



# Imaging the Musculoskeletal System

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# Radiology Team 429

**In this team we used the outlines from the:**

**Doctor's slides**

**Lecture notes are in red boxes**

**427 Radiology team**

**Diagnostic Imaging –PETER  
ARMSTRONG – 6<sup>Th</sup> Edition**

**Sorry we don't hold responsibility for any missing information or perhaps – perhaps -wrong material.**

**We tried our best to present this lecture in the best way, and we hope what we wrote is enough to cover the subjects.**

**Team Leaders:**

Abdulmajeed Al-Sadhan, Ibrahim Al-Sadhan, Sarah Mahasin

**Team Members:**

Arwa Al Madani, Abdullah Alessa

**Best Wishes : )**



# OBJECTIVES

The main focus and objective of this lecture is to help student to be competent in looking at MSK images and interpreting findings, by learning:

- Normal radiological anatomic landmarks
- System of analyzing findings

BONE DENSITY  
BONE TEXTURE  
DISTORTION /  
DISPLACEMENT  
OF NORMAL  
STRUCTURES



"Where to look & What to look for"

IMPORTANT SITES

- Recognize features of certain disease entity





# **IMAGING OF MUSCULOSKELETAL SYSTEM**

PLAIN FILM

Corner Stone

COMPUTED TOMOGRAPHY

MAGNETIC RESONANCE IMAGING

ULTRASOUND

ANGIOGRAPHY

NUCLEAR MEDICINE

Useful in complex skeletal trauma

Useful in bone, joint, soft tissue







# **IMAGING OF MUSCULOSKELETAL SYSTEM**

- Tendons/ligaments/muscles.
- Detect fluid collections around joints or within muscles.
- Soft tissue masses and cysts.

ULTRASOUND

ANGIOGRAPHY

NUCLEAR MEDICINE

bone scan is very sensitive  
but is relatively non-specific



# Notes Imaging Modalities

- **Plain Film:**
  - Most of bone pathology can be seen by plain films
  - Certain areas (complex anatomy such as shoulder & pelvis) needs further imaging evaluation by CT or MRI; in particular in cases of trauma.
- **CT:** is better in trauma because it is faster and show bone cortex and trabecular texture
- **MRI:**
  - Useful in bone, joint, soft tissue, bone marrow changes, the joint
- **Ultrasound:**
  - Tendons/ligaments/muscles.
  - Detect fluid collections around joints or within muscles. Soft tissue masses and cysts
  - initial for the soft tissue structures, architecture of the tendon and ligament
  - fluid: hematoma in the soft tissue of the muscle

# Notes Imaging Modalities

- **Angiography:**
  - vascular structures, imp in surgical management (underlying pathology), not specific but high sensitivity, not a diagnostic modality
  - imp in surgical management of underlying pathology “tumors”
  - imp in interventional approach in vascular malformation in the limbs for example
- **Nuclear Medicine:**
  - bone scan is very sensitive but is relatively non-specific

# Interpreting Images

Look at:

- Bone density
- Bone texture
- Distortion /displacement of normal structures
  
- Cortex of the bone
- Margins of the bone
- Articular surface of the joint
- Junction between the cortex and the medulla
- Pediatric: epiphyseal plate

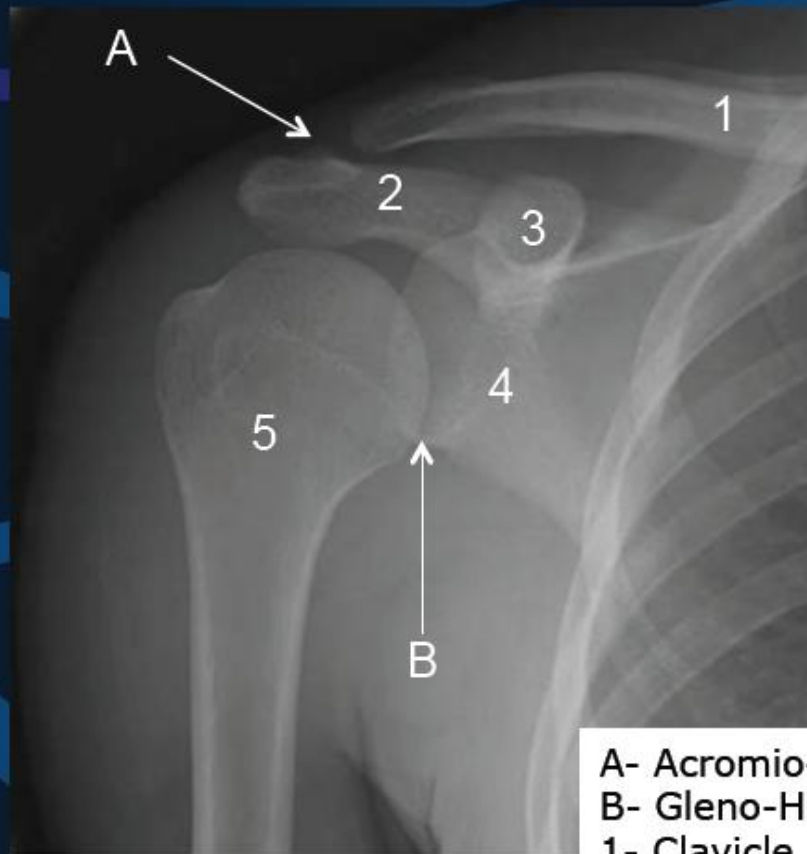




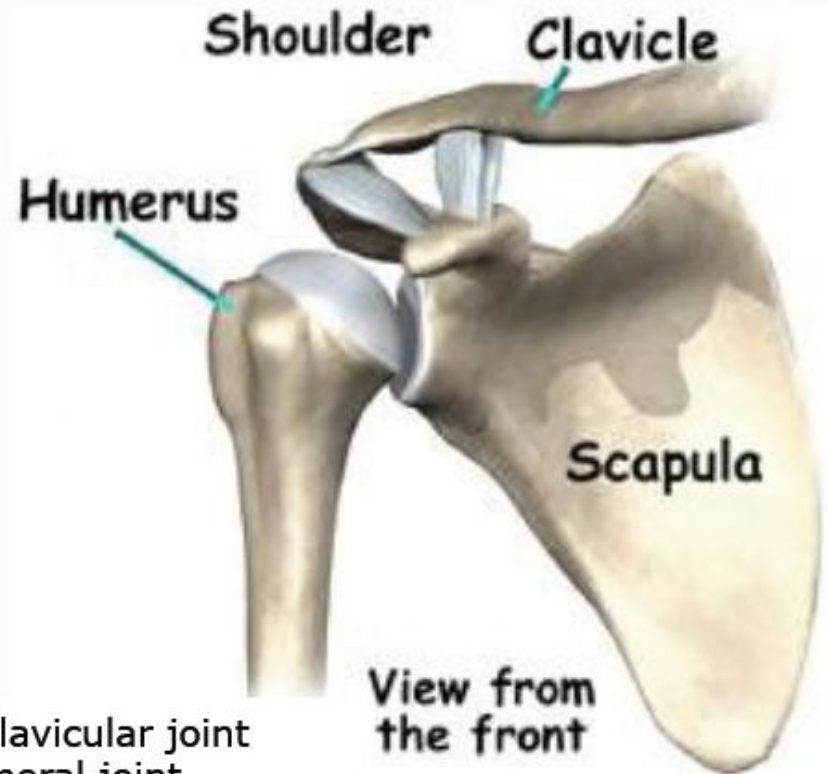
# *MUSCULOSKELETAL RADIOLOGICAL ANATOMY*

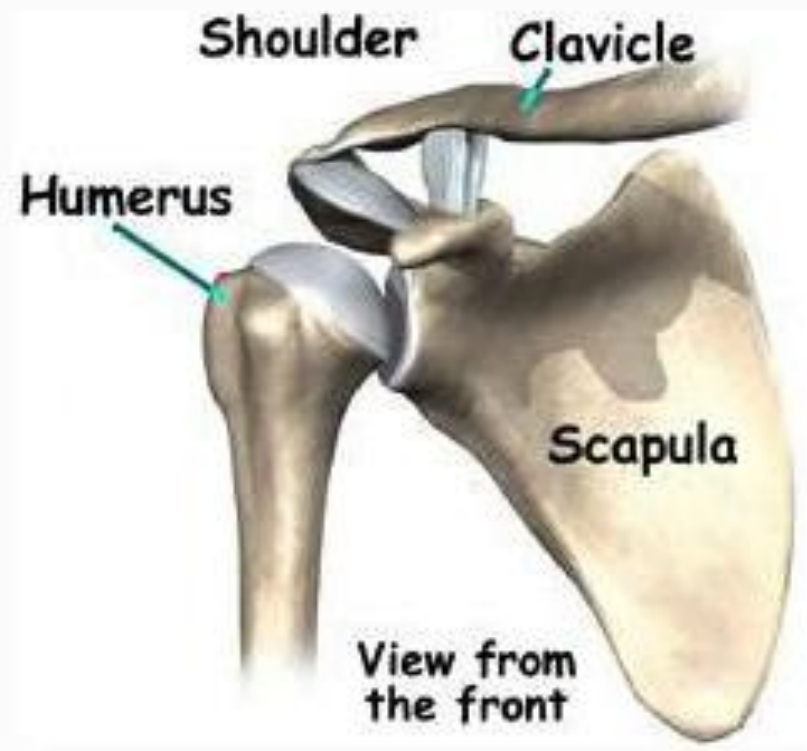


## Musculoskeletal Radiological Anatomy



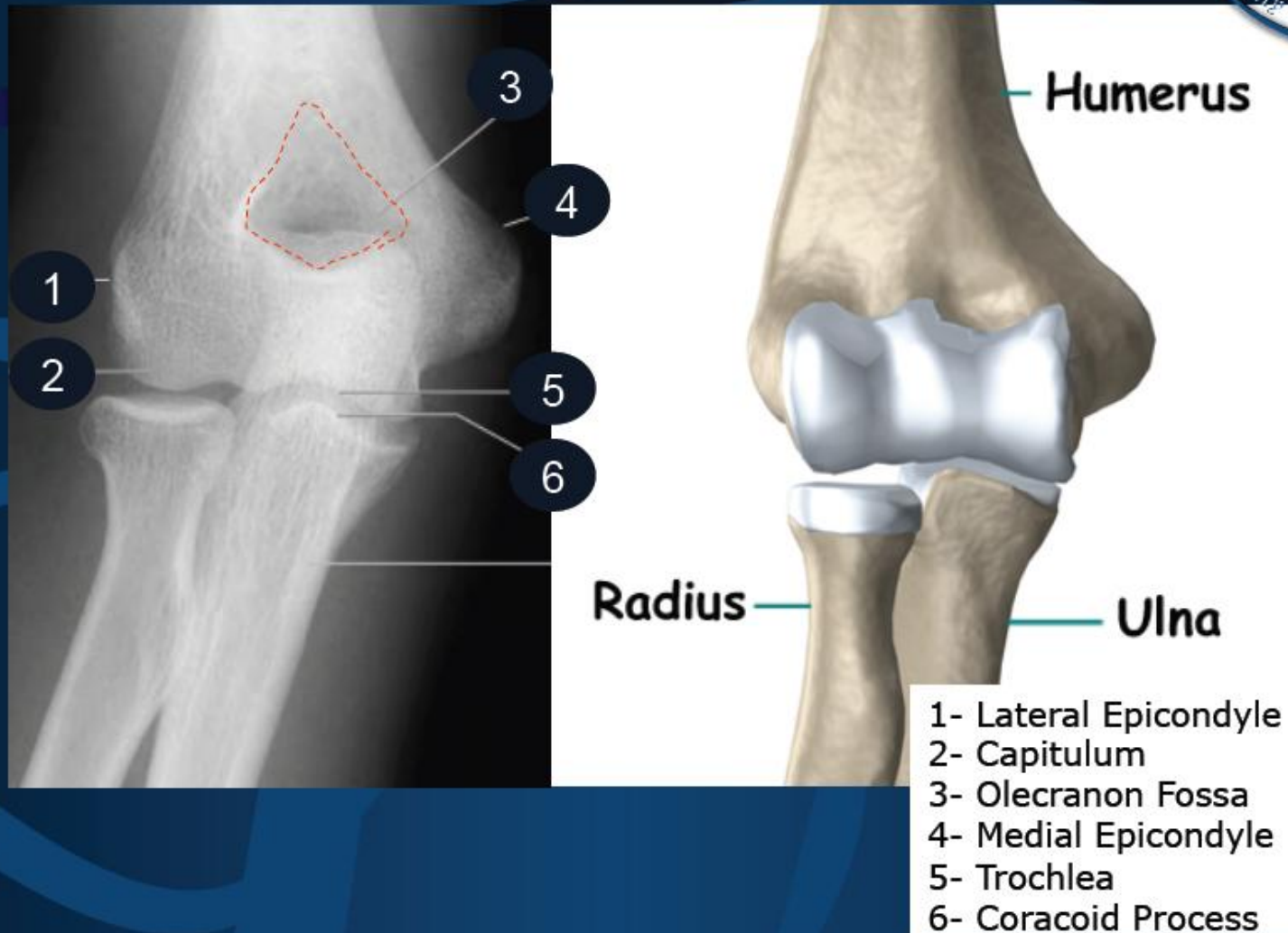
- A- Acromio-Clavicular joint
- B- Gleno-Humeral joint
- 1- Clavicle
- 2- Acromioclavicular process
- 3- Coracoid process
- 4- Glenoid process
- 5- Humerus





**The shoulder joint**

## Musculoskeletal Radiological Anatomy

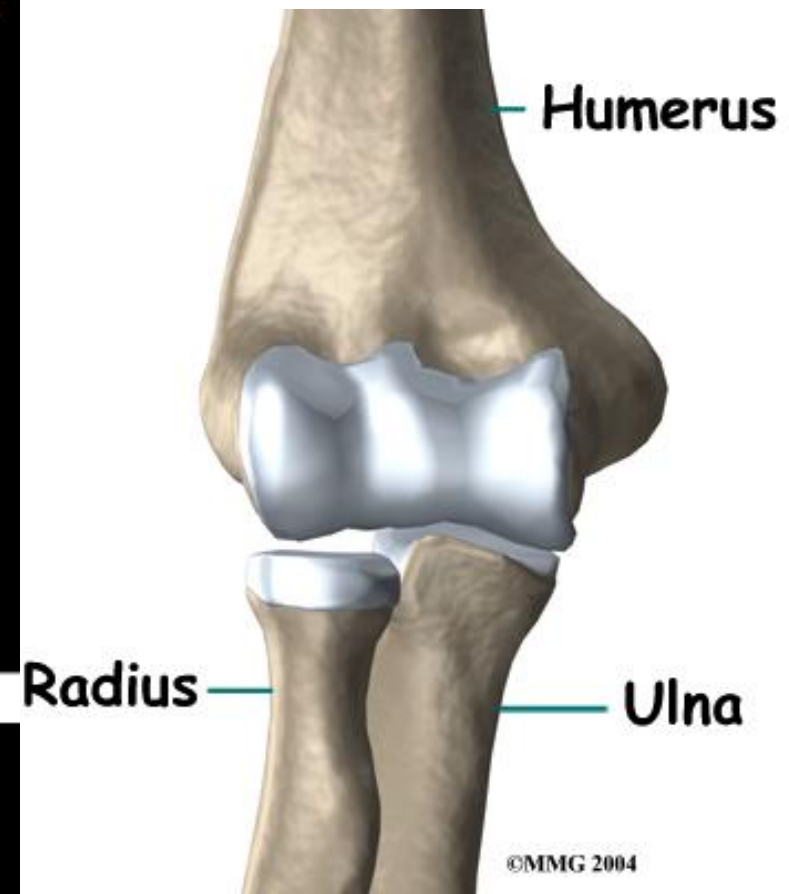




Anteroposterior view

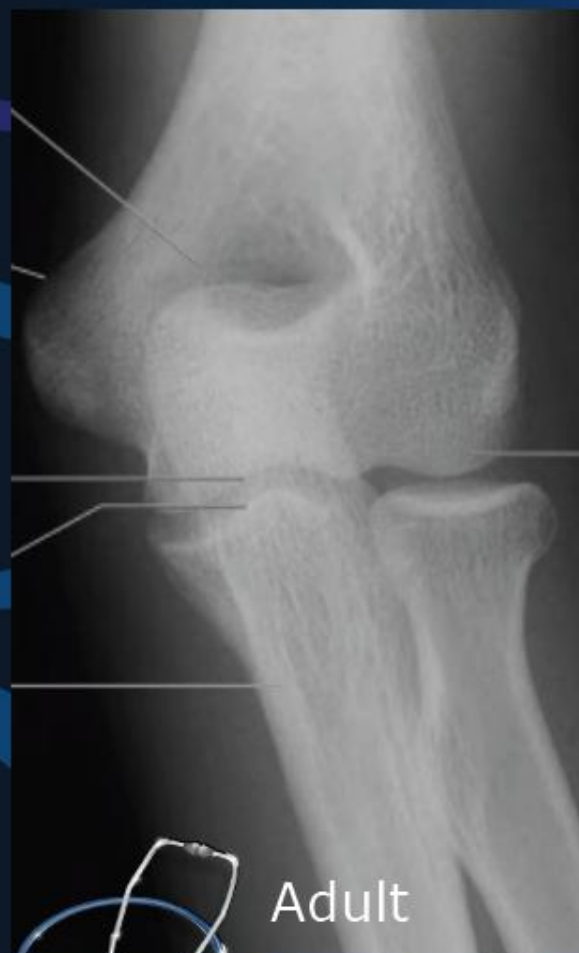


Lateral view





## Musculoskeletal Radiological Anatomy



Adult



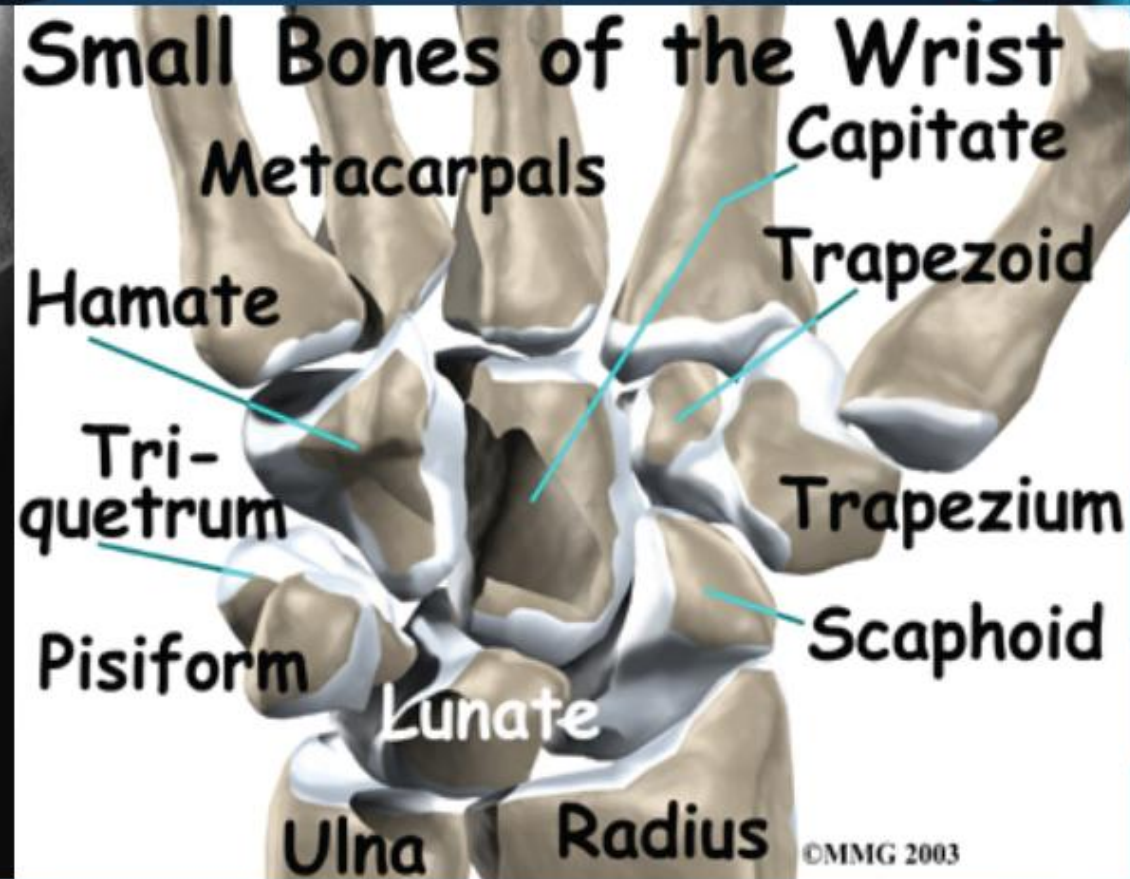
Child 11-Year old



Child 5-Year old



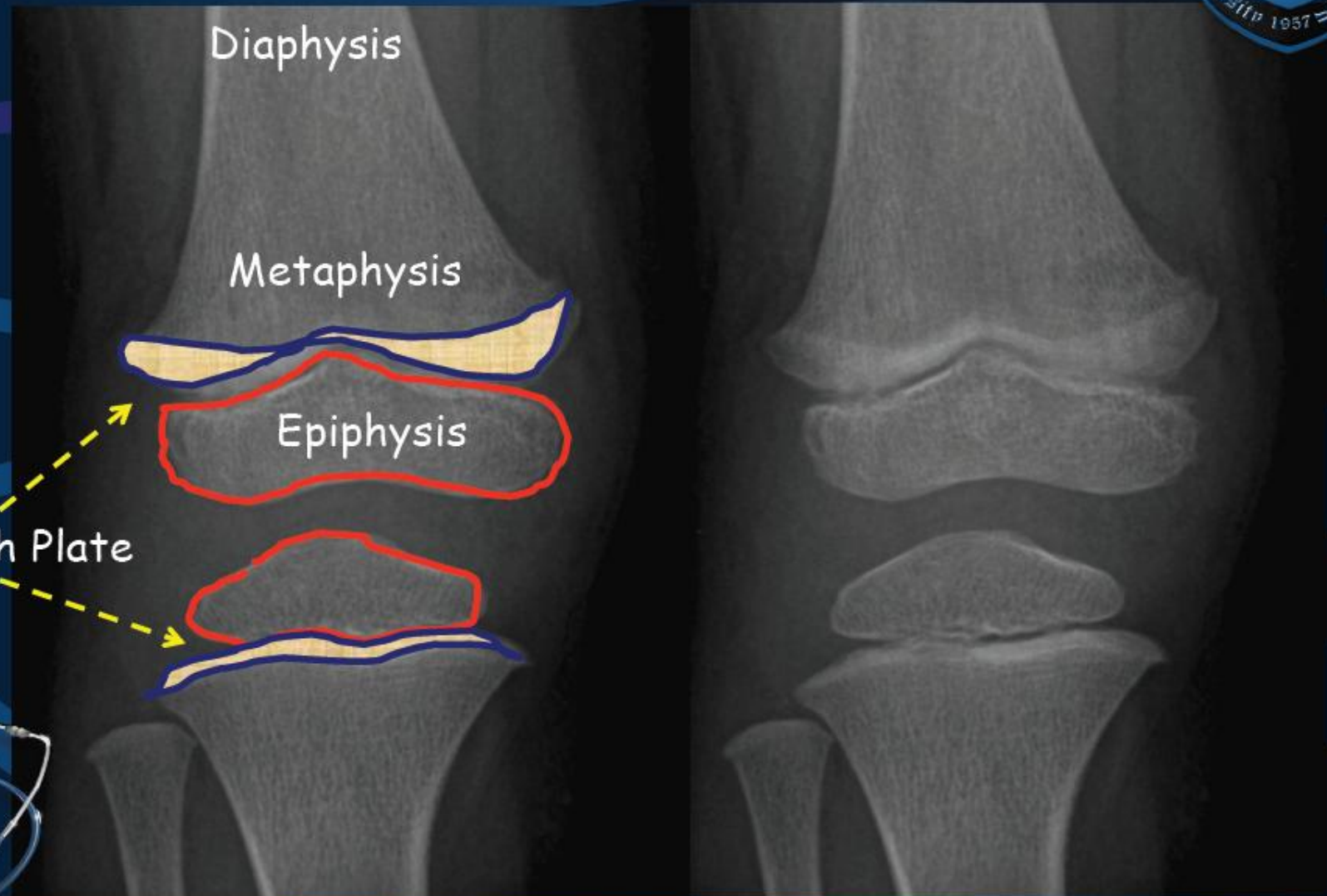
## Musculoskeletal Radiological Anatomy



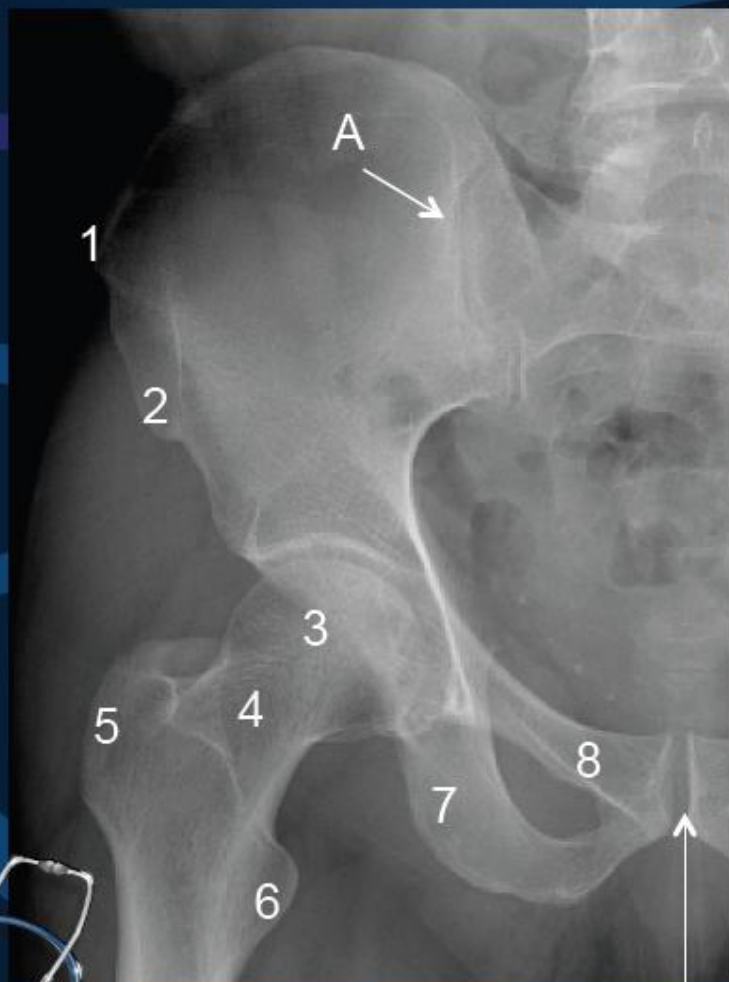
8 Carpal bones : 4 proximal, 4 distal



## Musculoskeletal Radiological Anatomy



## Musculoskeletal Radiological Anatomy



- A-Sacro-iliac Joint
- B-Symphysis Pubis
- 1- Superior Anterior Iliac Spine
- 2- Inferior Anterior Iliac Spine
- 3- Femur Head
- 4- Femur Neck
- 5- Greater Trochantara
- 6- Lesser Trochantara
- &- Ischium
- 9- Superior Pubic Ramus

**Pelvis**

**Labrum**

**Femoral Head**

**Femur**

**Acetabulum  
(Hip Socket)**



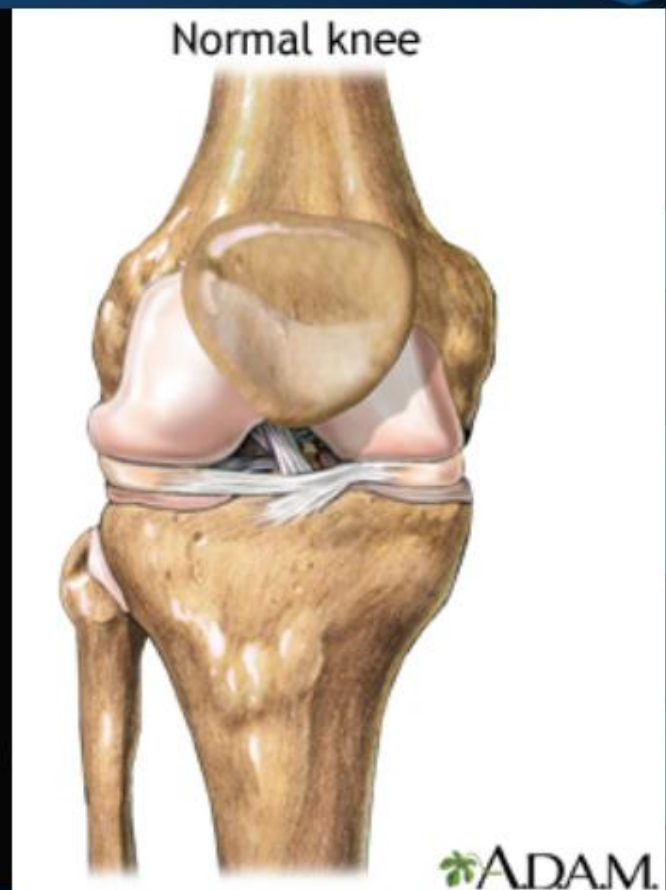
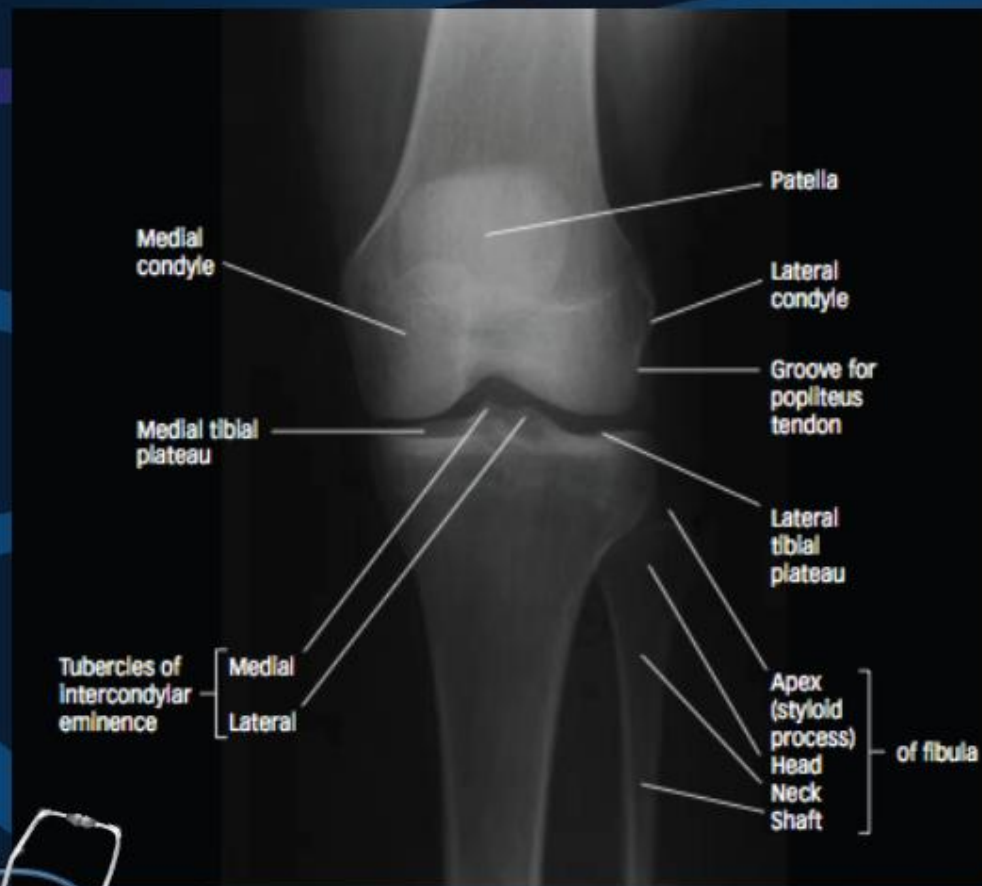


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## Musculoskeletal Radiological Anatomy



# INTERPRETATION

Normal

Rickets

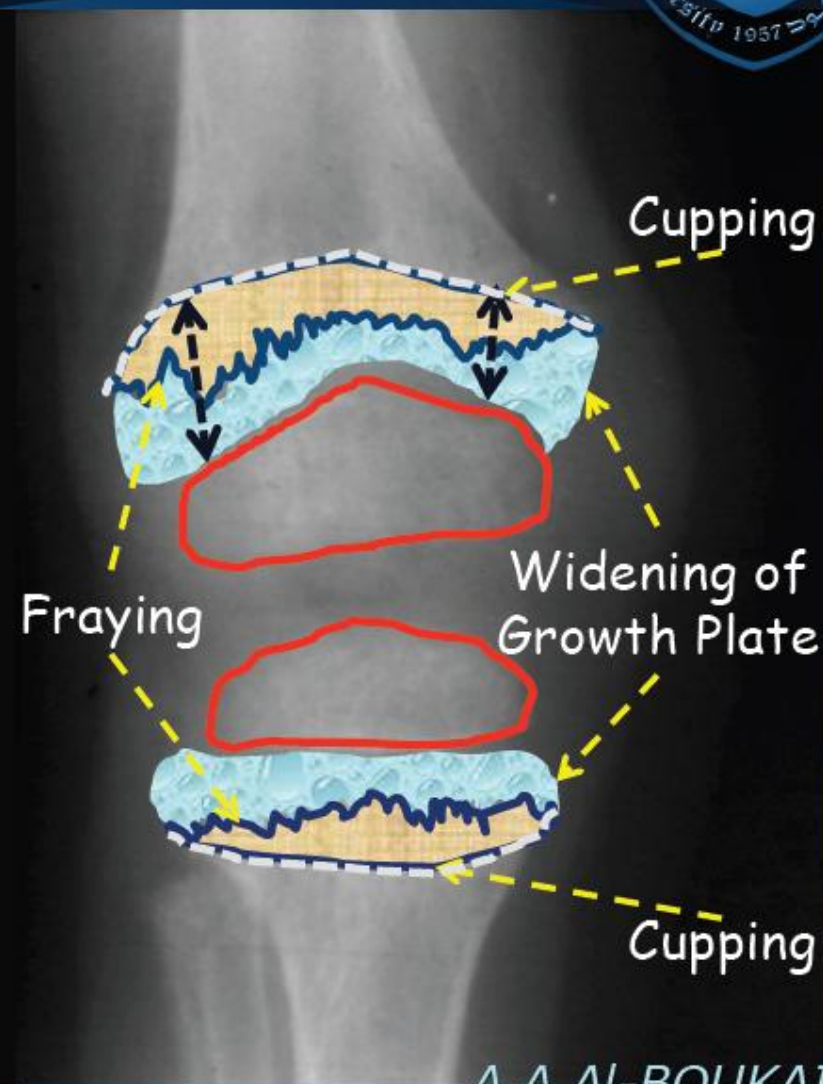
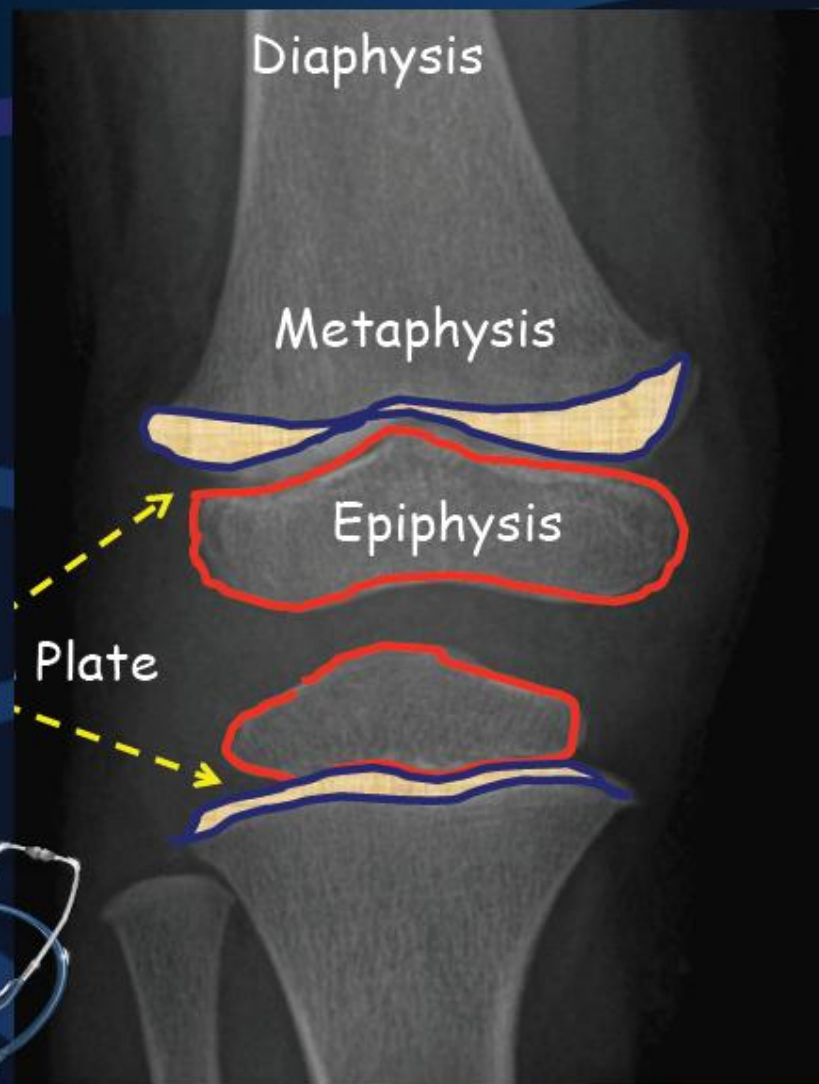


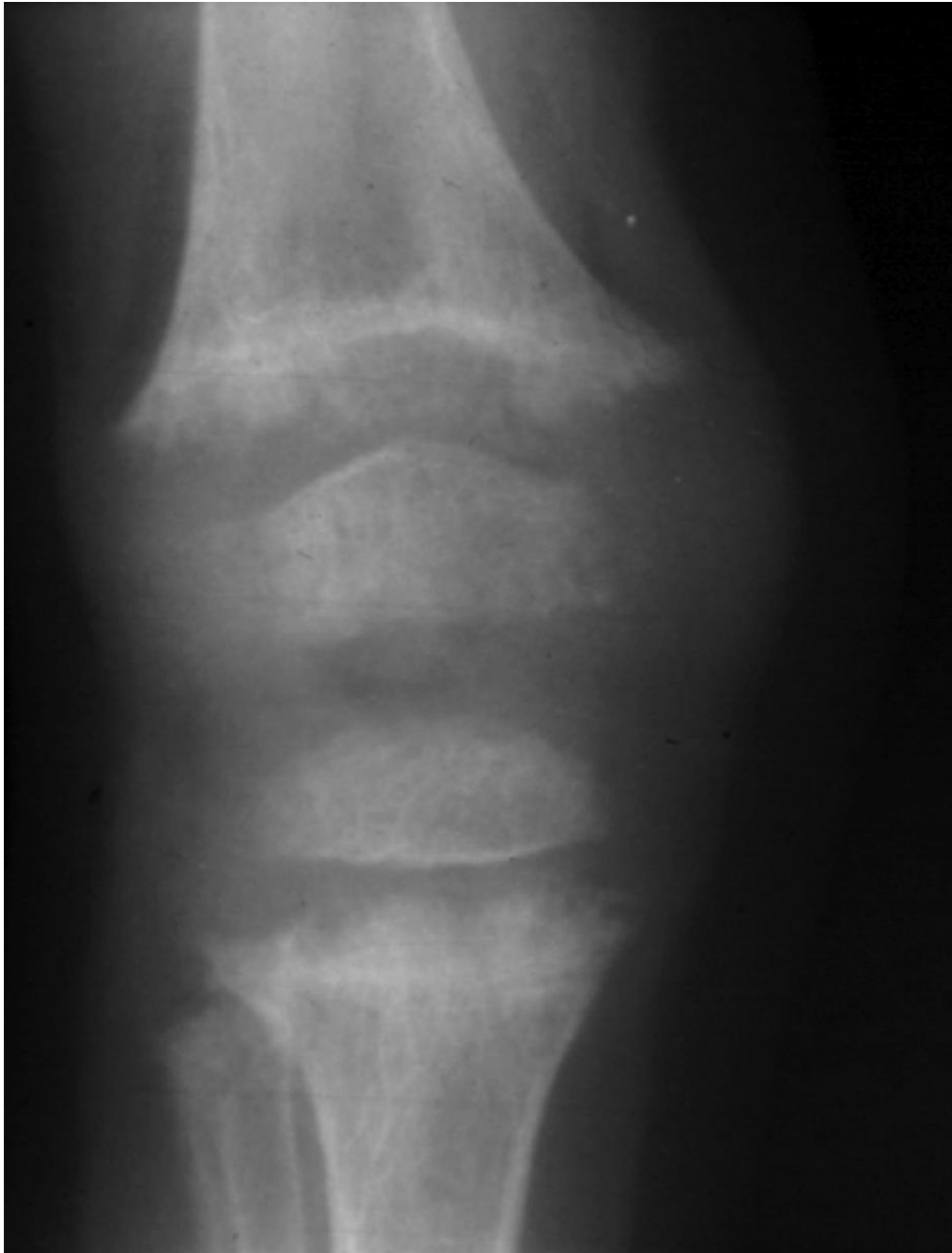


# INTERPRETATION

Normal

Rickets





- Borders are not sharp, ill defined
- Trabecule is hazy, hazy texture
- Growth plate is widened
- Metaphyseal margin is irregular
- Cartilage invaginates the bone
- Patella is normally not ossified in a patient infants



# OBJECTIVES

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"Where to look & What to look for" A A Al-BOUKAI-15



# *MUSCULOSKELETAL PATHOLOGY*

*Congenital*

*Arthritis*

*Metabolic*

*Trauma*

*Infectious*

*Hematological*

*Neoplastic*





# *MUSCULOSKELETAL RADIOLOGICAL TRAUMA*







# ***BASIC PRINCIPLES IN RADIOLOGY OF BONE TRAUMA***

- Two perpendicular views.
- Radiograph should include the joint nearest to the trauma.
- The paired bone concept.
- The weakest link concept (Adult vs. Children).
- Comparison films.



# Basic Principles

- Two perpendicular views
  - Frontal
  - Lateral
- Paired bone concept:
  - if one is fractured check the other it may be also fractured or dislocated from either end
- Weakest link concept: the weakest component in children is the bone, adult is the soft tissue (bone is more consolidated)
  - Adults: The soft tissue structures (muscles/ ligaments/ tendons)
  - Children: The physeal plate (growth plate)





# *TERMINOLOGY IN BONE TRAUMA*

DISLOCATION vs. SUBLAXATION

CLOSED vs. OPENED FRACTURES

GREENSTICK vs. TORUS FRACTURES

PHYSEAL INJURIES

STRESS FRACTURES

PATHOLOGICAL FRACTURES



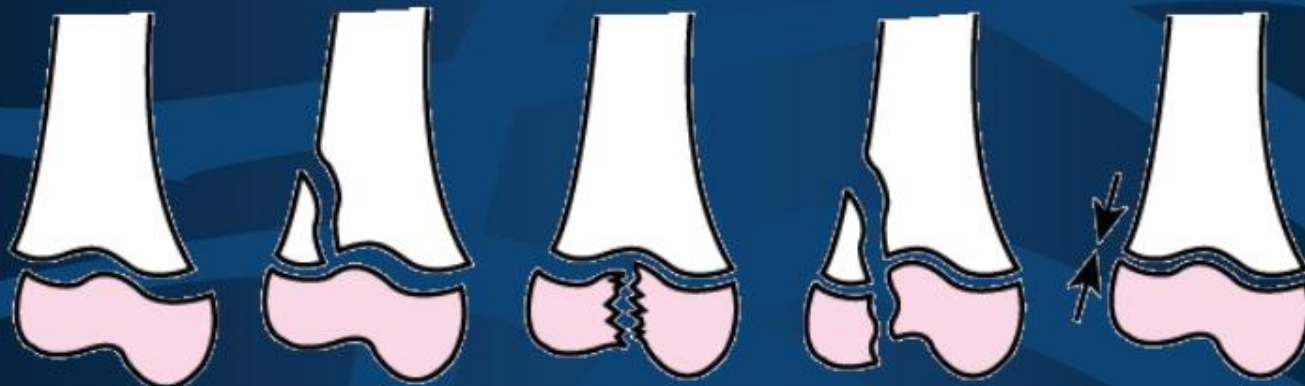
# Bone Trauma Terminology

1. **Dislocation:** bones in a joint become displaced or misaligned . It is often caused by a sudden impact to the joint. The ligaments always become damaged as a result of a dislocation.
1. **Subluxation:** is an incomplete or partial dislocation of a joint or organ. The fracture is partial and intact in some position and displaced.
2. **Closed fracture:** is a broken bone that does not penetrate the skin
3. **Open (compound) fracture:** involve wounds that communicate with the fracture and disruption of overlying skin. May expose bone to contamination
4. **Greenstick fracture:** a fracture that penetrates (perforate) one cortex while the opposite one is still intact (ramifies within the medullary bone). It is an incomplete fracture of a long bone, usually seen in young children.
5. **Torus fracture (Buckle fracture):** is an injury which is insufficient to break the cortex and instead it will produce buckling usually metaphyseal in location. It often results from trabecular compression from an axial type loading force (along long axis of bone). Usually seen in children, frequently in the distal radius diaphysis or metaphysis.

# Bone Trauma Terminology

6. **Stress Fractures:** overuse injuries of bone. These fractures, which may be nascent or complete, result from repetitive sub-threshold loading that, over time, exceeds the bone's intrinsic ability to repair itself . It typically occurs in weight-bearing bones, such as the tibia and metatarsals (bones of the foot).  
ex. soldiers, high heels (symptom: pain in the forefoot, image: affects shaft and fracture lines are vertical)
7. **Pathological fractures:** are fractures that occur in a bone that is affected by a destructive process that results in altered bone texture and strength. Causes of weakened bone include tumors, infection, and certain inherited bone disorders.

## SALTER-HARRIS INJURIES



I

II

III

VI

V






# 8. Physeal Injuries

## Salter Harris Injuries

- **SH I:** This fracture typically traverses through the hypertrophic zone of the cartilaginous physis, splitting it longitudinally and separating the **epiphysis** from the **metaphysis**.
- **SH II:** The fracture splits partially **through the physis** and includes a variably sized triangular bone **fragment of metaphysis**. This particular fracture pattern occurs in an estimated 75% of all physeal fractures, and it is the **most common** physeal fracture.
- **SH III:** This fracture pattern combines **physeal injury with an articular discontinuity**. This fracture partially involves the physis and then extends through the epiphysis into the joint .
- **SH IV:** This fracture runs obliquely through **the metaphysis, traverses the physis and epiphysis**, and enters the joint .
- **SH V:** These lesions **involve compression or crush injuries to the physis** and are virtually impossible to diagnose definitively at the time of injury. Knowledge of the injury mechanism simply makes one more or less suspicious of this injury. No fracture lines are evident on initial radiographs, but they may be associated with diaphyseal fractures.
- This type has the worst prognosis, because it affect bone growth. Impaction injury: the bone will be fused together, lead to premature closure of growth plate

Case: man admitted to the ER with injury to the finger



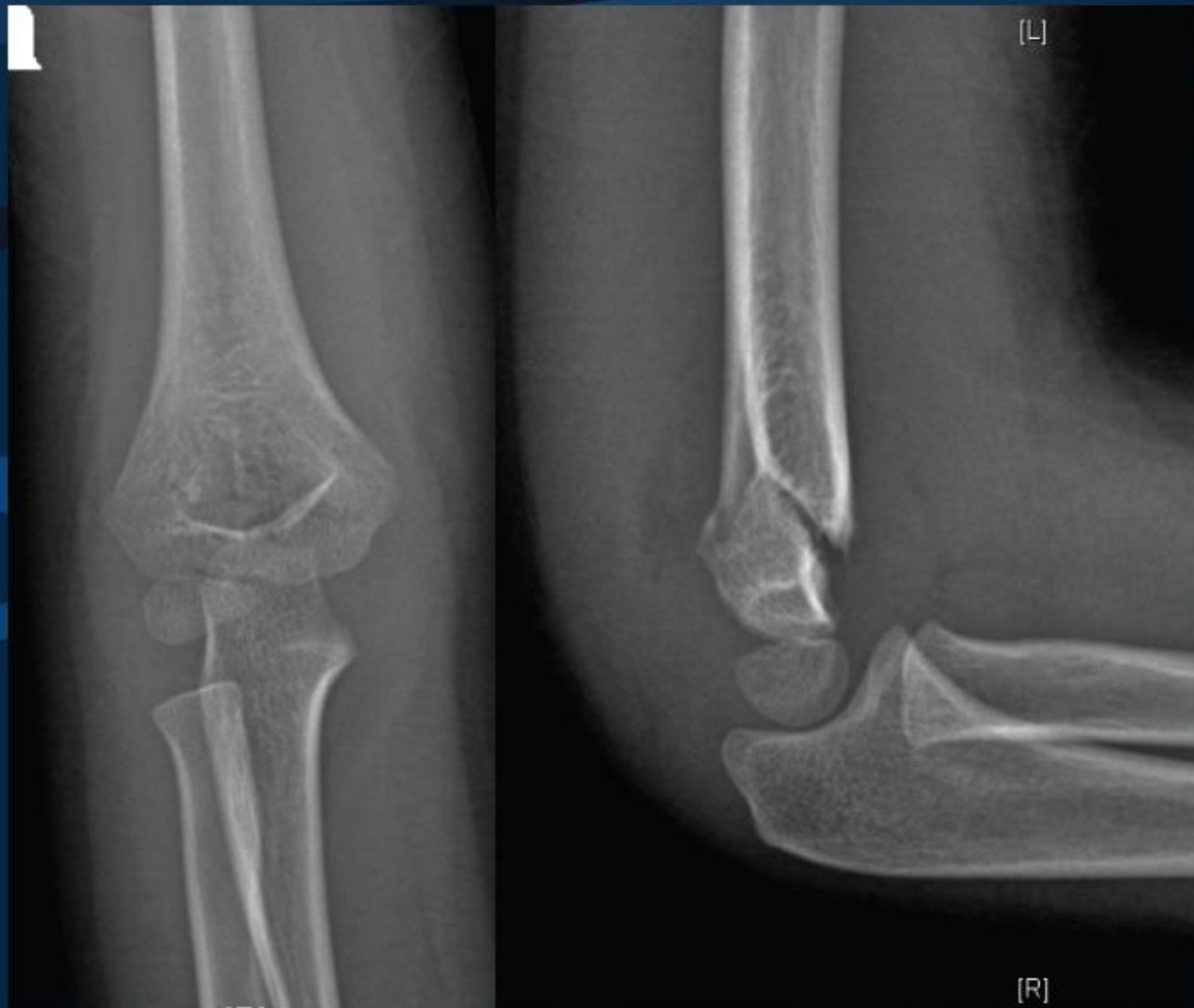
Frontal view: phalanges of middle finger are not aligned

Lateral view: fracture, dislocation

- Displacement of the ulna
- Frontal view: ulnar misalignments
- Lateral view: dislocation of radial and ulna and displacement



Case: Child presented ER with history of trauma, swelling of elbow joint

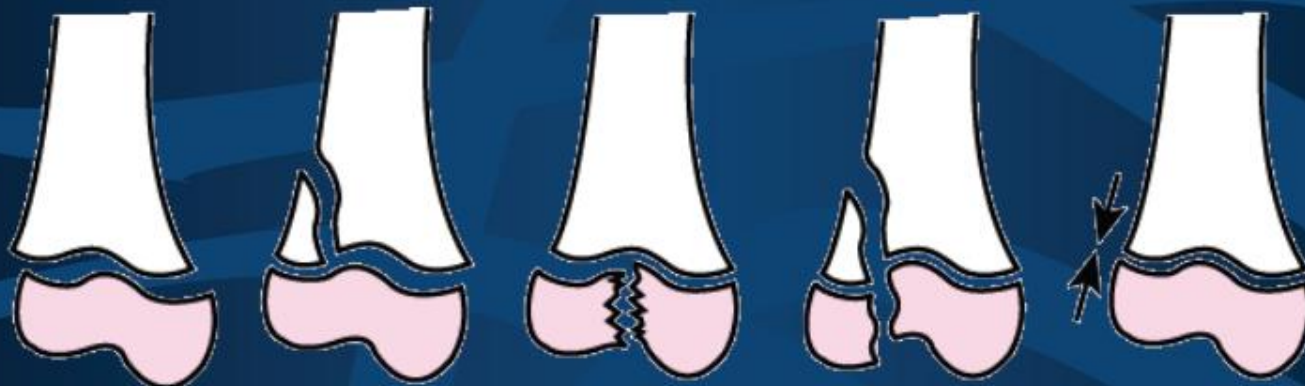


Frontal: fracture

Lateral: one side, greenstick fracture, opposite side is intact



## SALTER-HARRIS INJURIES



I

II

III

VI

V



Salter-Harris 1

Normal



- Wide and irregular growth plate
- Type 1 (separation)

Traumatic Osteolysis of epiphyseal plate  
Salter-Harris injury Type1

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Salter-Harris 1

Normal



Traumatic Osteolysis of epiphyseal plate  
Salter-Harris injury Type1

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# 11years old boy with swelling of wrist pain



- Type 2 avulsion of the metaphysis
- Avulsion of the metaphysis
- Most common type

Growth plate injury ( Salter-Harris injury type II )



## 9years old boy with pain

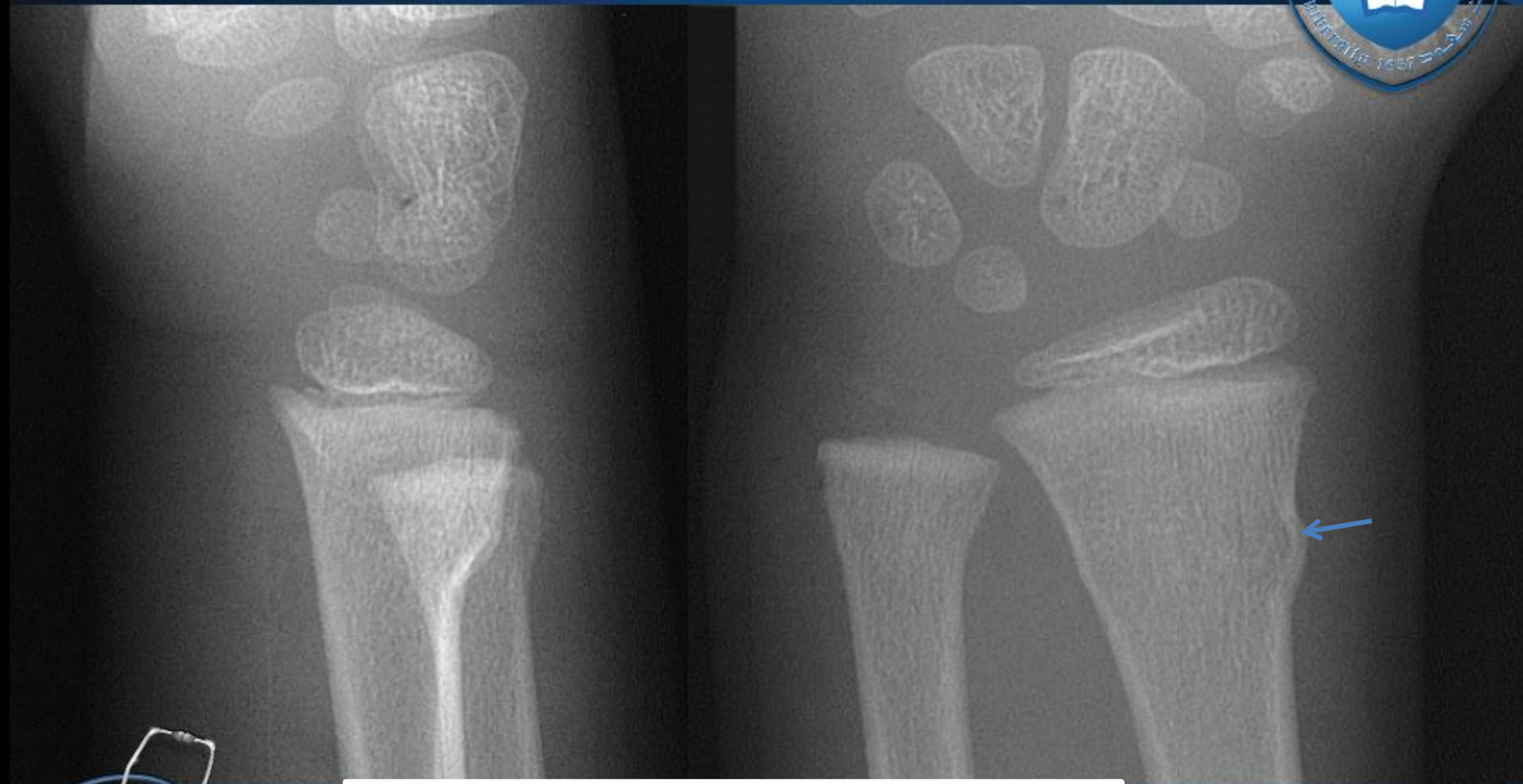
- Length of the finger, right side middle finger has disturbed growth
- Epiphyseal plate is invaginated inside
- Type 5

RT



Salter-Harris injury Type V





- Torus fracture
- Margin of the radius, minimal change
- Cortical bending/buckling
- Due to longitudinal force opposing each other



Greenstick fracture





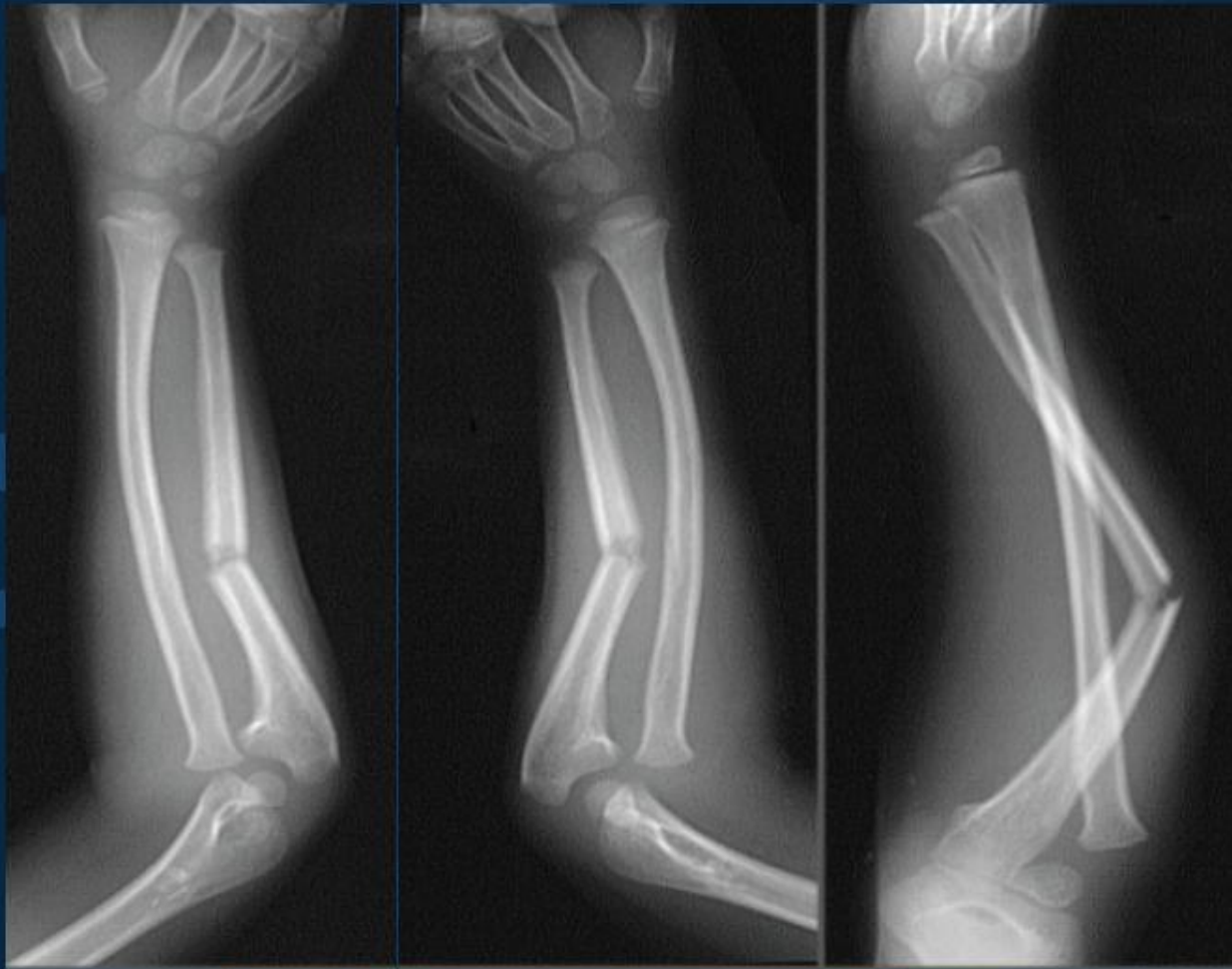
radius is fractured  
and ulna is bent



Bowing Fracture







55 years old patient limping with hip pain

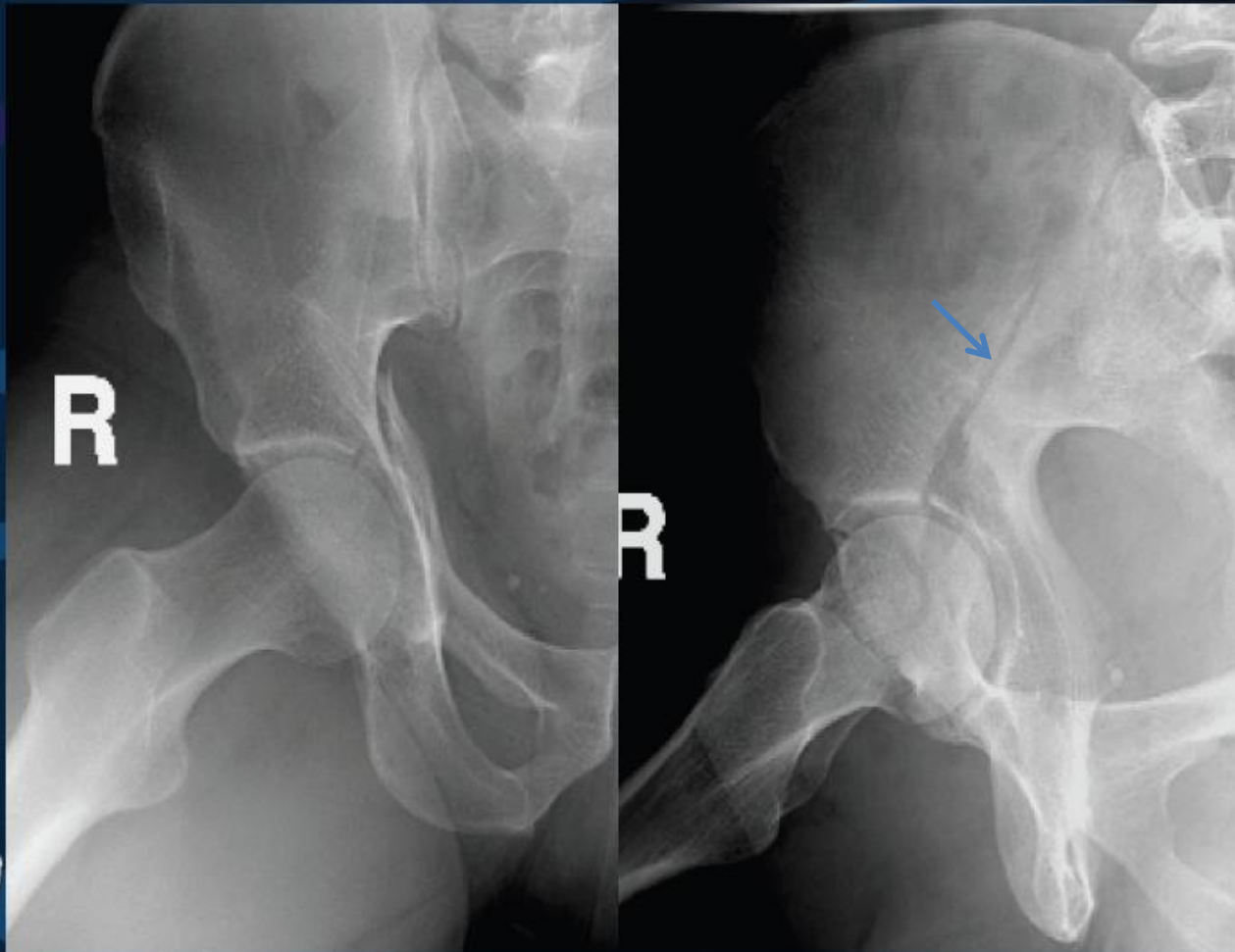


Supra-acetabular fracture

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55 years old patient limping with hip pain



Supra-acetabular fracture

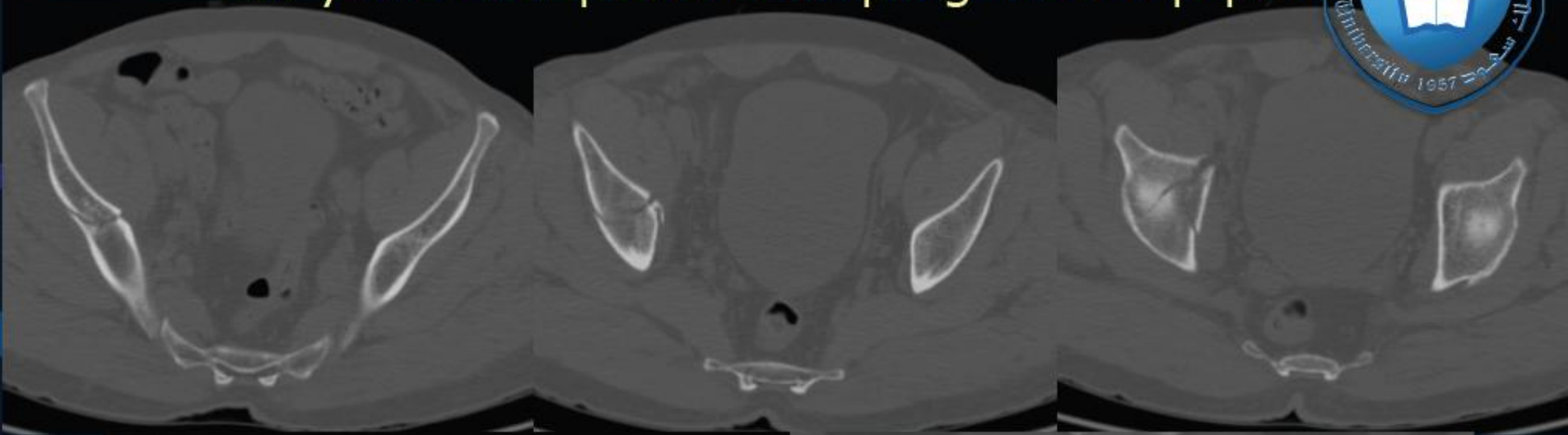




CT: Axial and Coronal  
Continuous pain and damage if bone is not removed



55 years old patient limping with hip pain



Supra-acetabular fracture

A A AI-BOUKAI-35

DFI

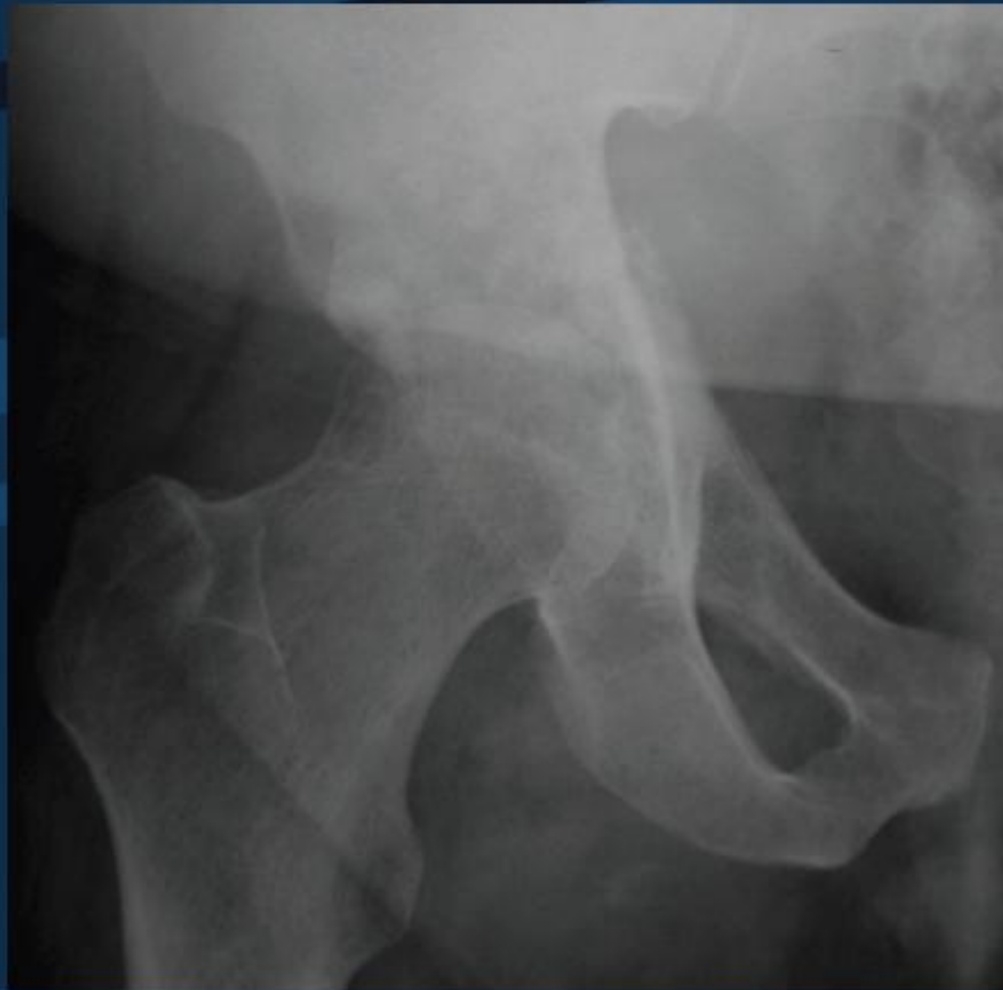


50 years old patient limping with hip pain



Supra-acetabular fracture

50 years old patient limping with hip pain



Supra-acetabular fracture

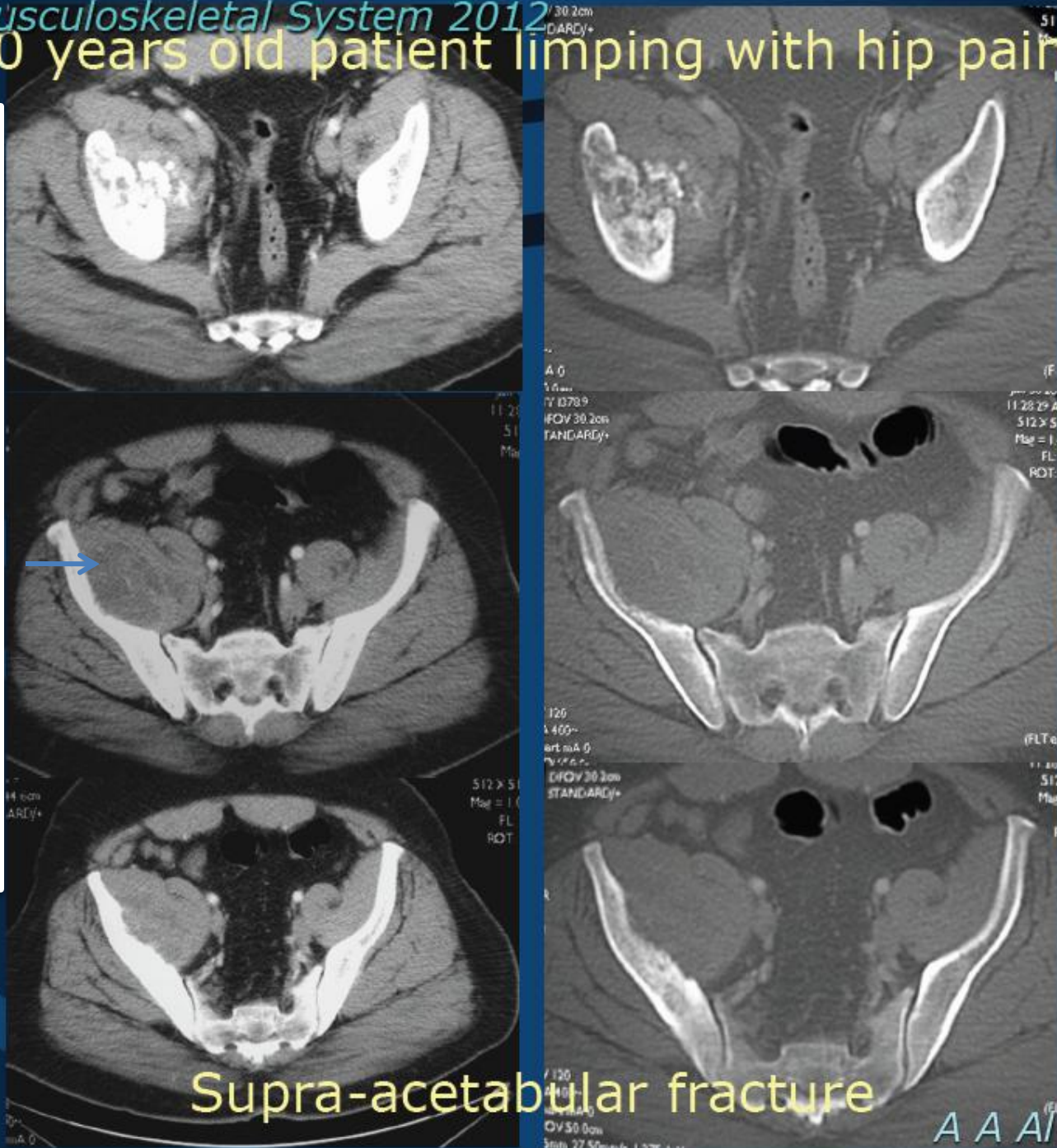


# Imaging of Musculoskeletal System 2012

## 50 years old patient limping with hip pain



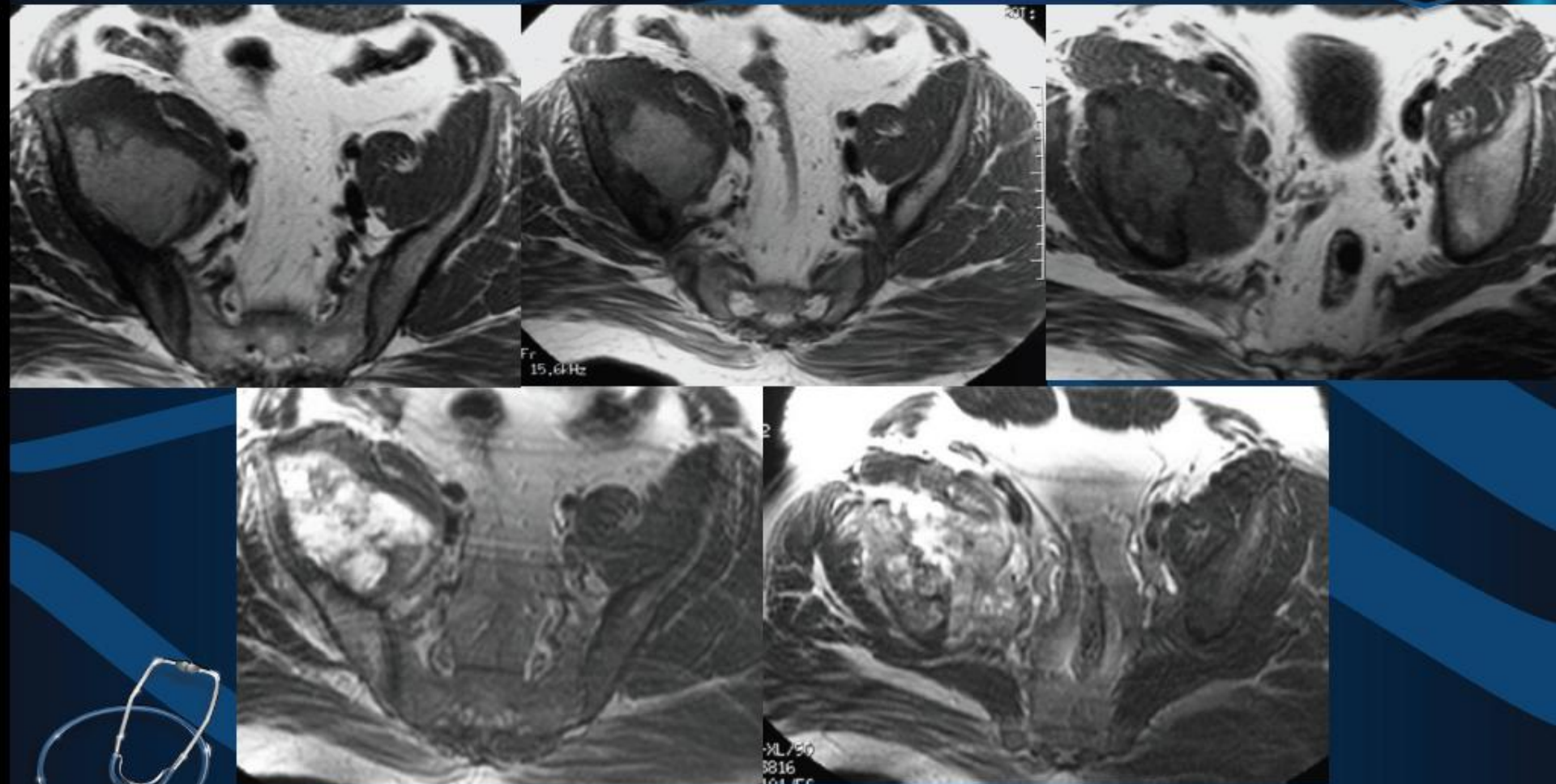
- Bone window: bone is abnormal
- Soft tissue window: mass on right
- Pathological fracture: tumor associated with soft tissue involvement, sarcoma of the bone led to the fracture



Supra-acetabular fracture



## 50 years old patient limping with hip pain



Supra-acetabular fracture !!

A A AI-BOUKAI-39





50 years old patient limping with hip pain

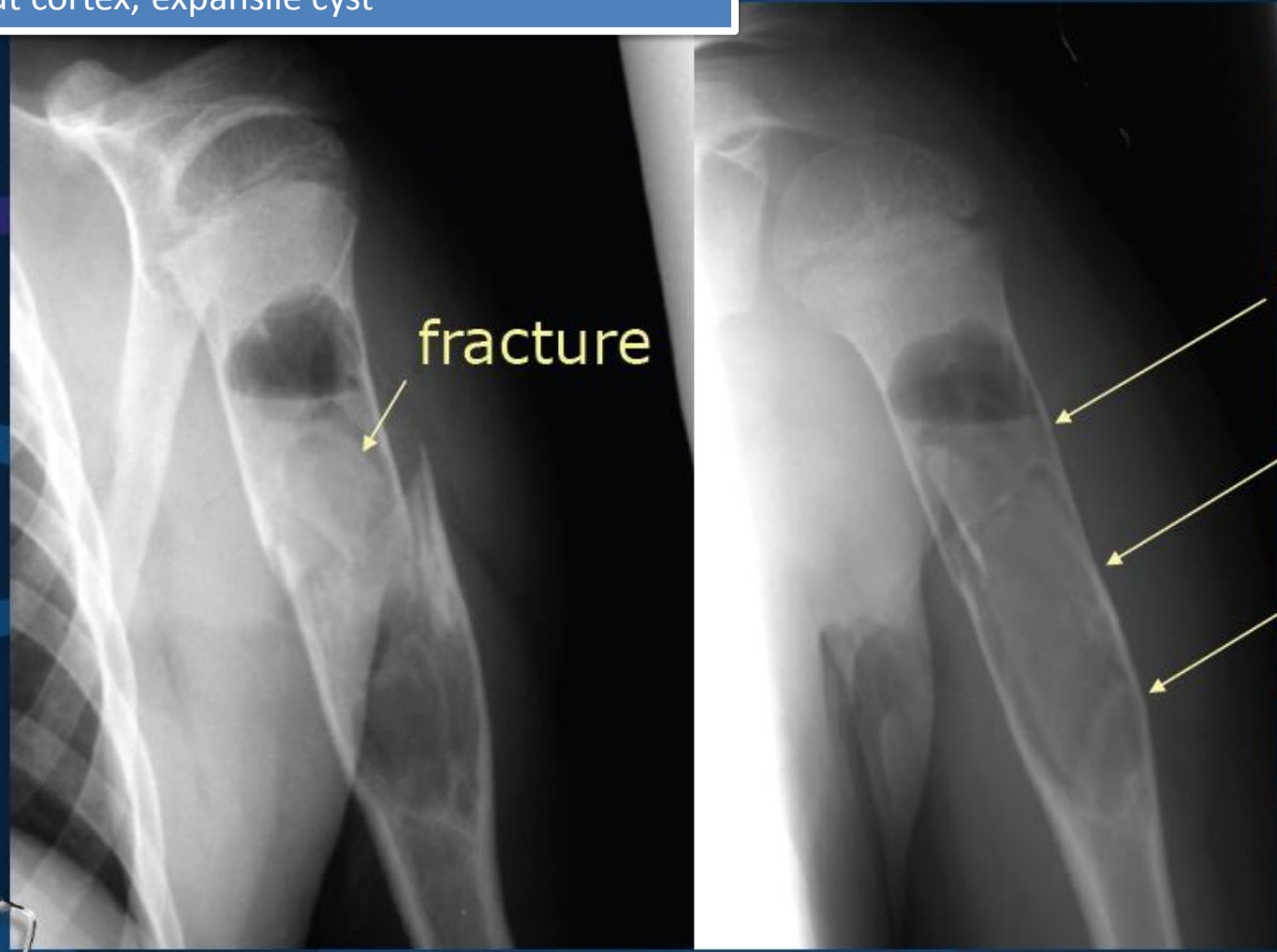


Pathological fracture secondary to sarcoma

A A Al-BOUKAI-40



- Rotation:
- Fracture line is clearer
  - Pathological fracture
  - Thinned out cortex, expansile cyst



Pathological fracture secondary to bone cyst

## 20 Years old lady finger pain



fracture





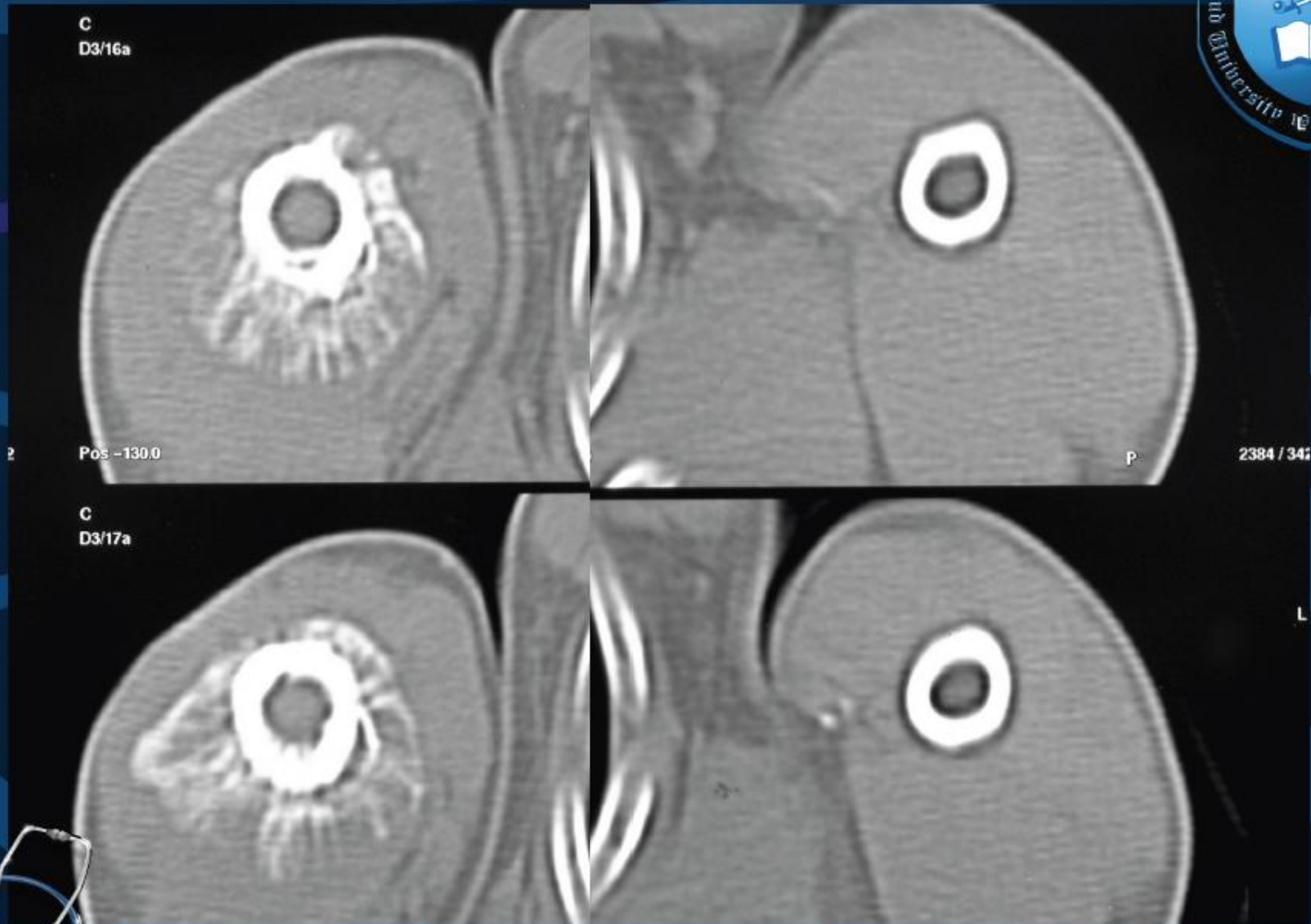
Pathological fracture secondary to sarcoma

Ewing Sarcoma: sunburst appearance

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## Stress fracture



Soldier complaining of pain of the forefoot  
The patient was discharged without treatment

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## Stress fracture



The previous patient returned with worsening pain in the forefoot

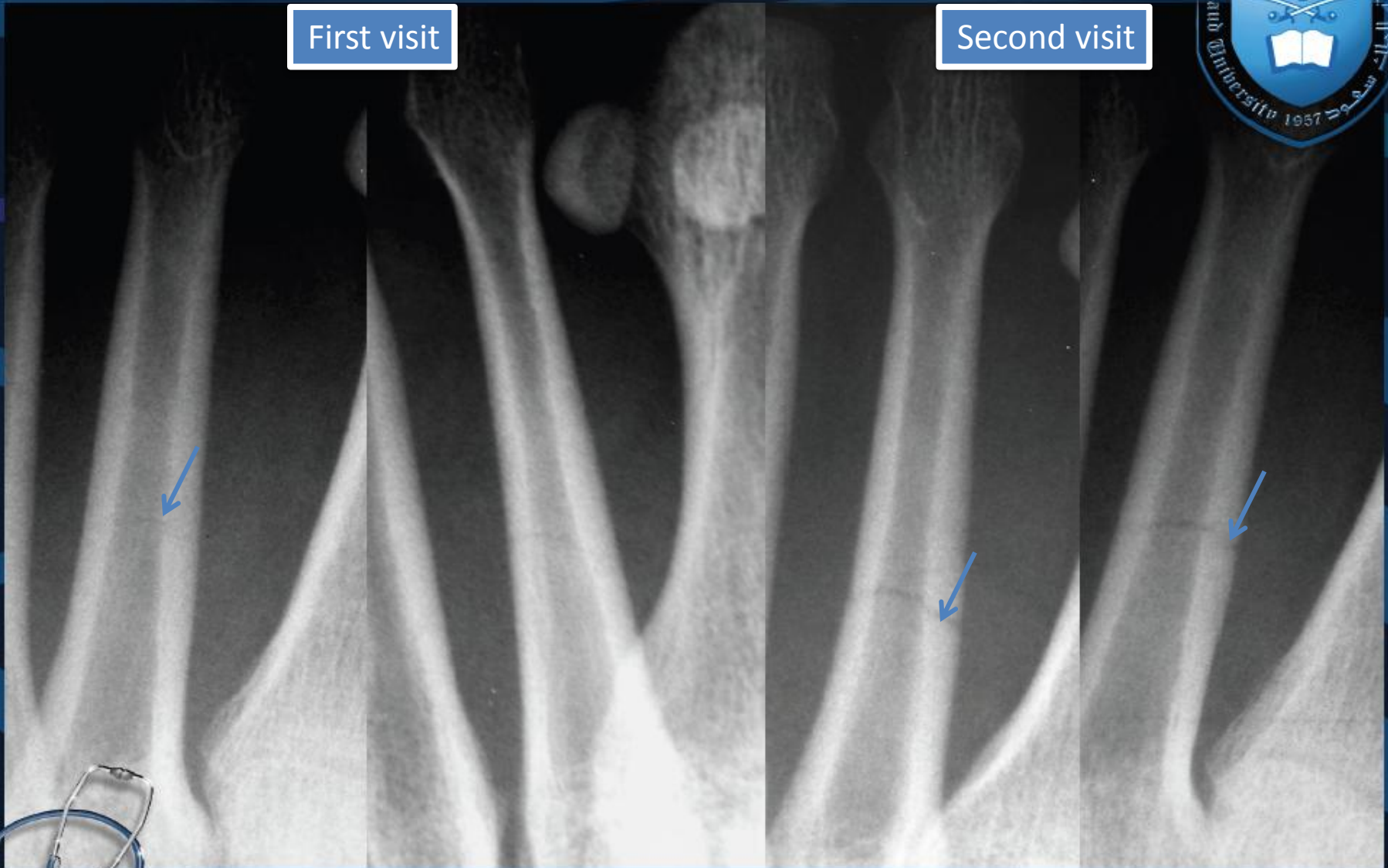


## Stress fracture after one week



First visit

Second visit



Magnified image shows vertical stress fractures on the mid-shaft



# Extra

- For more cases, visit this website:

<http://radiopaedia.org/encyclopaedia/cases/musculoskeletal>

- More images:

<http://radiopaedia.org/articles/musculoskeletal-curriculum>



THANKS

