



# Appendicular Skeletal Trauma

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# Types of cognitive error

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- Satisfaction of search;
  - Once a diagnostic finding is identified the search stops and additional potentially important finding is missed
- Alliterative error;
  - Bias from prior reports influencing the current report
- Watching the grass grow;
  - The finding is compared to only the most recent previous exam and not to older exams, thereby missing the slow growth/change over a long period of time
- Ascertainment bias;
  - Personal bias toward certain patient characteristics
- Anchoring;
  - Early determination of diagnosis and “fitting the findings” to the diagnosis
- Gambler’s fallacy;
  - Thinking that if one has recently seen several patients with a certain pathology, the chances that the next patient has the same pathology are slim
- Availability bias;
  - Recent exposure to a diagnosis, especially a missed call, increases sensitivity to that abnormality, leading one to overcall this in the future
- Framing bias;
  - Misdirection by clinical history
- Distraction;
  - Distraction during the interpretation of a case can interfere with the search pattern and increase the chances of missing relevant findings.

# Top 10 Missed Fractures

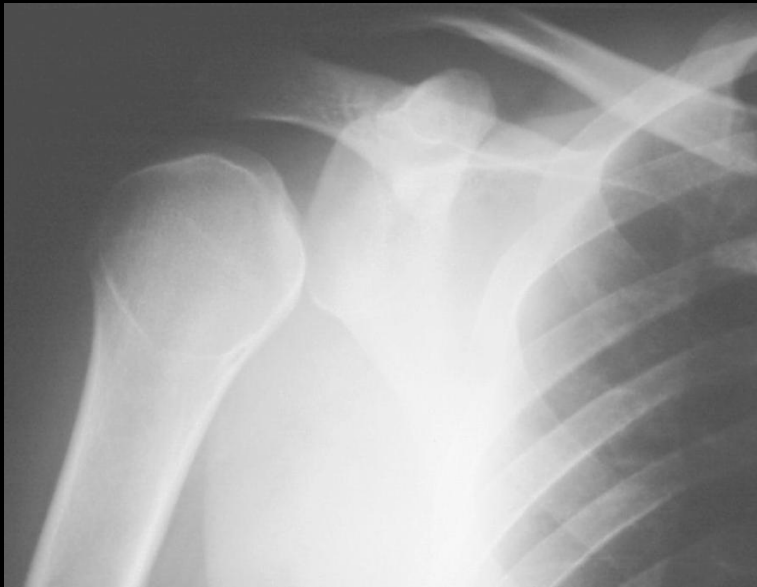
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- 1. Base of skull
- 2. Odontoid process
- 3. Zygomatic arch and orbit
- 4. C7 Fracture dislocation
- 5. Posterior dislocation of humerus
- 6. Scaphoid, lunate and perilunar dislocation
- 7. Sacroiliac fractures
- 8. Undisplaced neck of femur
- 9. Dislocated hip with ipsilateral femoral fracture
- 10. Tibial plateau fractures

# Top 10 Missed Fractures

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## 5. Posterior dislocation of humerus





# Top 10 Missed Fractures

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## 6. Scaphoid, lunate and perilunar dislocation



# Top 10 Missed Fractures

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## 7. Sacroiliac fractures



# Top 10 Missed Fractures

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## 8. Undisplaced neck of femur



# Top 10 Missed Fractures

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## 9. Dislocated hip with ipsilateral femoral fracture



# Top 10 Missed Fractures

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## 10. Tibial plateau fractures



# Reasons for Misses

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- Simple miss
- Satisfaction of Search
- Inadequate study
- Not what was expected
- Corner of film finding
- Inappropriate history
- Working conditions

# Satisfaction of Search

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- One of the commonest reasons to miss injuries
- See most obvious injury
- Miss other (more significant) injury



Reasons for Misses

# Satisfaction of Search

?



SATISFIED



SH2 fracture distal tibia with base of 5<sup>th</sup> MT fracture



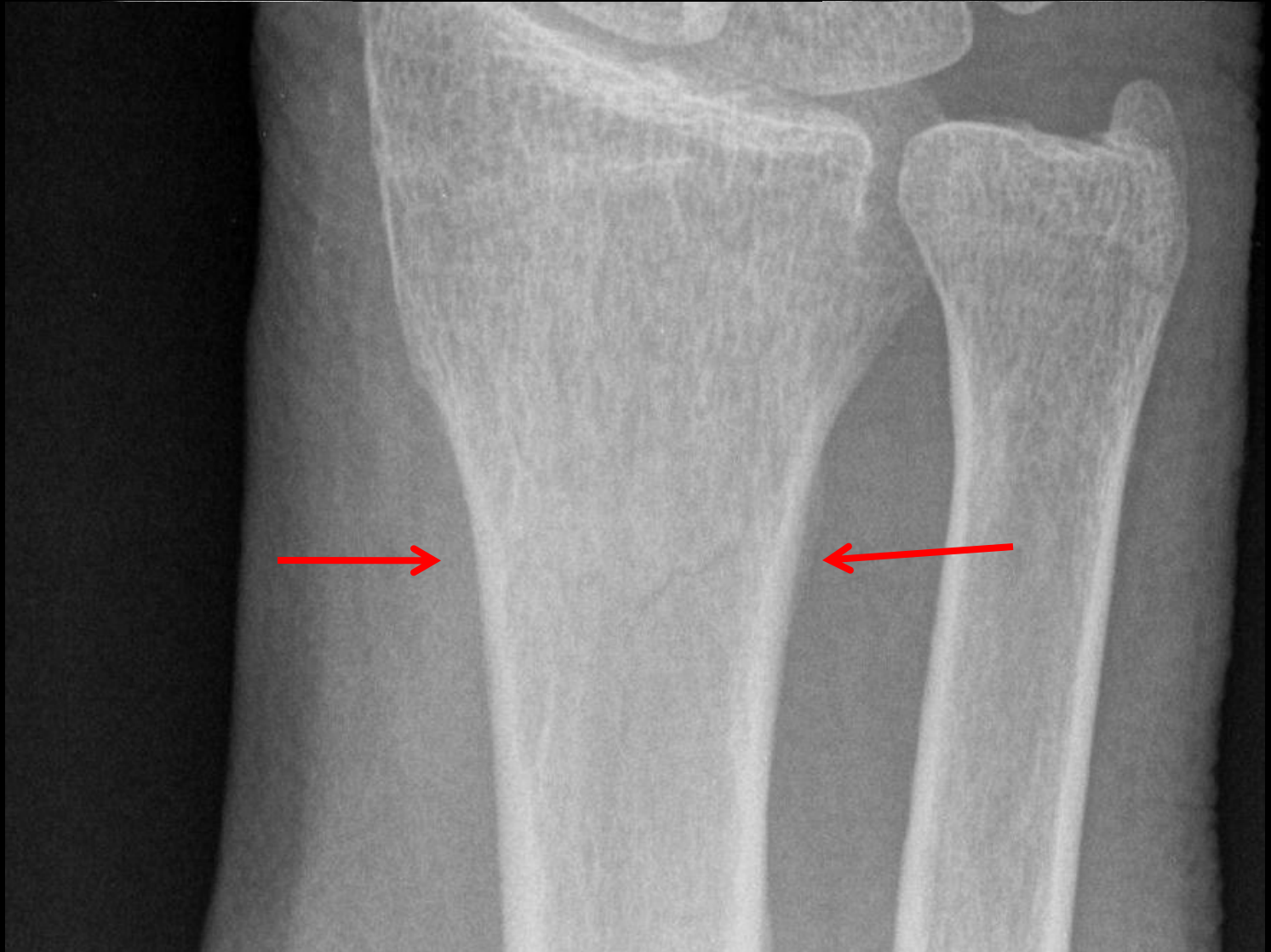
Reasons for Misses

# Satisfaction of Search

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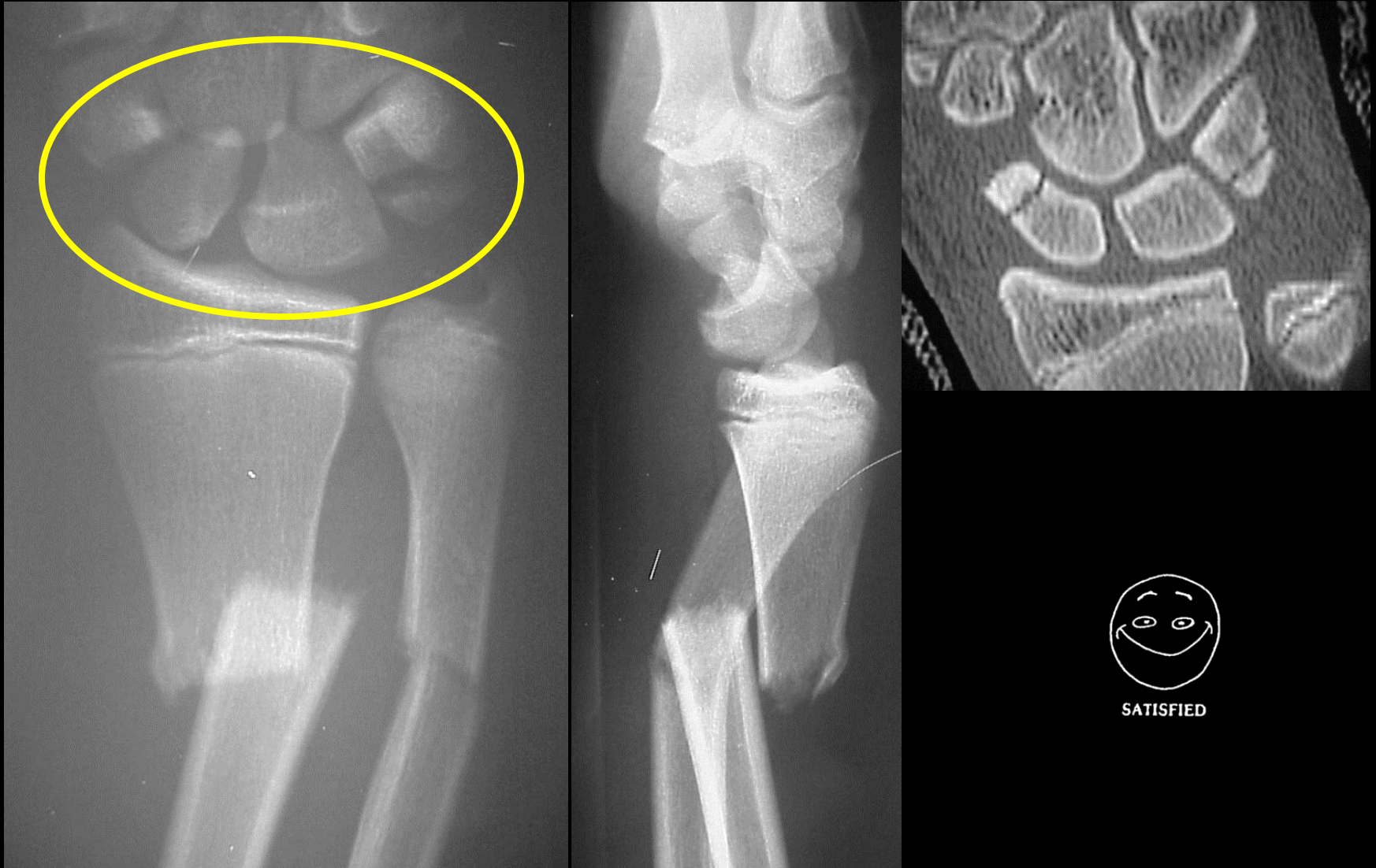


SATISFIED



Reasons for Misses

# Satisfaction of Search



Trans scaphoid and triquetral peri lunate 15M

# Satisfaction of Search

- Simple miss
- **Satisfaction of Search**
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Reasons for Misses

# Satisfaction of Search

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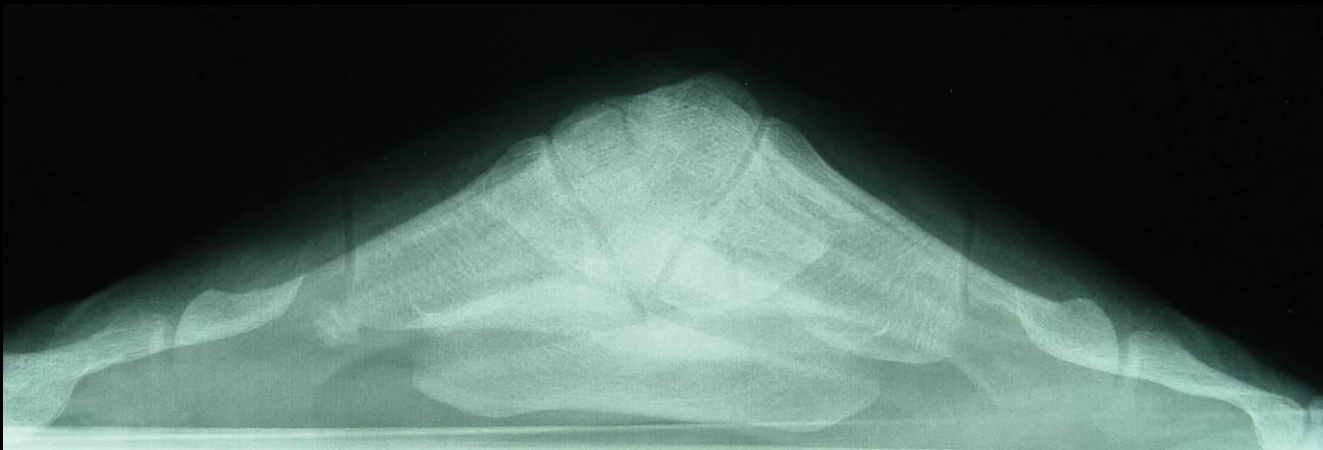
Missed scaphoid fracture



# Inadequate Study

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- Need two or more views to assess for fracture or dislocation
- Need appropriate study
- Insist on good quality studies
  - With empathy
- If equivocal, ask for more



Reasons for Misses

# Inadequate Study

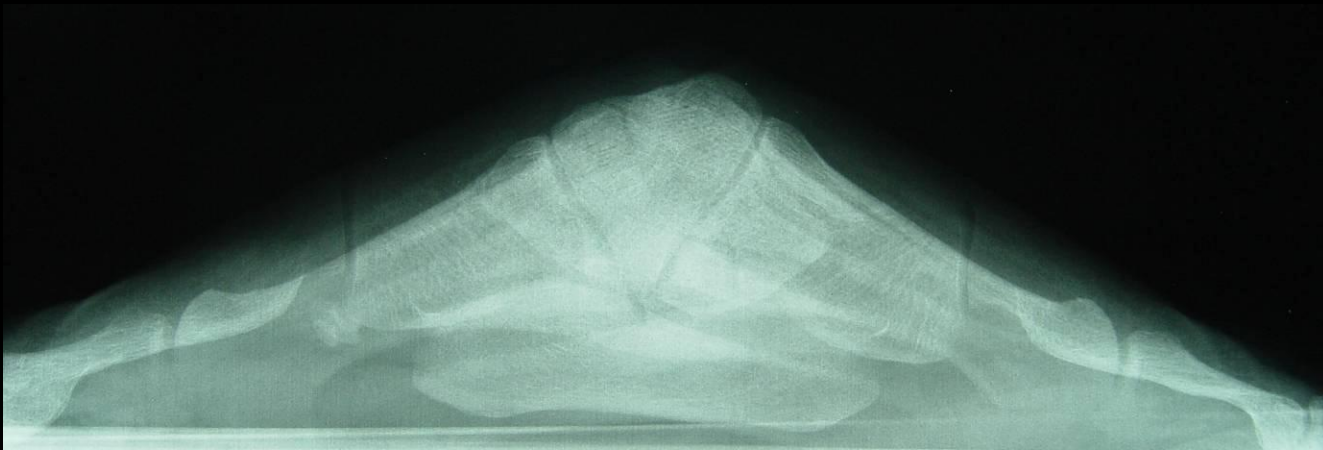


Scaphoid fracture on ulna deviation view 19F

# Inadequate Study

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- All films need
  - Patients name
  - Patients number
  - Date and time of study
  - Side marker (lead, not added later)
  - Cone marks
  - Appropriate exposure



## Two or more Views

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- One view is never enough to assess for fractures



Posterior process fracture of calcaneus



Reasons for Misses - Inadequate Study

# Two or more Views

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Reasons for Misses - Inadequate Study

# Two or more Views

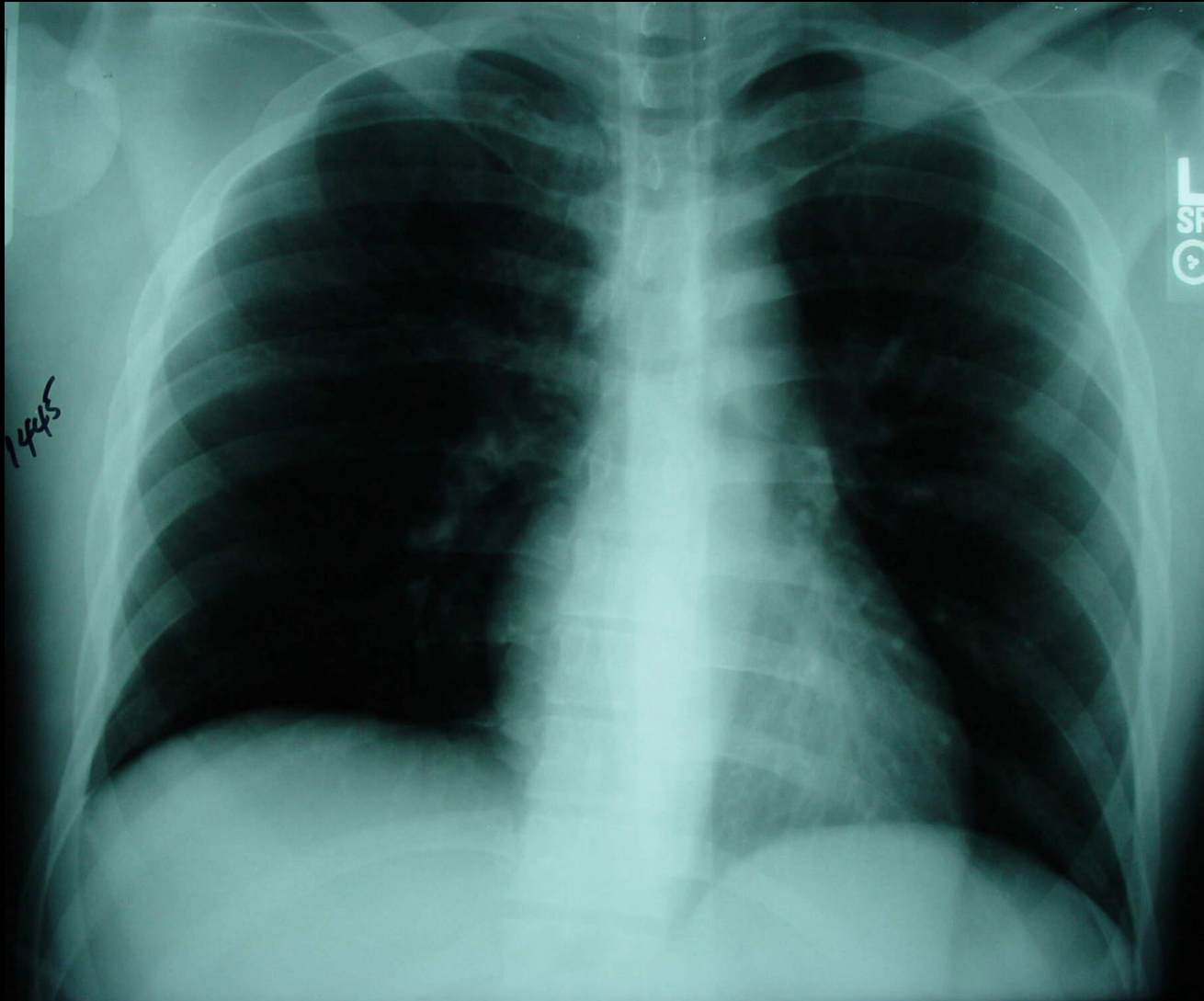
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Reasons for Misses

# Not what was expected

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Dislocated right shoulder

# Ways to Avoid Missing Fractures

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- Look for fracture patterns
- Look at regions that should align
- Look for secondary signs of fracture
- Look for the common sites of fractures
- Have check lists for each region
- Special circumstances

# Fracture Patterns

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- Patterns help us know where to look
  - Transtriquetral / scaphoid perilunate fracture dislocation
  - Maisonneuve
  - Essex Lopresti
  - Galeazzi
  - Monteggia
  - Waist of Scaphoid
  - Femoral shaft and neck



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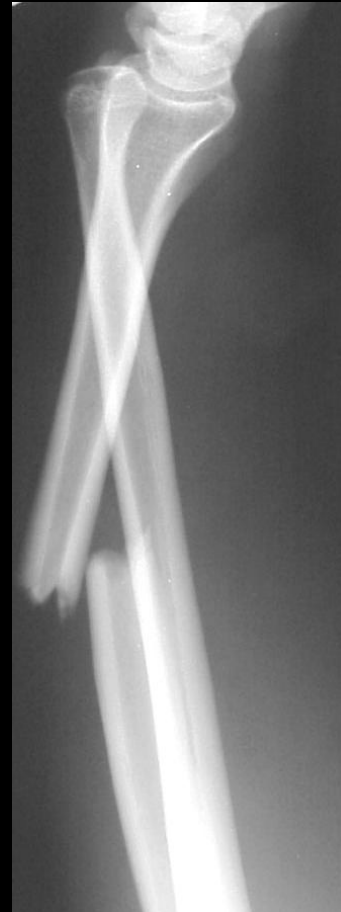
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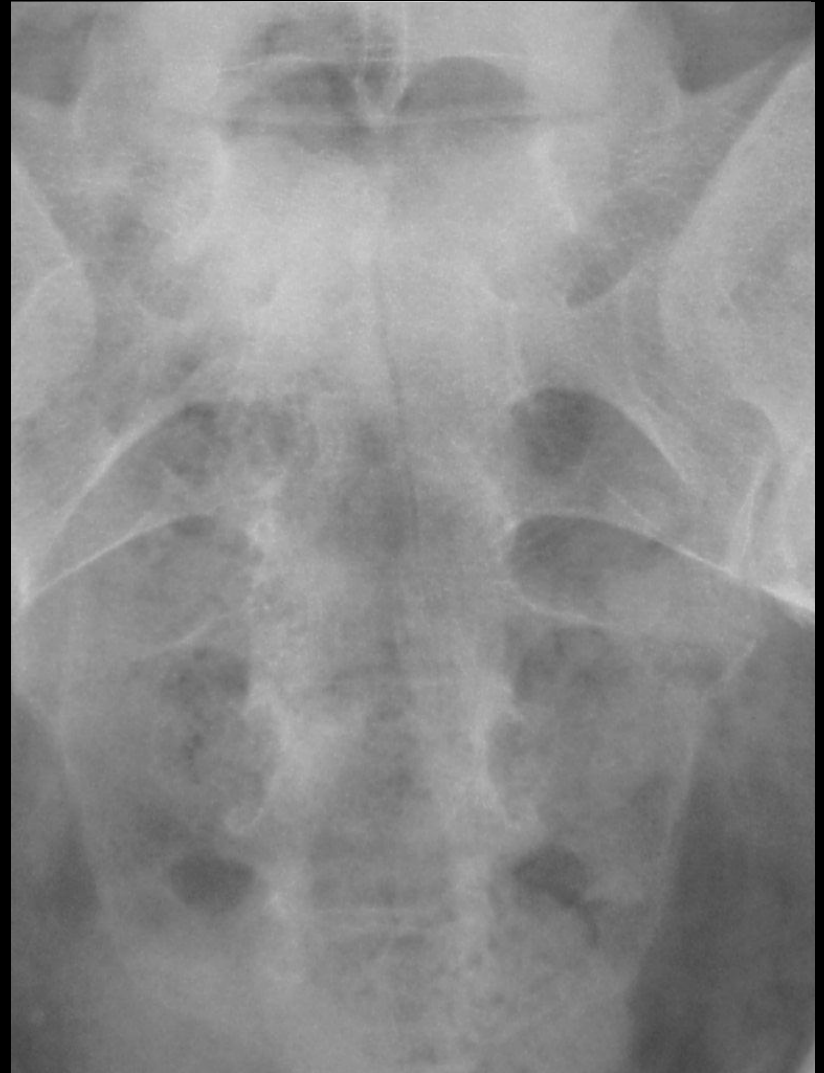
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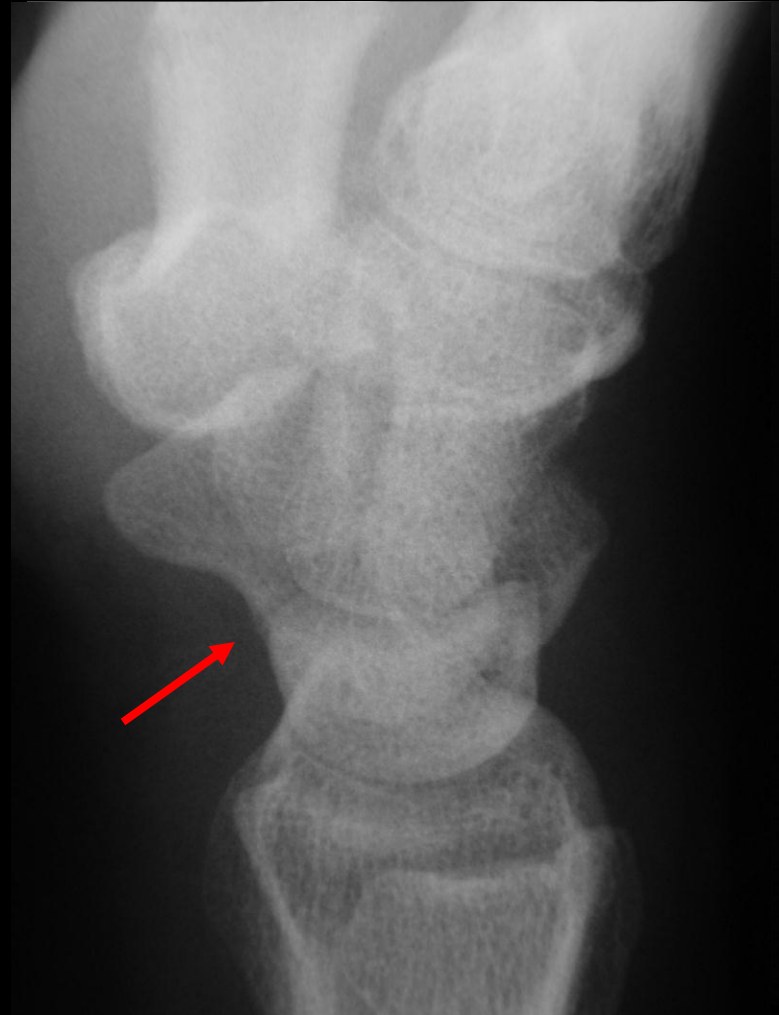
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Vertical Sacral fracture

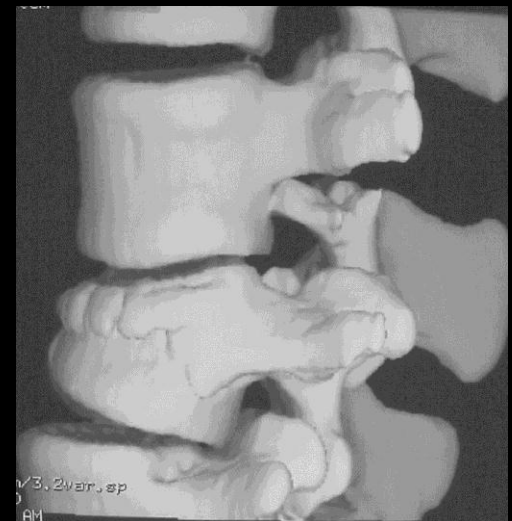
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# Pattern Approach

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# Pattern Approach



# Pattern Approach

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# Pattern Approach

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# Pattern Approach

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# Pattern Approach

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# Pattern Approach Volar Plate of Phalanx

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Adjacent structures

# Pattern Approach Mallet Fracture

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# Ways to Avoid Missing Fractures

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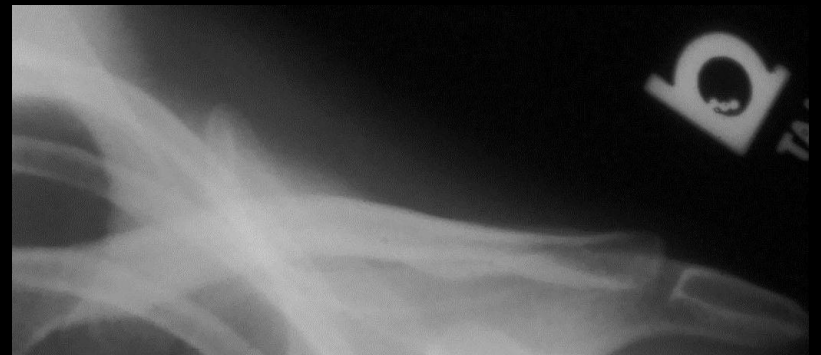
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# Alignment Rules

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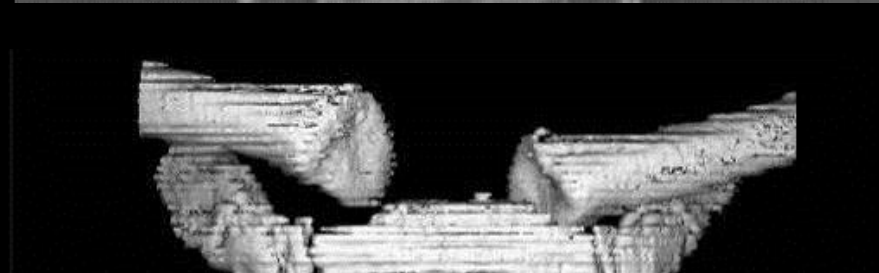
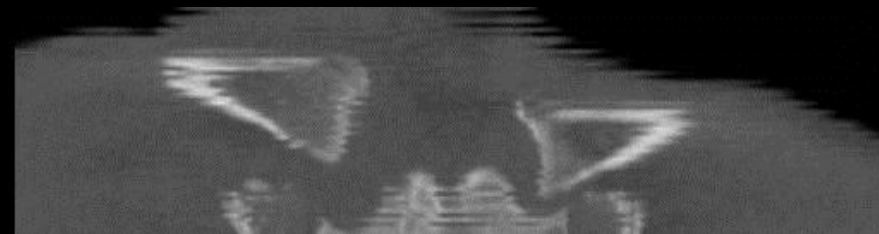
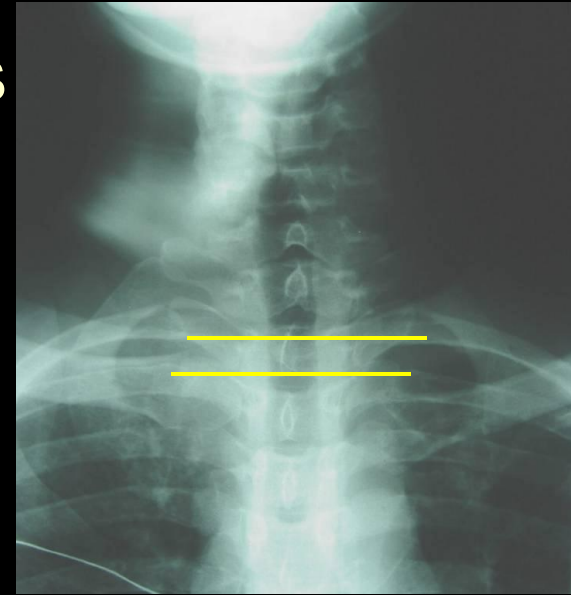
- These are helpful at various sites
  - ACJ
  - SCJ
  - Lisfranc joint
  - Elbow in children
  - Carpal bones
- Also check for rotation



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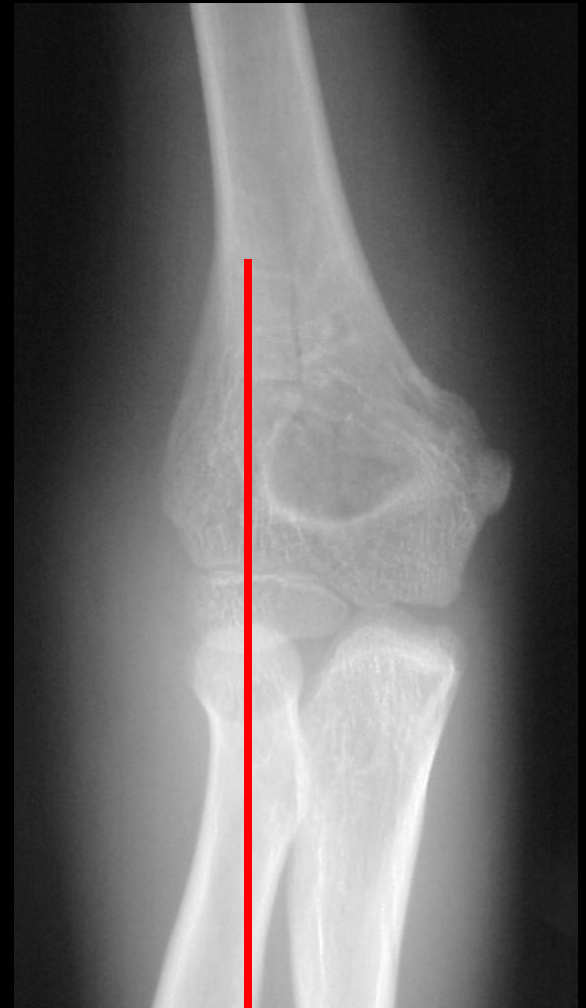
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If in doubt recommend weight bearing

# Alignment Rules Childhood Elbow Fractures

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Can Radiology Make Trauma Less Obscure

CRITOE

1 3 5 7 11 11

# Alignment Rules

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Many distal radial fractures have a SCL injury

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# Alignment Rules

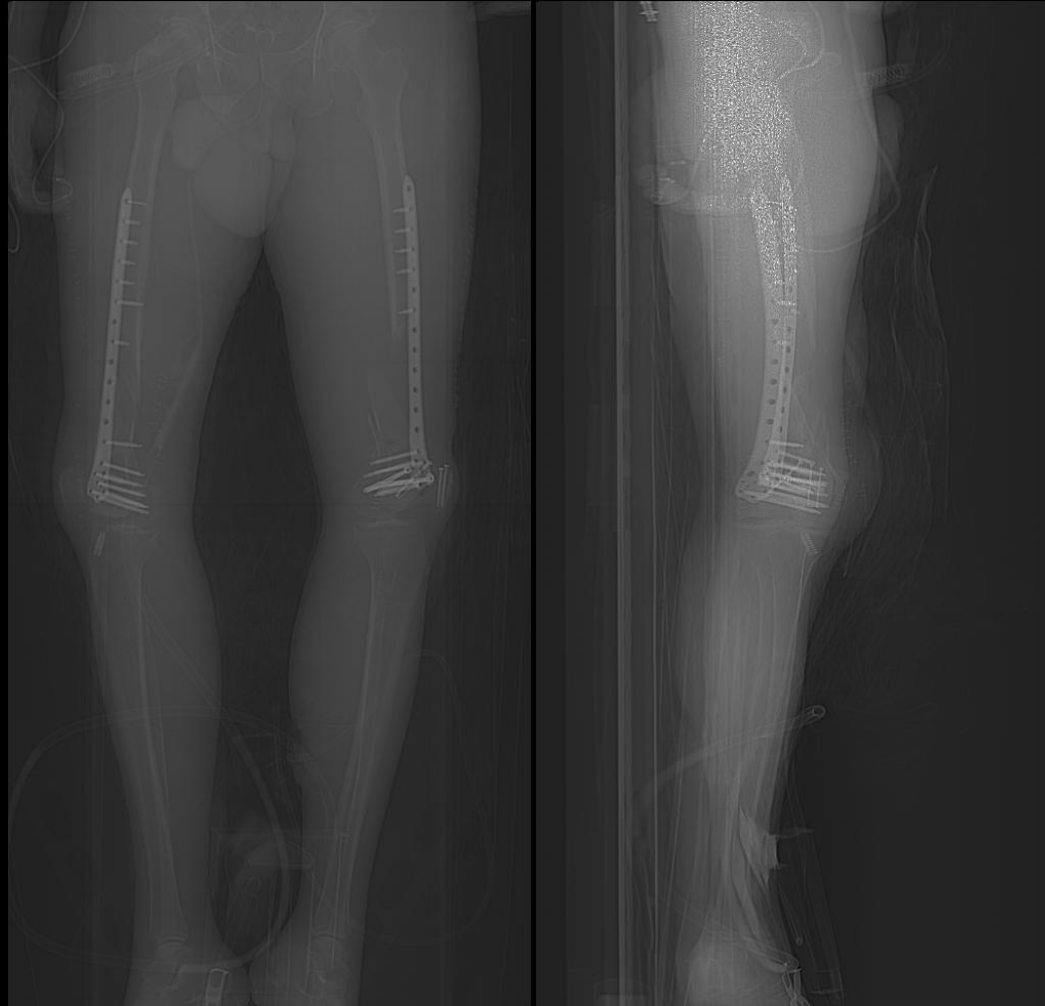
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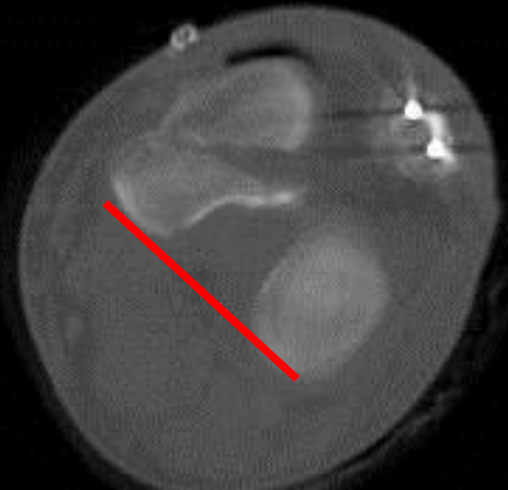
# Alignment Rules - Rotation

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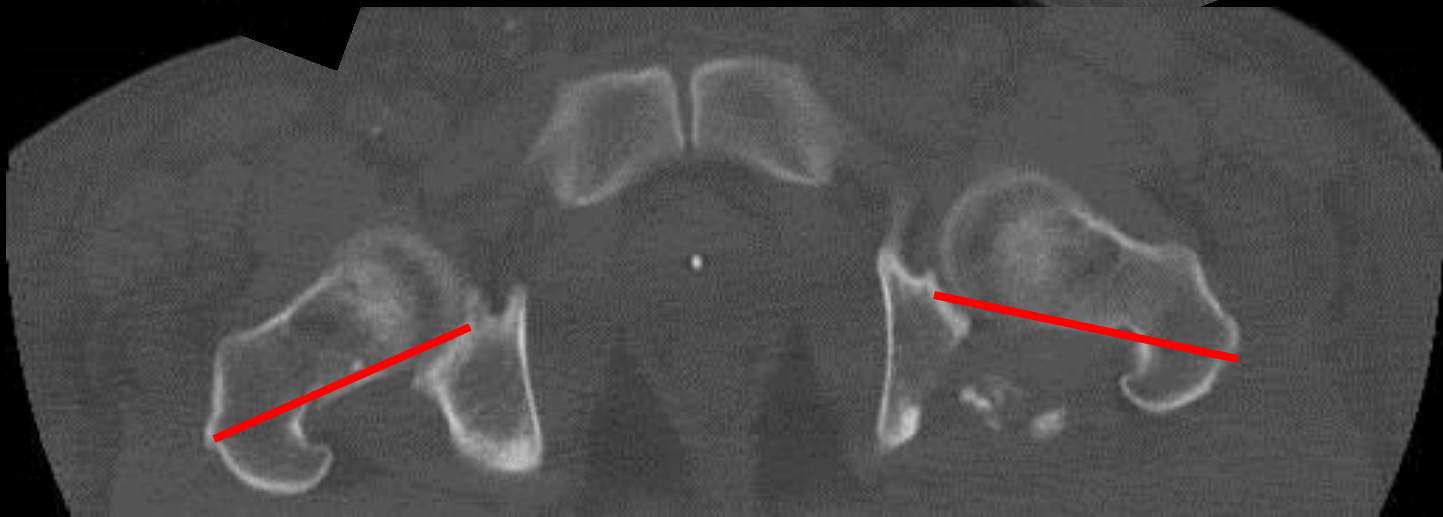
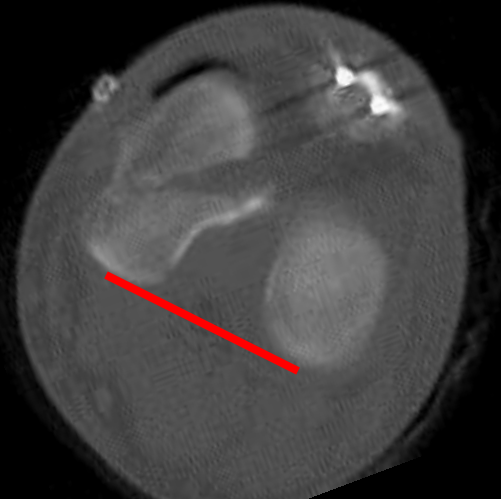
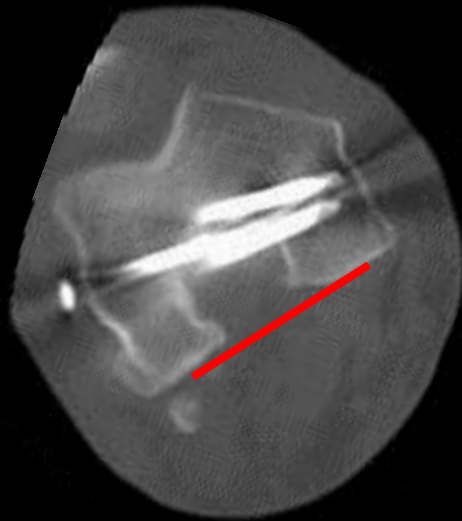
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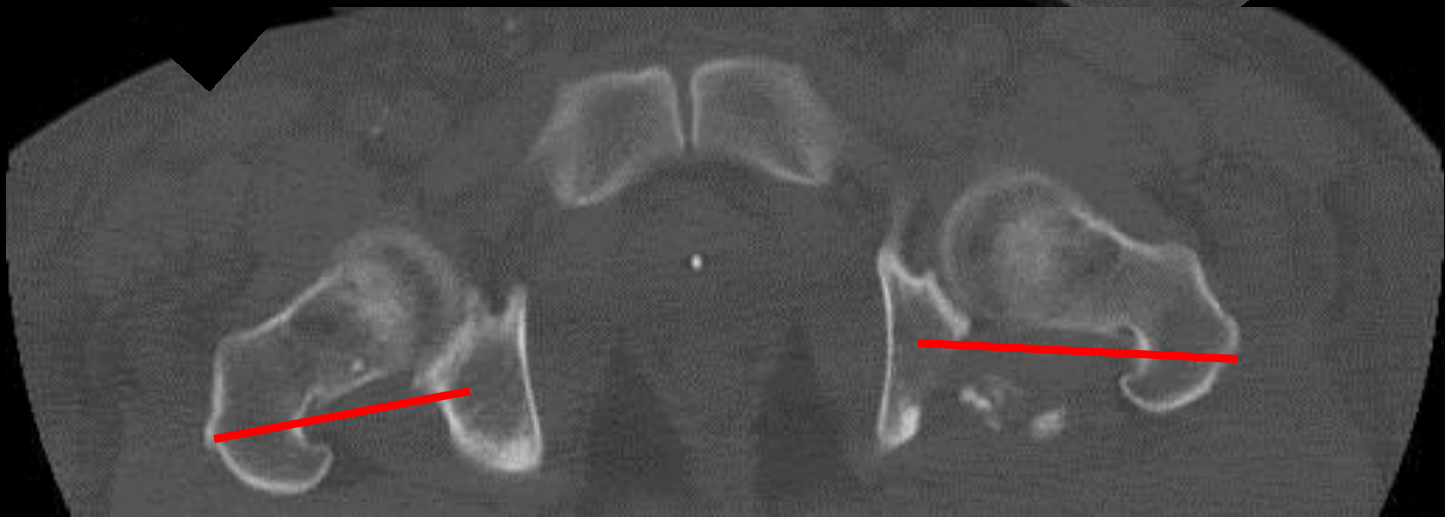
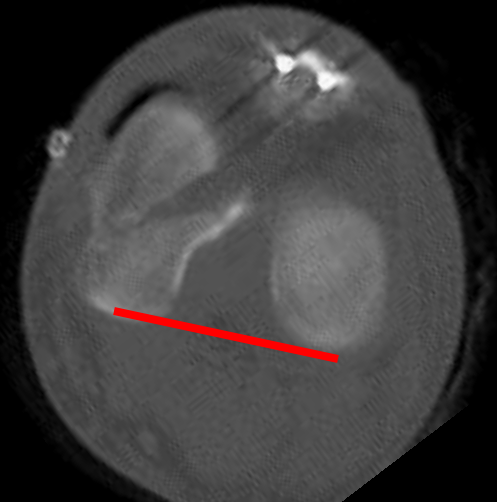
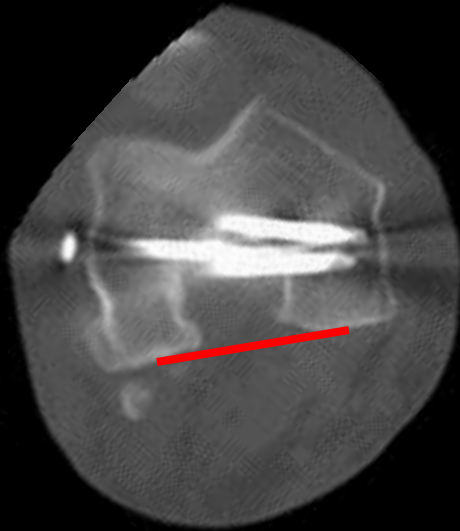
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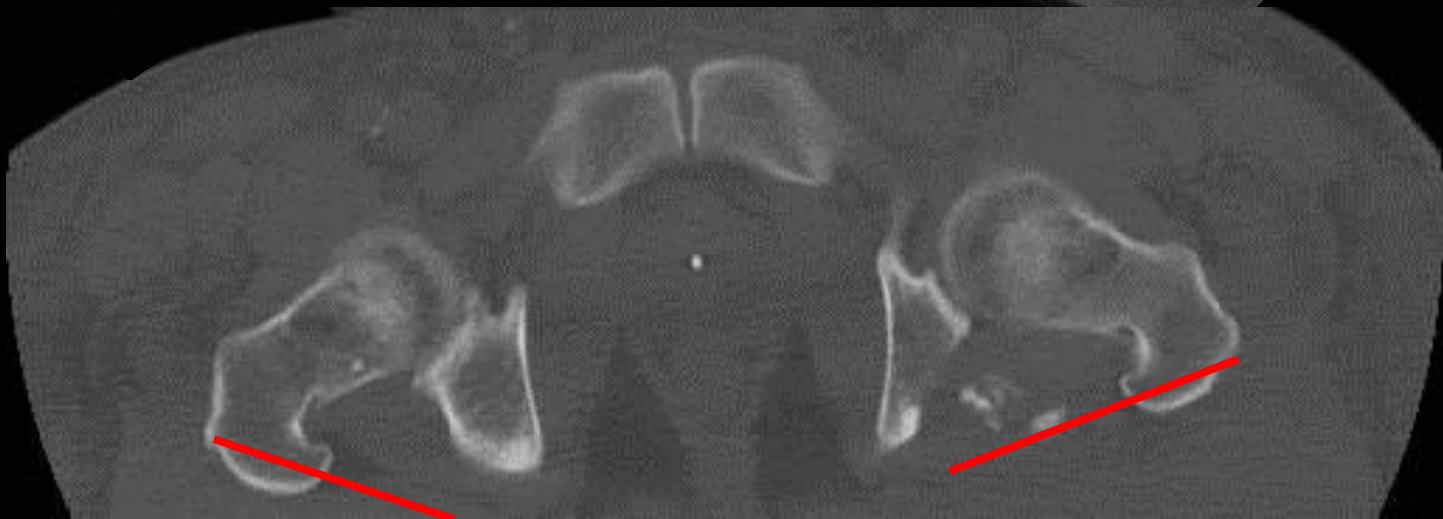
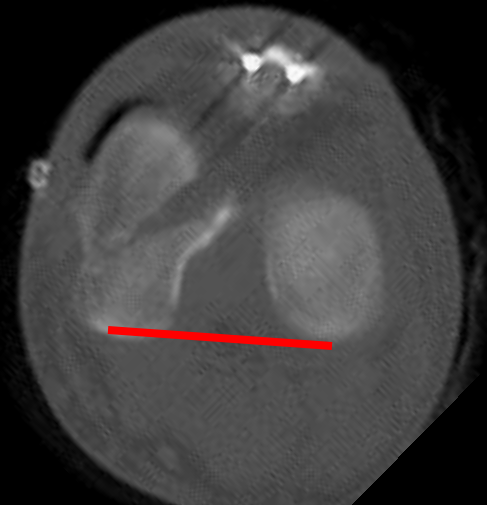
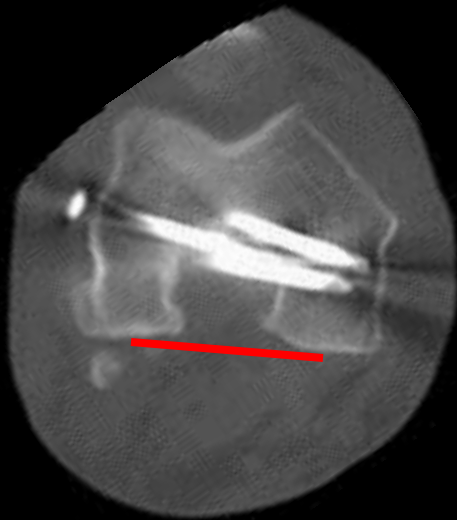
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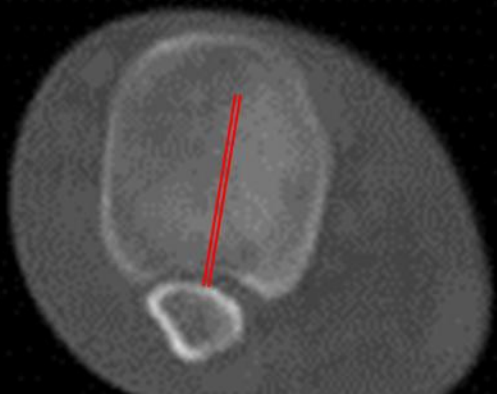


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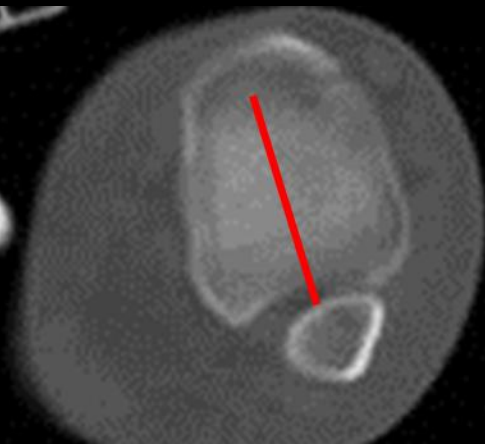
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FOV  
F



# Ways to Avoid Missing Fractures

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# Secondary Signs

## Joint Effusion

---

- Secondary signs
  - Joint effusion
  - Lipohearthrosis
  - Gas in joint
  - ST swelling
  - Obliteration of fat planes
  - Fat in joint on CT
  - Bone edema on CT
  - Intraosseous Vacuum
  - Delayed resorption
  - Delayed sclerosis



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The hinge joints

Secondary Signs  
**Joint Effusion**

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Acute



6w later



# Lipohemarthrosis

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Tibial Plateau Fracture

# Lipohemarthrosis

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# Lipohemarthrosis

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Tibial Plateau Fracture

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-TABLE LATERAL



# Lipohemarthrosis

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Open tibial plateau Fx

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# Soft Tissue Swelling

- Secondary signs
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# Fat plane obliteration

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Between the radial collateral ligament and APL/EPB

Obliterated in Fx / Infection

# Fat in joint on CT

---

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# Lipohemarthrosis

36

Anterior recess of the  
posterior subtalar joint



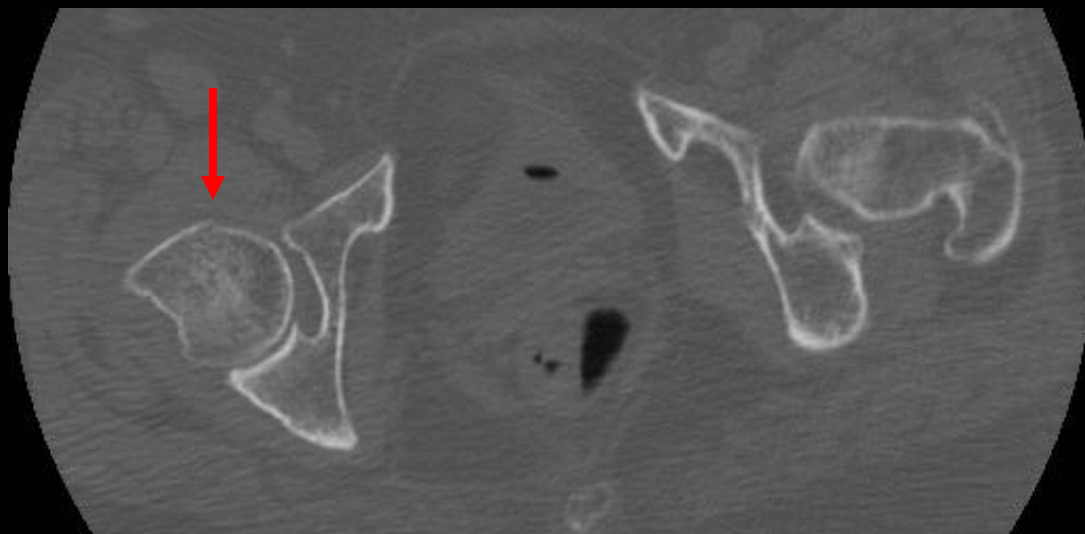
W 2000 : L 500

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Secondary Signs  
**Lipohemarthrosis**



Fat fluid level in iliopsoas bursa 61F



Secondary Signs

# Lipohemarthrosis

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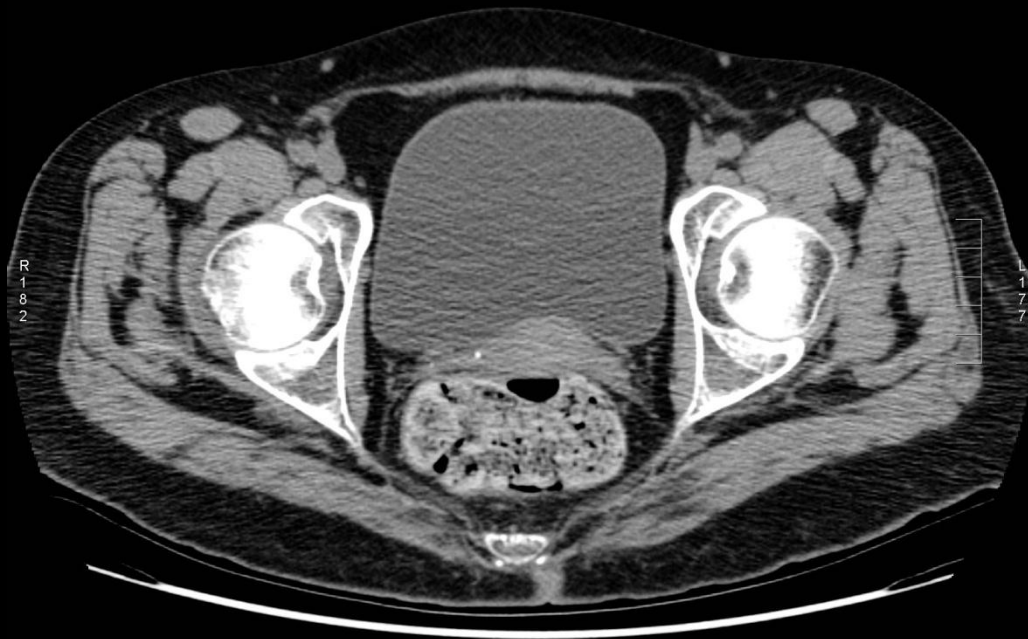




Secondary Signs

# Lipohemarthrosis

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60 y/o female with pain s/p fall

Secondary Signs

# Lipohemarthrosis

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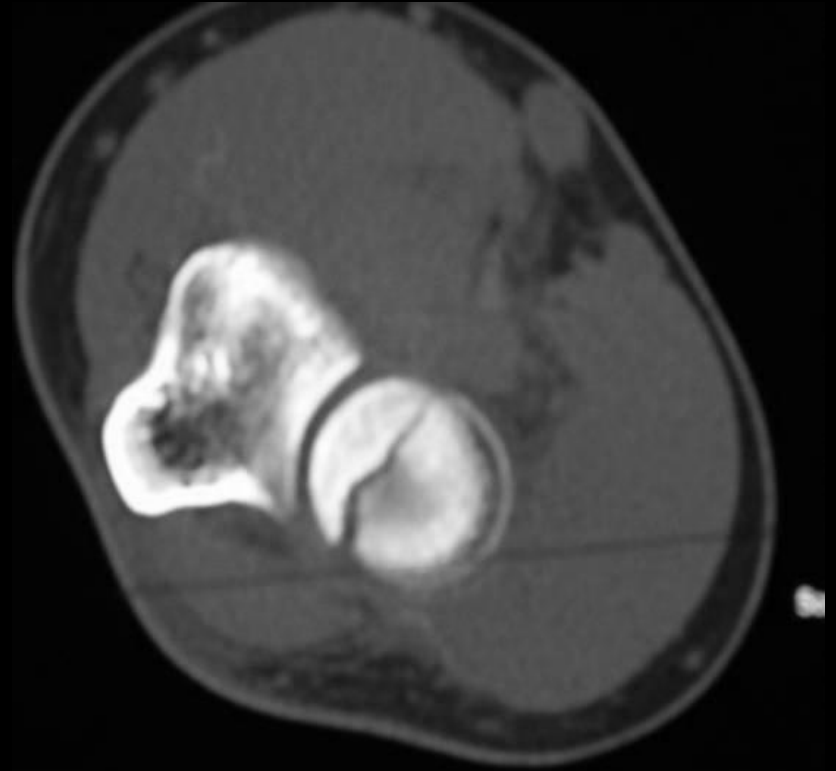
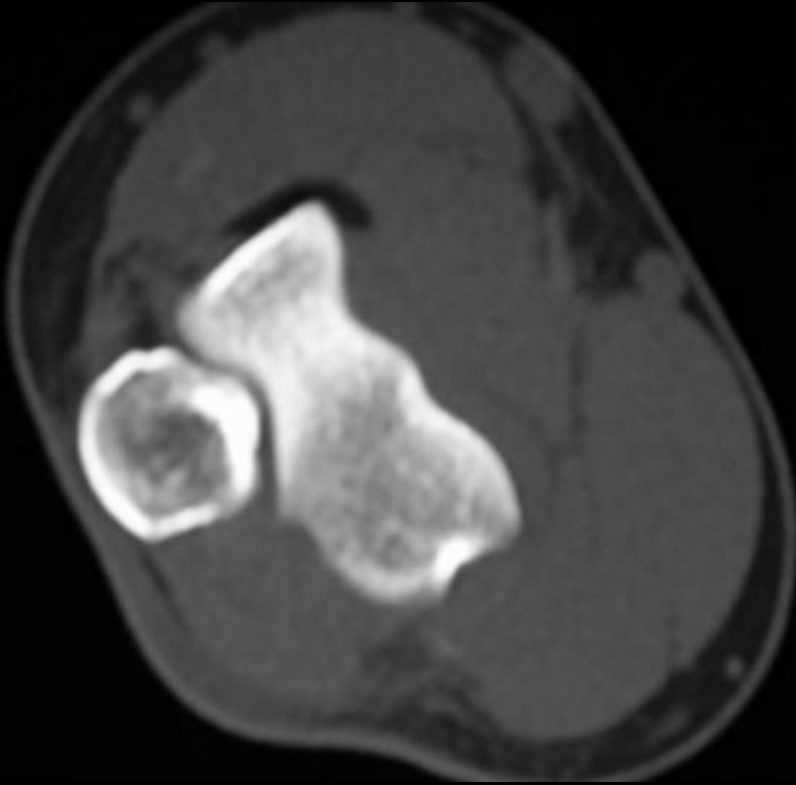


60 y/o female with pain s/p fall

Secondary Signs

# Lipohemarthrosis – Radial head Fx

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Secondary Signs

# Lipohemarthrosis

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Sag PD



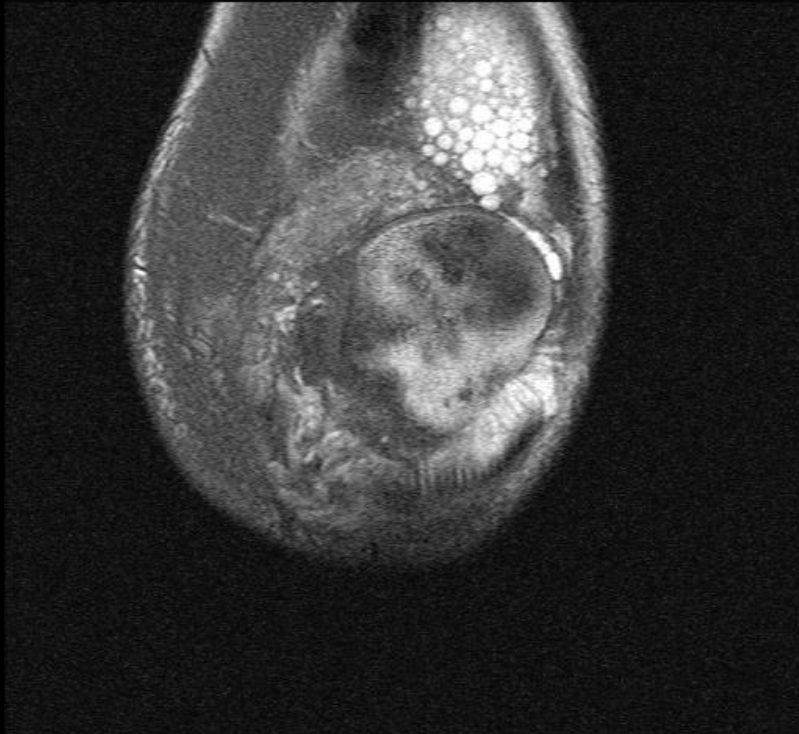
Sag T2FS

Bubbles may be more acute

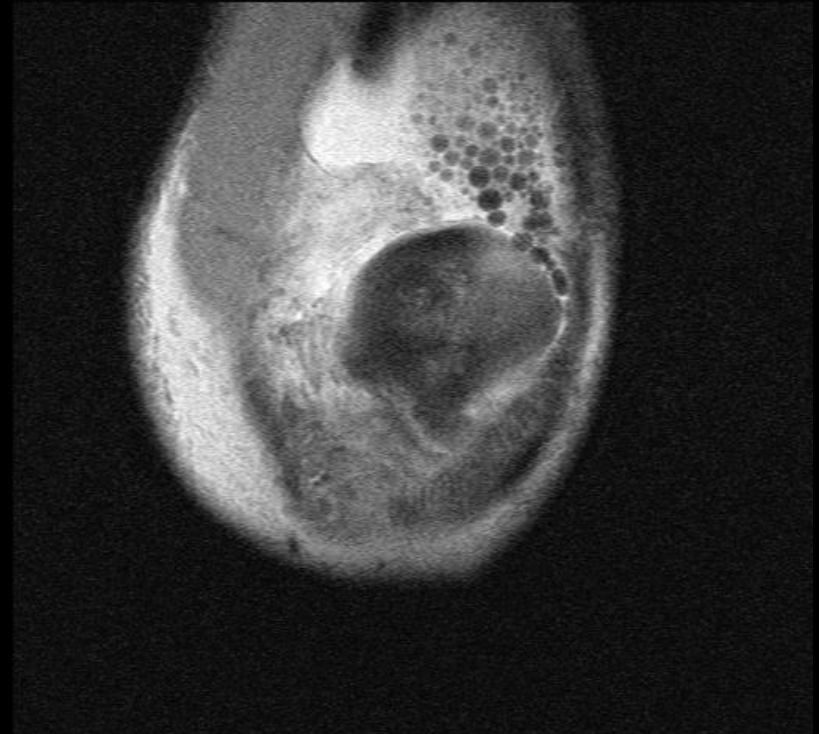
Secondary Signs

# Lipohemarthrosis

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Cor T1



Cor PDFS

Bubbles may be more acute



Secondary Signs

# Lipohemarthrosis

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Ax PDFS

Bubbles may be more acute

Lateral patella dislocation with patella Fx



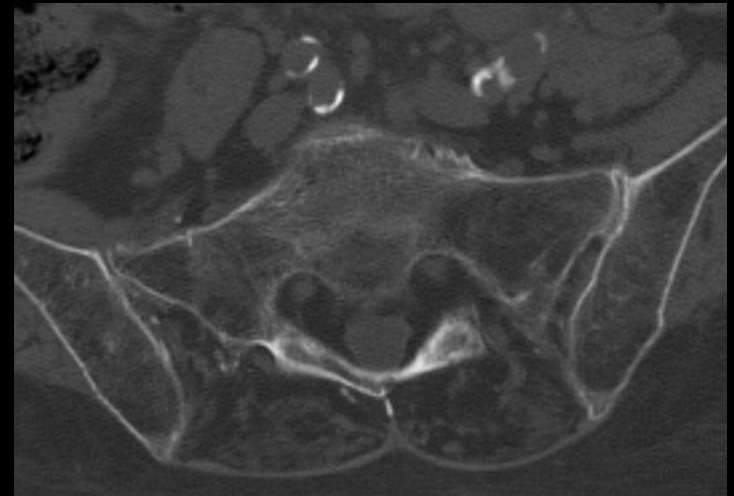
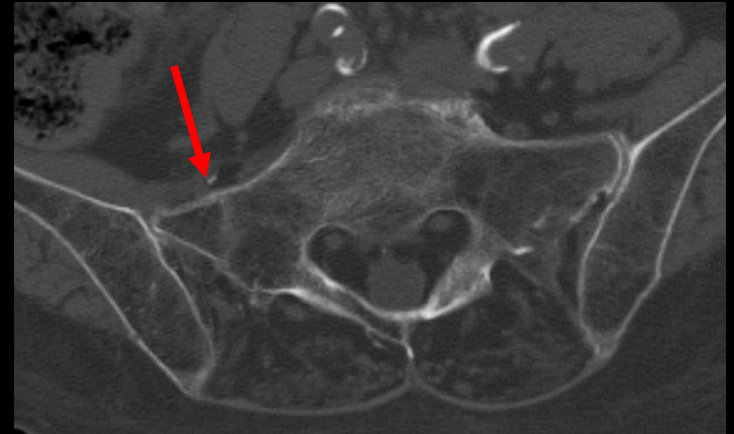
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  - Delayed sclerosis



# Bone edema on CT

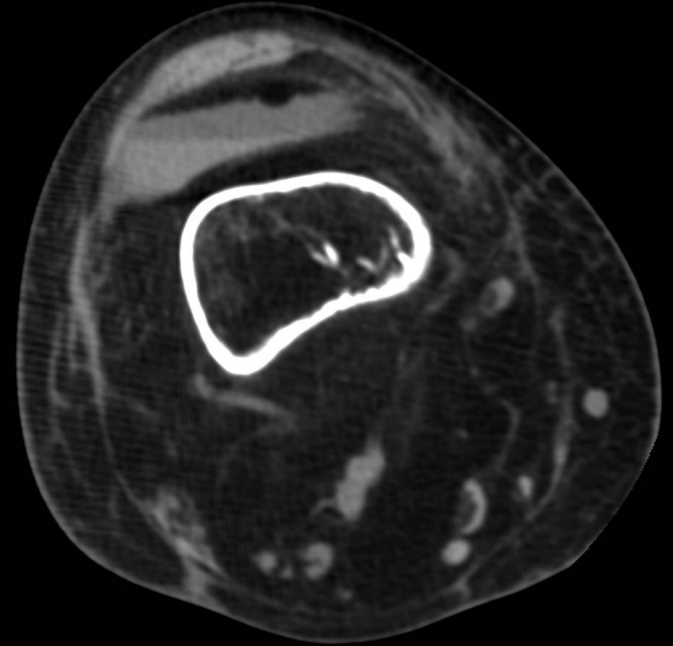
- Secondary signs
  - Joint effusion
  - Lipoarthrosis
  - Gas in joint
  - ST swelling
  - Obliteration of fat planes
  - Fat in joint on CT
  - **Bone edema on CT**
  - Intraosseous Vacuum
  - Delayed resorption
  - Delayed sclerosis



# Lipohemarthrosis

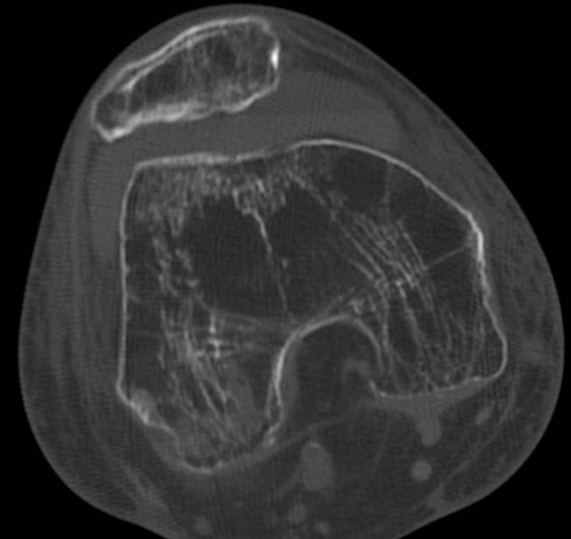
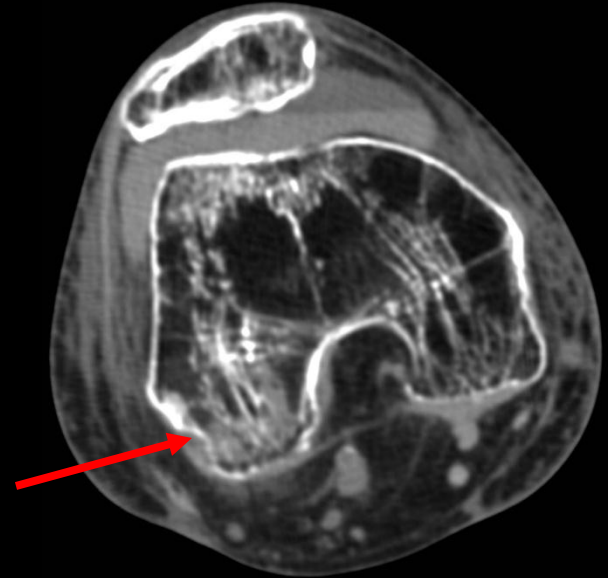
---

- Secondary signs
  - Joint effusion
  - Lipohemarthrosis
  - Gas in joint
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  - Fat in joint on CT
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# Lipohemarthrosis

- Secondary signs
  - Joint effusion
  - **Lipohemarthrosis**
  - Gas in joint
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  - Intraosseous Vacuum
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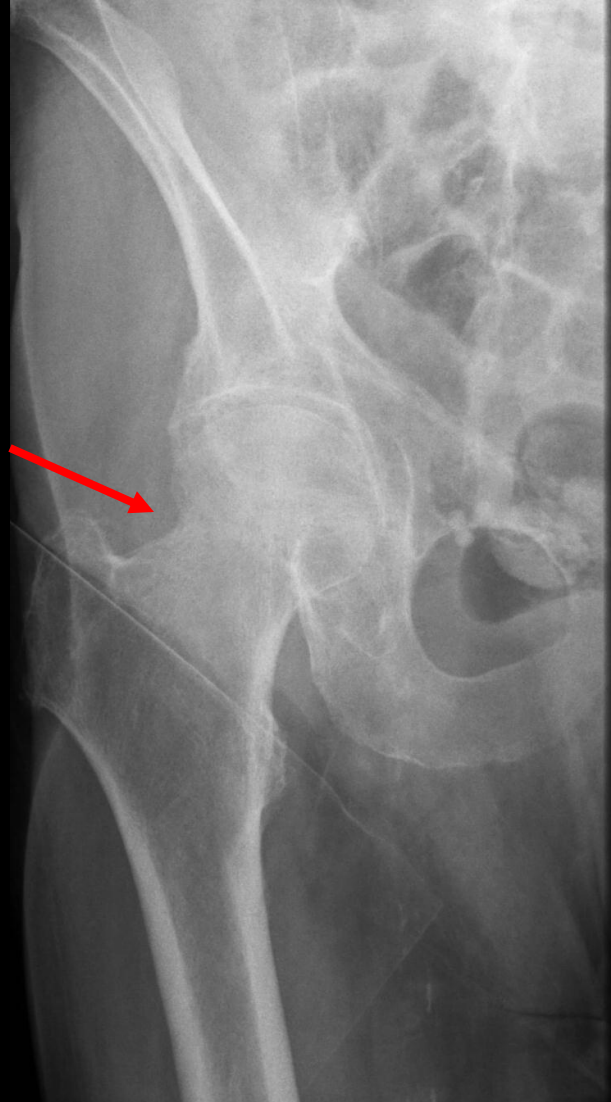




Secondary Signs

# Intraosseous Vacuum Phenomenon

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Secondary Signs

# Intraosseous Vacuum Phenomenon

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Secondary Signs

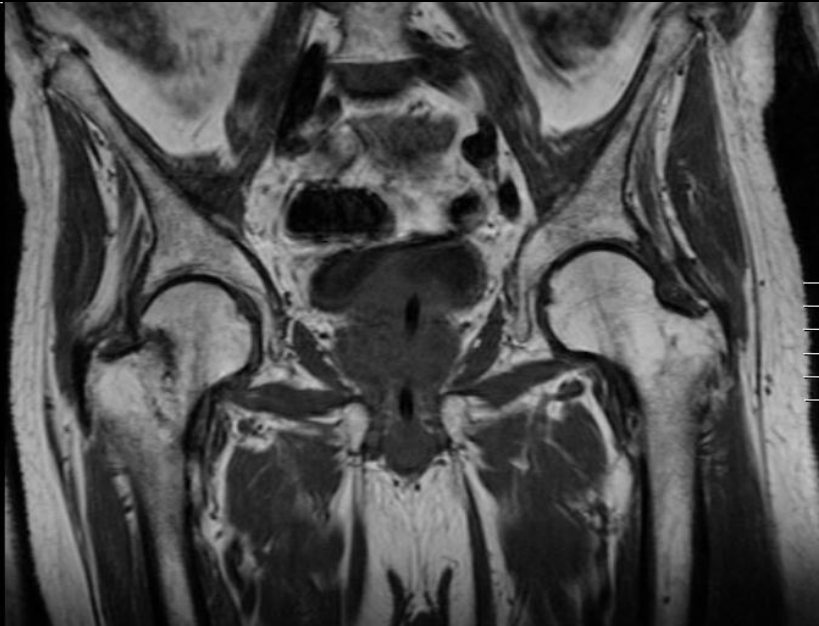
# Intraosseous Vacuum Phenomenon

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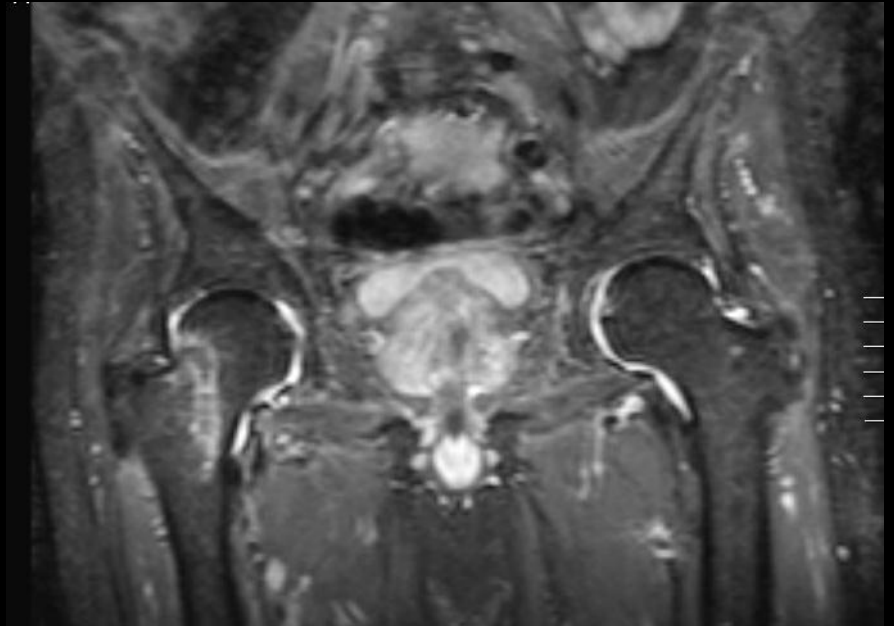


Secondary Signs

# Intraosseous Vacuum Phenomenon



Cor T1



Cor PDFS

## Secondary Signs

# Delayed resorption

- Secondary signs
  - Joint effusion
  - Lipohemarthrosis
  - Gas in joint
  - ST swelling
  - Obliteration of fat planes
  - Fat in joint on CT
  - Bone edema on CT
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  - Delayed resorption
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Acute



2w later

# Delayed resorption

---



## Secondary Signs

# Delayed sclerosis

---

- Secondary signs
  - Joint effusion
  - Lipohemarthrosis
  - Gas in joint
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  - Obliteration of fat planes
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Presentation



1 month follow up



# Ways to Avoid Missing Fractures

---

- Look for fracture patterns
- Look at regions that should align
- Look for secondary signs of fracture
- Look for the common sites of fractures
- Have check lists for each region
- Special circumstances

# Hill Sachs

---



ER



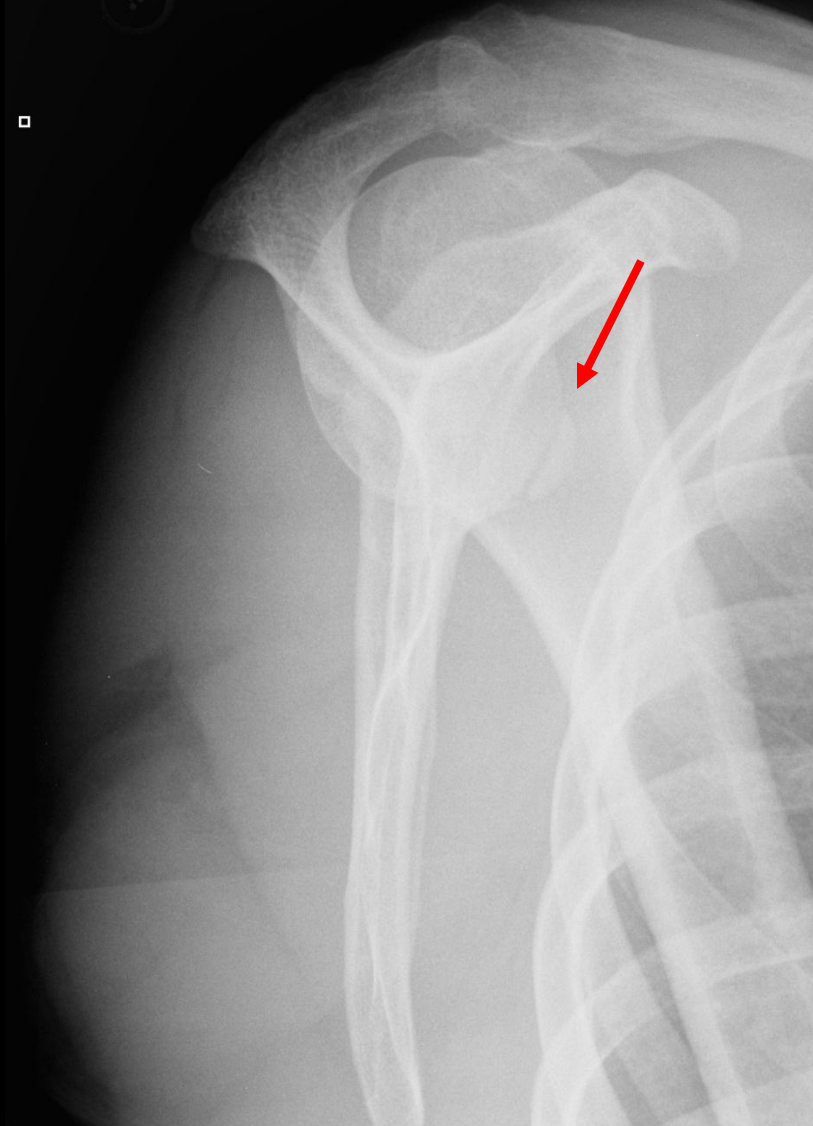
Neutral



IR

Stryker view – supine hand on head

# Bony Bankart



Consider Westpoint

# Greater Tuberosity of Humerus

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One of the most commonly missed fractures



# Hook of Hamate Fracture

---



Hook not seen on AP

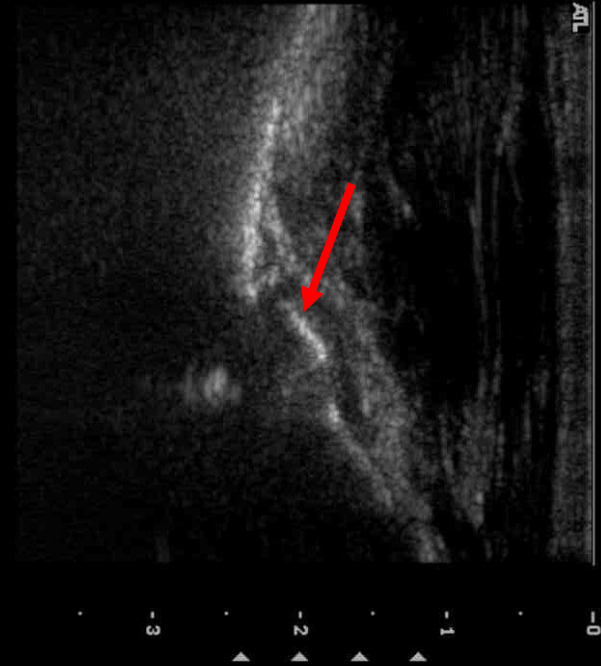


# Beak Ligament Avulsion Fracture

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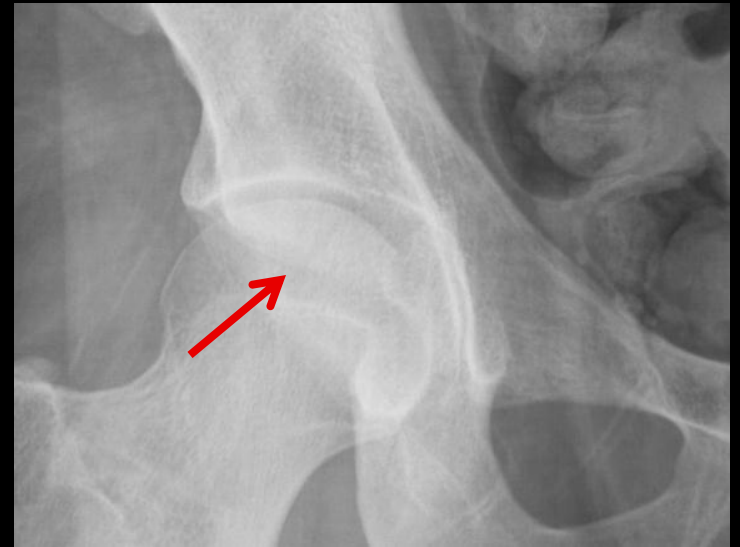
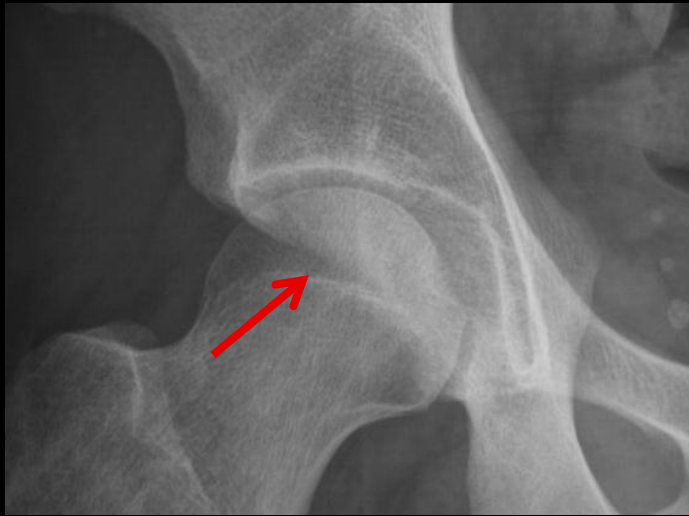


R THUMB CMCJ LONG



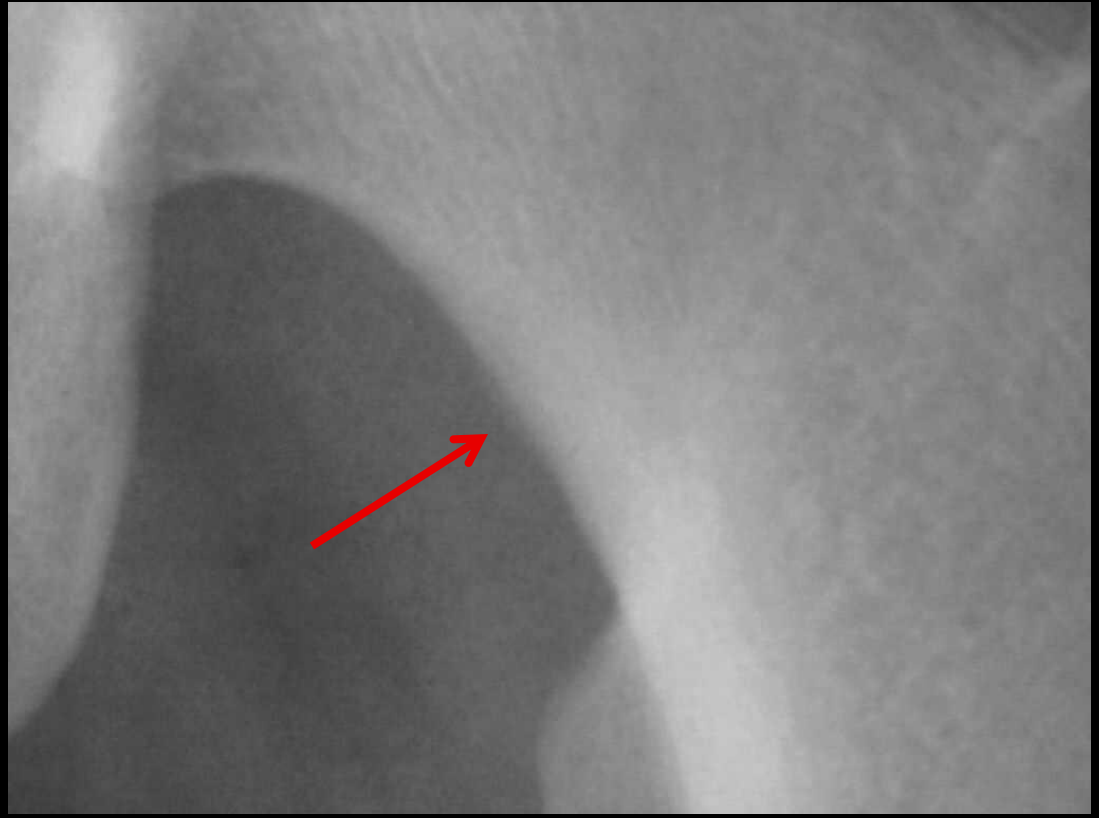


# Acetabular fracture



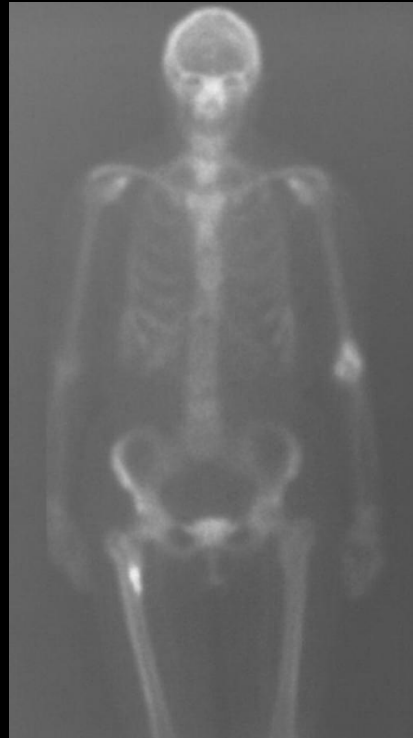
# Femoral Neck Stress Fracture

---



# Proximal Femoral Stress Fracture

---



# Tibial Plateau Fracture

- Fall with twist
- Ped V's MVA
- 50% > 50Y
- 80% lateral due to valgus
- Obliques useful
- MRI for diagnosis
- CT to stage
- Schatzker classification



# Segond Fracture

---



Segond fracture suggests the presence of significant pathology

A small, vertically oriented, avulsed bony fragment

Involves the lateral aspect of the proximal lateral tibia

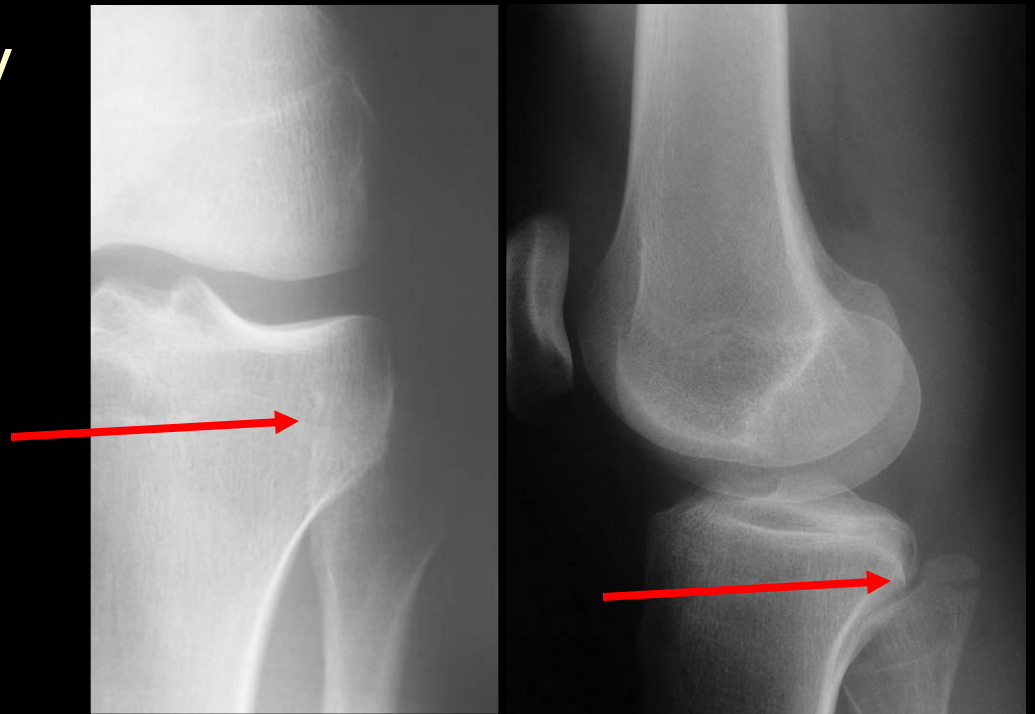
Nearly always associated with a tear of the anterior cruciate ligament in the older population

Alternatively, an avulsion of the tibial spines is seen in younger patients

# Proximal Fibula Fractures

---

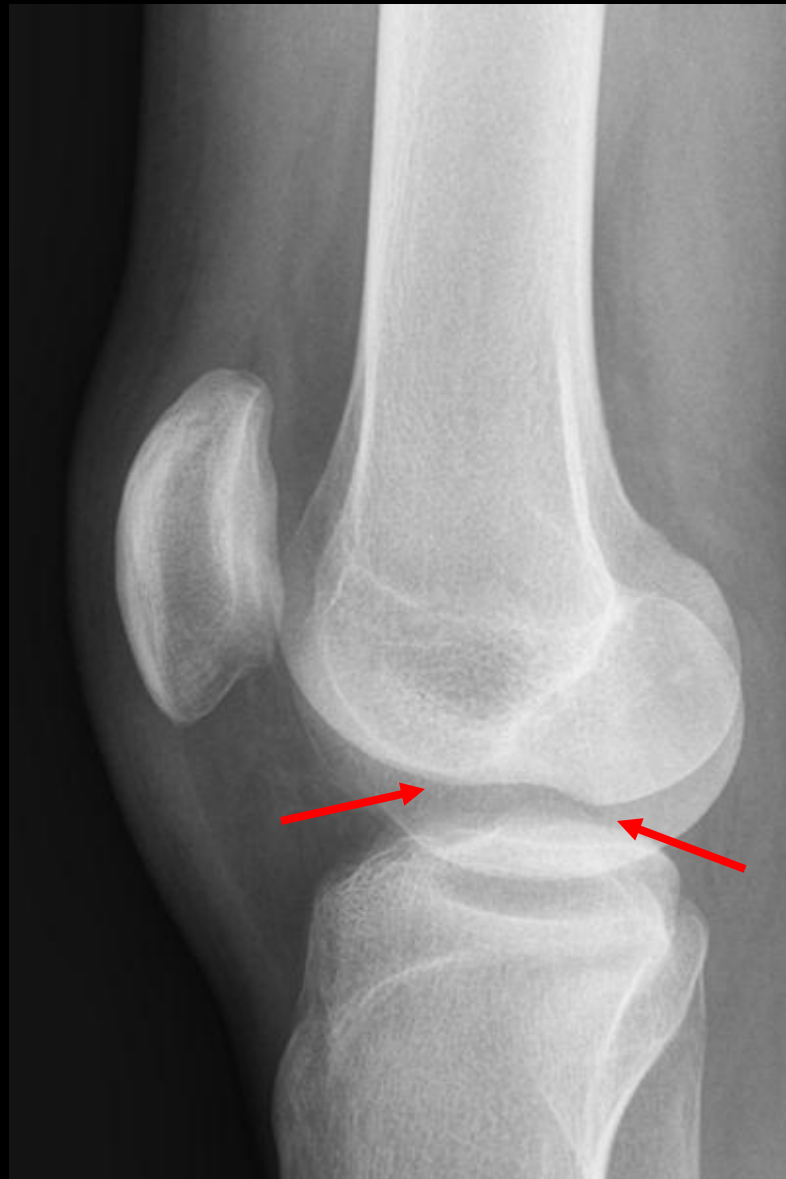
- Can indicate an unstable posterolateral corner
- Ass. ACL injury





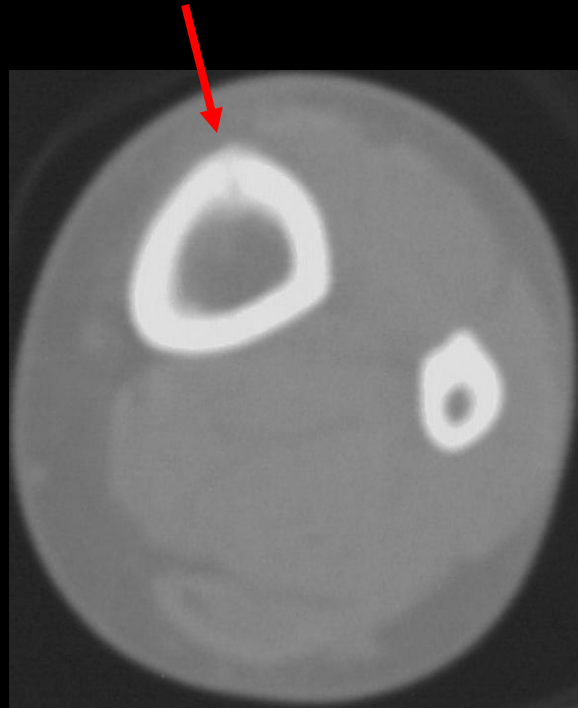
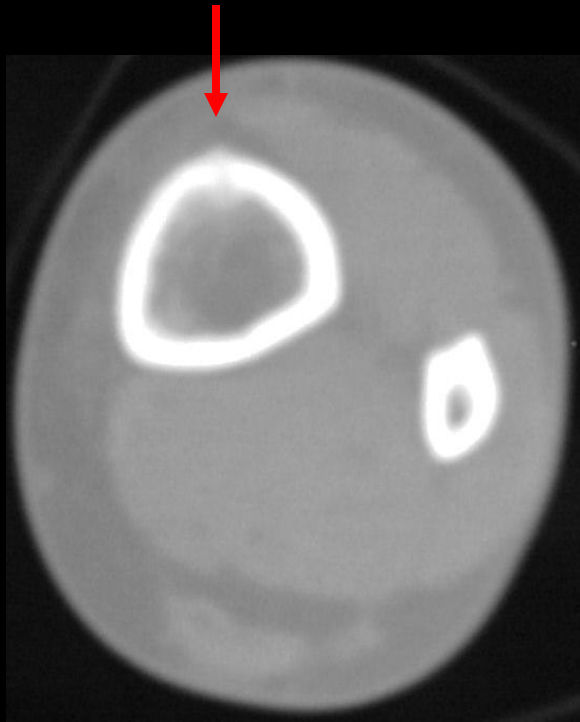
# Deep lateral condylopatellar notch

---



# Longitudinal Stress Fracture

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# Toddler Fracture

---



# Metatarsal Stress Fractures



2nd metatarsal neck stress fx 28F

# Ways to Avoid Missing Fractures

---

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# Ankle Injury - Check List

---

- **Malleoli**
- Lateral process of Talus
- Talar dome
- Anterior process of Calcaneus
- EDB avulsion
- Base of 5<sup>th</sup> metatarsal
- Jones fracture
- Does ankle fracture suggest Maisonneuve
- Dorsal chip fractures





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# Special circumstances

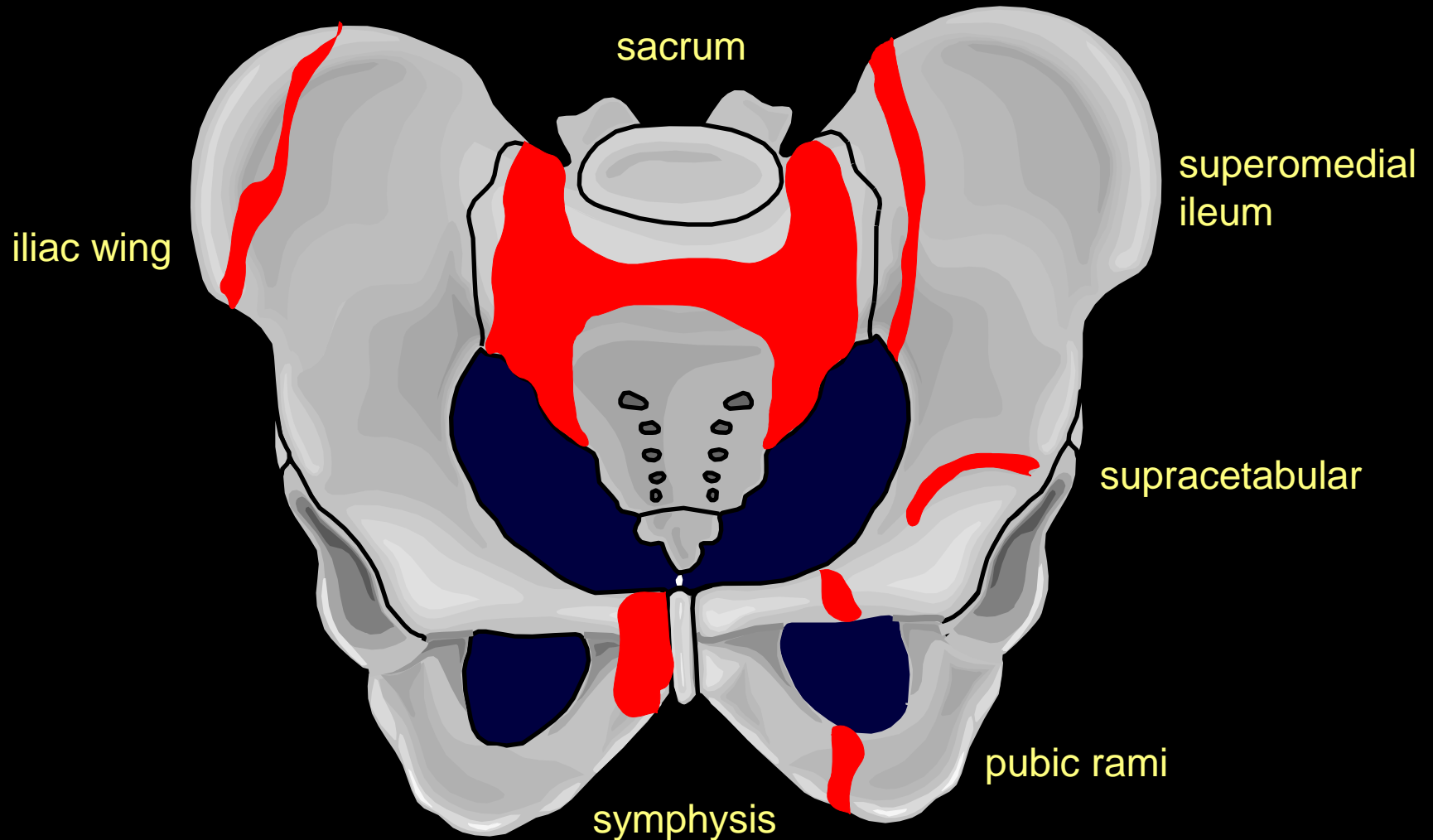
## Elderly

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- Fractures often hard to see
- Degenerative changes obscure fractures
- Fatty marrow makes bone edema useful sign
- Fractures more often fatal
- If alters management, low threshold for MRI

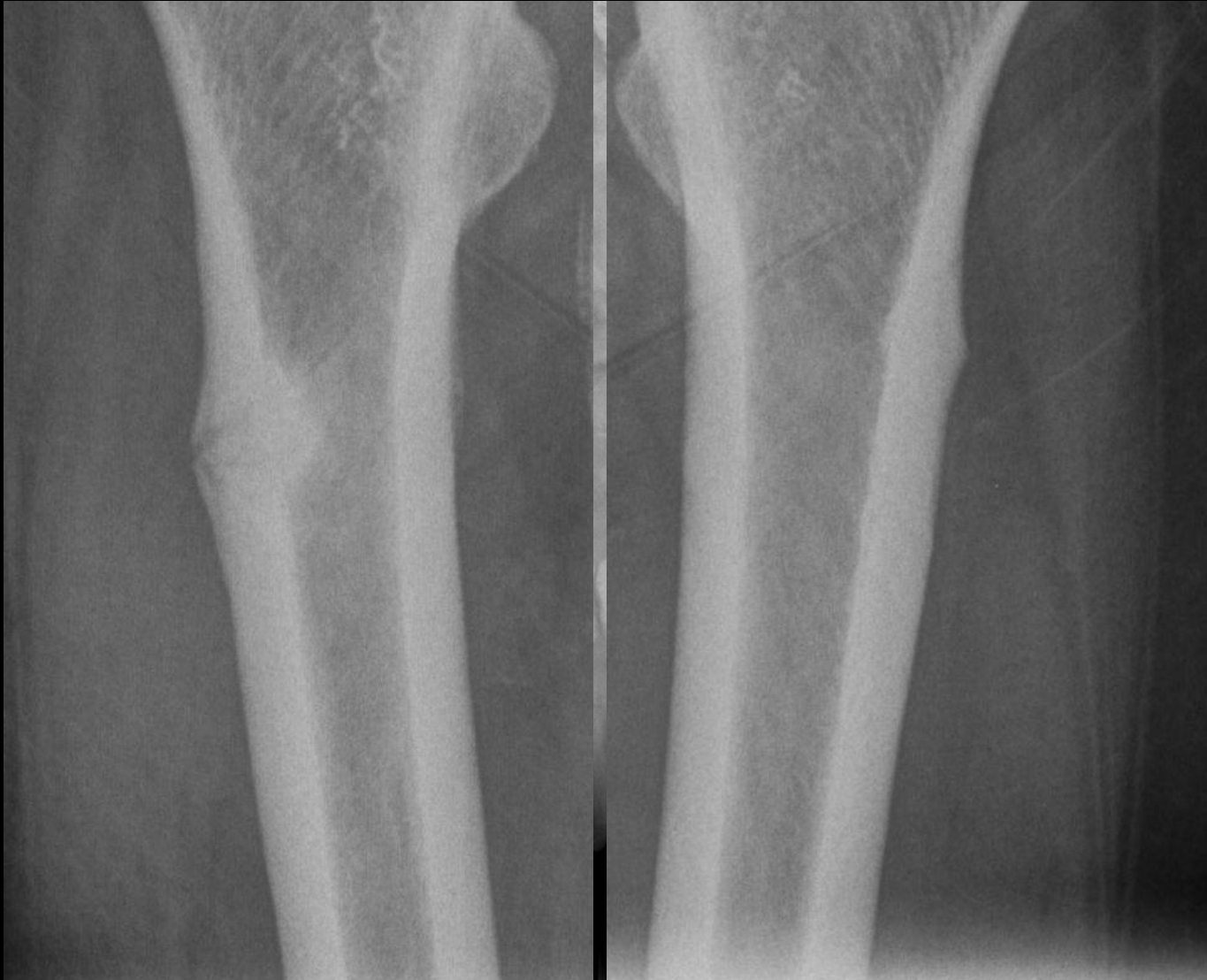
# Pelvic Insufficiency Fractures

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# Bisphosphonate fractures proximal femur

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84 year old female with bilateral hip pain



# Pathologic lesser trochanteric avulsion

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# Special circumstances

## Childhood Fractures

---

- Tendons stronger than bone
  - Apophyseal avulsion

- Fracture patterns
  - Salter Harris

- Incomplete fractures
  - Plastic bowing
  - Torus / Buckle
  - Greenstick

- Remember NAI



# Childhood Fractures

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- SCFE is Salter 1 fracture of femoral epiphysis
- Bilateral in 25%
- Best seen on frog-leg lateral



# Childhood Fractures

---

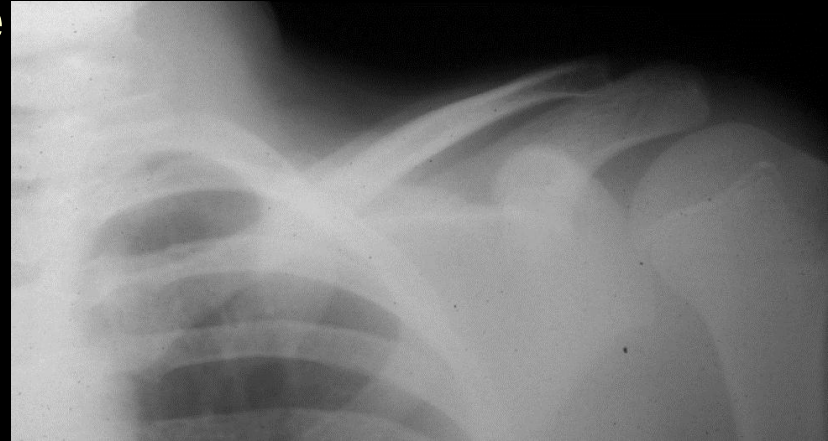
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# Problem solving

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- Repeat
- Oblique views
  - Tibial plateau
  - Radial head
- Dedicated views
  - Scaphoid
  - Radial head
- Single emulsion
  - Periphery
- Tomography, CT, MRI, Scintigraphy