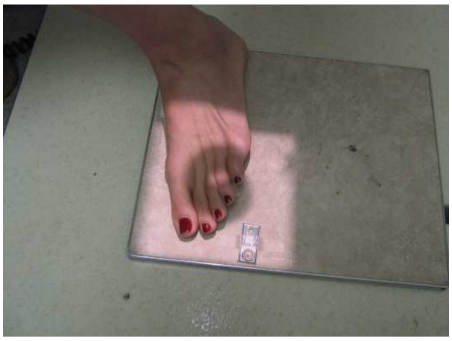



Figure 6-12a Medial oblique toes position.

Figure 6-12b Medial oblique toes view.

Lateral Oblique Radiograph - toes:

- Film cassette is flat
- Tube angulation is 0 degrees
- Position: The foot is rotated 45 degrees laterally
- Central ray aimed at the 3rd proximal phalanx

Figure 6-13a Lateral oblique toes position.

Figure 6-13b Lateral oblique toes view.

Isolated Lateral Hallux Radiograph:

- Cassette is vertical
- Tube angulation is 90 degrees from vertical
- Central ray is aimed the hallux

Figure 6-14a Isolated lateral hallux position.

Figure 6-14b Isolated lateral hallux view.

Isolated Lateral Radiograph of a Lesser Digit:

- Cassette is vertical
- Tube angulation is 90 degrees from vertical
- Central ray is aimed the toe in question

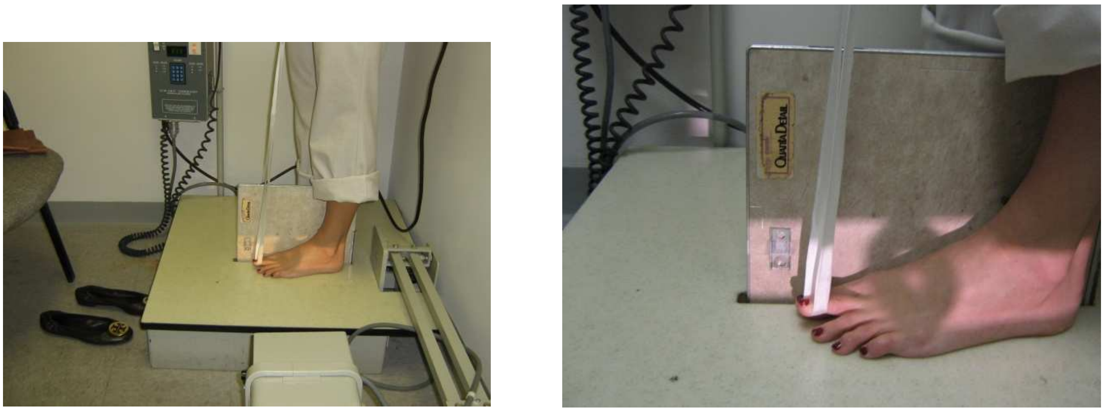


Figure 6-15a Isolated lateral position of a lesser digit.

Figure 6-15b Isolated lateral view of a lesser digit.

When positioning for sesamoid axial and calcaneal axial radiographs, the patient will have their back to the x-ray tube. Therefore, in order to protect the gonads, the lead apron must be placed behind the patient.

Sesamoid Axial Radiograph:

- Film cassette is vertical
- Tube angulation is 90 degrees
- Digits extended against the plate
- Pt. elevates the heel
- Central ray at plantar surface of metatarsals
- Note that the lead apron is on the patient's back

Figure 6-16a Sesamoid axial position.

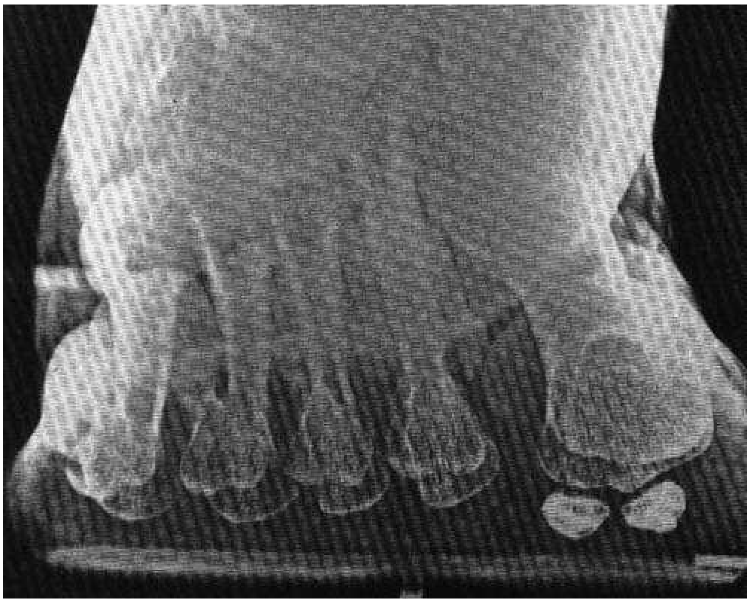
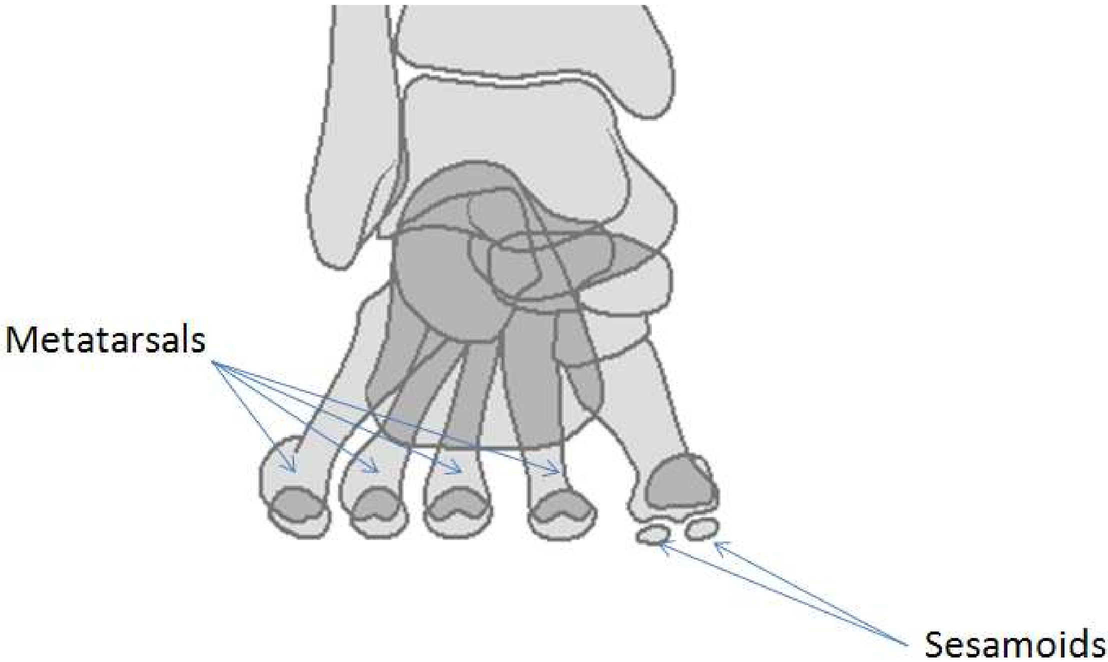


Figure 6-16a Sesamoid axial view.



Calcaneal Axial Radiograph:

- Patient stands on horizontal cassette
- Patients back to x-ray tube
- Tube angulation 45 degrees
- Central ray aimed at posterior heel
- Lead apron on patient's back

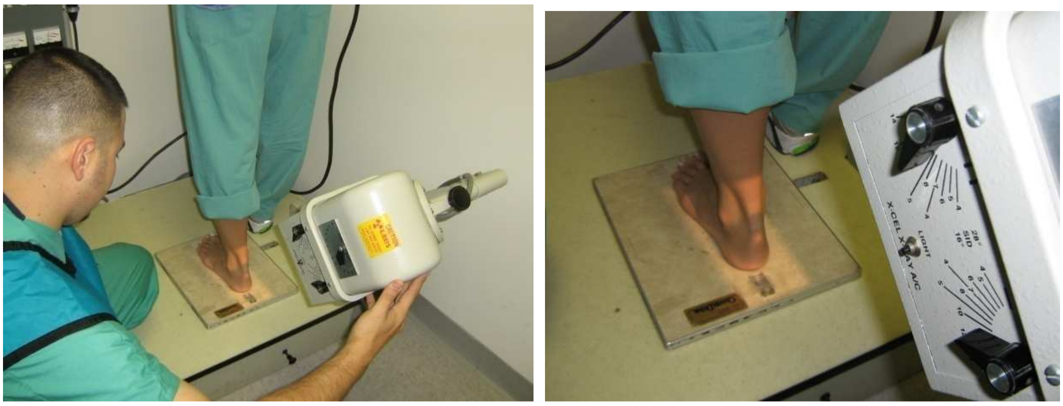
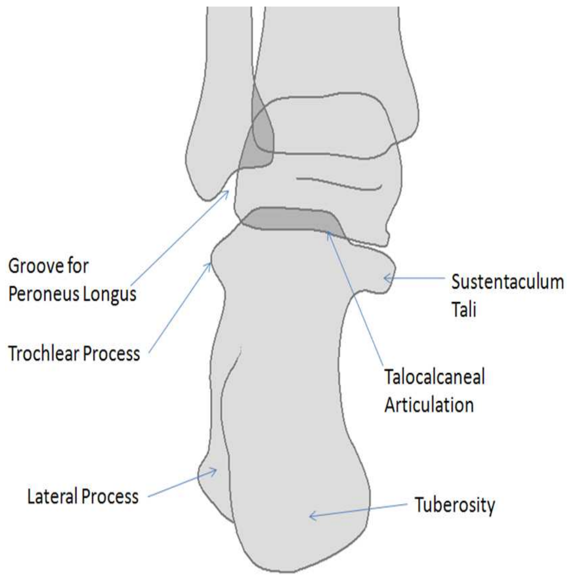


Figure 6-17a Calcaneal axial position.

Figure 6-17b Calcaneal axial view.



Lateral Radiograph of the Calcaneus for Foreign Body:

- Cassette is vertical
- Tube angulation is 90 degrees from vertical
- Central ray is aimed above the area of the suspected foreign body

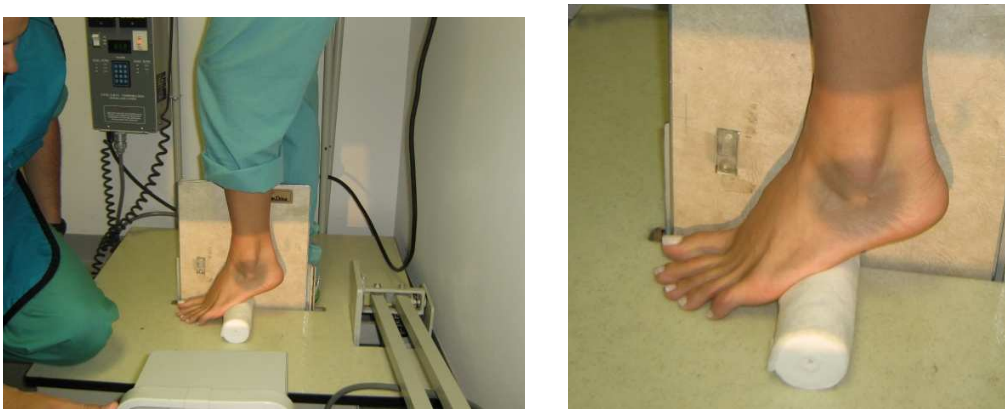


Figure 6-18a Lateral calcaneus for foreign body position.

Figure 6-18b Lateral calcaneus for foreign body view.

Ankle Radiography: Standard radiographs:

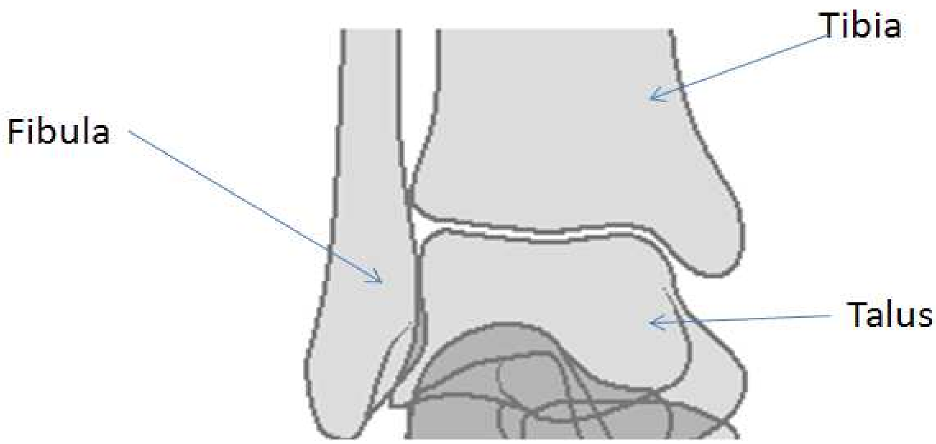
- AP
- Mortise
- Lateral

Anteriorposterior (AP) radiograph of the ankle

- Cassette is vertical
- Tube angulation 90 degrees
- Central ray at anterior ankle

Figure 6-19a AP ankle position.

Figure 6-19b AP ankle view.



Ankle Mortise:

- Arranged like AP
- Foot internally rotated 15 to 20 degrees so that imaginary line connecting both malleoli parallels that of the plane of the film
- Central ray to the center of the ankle joint


Figure 6-20a Ankle mortise position.

Figure 6-20b Ankle mortise view.

Lateral Ankle Radiograph:

- Positioned same as foot with
- Elevate the central ray to the ankle joint
- Collimate to the ankle (may open the collimator to include foot if desired)

Figure 6-21a Lateral ankle position.

Figure 6-21b Lateral ankle view.

Special Ankle Radiographs:

- Stress inversion
- Anterior drawer

Stress Inversion – Ankle Radiograph: Figure 6-22 shows the patient in position for a stress inversion radiograph and the resulting image.

Figure 6-22a Stress-inversion ankle position.

Figure 6-22b Stress-inversion ankle view.

Anterior – Drawer Ankle. Figure 6-23 shows the patient in position for an anterior drawer radiograph and the resulting image.

Figure 6-23a Anterior drawer ankle position.

Figure 6-23b Anterior drawer ankle view.

Anteriorposterior Proximal Tibia-Fibula Radiograph. Figure 6-24 shows the patient in position for the AP tibial-fibula radiograph and the resulting image.

Figure 6-24a AP tibia-fibula position.

Figure 6-24b AP tibia-fibula view.

Lateral Proximal Tibia – Fibula Radiograph. Figure 6-25 shows the patient in position for a tibia -fibula radiograph and the resulting image.

Figure 6-24a Lateral tibia-fibula position.

Figure 6-24a Lateral tibia-fibula view.

Summary

- Anterior: front of the body
- Posterior: back of the body
- Medial: closer to the midline of the body
- Lateral: farther from the midline of the body
- Proximal: near the attachment of a limb or closest to the point of origin
- Distal: far from the attachment of a limb or farthest from the point of origin
- Patient identification information, a right or left marker, and exam date must be permanently recorded on all radiographs to be medico-legally acceptable
- DP, oblique, and lateral are the most common radiographs taken for the foot
- AP, mortise and lateral are the most common radiographs taken for the ankle
- The foot is rotated 45 degrees for the oblique foot
- The ankle is rotated 15 degrees INTERNALLY for the mortise ankle
- The x-ray tube is angled 90 degrees for the lateral foot

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