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Using Imaging to Your Advantage: The Lower Extremity and Differential Diagnosis

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March 14, 2018

Description of this course

The subject matter of this course will include:

(1) a review of principles of lower extremity imaging
(2) differential diagnosis of the lower extremity
(3) incorporating imaging with the clinical examination, and
(4) case studies designed to assist clinicians in matching imaging to the clinical examination

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Course Objectives

As a result of this course, participants will be able to:

1. Describe the main principles of lower extremity imaging as it relates to a physical therapist
2. Differentially diagnose common lower extremity conditions
3. Implement clinical decision making in matching imaging with the patients clinical examination
4. Discuss case studies to illustrate the clinical decision making process in matching imaging to the patient presentation for lower extremity conditions

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CONTINUED

Can you order imaging in your state?

- Yes
- No

6

CONTINUED

Do you order imaging in your clinical practice?

- Yes
- No
- Unaware if I can or not

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CONTINUED

Practice authority

- RC 12-16
- Charged APTA to pursue practice authority for imaging in PT practice
- 93% in favor
- APTA has launched an analysis of all state practice acts

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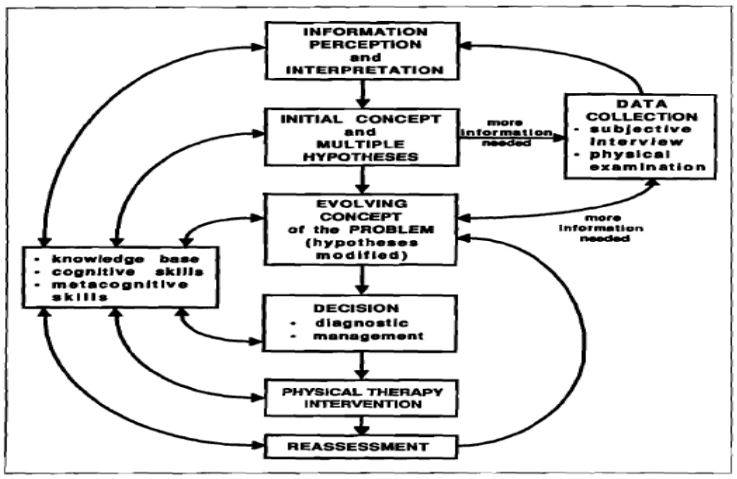
Clinical Exam



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CAPTE requirements: Diagnostic Imaging

- Able to bear weight?
- Age?
- Trauma?
- Prior surgery?
- Risk factors present?
- Pain?
- Tenderness to palpation?

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To order or not to order films...

- Imaging studies are normally indicated ONLY when positive findings will influence decision making.
- Stress fracture example

- To appropriately select diagnostic tests, PT's must know when the sensitivity is appropriate to screen for a given condition and to know when the specificity is adequate to confirm the condition.

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Videos

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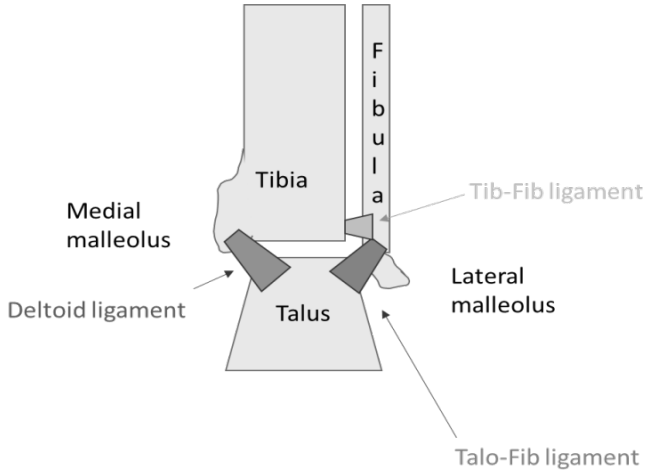
Ankle Anatomy review



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AP view / Mortise view / Lateral view

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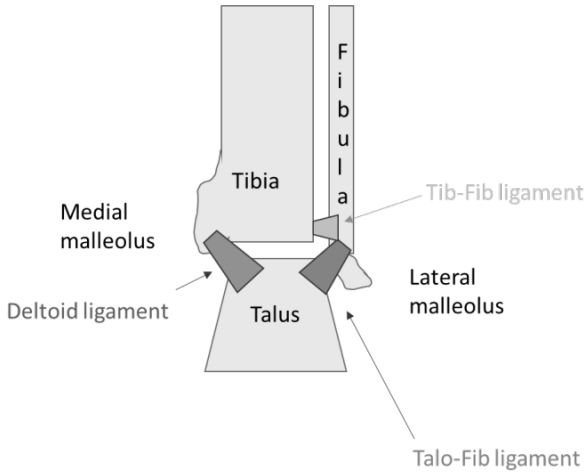
CONTINUED

Weber classifications: Weber A



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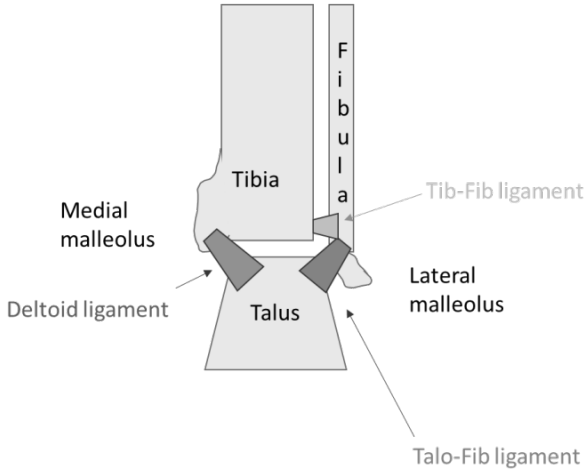
Weber classifications: Weber A



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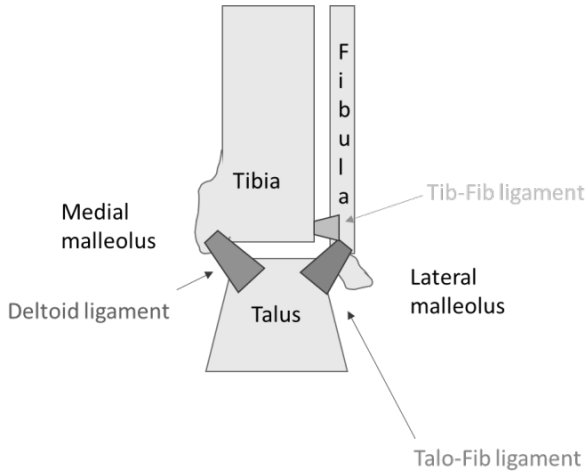
Weber classifications: Weber B



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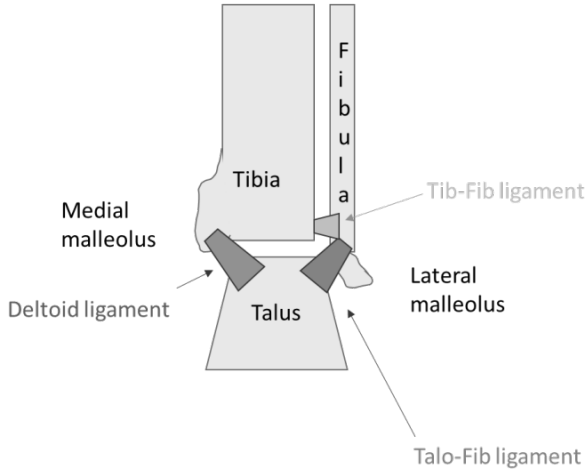
Weber classifications: Weber B



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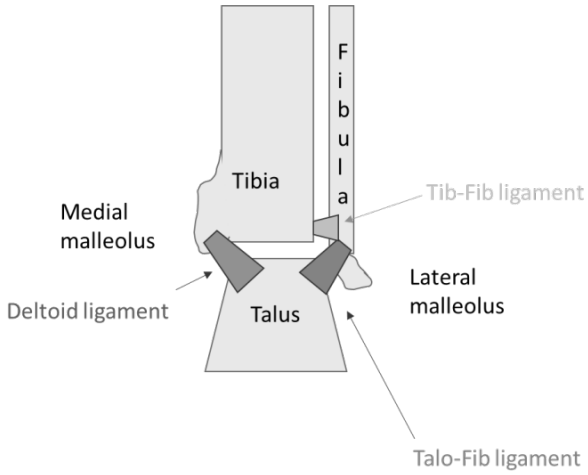
Weber classifications: Weber C



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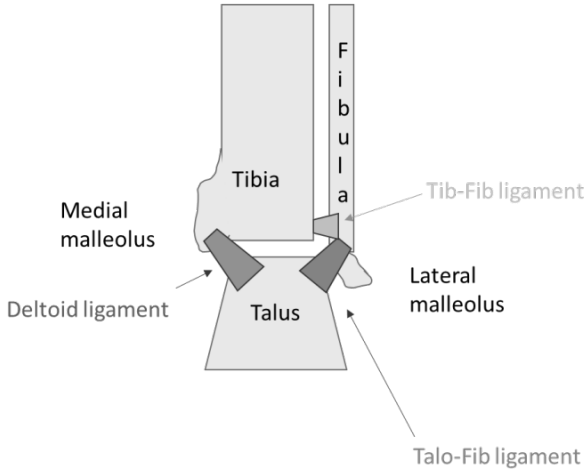
Weber classifications: Weber C



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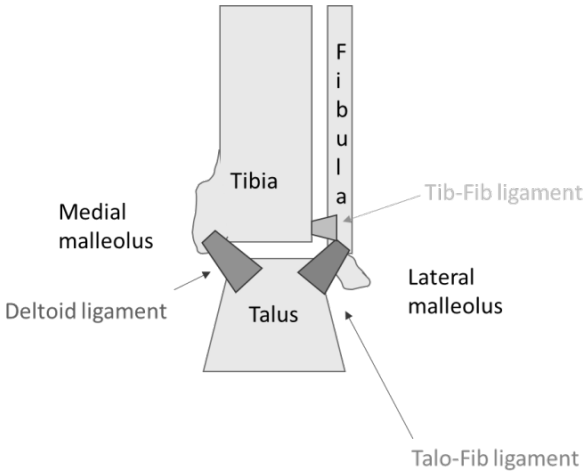
Weber classifications: High Weber C



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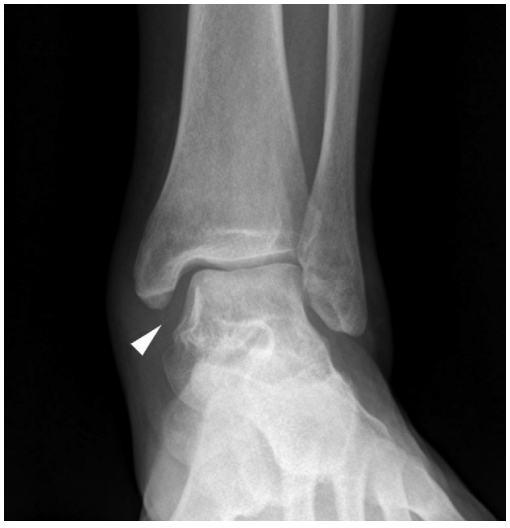

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Summary slide

Types

- **Weber A**
  - MM—compression fracture
  - LM—avulsion fracture
- **Weber B**
  - MM—avulsion fracture
  - LM compression fracture below syndesmosis
- **Weber C**
  - MM—avulsion fracture
  - Compression fracture above syndesmosis
- **High Weber C**
  - MM—avulsion fracture
  - Compression fracture proximal fibula

Look for:

- Multiple views: AP & mortise view.
- MM avulsion fracture: Weber B or C?
- Maisonneuve fracture

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CONTINUED

The Knee

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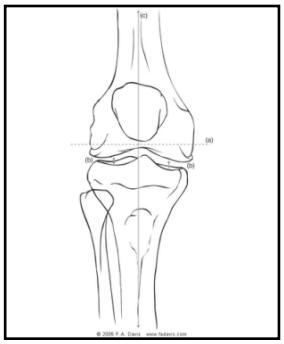
CONTINUED

Evaluating A-P Radiographs of the Knee

- Joint Space
  - Medial = Lateral
- Neither Valgus or Varus deformity
- Inferior pole of the patella does not cross the joint space



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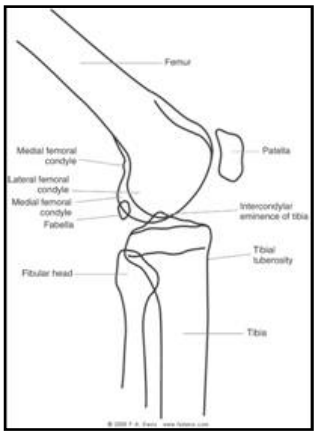
Lateral View of the Knee



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Lateral View of the Knee

- Patellar Tendon Length = Length of the Patella
  - Within 20%
- Flabella
  - Sesamoid in the Lateral Gastrocnemius tendon
  - 18% Prevalence

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Patella Alta

- Length of the patella is approx. equal to the length of the patellar tendon

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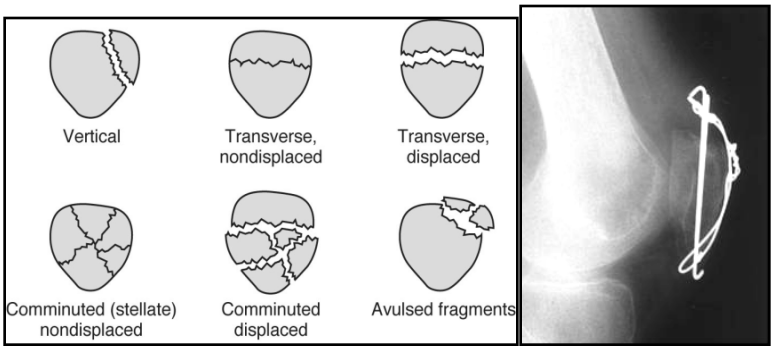
CONTINUED

Patellar Fractures



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Heterotrophic Ossification

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da Foot

33

"Purple horse, purple horse; what do you see?

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CONTINUED

Screw it!

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CONTINUED

The hip

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Take a look at the next image and tell me what you see…

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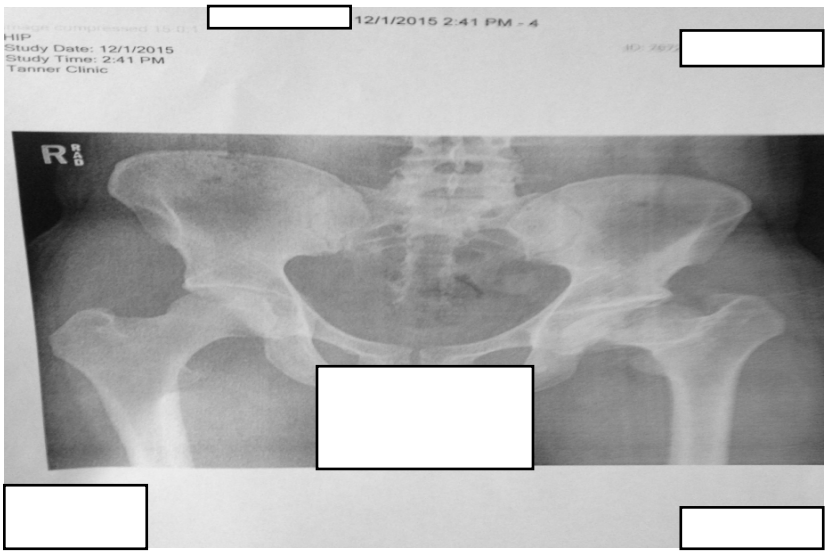

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Imaging choices

- **Used to confirm your clinical exam**
- Plain films
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound
- Bone scan

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Plain films

- Plain film radiographs are not sensitive to subtle pathology. Significant changes must occur to the structure of the bone before radiographs will reveal it.
- The chance of having a false negative for subtle, early-stage pathology, such as:
  - stress injuries
  - metabolic bone disease
  - infectious processes
  - nondisplaced fxs &
  - neoplasms
- is HIGH with plain radiographs.

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Proper Use of Musculoskeletal Imaging

- 20-40% of statements on radiology reports have been found to be erroneous, many with life-threatening consequences
  - Errors of Observation
  - Errors of Interpretation
- Before Asking for Imaging, Ask…
  - Will the Results Change the Course of Treatment or Alter the Outcome of the Problem?

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Plain view radiography

Advantages

- Easy
- Cheap
- Quick
- Digitized
- Availability
- Diagnostic for certain conditions (traumatic fractures)

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CONTINUED

Plain view radiography

Disadvantages

- Over utilized
- Ionizing radiation
- Poor view of soft tissues
- Not sensitive: must lose 30-70% of bone density before visual changes noted on films
- For certain conditions a screening tool **NOT** a diagnostic tool

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Radiographs

- Ionized radiation is directed at a standardized angle to the area to be imaged
- Each substance or tissue will absorb varying amounts of radiation based on density of tissue
- Remainder of the beam reaches the film placed beneath the patient
- Various intensities produce various shades of gray on the radiograph

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Radiodensity

- Qualities of an object that determine how much radiation it absorbs.
- Increased radiodensity = increased absorption = more radiopaque
- Decreased radiodensity = decreased absorption = more radiolucent

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Radiodensity

- DETERMINED BY:
  - Composition of the object
  - Thickness of the object
  - Intensity of the radiation

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Four Major Densities

- Air (appears black)
- Fat (appears gray/black)
- Water (appears gray)
- Bone (appears white)

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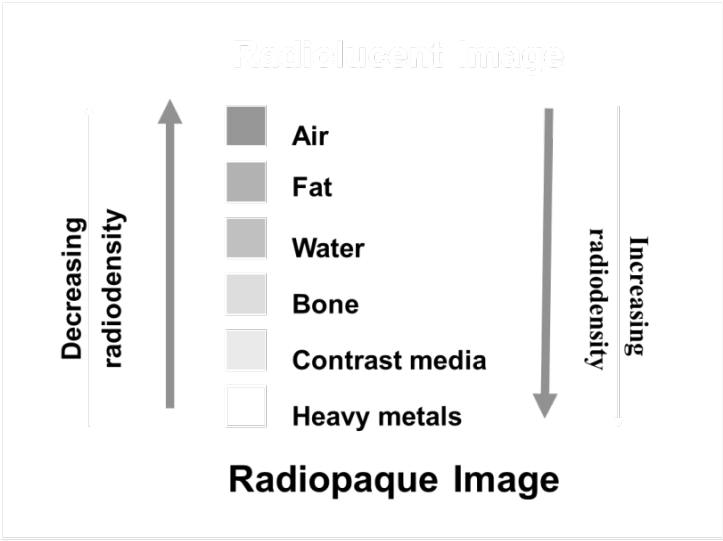

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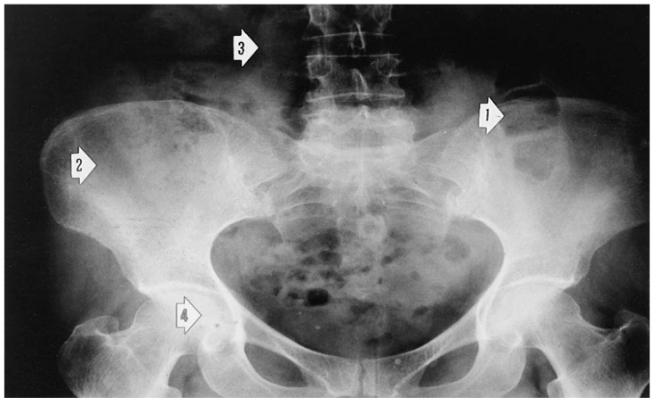
Four Major Densities



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Reading radiographs

Alignment

- Assess size of bone(s)
- Number of bones
- Assess shape & contour
- Position of bone compared to joint

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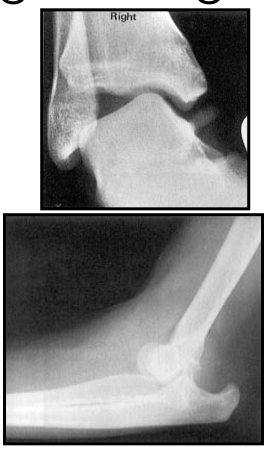
Evaluating Radiographs

- **A**lignment
  - Aberrant size
  - Smooth and continuous cortical outlines
  - Normal joint articulations and spatial relationships



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Evaluating Radiographs

- **A**lignment
  - Extra bones
  - Missing bones
  - Deformities
    - Developmental
    - Disease
  - Congenital anomalies

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Reading radiographs

Bone density

- General
- Compare bone density at weight bearing surfaces
- Texture abnormalities

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Evaluating Radiographs

- **B**one Density
  - General Appearance
    - Sufficient contrast within each bone (cortical shell vs. cancellous center)
    - Sufficient contrast between bone & soft tissue

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Evaluating Radiographs

- **B**one Density
  - Sclerosis
    - Localized increase in bone density secondary to physical stress
      - Normal (weight bearing)
      - Healing

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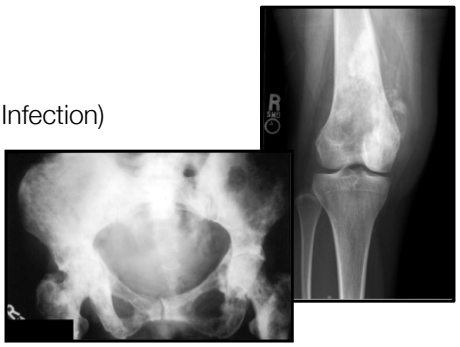
Evaluating Radiographs

- **B**one Density
  - Sclerosis
    - Excessive (OA)
    - Reactive (Tumor or Infection)



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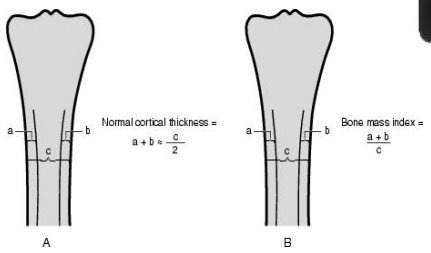
Evaluating Radiographs

- **B**one Density
  - Cortical Thinning
    - Osteoporosis



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Reading radiographs

Cartilage Spaces

- Joint space width
- Assess subchondral bone
- Look at growth plates & epiphysis

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Evaluating Radiographs

- **C**artilage Spaces
  - Well-preserved joint spaces
  - Smooth subchondral surfaces
  - Normal sized Epiphyseal plates

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Reading radiographs

Soft tissues

- Assess gross muscle size
- Look at the soft tissue outline
- Look at the joint capsule outline
- Assess the periosteum

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Evaluating Radiographs

- **S**oft Tissues
  - Limited Value Since These Structures are Normally Indistinct.
  - If Visible, Look at:
    - Muscles
    - Fat Pads
    - Joint Capsules
    - Periosteum

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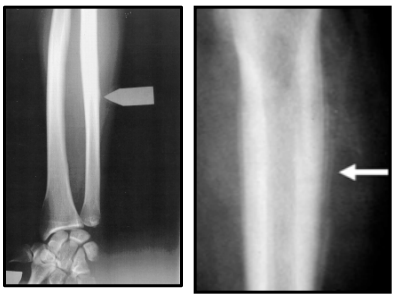
Evaluating Radiographs

- **S**oft Tissues
  - Periosteum (normally indistinct)
    - Elevated, lifted away (osteomyelitis, neoplasm)
    - Laminated ("Onion Skin")



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CONTINUED

Evaluating Radiographs

- **S**oft Tissues
  - Periosteum (normally indistinct)
    - Spiculated

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CONTINUED

Ordering Film series

- Angles of projection that best demonstrate the anatomy of the area of interest
- Utilizes the least number of exposures
- Examples: AP, lateral and oblique views

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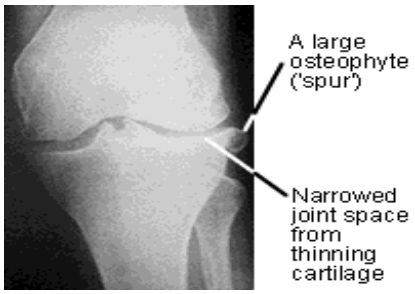
Osteoarthritis



- Changes in articular cartilage
- Bony overgrowth in margins of joints
- Joint space narrowing
- Osteophyte formation
- Joint deformity

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CONTINUED

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Rheumatoid Arthritis

- How does it differ from OA?

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Pathology: recognizing fractures

Radiographic Findings

- Break in continuity of cortex
- Added radiodensity of cortical bone
- Added radiodensity in cancellous bone (2 views)
- Added radiodensity in soft tissues
- Bone fragments

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"Brown Bear, brown bear what do you see?"

70

"Blue bird, blue bird what do you see?"

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Commonly missed fractures of the Pelvis

Pelvis

Sacrum	Fall from a height, motor vehicle accident	• Note subtle break in smooth sacral arcuate lines • Pelvic outlet views improve visualization of the sacrum and rami
Pelvic ring Fx	Motor vehicle accidents, pedestrian accidents, fall from height	Look for multiple injuries due to the inflexible ring structure of the pelvis; watch for rami fracture and sacroiliac dissociation

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Commonly missed fractures of the Hip

Hip

Femoral neck	Direct trauma, as from a fall	*Note:* Some patients can bear weight despite a Fx • Look for cortical disruption or impacted hyperlucency
Acetabulum	Direct contact with femoral head, as in "dashboard" injuries	• See loss of smooth cortical transition from femoral neck to head as well as trabecular disruption • Anterior acetabular Fx is revealed by a break in the iliopubic line • Posterior acetabular fracture is shown by a break in the ilioischial line, looking be-hind the superimposed femoral head • Additional oblique views help for initially negative standard-view films

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Commonly missed fractures of the knee

Knee		
Tibial plateau	Valgus force with axial load, such as strike by car bumper	Two views provide only 85% sensitivity; oblique views increase sensitivity May be accompanied by other injuries: • ACL tear (75%–100%), medial and lateral menisci tears (66%–70%), fibular head avulsion fracture • MRI is needed to evaluate the ACL and possible injuries to menisci and other structures • Assessed with axial patellofemoral "sunrise" view • Lateral view is best to detect transverse fractures Requires AP view of the knee as well as AP view of the ipsilateral ankle
Tibial spine		
Segond fracture (small proximal lateral tibial avulsion Fx)	Internal rotation and varus stress	
Patella	Motor vehicle injuries, direct fall onto the knee	
Maisonneuve fracture (proximal fibula fracture with distal tibiofibular disruption)	Abduction and external rotation of the ankle	

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Commonly missed fractures of the foot

Foot		
Calcaneus	Fall on the heels from a height	• A Boehler angle of less than 25° suggests a Fx • Consider obtaining a "calcaneal view" (long axial view) • Often requires CT imaging to assess fragments and intra-articular extension Can find subtle cortical break on lateral view • These two fractures have a 10% association rate • Ensure both thoracolumbar and calcaneal studies are evaluated
Talus	Excessive dorsiflexion of the ankle	
Thoracolumbar Fx + calcaneus Fx	Jump from a height transmits force from heels to spine	

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Computed Tomography

Principles

- Utilizes electromagnetic radiation
- X-ray tube and X-ray detector rotate around patient
- Detectors connected to a computer which formulates the images

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CT

Advantages

- Greater anatomic detail vs plain films
- Very sensitive and specific modality for fracture detection
- Excellent images through plaster/fiberglass
- Additional views available (e.g. axial views)
- Multi-planar reconstructions

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CT

Disadvantages

- Utilizes ionizing radiation
- Expensive
- Extensive artifacts from metals

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CT does a good job of…

- Identifying subtle or complex fractures
- Identifying degenerative changes
- Identifying a loose body in a joint
- Being used in a high trauma case
- Being inexpensive compared to an MRI
- Being less of an issue for patients that are claustrophobic

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MRI

- Non-ionizing radiation
- Patient placed in a strong magnetic field that causes water molecules to align
- Pulse of radiofrequency disturbs proton alignment is disturbed by radiofrequency pulse
- Radiofrequency is turned off & protons return to original alignment.
- Soft tissue has varied water content, energy absorbs and releases at different rates and this energy difference is used to create the images

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MRI

Advantages

- Excellent resolution of soft tissues
- Safe as there is no ionizing radiation for images

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MRI

Disadvantages

- Expensive
- Time consuming
- Claustrophobic patients!
- Limitations in ability to visualize cortical bone
- Risk of injury if pacemakers, metal or foreign bodies, hardware, cochlear implants

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kNEEPA
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3.0thk/1.5sp
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256x256/2 NEX
StF/NP/SPF

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MRI

- T1 weighted images are best to demonstrate anatomic structure
- T2 weighted images contrast normal and abnormal tissue
- Soft tissue tumors, water, bleeds and CSF appear dark on T1 and bright on T2 images.

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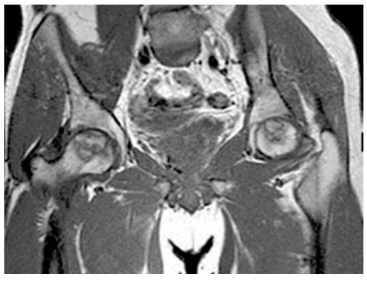
MRI for the lower extremity

- Most sensitive for infection
- Most sensitive for occult fractures
- Tumors
- ACL and PCL, MRI is the best
- Most sensitive for early osteonecrosis



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REMEMBER

- Careful History should match imaging
- One view is not a complete view
- Include joint above and below
- Fractures may not show up on an initial radiograph so need repeats

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Role of Imaging in Medicine

- Establish a medical diagnosis by identifying:
  - Fractures or Fracture Healing
  - Dislocations
  - Soft Tissue Injuries (ligament, cartilage, nerve, etc.)
  - Diseases Affecting Bone
  - Degenerative Processes
  - They should be ordered to answer a specific question

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Role of Imaging in Physical Therapy

- Same as for Medicine, but in addition…
  - Assess bony alignment
  - Identify bony blocks to movement
  - Visualize exact location of fractures to plan interventions
  - Identify exact position of fixation devices
  - Assess bone healing to make decisions about movement and weight bearing

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Don't Treat the Image !!!!

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CONTINUED

Questions???

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