Radiology for Physical Therapists

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Purpose: After completing PT 210, students will be able to

- discuss bone physiology and the effects of mechanical principles on bone as measured by plain films
- outline the principles of radiology
- estimate when diagnostic radiological tests are indicated
- view x-rays and MR's and integrate the structural impairment into the rehabilitation program
- discuss the radiological findings with patients and their physicians
- interpret the radiologist report

Electromagnetic Fields

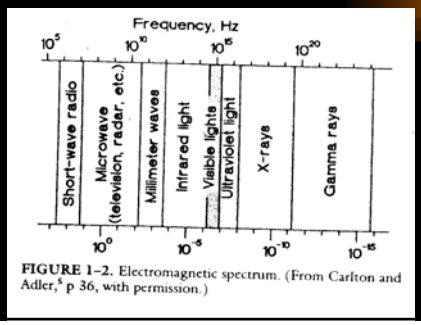
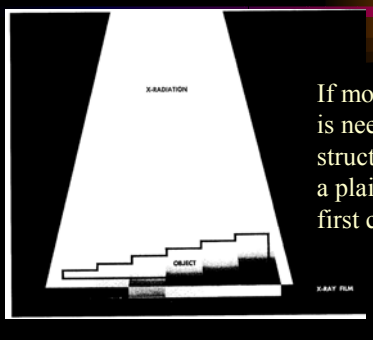


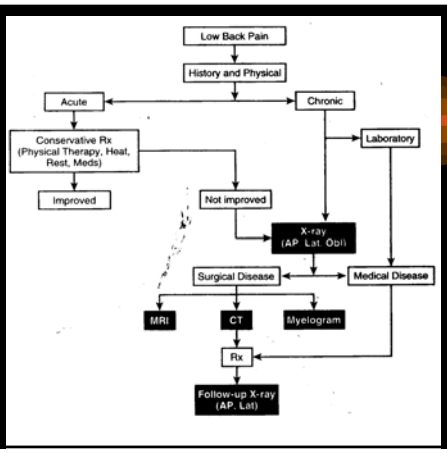
FIGURE 1–2. Electromagnetic spectrum. (From Carlton and Adler,[5] p 36, with permission.)

X-rays high frequency short wave length

X-ray



If more information is needed about structural changes, a plain film is the first choice



Dx Process

Radiodensity

- Physical quality of an object that determines how much radiation it absorbs from the x-ray beam
- Radiodensity determined by
  - Composition (atomic weight)
  - Thickness

Radiodensity

- The greater a object's composition or thickness, the greater its radiodensity
- Radiopaque and radiolucent: describe greater and lesser degrees of radiodensity
- Inverse relationship between the amount of radiodensity of an object and amount of blackening on the x-ray film

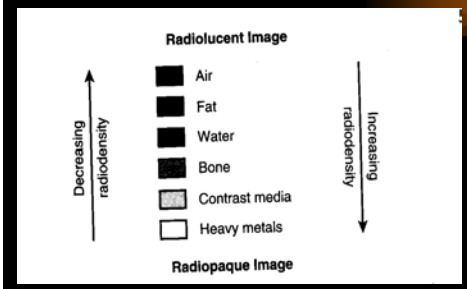
Radiolucency

- Air- black: least radiodense substance (in lungs, stomach and digestive tract); also represents black surrounding background
- Fat: gray-black: fat is more radiodense than air; present subcutaneously along muscle sheaths and surrounds organs
- Water- gray: Water based substances more radiodense than fat; all fluids and soft tissues (blood, muscle, cartilage, tendons, ligaments, nerves, fluid filled organs) share @ same density (medium gray)

Radiolucency

- Bone- white Bone is the most radiodense substance occurring naturally and casts the whitest image of the four densities; teeth image the whitest because of calcium
- Contrast media- bright white outline (barium sulfate in upper and lower GI studies): images as bright white outline
- Heavy metals-solid white: used in teeth fillings, prosthetic devices, pins, wires, rings or lead shield used for gonad protection

Radiolucency



Black

Grey black

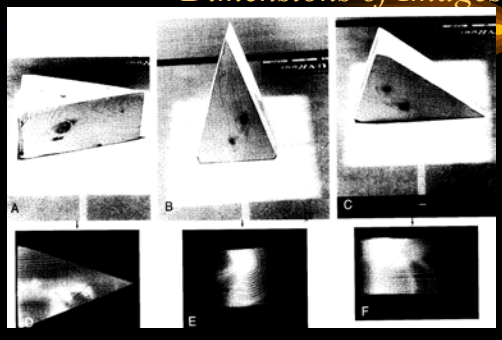
Gray

White

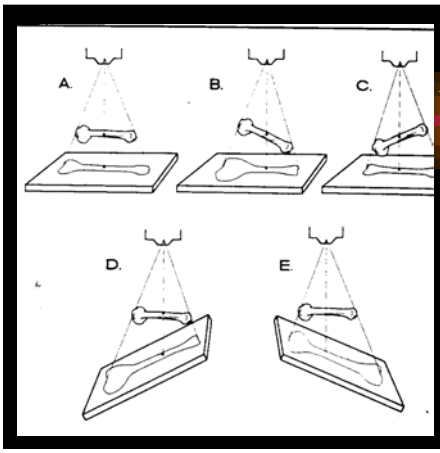
Bright white Outline

Solid white

Dimensions of Images

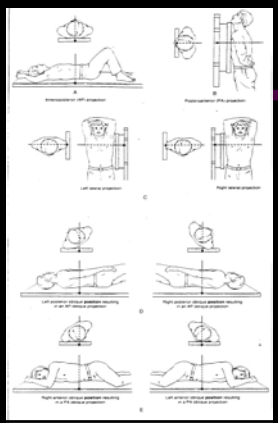


Distortion



X-ray should be perpendicular to the source
One projection= 2 dimensions (width and length)
Second projection perpendicular to first=depth

Positions



At least two projections needed, perpendicular to each other
Multiple projected needed to counter distortion and overlap and provide the 3rd dimension
AP and lateral or oblique are most common
Lateral 90 o to AP
Oblique 45 o to AP

Roentgen Rose

- Think perceptually (recognizing form in 3 dimension)
- Density and thickness: greater radiographic densities
- Each image should add either to the information about density (e.g. fluids, fat, or bone)
- Form should be deduced from pictures

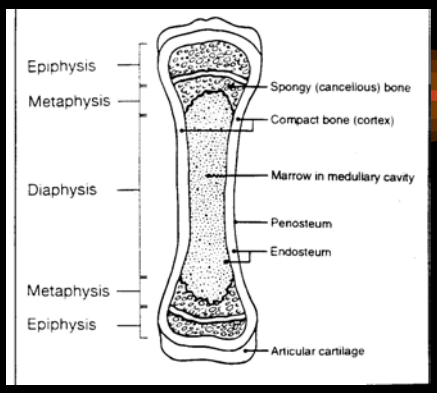
Viewing Films

- Mount on a view box (illuminator)
- Look for R/L markings
- Place radiographs as if the patient were facing the person viewing the films (possible with AP and PA radiographs)
- Lateral radiographs viewed in same direction that path of beam traveled
- Hands and feet viewed through dorsal aspects, digits pointing up

Interpretation

- **Orthopedic radiology**: looking for changes in structure (development or trauma or congenital, inflammation, lesions, growth problems related to bones, changes in joint surfaces, tendons, ligaments, discs and menisci).

Bone



Interpretation of Plain Films

- A Alignment
- B Bone
- C Cartilage
- S Soft Tissue

Alignment

- Alignment
  - Gross size of bones
  - Number of bones
  - Normal shape and contour and normal expected alignment
  - Joint position

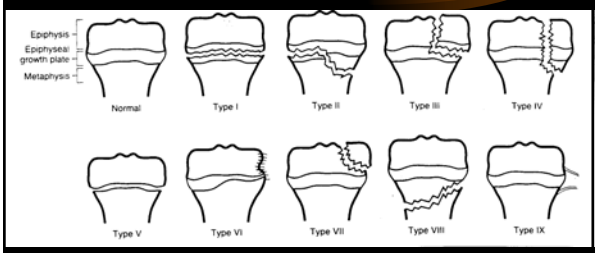
Bone Density

- Assess general bone density (* bone density studies for osteoporosis are not calculated with typical plain films but rather a Dexascan is used (large or extremity specific; provides a calculated density measure)
- Assess local bone density
- Assess texture abnormalities

Cartilage

- Assess joint space width
- Assess the subchondral bone
- Assess the epiphyses and growth plates

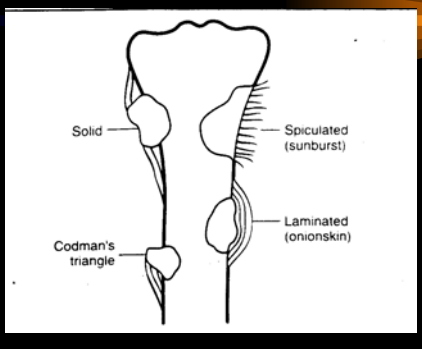
Epiphyseal Fractures: Children



Soft Tissue

- Assess the gross size of the musculature
- Assess the outline of joint capsules
- Assess the periosteium

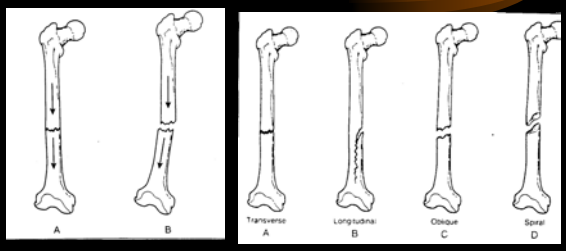
Periosteum Changes



Trauma

- Most common disorder of the skeletal system results from trauma
- Fractures and dislocations comprise the majority of trauma
- Task of radiologist is to
  - Diagnose and evaluate the characteristics of the fracture or dislocation
  - Assess the results of treatment
  - Monitor the healing process and complications

Bone Fractures: General Definitions



Complete or incomplete; location of fracture important; fracture line important and usually results from force from different directions

Other Radiographic Evaluations

- Contrast enhanced radiographs
  - Arthrography: contrast media study of the synovial joints related to soft tissue contracture; contract material injected into the joint space, distending the capsule and outlining internal tissues (shoulder, elbow, wrist, knee and ankle joints)

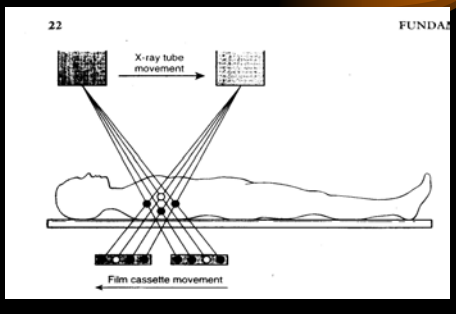
Mylography

- Contrast media study of spinal cord, nerve root, and dura mater; contrast injected into the subarachnoid space and mixes with the cerebrospinal fluid to produce a column of radiopaque fluid
- Table on which patient positioned tilted until contrast flows under the influence of gravity to specific spinal level
- Imaged via radiographs; common to perform a CT scan while contrast still localized (CT myelogram)

Conventional Tomography

- Radiographic evaluation of one predetermined plane of the body
- Structures above and below plane of interest blurred out
- Use accessory equipment that allows x-ray tube and film to move about a fulcrum point during film exposure
- Plane of body is level with fulcrum ,will be in focus
- Major clinical application is evaluation of irregular shaped bones and fractures (skull, tibial plateau, cervical vertebra); also good for tumors

Conventional Tomography



Computed Tomography (CT)

- Different than conventional tomography and radiography (involved directing x-ray beam through the patient and detecting transmitted rays with film)
- CT scanner is a machine in which an x-ray source and a set of x-ray detectors are positioned opposite each other within the gantry of the scanner
- Detectors are connected electronically to 1 or more computers connected to a display and control terminal

Computed Tomography (CT)

- x-ray beam and detector system housed in a circular scanner and moves through an arc of 360 degrees about patient (x-ray beam directed through patient to detector array and measure amount of radiation transmitted through patient (50 msec to 2 seconds)
- Tissues absorb various levels of radiation according to their densities
- Detector system measures and transmits information to computer
- Each image represents an axial cross-sectional slice of body measuring .3 to 1.5 cm thick

CT

- Each image generated by CT scanner made up of many tiny boxes called pixels (similar to MRI image)
- Each pixel assigned a value (CT number)
- Number based on calculated attenuation of x-rays in that region compared to standard attenuation of water (assigned number 0)
- Numbers > 0 become gray : low CT number appears blacker than bone (bone has a higher CT number)
- Displays set to optimize visualization of different densities (fat, muscle water) while bone is white

Computed Tomography (CT)

- CT is valuable in evaluation of various bone and soft tissue tumors, subtle or complex fractures, intra articular abnormalities, the detection of small bone fragments, and quantitative bone mineral analysis important in the management of osteoporosis and other metabolic bone disorders

1996 Costs

TABLE 1–3 Common Imaging Examinations, Their Cost, and Their Radiation Dosage

Examination	Costs: Professional and Technician Time	Radiation Dose, Average
Plain film series lumbar spine	$250	2000–3000 MR
PF knee	$161	50–100 MR
Contrast arthrogram knee	$716	50–100 MR
Myelography lumbar spine	$1100	2500 MR
Conventional tomography		
knee	$438	2000 MR
Lumbar spine	$438	8000–10,000 MR
Computed tomography		
knee	$923	2000–4000 MR
Lumbar spine	$970	200–400 MR
MRI		
knee (avg)	$1000	No radiation
Lumbar spine	$1000	No radiation
Bone scan (Technetium) Whole skeleton	$581	20–25 millicuries

*Average 1996 hospital costs for technical & professional charges. From correspondence—North Hills Passavant Hospital, Pittsburgh, PA. MR = millirads