Musculoskeletal Trauma: The Language of Extremity Fractures

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Goals

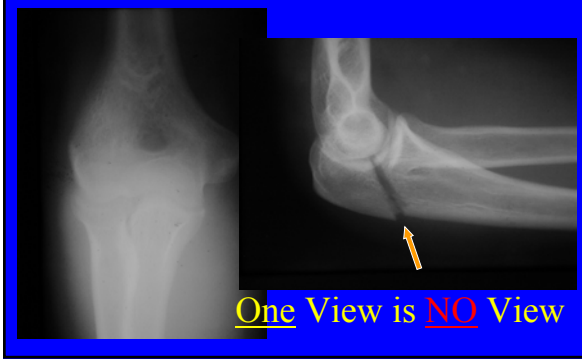
1. Develop a systematic approach to evaluating the trauma radiograph
2. Trauma evaluation
   - *Recognize* the injury
   - Correctly *Describe* its features
   - Effectively *Communicate* nature of injury to colleagues

Recognize the Injury Rule #1

Radiograph where it hurts or where it is deformed

Recognize the Injury: Rule #2

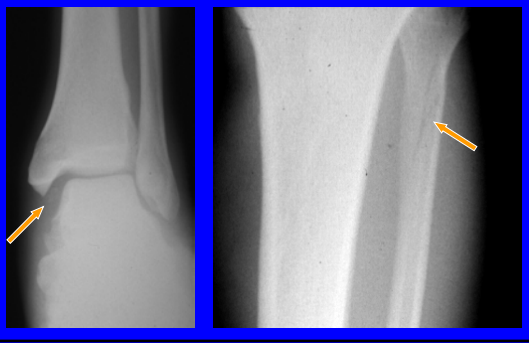
Two Orthogonal Views at a Minimum



One View is NO View

Recognize the Injury: Rule #3

Long Bones: Need to See the Joints at Both Ends



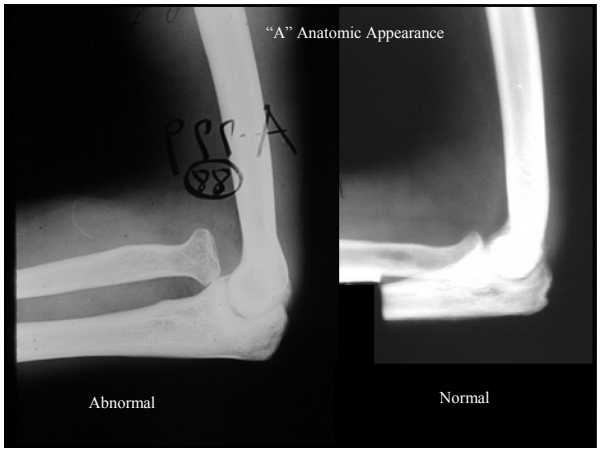
Systematic Approach

- Trauma ABC's
  - Airway, Breathing, Circulation
  - Evaluate extremities after stabilizing ABC's

Systematic Approach Evaluating the Extremity Radiograph

- ABC's of Bones
  - A = anatomic appearance
  - B = bony mineralization
  - C = cartilage (joint space)
  - S = soft tissues

"A" Anatomic Appearance



"A" Anatomic Appearance

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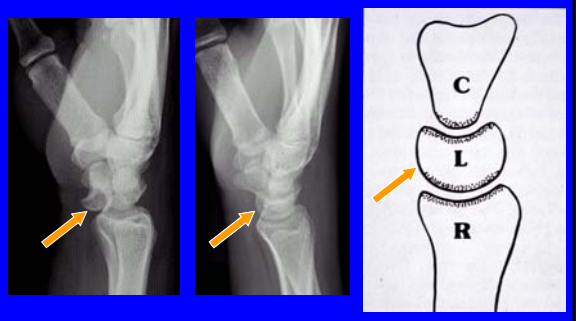
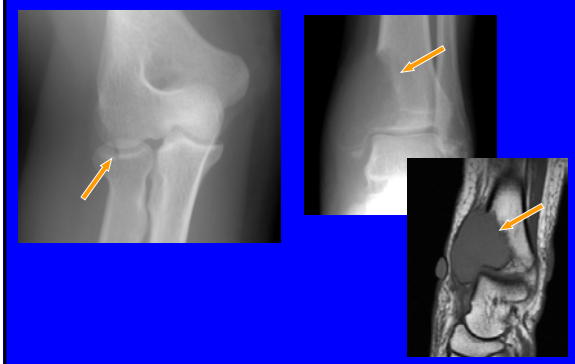
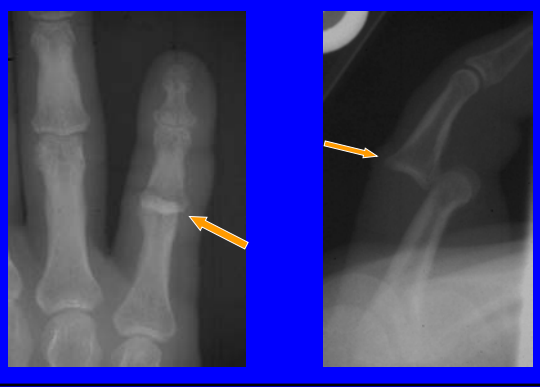


"B" Bony Mineralization



"C" Cartilage "Joint Space"



"C" Cartilage "Joint Space"

"S" Soft Tissues

Systematic Approach to Describing the Radiographic Findings

- Integrity of Skin
  - Open or Closed
- Severity of Fracture
  - Incomplete/Complete
  - Comminuted
- Fracture Line
  - Transverse, oblique, spiral
- Location
- Separation/Overlap of Fragments
- Displacement
  - Alignment/Position
- Relationship to Joint/Growth Plate
- Integrity of Underlying Bone
  - Pathologic fracture

Integrity of Skin

- Open
  - Surgical emergency – washout/debridement
  - Open fracture → open surgical reduction
  - Gas in soft tissues/bone thru skin
- Closed
  - Overlying skin intact
- Old terminology
  - Simple
  - Compound

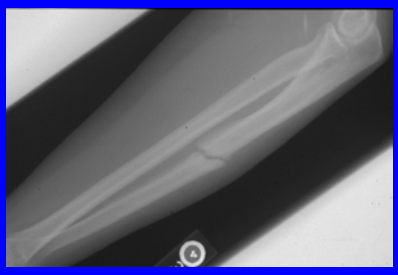
Open Ankle Fracture

Crush Injury to Distal Phalynx

Is the nail bed intact?

Fracture

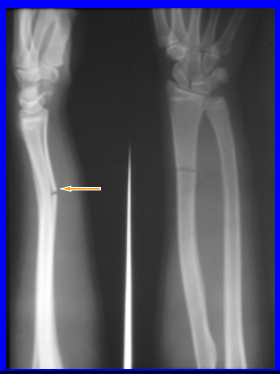
- A complete or incomplete break in the continuity of bone or cartilage



Severity of Fracture

- Incomplete – only one side of cortex
  - Usually in children
  - Greenstick – break on convex side
  - Torus – buckle
  - Adults: stress fracture
- Complete – complete disruption of cortex

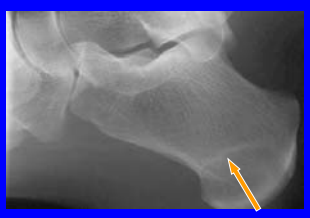
Greenstick

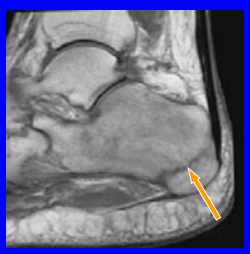


-Bowing with fracture on convex side

Torus "Buckle" Fracture

Incomplete fracture in adult is usually a stress fracture





Complete Fracture

Direction of Fracture Line

- Transverse
- Oblique
- Spiral

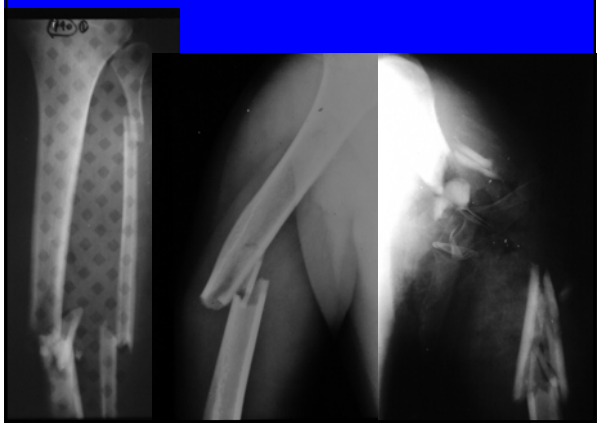
Transverse

Oblique

Spiral

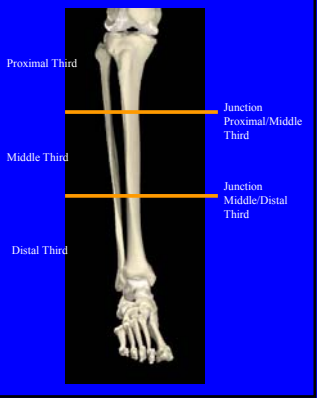
Comminuted Fracture

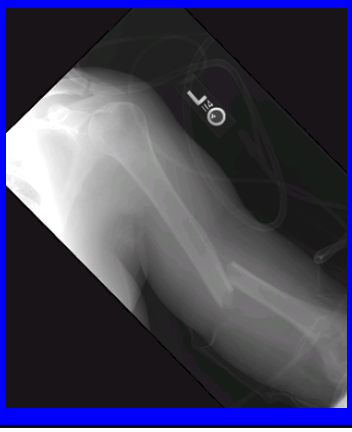
- More than two fragments
  - -- Segmental
  - -- Butterfly



Location

- Long bones: divide diaphysis of into thirds





Location

•Anatomic description for other areas
- –Femoral neck
- –Intertrochanteric
- –Tibial plateau
- –Femoral condyle
- –Humeral neck

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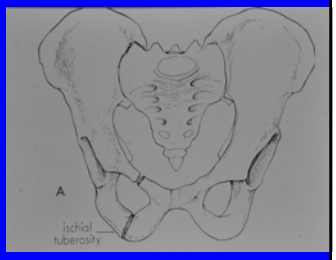
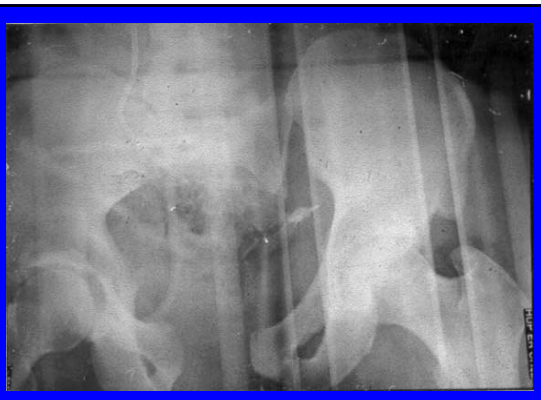
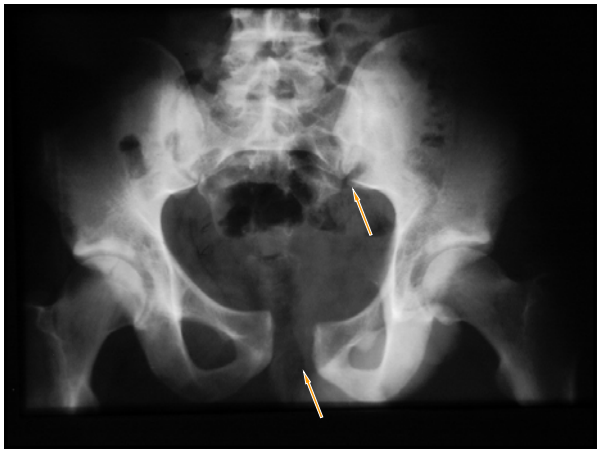
Rings

- Pelvis
- Mandible
- Radius/ulna
- Tibia/fibula
- Post elements spine
- Orbit
- Maxillary Sinus







Ulna/Radius

Tibia/Fibula

Act Like Ringed Structures

-If one bone fractured

-Look for fracture or dislocation of other bone

Separation/Overlap of Fragments

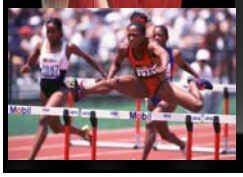
- Distraction
  - Separation of fragments
    - Tendon
    - Traction
    - Interposed soft tissue

Mallet Finger

-Sudden resisted flexion of DIP joint

-Finger jammed or distal tip hit with a ball

Avulsion Fracture of Flexor Digitorum



Skier's Thumb Injury

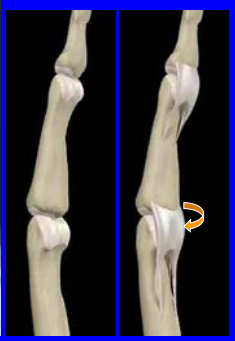
Disrupt Ulnar Collateral Ligament

Stress Views

Adductor pollicis apponeurosis

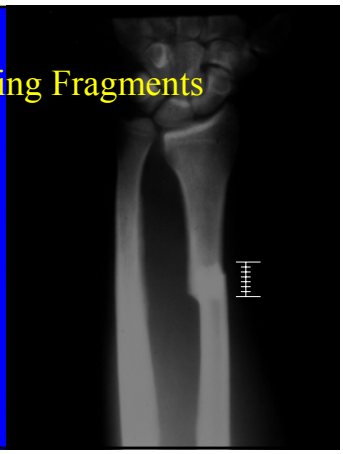
Volar Plate Avulsion

-Hyperextension injury



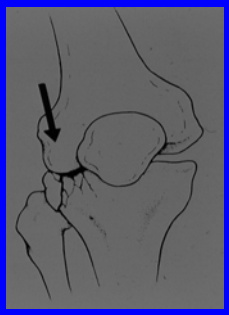
Overriding Fragments

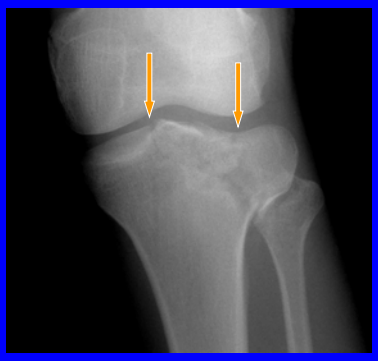
- Describe in cm



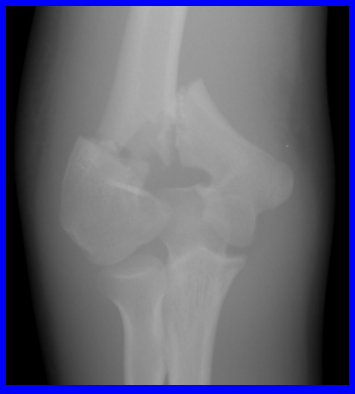
Separation/Overlap of Fragments

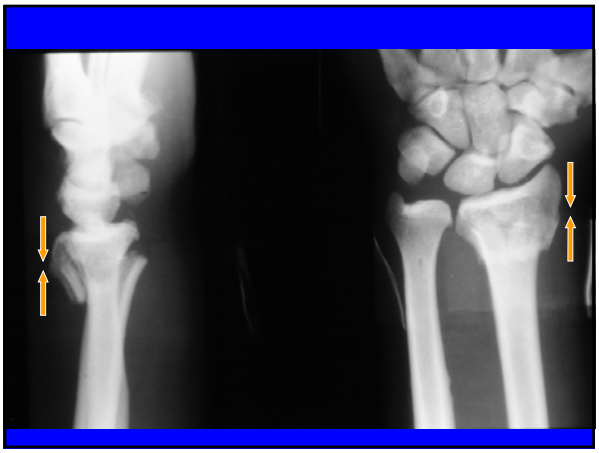
- Impaction
  - Fragments driven into each other
  - Depression
    - Cortical meets cancellous
  - Compression
    - Crushing of trabecular bone





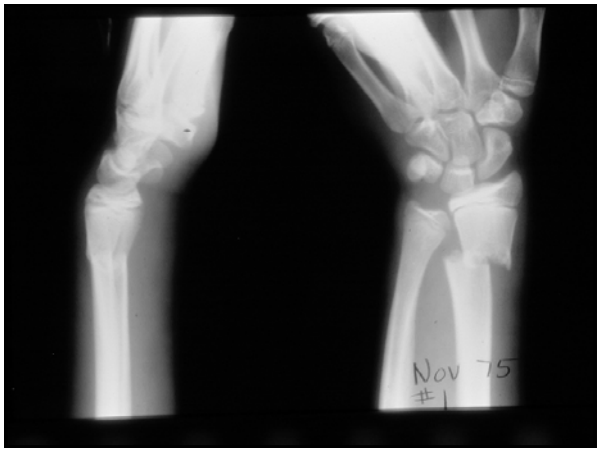
Lateral tibial plateau displaced downward





Position (Displacement)

- Description of fragments relative to normal
- Assume proximal fragment is normal
- Describe distal fragment relative to prox
  - Use shaft width as a guide
- Use terms anterior, posterior, medial or lateral



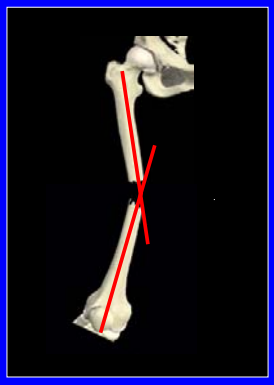
Angulation

- Relation of long axes of one fragment to another
- Angulation is independent of displacement
- Assume proximal fragment is normal
- Describe direction of fracture apex

or

- Describe direction distal fragment

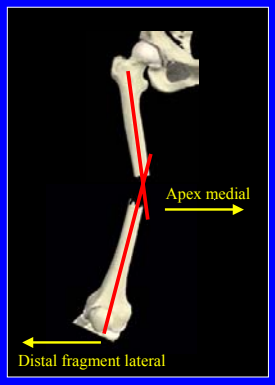
Fracture Description



Angulation

1. Assume proximal fragment is normal
2. Draw the axes of the two fragments

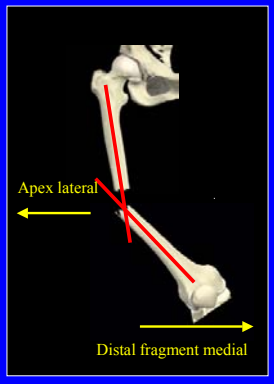
Fracture Description



Angulation

1. Preferred method: Fracture apex is medially angulated
2. Alternate method: Distal fragment is laterally angulated

Fracture Description



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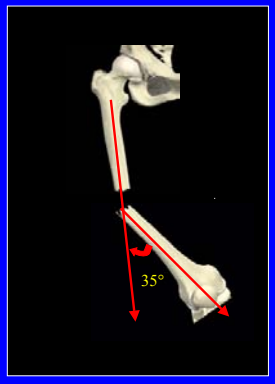


Angulation

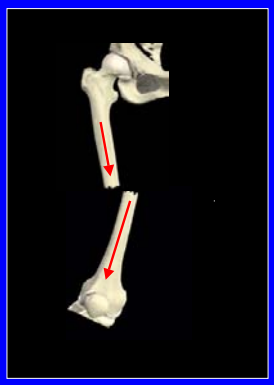
-Quantify by measuring the number of degrees “off” the long axis of the proximal fragment

35° of apex lateral angulation at the fracture site

or

35° of medial angulation of the distal fracture fragment

Fracture Description



Displacement

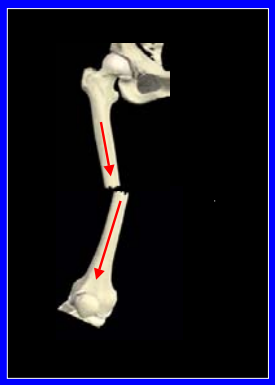
Quantify and give direction of displacement of distal fragment

Use “shaft-width” to Quantify

-Distal fragment displaced 1 shaft-width medially

-Apex medial angulation

Fracture Description



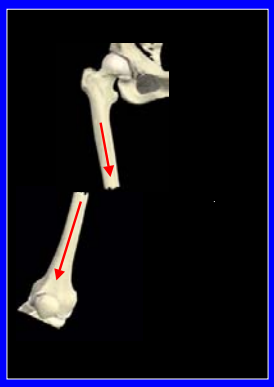
Displacement

Quantify and give direction of displacement of distal fragment

-Distal fragment displaced 1/2 shaft-width medially

-Apex medial angulation

Fracture Description



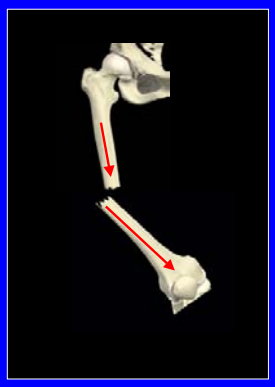
Displacement

Quantify and give direction of displacement of distal fragment

-Distal fragment displaced 2 shaft-widths laterally

-Apex medial angulation

Fracture Description



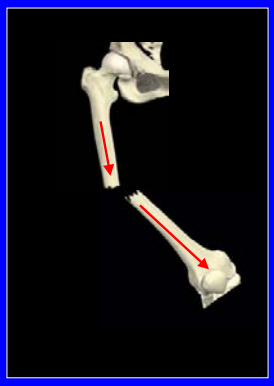
Displacement

Quantify and give direction of displacement of distal fragment

-Distal fragment displaced 1 shaft-widths laterally

-Apex lateral angulation

Fracture Description



Displacement

Quantify and give direction of displacement of distal fragment

-Distal fragment displaced 1 shaft-width medially

-Apex lateral angulation

Fracture Description

-Distal fragment displaced 1 shaft-width laterally

-20° of apex medial angulation at fracture site

-1 cm of shortening (overlap) of fracture fragments

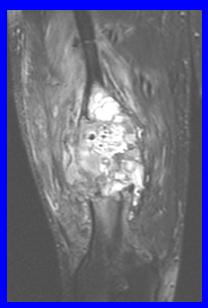
Integrity of Underlying Bone

- Underlying bone is abnormal
- Diagnosis may be benign or malignant
- History is often minimal trauma

Pathologic Fractures

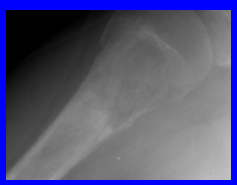
Benign Etiologies

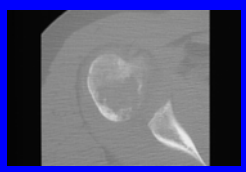
Pathologic Fractures

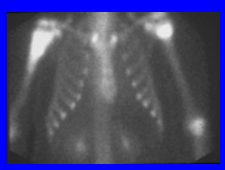


Malignant Etiologies

Pathologic Fractures







Malignant Etiologies

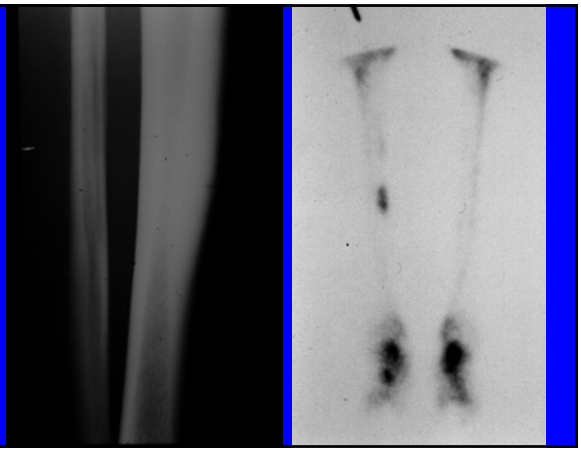
Stress Fracture

- Excess or abnormal stress applied to normal bone
- Resorption exceeds repair
- Bone scan or MR are more sensitive for detection of early stress fracture
- Insufficiency fracture
  - Normal stress to osteoporotic bone

Stress Fracture

healing

Late healing

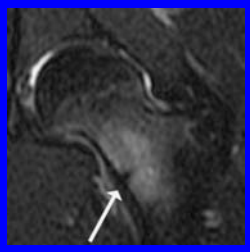


Stress Fracture of Hip

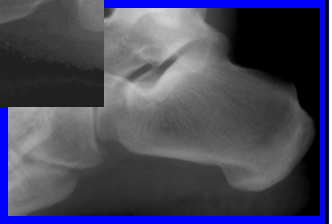
19 y.o. basic trainee presents with pain in left hip while running

-Plain film: demonstrates sclerotic line in femoral neck perpendicular to normal trabeculae

Stress Fracture of Hip



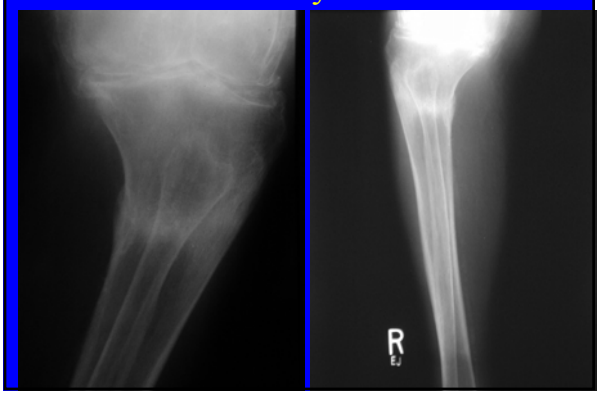
-MRI: demonstrates black line on all pulse sequences



Ill-defined white line running perpendicular to the normal trabecular pattern

Normal trabecular pattern

Insufficiency Fracture



Fracture Union Terminology

- Callus – new bone formed at fracture site
- Remodeling – reforming of callus along lines of stress to approximate normal contour
- Delayed Union – Fracture fails to heal in usual time but will heal if cause of delayed healing is corrected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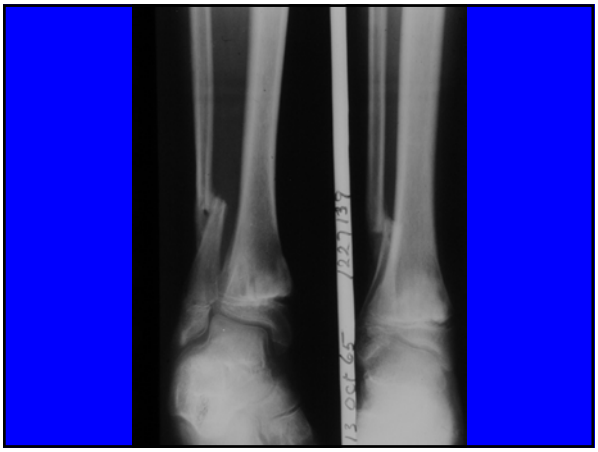
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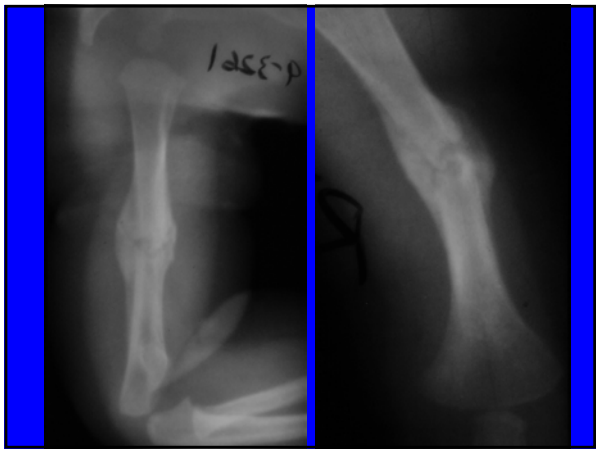
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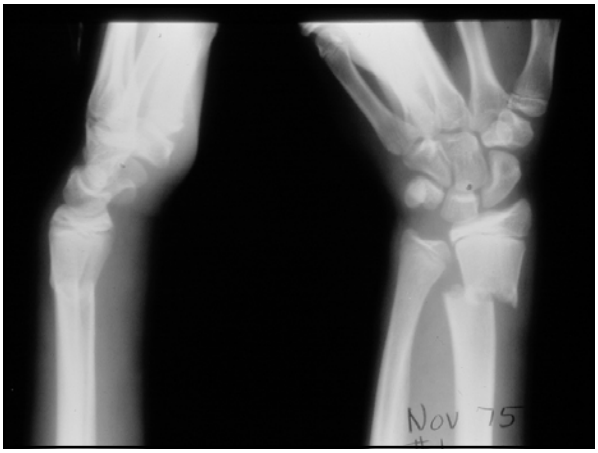
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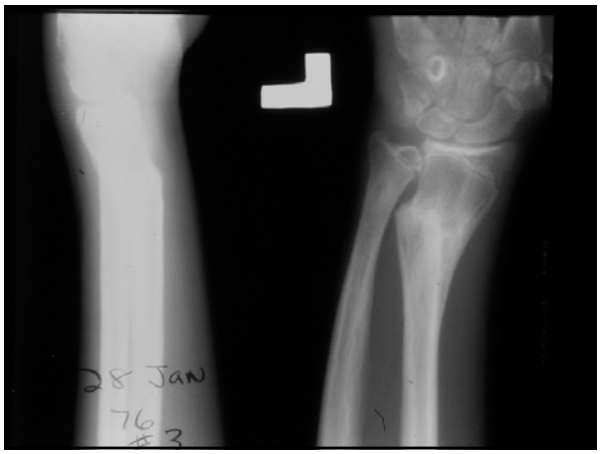
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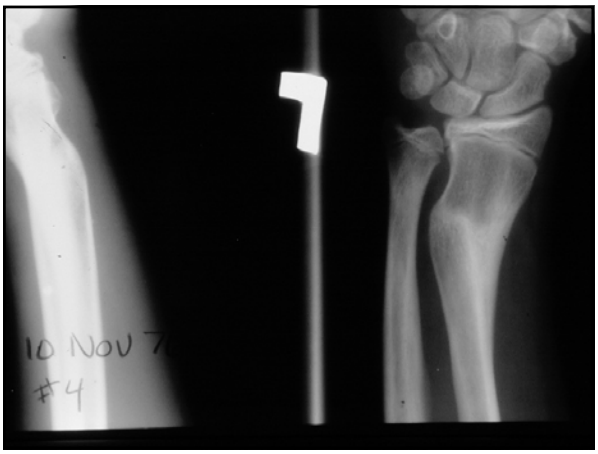
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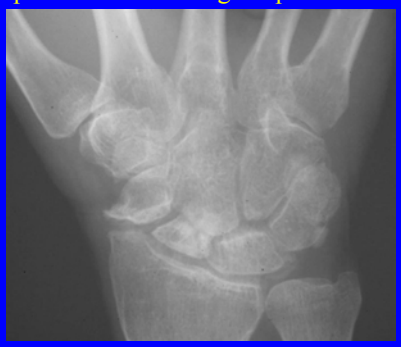
Fracture Union Terminology

- Non-union – failure of fracture fragments to unite and healing process has stopped
- Pseudoarthrosis – Bursal sac and fibrous tissue that develops at site of non-union
- Malunion – fracture fragments have healed with angular or rotational deformity that impairs function

Complications Following Scaphoid Fracture

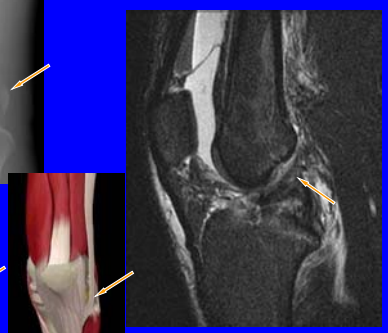


Nonunion

Avulsion Fracture

- Fracture involving ligament or tendon insertion

Segond Fracture: Lateral Capsule avulsion

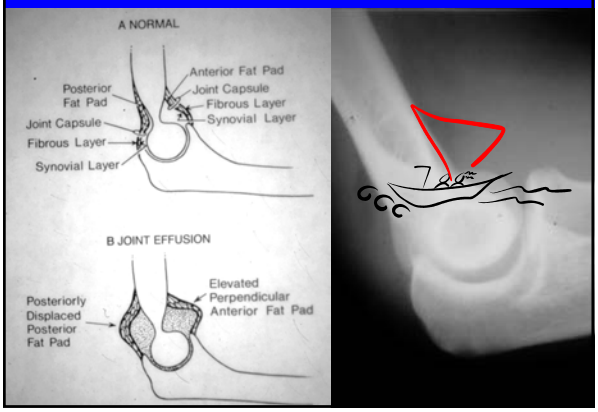


Association with ACL Disruption

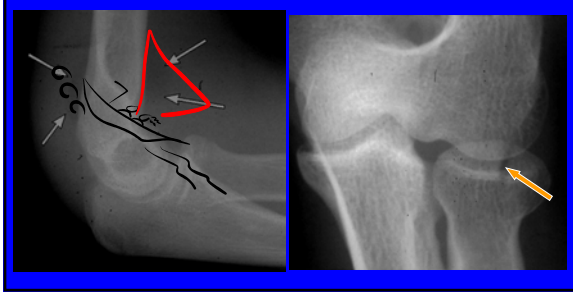
Intraarticular Fracture

- Often present with effusion
- Increased risk of post-traumatic osteoarthritis
- May involve bone and/or cartilage
- May require advanced imaging (CT or MR) to adequately characterize

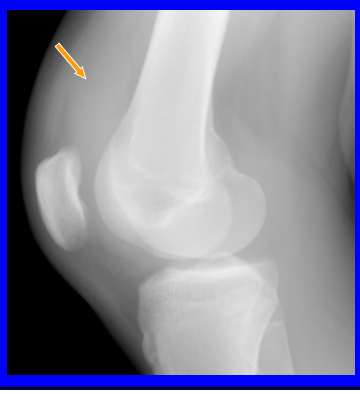
The "Sail" Sign

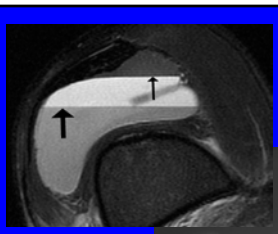


Elbow Effusion = Fracture Until Proven Otherwise

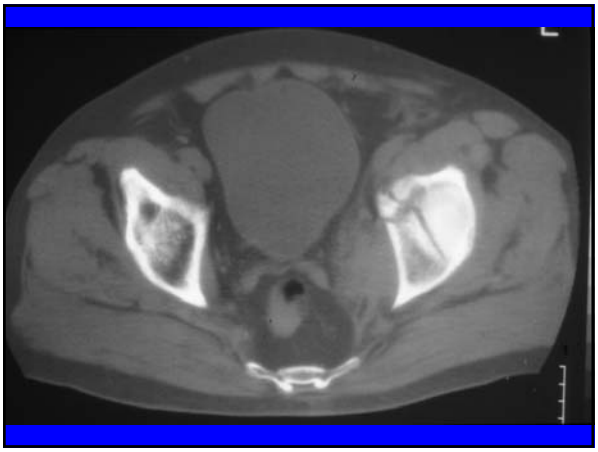


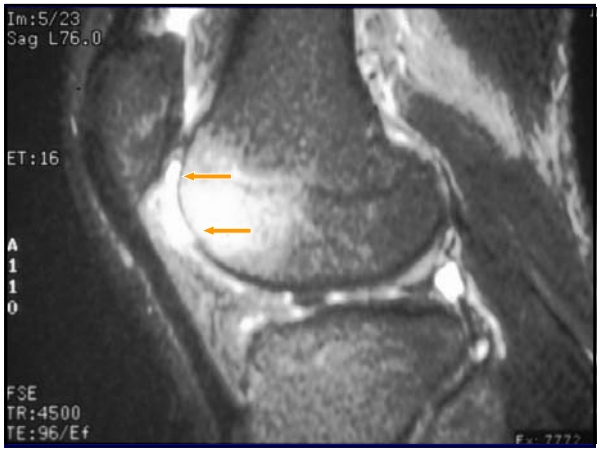
Joint effusion = internal derangement





Fat/ fluid level = intra-articular fracture

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A
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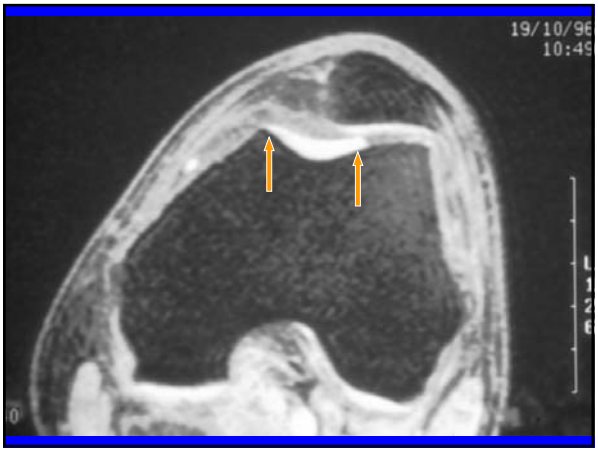
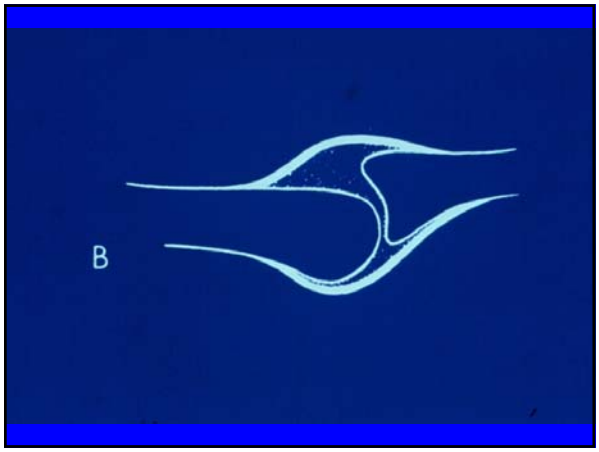
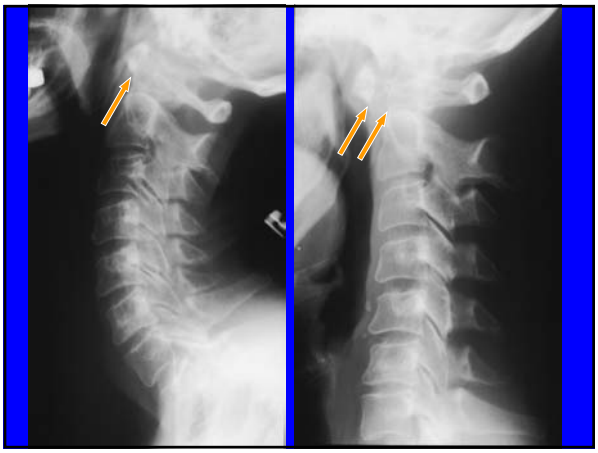
TE:96/Ef


19/10/96

Subluxation

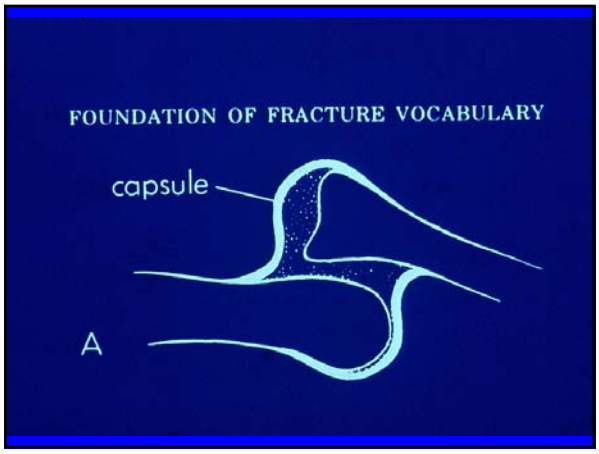
- Abnormal relationship between ends of a joint with some contact of the articular surfaces
- Incomplete dislocation





Dislocation

- Complete separation of articular surfaces
- May be associated with a fracture
  - Fracture dislocation




Anterior dislocation

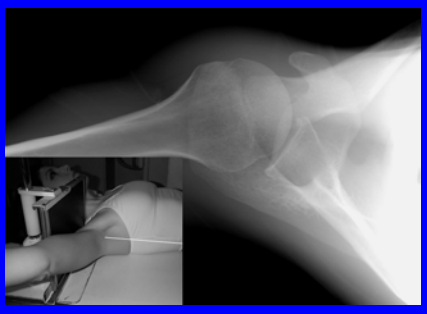

Normal

Imaging of Glenohumeral Joint

AP-view

-Standard AP view is oblique to the GH joint

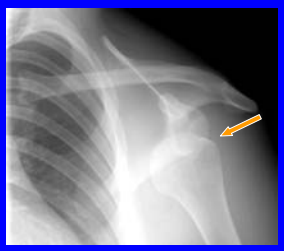
Imaging of Glenohumeral Joint



-Axillary view

-Evaluate for subluxation/ dislocation

Anterior Dislocation



-Mechanism: fall on outstretched arm

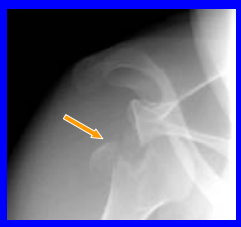
-X-ray: humeral head displaced anterior and medial

Anterior Dislocation


Axillary view


Scapular "Y" view

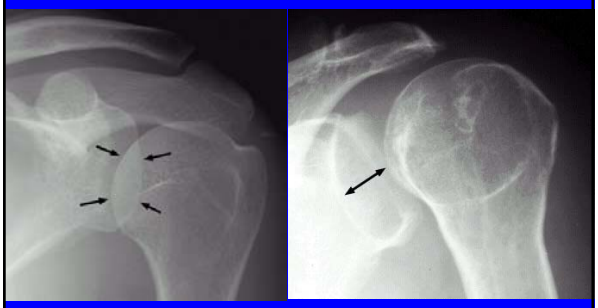
Lesions Associated with Anterior Dislocation



-Occurs secondary to humeral head impaction against inferior glenoid rim

Hill Sachs Lesion

"Positive Rim" Sign



Normal AP View

Posterior Dislocation

Posterior Dislocation

-50% missed on initial x-rays

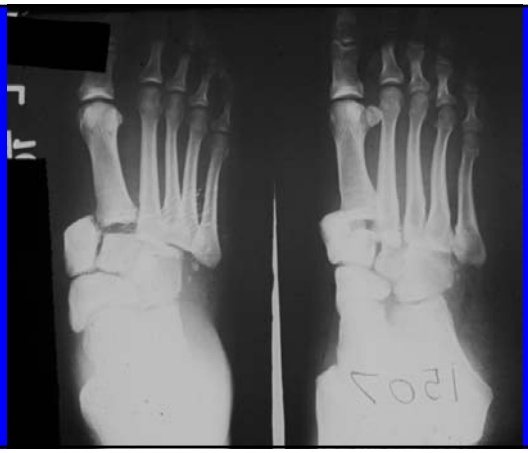
-Very obvious on axillary view

-Dislocates straight posterior on AP view- sometimes difficult to detect

-<u>Locked in internal rotation</u>; most reliable sign

Posterior Elbow Dislocation

-Direction of dislocation described by the position of the distal bones



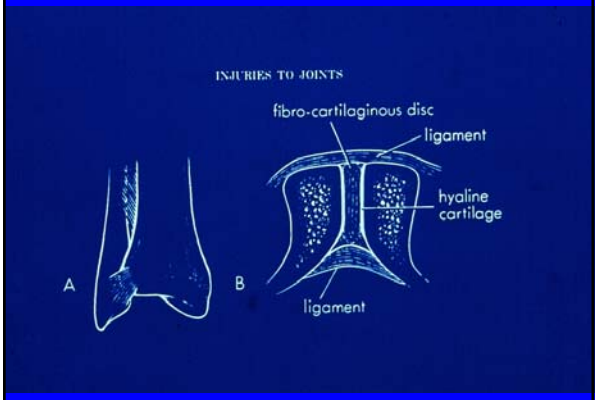
Normal Anatomy of the Lisfranc Joint

Alignment

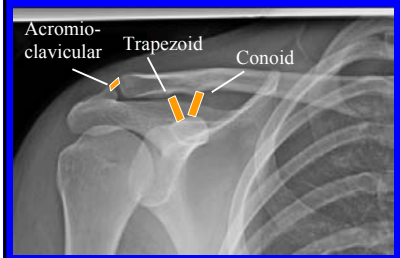
Lisfranc Ligament

Diastasis

- Disruption of fibrocartilaginous joint
  - Pubic symphysis
  - Sacroiliac joint
  - Tibiofibular syndesmosis
  - Acromioclavicular joint



Acromio-clavicular Joint Injuries



-Mechanism: fall on outer prominence of shoulder

-AC joint: weak capsule and inherently unstable

-Grade I injury- mild strain of AC joint

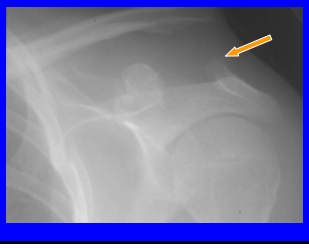
Acromio-clavicular Joint Injuries

-Grade II injury- moderate strain

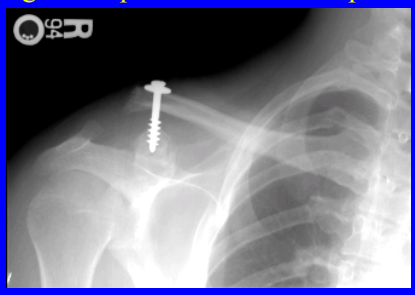
Acromio-clavicular Joint Injuries

-Grade III injury- severe

-Ruptured AC and CC ligaments



Surgical Repair of AC Joint Separation

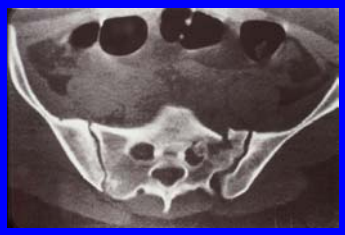


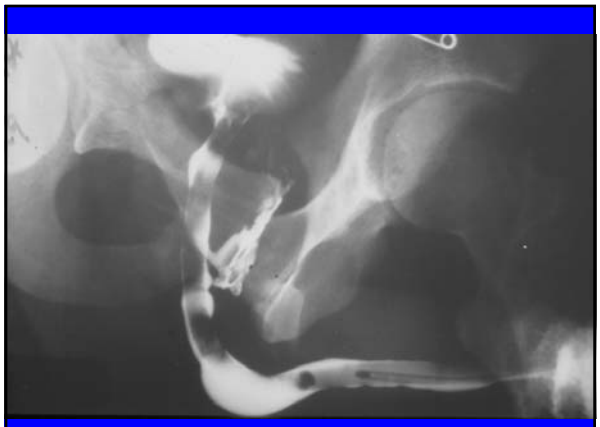
-Screw or wire: 8-10 weeks

-Until CC ligaments heal

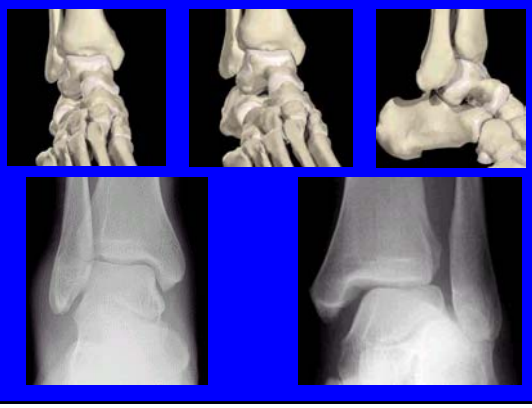
Radiographic Evaluation

- CT--best view of posterior ring

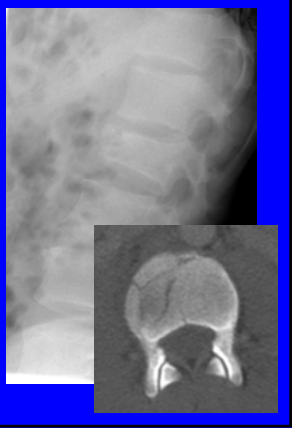




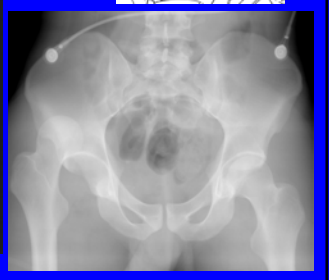
Distal Tib-Fib Joint



Lover's Heal



Dashboard Injury

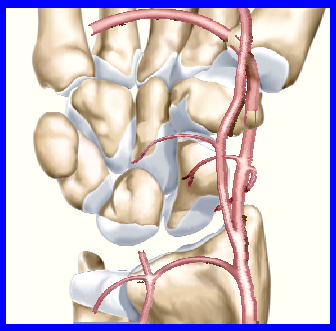


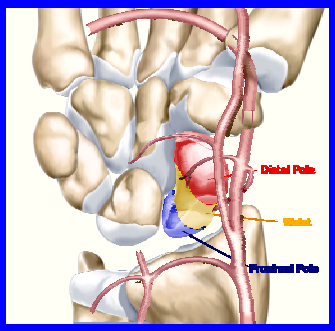
Anatomic Snuff Box Tenderness

Scaphoid Fracture

Scaphoid View: Ulnar Deviation

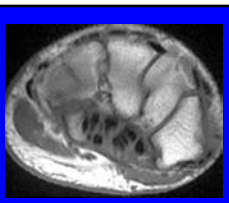


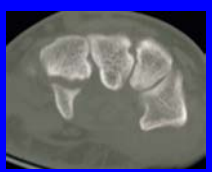




Suspected Hamate Fracture- Point tenderness


Carpal Tunnel View



Persistent Lateral Ankle Pain Following Inversion Injury


-Fracture of the lateral talar process

-Intraarticular fracture: 50% missed on initial plain film study

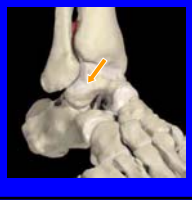
Mechanism of Injury

Snowboarder's Fracture

Inversion injury with foot in dorsiflexed position

Fracture of the Lateral Talar Process





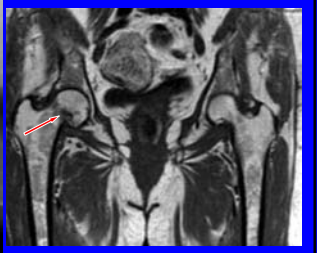
-Subtalar joint

-Talofibular joint

-MR/CT to evaluate for radiographically occult fracture

-Surgical Lesion

Occult Hip Fracture

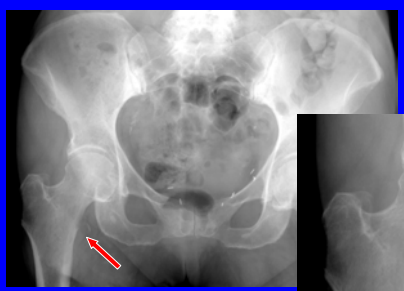
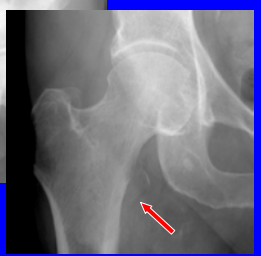



18 y.o. airman basic with right hip pain


Bone scan confirms stress fracture of the medial hip

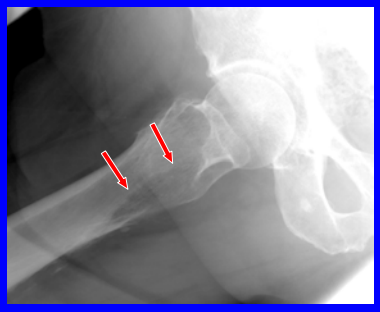
-Subtle perpendicular sclerotic line involving inferior medial femoral neck

Lesser Trochanter

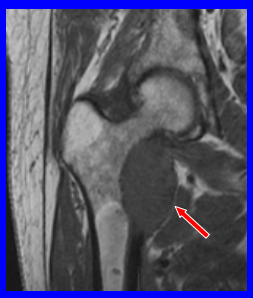
-Pathologic fracture until proven otherwise

Lesser Trochanter



Large lytic lesion in intertrochanteric region of femur

Lesser Trochanter



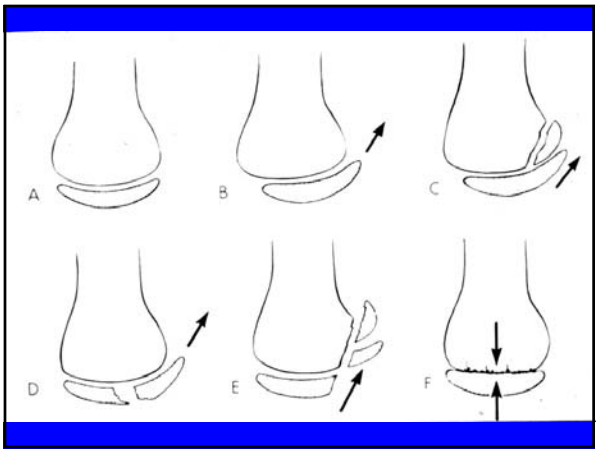
Pediatric Injuries

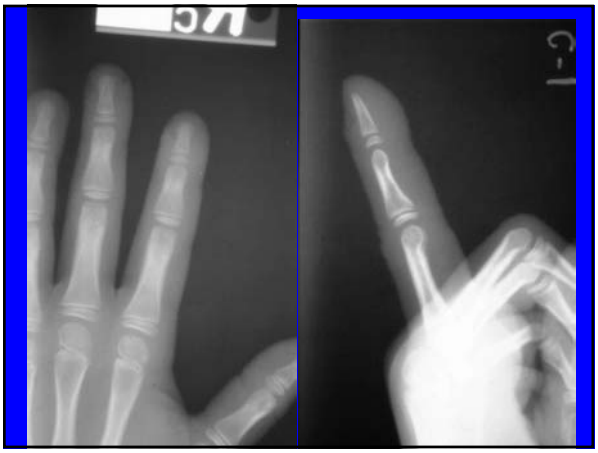
- Injuries occur in different pattern in growing bone
  - Greenstick, torus, plastic fractures
- Injury to physeal plate
  - Growth arrest and limb length discrepancy
- Injuries tend to heal faster

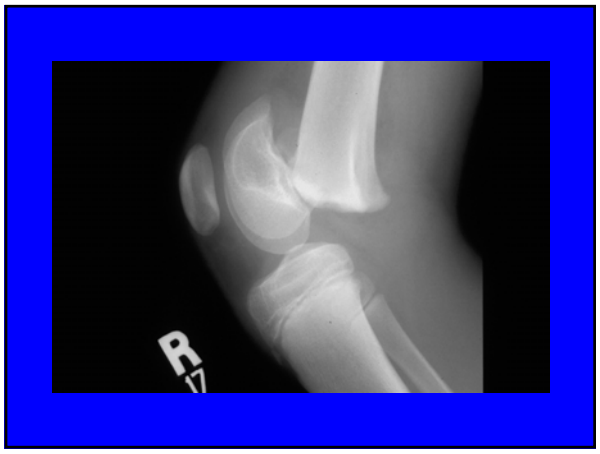
Salter Harris Injuries

- I – Through physeal plate
  - May need comparison views to recognize
- II – Physeal plate + metaphysis
  - Most common
- III – Physeal plate + epiphysis
- IV – Metaphysis, physeal plate, epiphysis
- V – Crush injury of physeal plate

- Risk of growth arrest increases with grade



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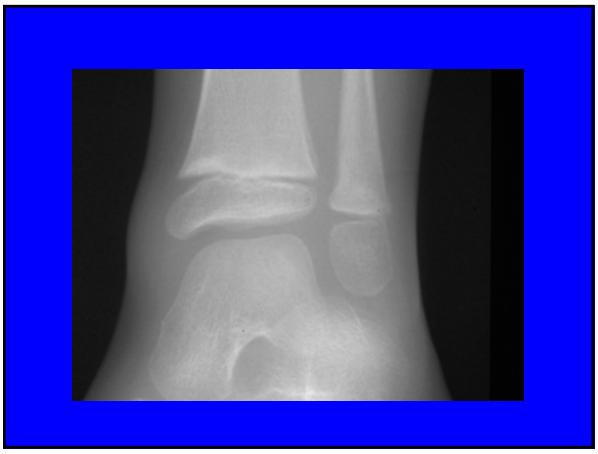

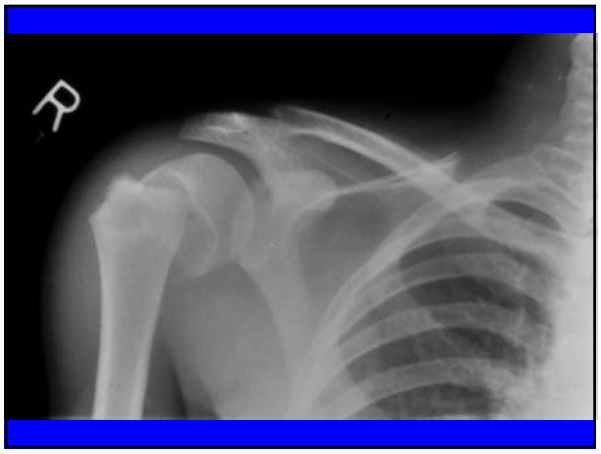
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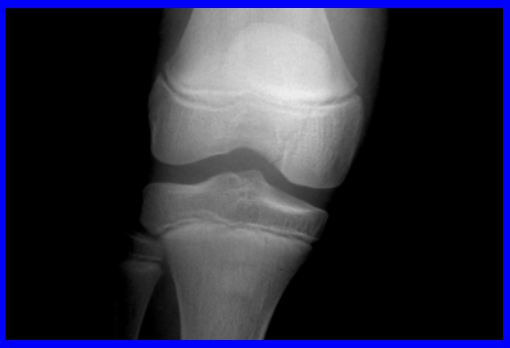
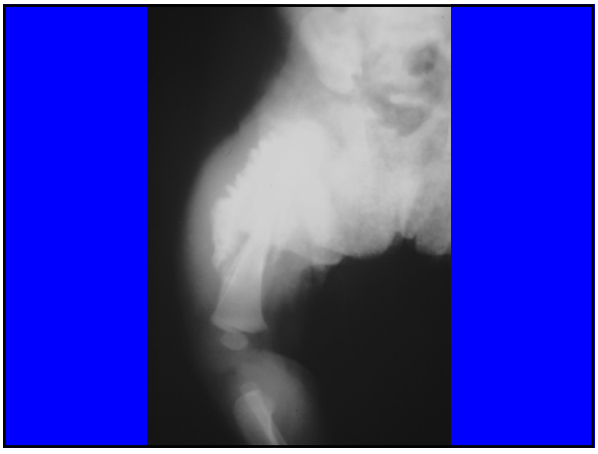


Nonaccidental Trauma

- Must consider child abuse with unexplained injuries
- Specific injury patterns
  - Transverse fracture through long bone
  - Metaphyseal corner fractures
  - Metacarpal/metatarsal fractures
  - Posterior/anterolateral rib fractures
  - Multiple fractures in different stages of healing



Thank you!!