BASICS OF RADIOLOGY & THE ORTHOPEDIC PLAIN FILM (KINES I)

Objectives of this reading: You will be able to express a basic understanding of the terminology and the most commonly used imaging technique, the plain-film radiograph.

Radiograph: this is the x-ray film showing an image of anatomy. Radiographs are formed when x-rays emanating from a localized source pass through a portion of the body and onto a detector (film plate) that records the density of x-rays as an image.

Plain film (conventional) radiograph: A radiograph made without contrast enhancement or other modifications. Plain radiographs account for the majority of imaging examinations, as high as 80%

Orthopedic radiology: Radiological diagnostic evaluation of the musculoskeletal system by a medical specialist (the Radiologist). The primary tool is plain film radiology although other techniques such as CT & MRI are common.

What is X irradiation & how is it used to make a radiograph?
X-rays are a short wave high-energy form of electromagnetic radiation (EMR) located just below gamma rays on the EMR scale. As with all EMR, X-rays behave as both a particle and a wave. When an X-ray particle moves through body tissues it may or may not strike atomic structures of the body. If it does strike or contact the atomic particles of the body, the X-ray particle will be either absorbed or deflected. The more “dense” the tissue, or the higher its average molecular weight, the more likely an X-ray particle will deflect and not pass through the body. X-rays passing thru and striking the film plate create a black area on the film. Where no rays hit the film, the area will become white. Regions of intermediate exposure produce a gray of varying scale.

TIDBIT :-) To demonstrate you are “in the know” always refer to an x-ray film as a “film”, “image”, or “radiograph” but never call it an “X-ray”.

Tissue Density and the Gray Scale
Radiographs produce an image in a bright white to dark black color gradient resulting from the density of the material being X-rayed. Knowing which tissues correlate to which color density is the key to interpreting X-ray images. Images can also be under or overexposed. An underexposed film results from inadequate x-ray penetration and appears overly white. Excessive x-ray penetration produces an overexposed film that appears blackish.

<table>
<thead>
<tr>
<th>Density</th>
<th>Mid-Density</th>
<th>↑ Density</th>
<th>↑ ↑ Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Water</td>
<td>Mineral</td>
<td>Heavy Metals</td>
</tr>
<tr>
<td>Black</td>
<td>Dark Gray</td>
<td>Mid Gray</td>
<td>Light Gray</td>
</tr>
<tr>
<td>Lungs, Trachea, primary bronchi, air in bowel or stomach</td>
<td>Adipose, Very osteoporotic bone, thin soft tissue</td>
<td>Muscle, tendon, organs, thin bones, overlapping thin soft tissues, blood</td>
<td>Cancellous bone, Thinner muscle, tendon, organ tissues, superimposition of thin soft tissues, large blood vessels</td>
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Nomenclature of Density:
1. Opaque: white or relatively whiter areas on the film such as bone, or, normally black areas which appear whiter than normal are referred to as “areas of density”, being “dense”, “areas of increased opacity” or an “opaque area”. AKA - Radiopaque
2. Dense: same as opaque, e.g. areas of “increased density” or “showing increased density”.
3. Sclerosis / Schlerotic: an increase in density in bone. Commonly associated with degenerative arthritis in subchondral bone. Also, associated with avascular necrosis post fracture. “Sclerosis is noted at the scaphoid bone” or “there is bony sclerosis of the proximal phalangeal periarticular bone”. 
4. Radiolucency / Radiolucent: low density tissues which appear more gray or black. The lungs should be more radiolucent, or “lucent” than the heart.
5. Lucency / Lucent: same as radiolucency- the lungs are “clear and lucent”. “The midshaft of the femur demonstrates an area/region of lucency” (which is bad).
Radiographic Distortion
In general: Remember you are viewing a two dimensional representation of a three dimensional object, with several structures often overlapping. Be careful here: overlap or superimposition of two or three normal structures will create odd appearing lines, regions, and shadows of variable density giving the appearance of a structural abnormality.

Like a flashlight beam, x-rays leaving the collimator are expanding in a conical pattern. This creates several sources of distortion, namely magnification & lengthening/ shortening, that may cause confusion.

1. **Magnification**: body parts closest to the beam source are enlarged and show less resolution or image sharpness on the film and body regions farthest from the beam source show less enlargement and greater image resolution. Stated in reverse: structures lying closest to the film plate demonstrate the best resolution and least enlargement.

2. **Shortening or Lengthening**: when an image is made with the x-ray beam approaching the subject from an angle the object will appear shorter in length on the film. If the structure being filmed is not lying flat on the x-ray table/film cassette the end of a bone for example, closest to the beam source will appear larger/longer than the portion of the bone furthest from the beam source.

Radiographic Views
View names typically describe the beam entry and exit. An anterior-posterior view implies the beam entered the patient anteriorly and exited posteriorly. A lateral view enters and exits from the sides and an oblique views from an angle. A marker will be on the film indicating R or L.

- **AP view**: common view of extremities (except wrist-hand), spine, head, and feet. An AP of the chest suggests a sick or bedridden patient because a PA is preferred. Keep in mind amplification and elongation. The heart will appear enlarged in an AP view of the chest. AP and PA chest views are usually labeled as such.
- **PA view**: common at the wrist(hand/fingers); also most common chest view
- **Lateral view**: lateral view, head, chest, extremities, spine
- **Oblique view**: may be labeled right or left oblique, medial-lateral oblique etc to indicate orientation. Common in extremities & spinal films
- **Dorsal plantar view**: same as an AP view of the foot
- **Special views**: there are many body regions best visualize with particular “special views” such as the “odontoid”, “swimmers”, or “sunrise” views you may see or read about in reports.

Properly Orienting and Viewing Radiographs
1. Hold the film and look at the general anatomy and any markers/labels for information.
2. Place the film in the view box correctly:
   - For **AP views** (extremity, head/spine) and **chest PA**: place in the viewing box with the patient facing you in anatomic position (except wrist-hand-fingers and feet-toes). The patient’s right is on your left. If the view is of the **wrist-hand-fingers (PA)** or **foot/toes (AP)**, point the digits up; meaning the hands and feet are oriented right on right and left on left (rather than anatomical position).
   - In general for **Lateral & Oblique** views, typically face them to your LEFT, or you can also attempt to orient in the same direction that the beam traveled (easy to say, hard to do). If it is a multi-view film and there is an AP or PA view accompanying, then use the AP or PA view to correctly orient the entire film.

Typical Views Ordered for the Upper Extremity
- **Glenohumeral Joint**: Two AP views: AP in ext rotation and AP in int rotation. Axillary view of the shoulder either in a superior-to-inferior or in an inferior-to-superior beam direction
- **Acromioclavicular joint**: AP bilateral view NWB and an AP bilateral view with 10-15 lbs weights strapped to each wrist (WB).
- **Scapula**: AP and Lateral (“Scapular Y”) views.
- **Humerus**: AP view & Lateral view (usually w/ elbow flexed 90°and humerus in ext rotation)
- **Elbow**: AP, Lateral (elbow at 90°) and Oblique views
- **Forearm**: AP and Lateral view (elbow at 90°).
- **Wrist and Hand**: PA, Lateral, and Oblique; Viewed with fingers pointing up.