Lecture 12:

Radiological Anatomy of the Skeletal System I

Radiology Team
Med433

● Slides ● Explanation ● Notes ● Additions ● Important

Objectives

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

- Normal radiological anatomic landmarks
- System of analyzing findings

"Where to look & What to look for"

- Recognize features of certain disease entities

IMAGING THE MUSCULOSKELETAL SYSTEM:

1- **PLAIN FILM**: it is the corner stone

- Most diseases bone can be diagnosed by film
- Certain areas: shoulder, pelvis may need further analysis CT is better than MRI for bone trabeculae and surrounding structure.

2- **COMPUTED TOMOGRAPHY** : Useful in complex skeletal trauma and always prior to bone surgery.

3- **MAGNATIC RESONANCE IMAGING**:

- Useful in bone, joint, soft tissue
- bone marrow changes, the joint, the capsule of the joint, surrounding structures

4- **ULTRASOUND** :

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

5- **ANGIOGRAPHY**: it is rarely used

- Vascularity
- Mapping
- Embolization

6- **NEUCLEAR MEDICINE**: Bone scan is very sensitive but is relatively non-specific

Used mainly for two things (infection and metastases)

Interpreting Images

"Where to look & What to look for"

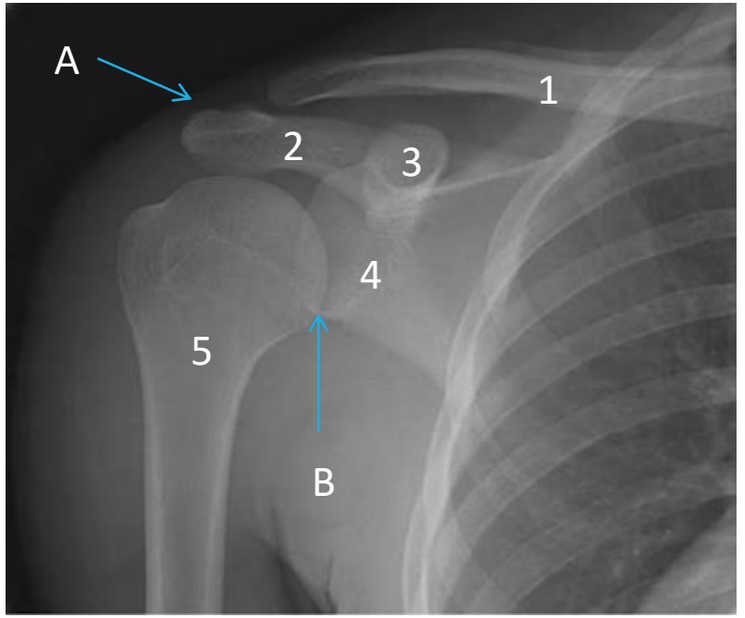
Where :

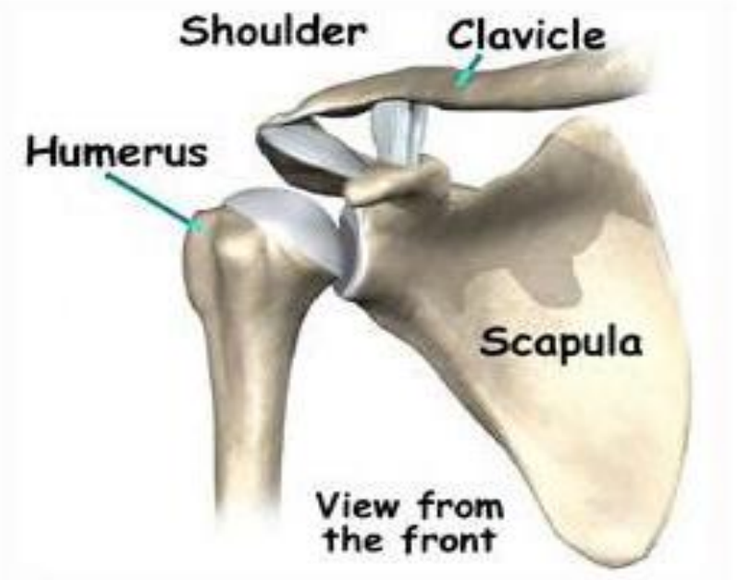
- Cortex of the bone
- Margins of the bone
- Articular surface of the joint
- Junction between the cortex and the medulla
- Pediatric: epiphyseal plate

What:

- Bone density
- Bone texture
- Distortion /displacement of normal structures

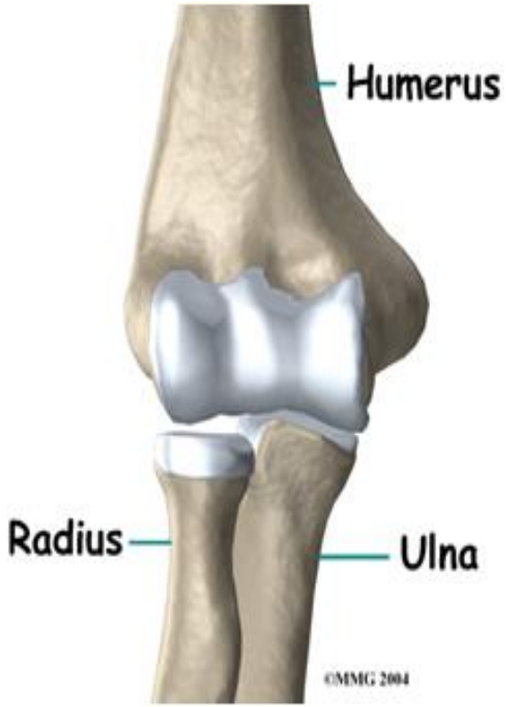
Musculoskeletal Radiological Anatomy





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

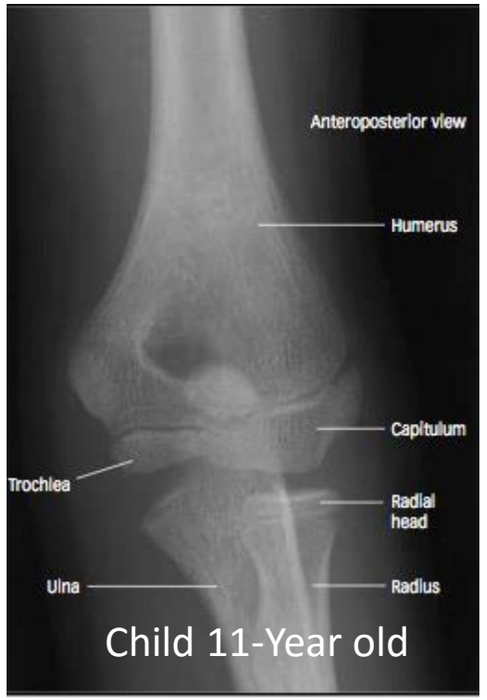
Anatomy of the Elbow



2- Capitulum
3- Olecranon Fossa
4- Medial Epicondyle
6- Coronoid Process
7- Radius Head

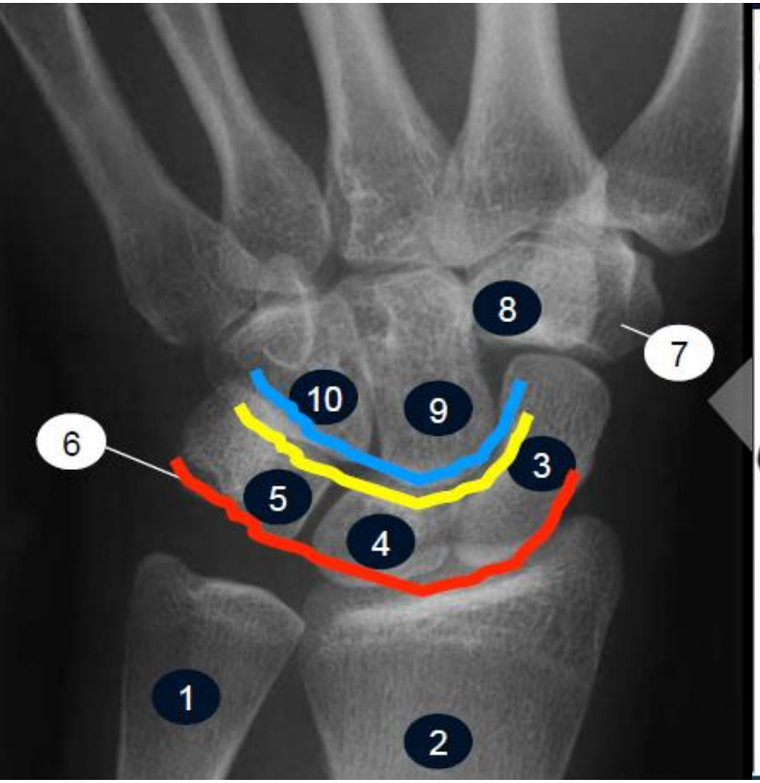
-in the **elbow** the biggest bone is **ulna**(medial) but in **wrist** it is **radius**(lateral)

Elbow joint in different ages



-The point from these picture is not to determine the exact age , but only to differentiate between the child and adult joints.
-in the child the bone density is low ,the joint space is bigger and there is growth plate.

Anatomy of the wrist



1- Ulna 2- Radius 7- Trapezium
3- Scaphoid 4- Lunate 8- Trapezoid
5- Triquetrum 6- Pisiform 9- Capitate
10- Hamate
(8 Carpal bones : 4 proximal, 4 distal)

Three carpal arcs should be traced:

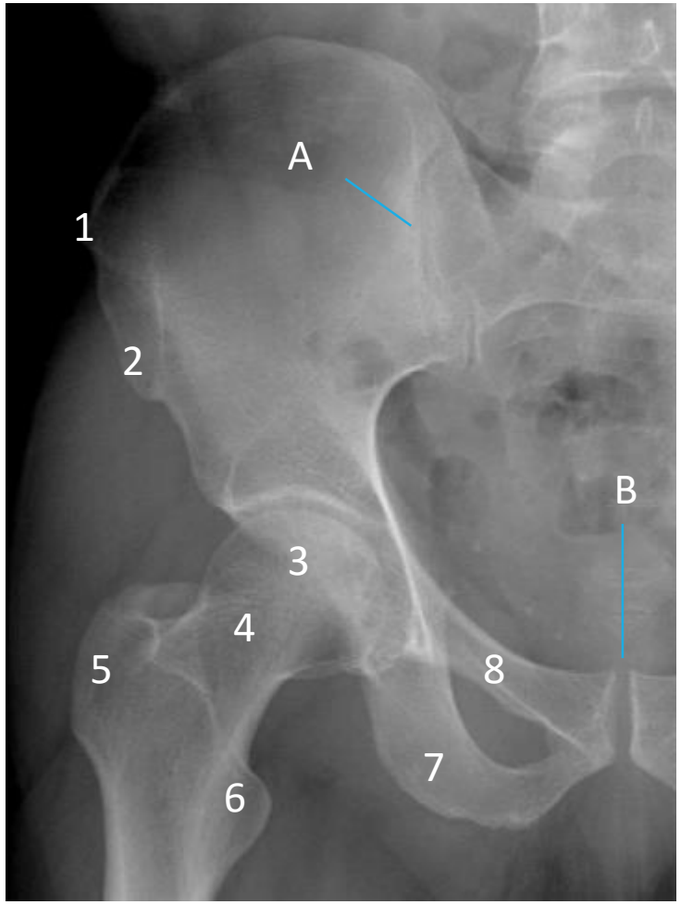
- **along the proximal row of carpal bones; proximal aspect.**
- **along the proximal row of carpal bones; distal aspect.**
- **along the capitate and hamate proximally.**

These three lines should remain unbroken

***The lines is used to determine any fracture and dislocation of carpals**

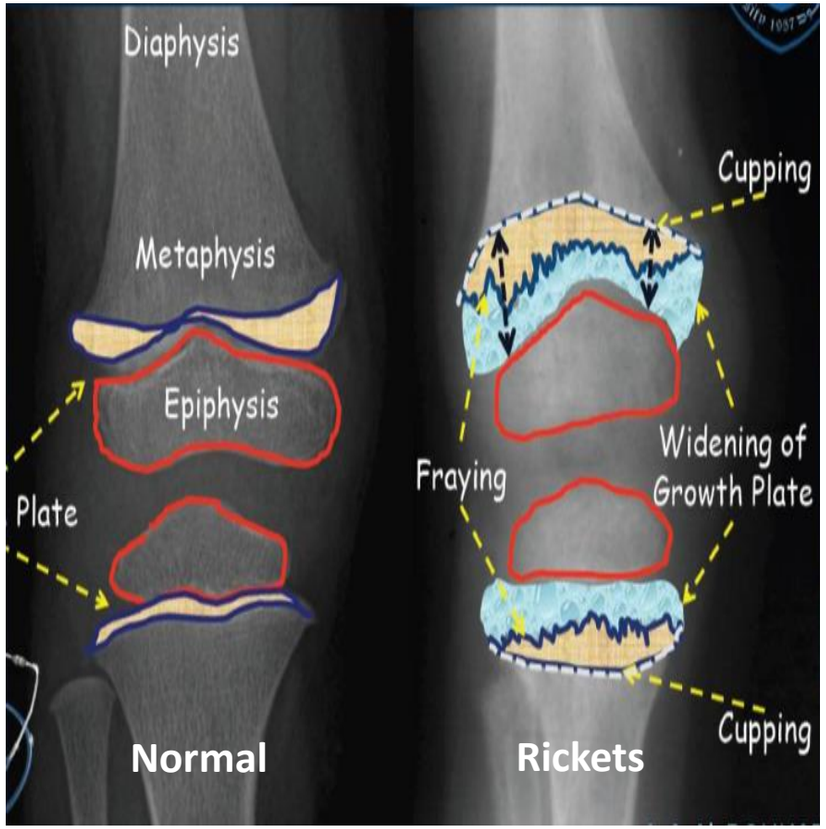
Carpal bones (Mnemonic) :
She Looks Too Pretty , Try To Catch Her

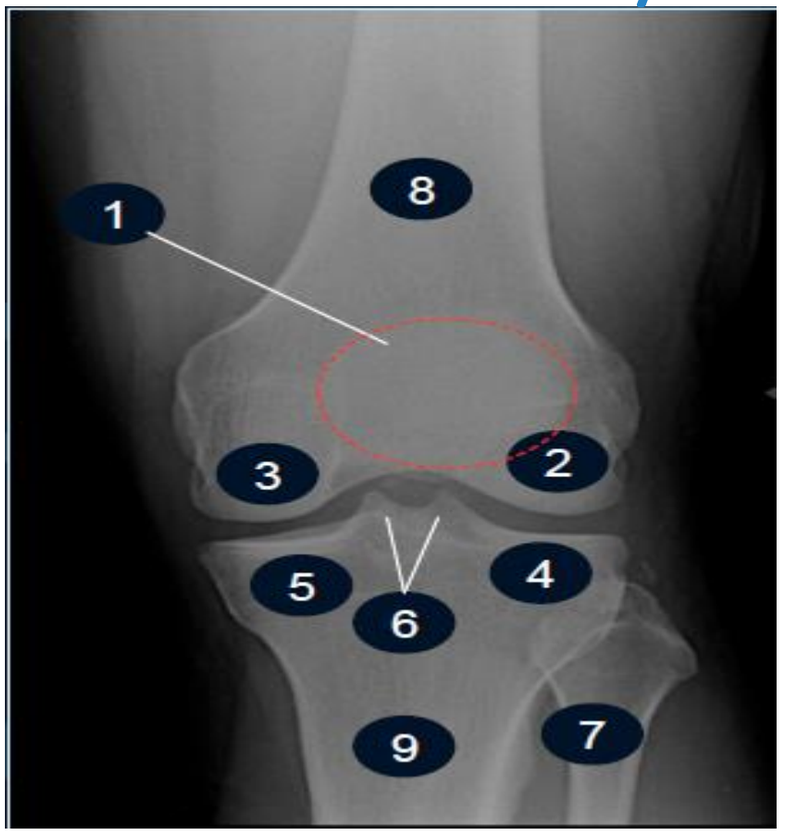
Pelvis and hip joints



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 Trochanta
6- Lesser Trochanta
7- Ischium
8- Superior Pubic Ramus

Knee Anatomy





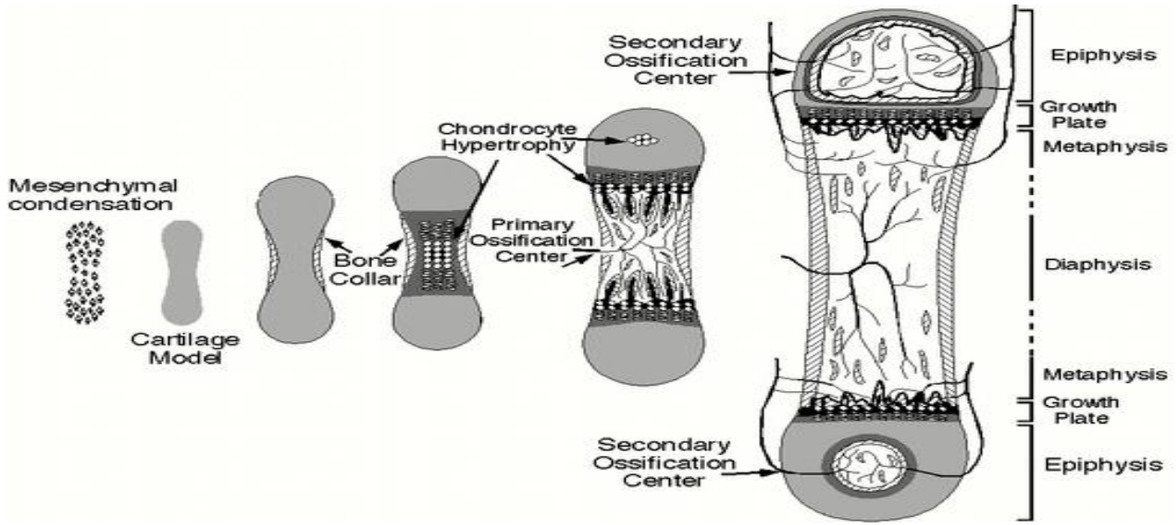
-The difference between normal knee and Rickets is :

-Concave outlines
-bone density changes
-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 pediatric patient

1- Patella
2- Lateral condyle
3- Medial condyle
4- Lateral tibial plateau
5- Medial tibial plateau
6- Tibial eminence
7- Fibula
8- Femur
9- Tibia

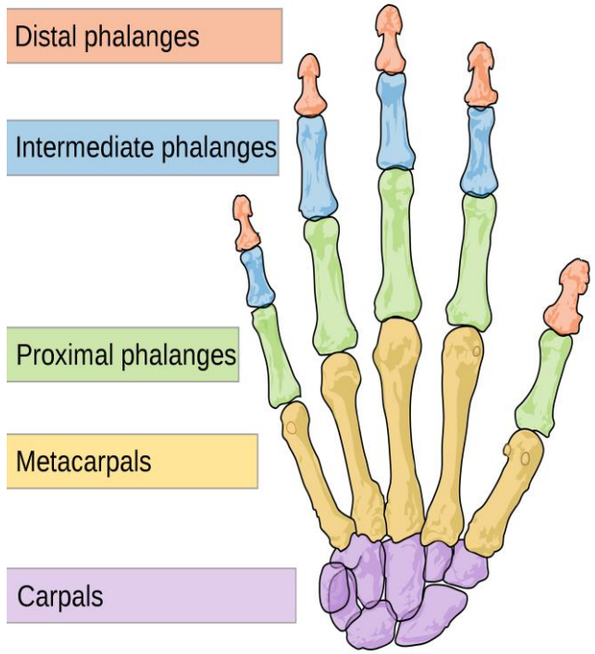
Tibia (medial) is bigger than fibula

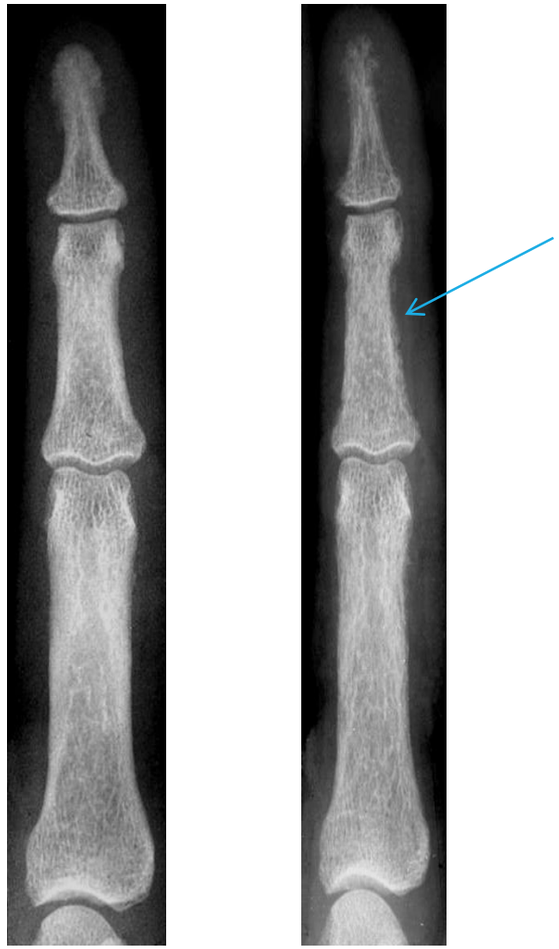
Phases of bone growth



Hyperparathyroidism

The hall mark of hyperparathyroidism is bone resorption in the radial aspect of middle phalanges of index and middle finger.





Normal Hyperparathyroidism

MUSCULOSKELETAL PATHOLOGY:

-***Congenital***
-Arthritis
-Metabolic
-Trauma
-Infectious
-Hematological
-Neoplastic

MUSCULOSKELETAL RADIOLOGICAL TRAUMA:

(TERMINOLOGY IN BONE TRAUMA)

Dislocation *vs.* Sublaxation
Closed vs. Open fractures
Greenstick *vs.* Torus fractures
Physeal injuries
Stress fractures
Pathological fractures

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.
2. Sublaxation: is an incomplete or partial dislocation of a joint or organ. The fracture is partial and intact in some position and displaced.
3. Closed fracture: is a broken bone that does not penetrate the skin
4. Open (compound) fracture: involve wounds that communicate with the fracture and disruption of overlying skin. May expose bone to contamination
5. 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.
6. 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 trabelcular compression from an axial type loading force (along long axis of bone). Usually seen in children, frequently in the distal radius diaphysis or metaphysis
7.STRESS FRACTURES: they happen in normal bone with abnormal stress
overuse injuries of bone. These fractures, which may be nascent or complete, result from repetitive subthreshold 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.
8.PATHOLOGICAL FRACTURES: the bone is abnormal

BASIC PRINCIPLES IN RADIOLOGY OF BONE TRAUMA

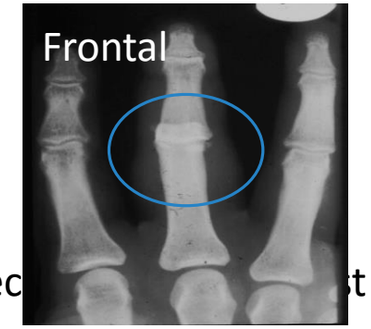
Two perpendicular views.

- Frontal
- Lateral

It is very important because fractures might be missed from one side view

❖ **Radiograph should include the joint nearest to the trauma.**

Any injury in the middle of bone , the image should include the higher and lower joint bec st



❖ **The paired bone concept.**

Ex. radius and ulna , ankle and knee: if one is fractured check the other because all structure of body is connected so the injury happen in multiple places .like the concept if breaking a ring it is impossible to break a ring only from one side

❖ **The weakest link concept (Adult vs. Children).**

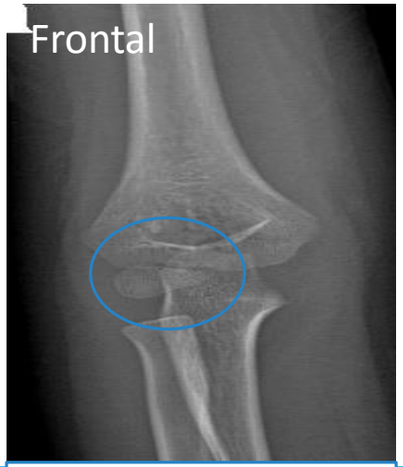
– Adults: The soft tissue structures (muscles/ ligaments/ tendons)

– Children: The physeal plate (growth plate)

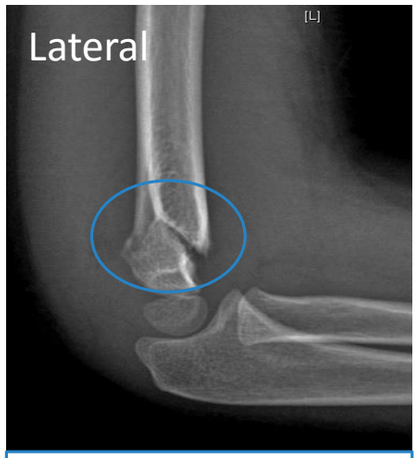
❖ **Comparison films.**

With old film if available (in past history)

Child with trauma and swelling of the elbow



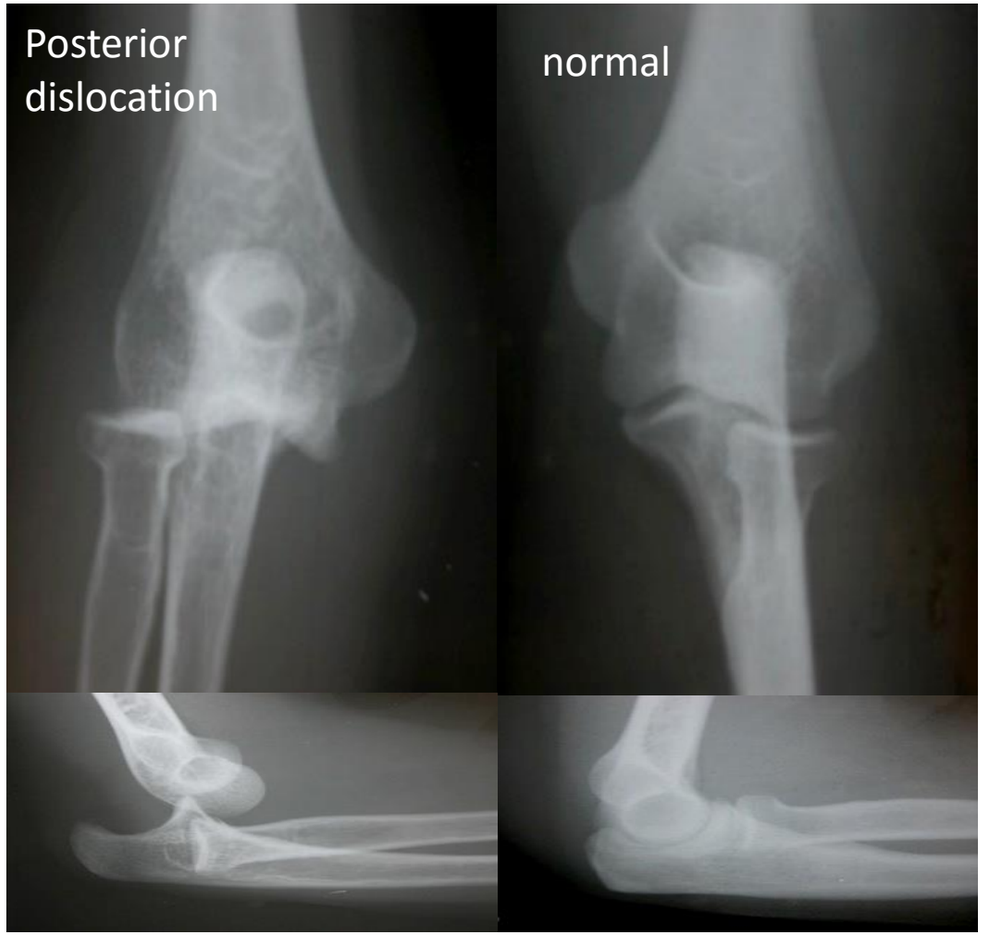
Ulnar misalignments



Dislocation of radial and ulnar and displacement

Dislocation:

It is described anterior or posterior by the relation of distal structure to the proximal



SALTER-HARRIS INJURIES:

They are fracture specific to growth plate and they are important because they might result in growth abnormality

Physeal 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.

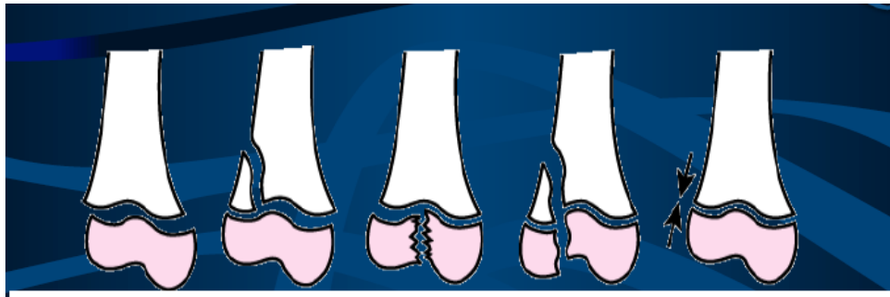
• **SH II**: The fracture splits partially through the physis and includes a variably sized triangular bone fragment of metaphysis. This particular fracture pattern occurs in an estimated 75% of all physeal fractures, and it is the most common physeal fracture.

• **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.



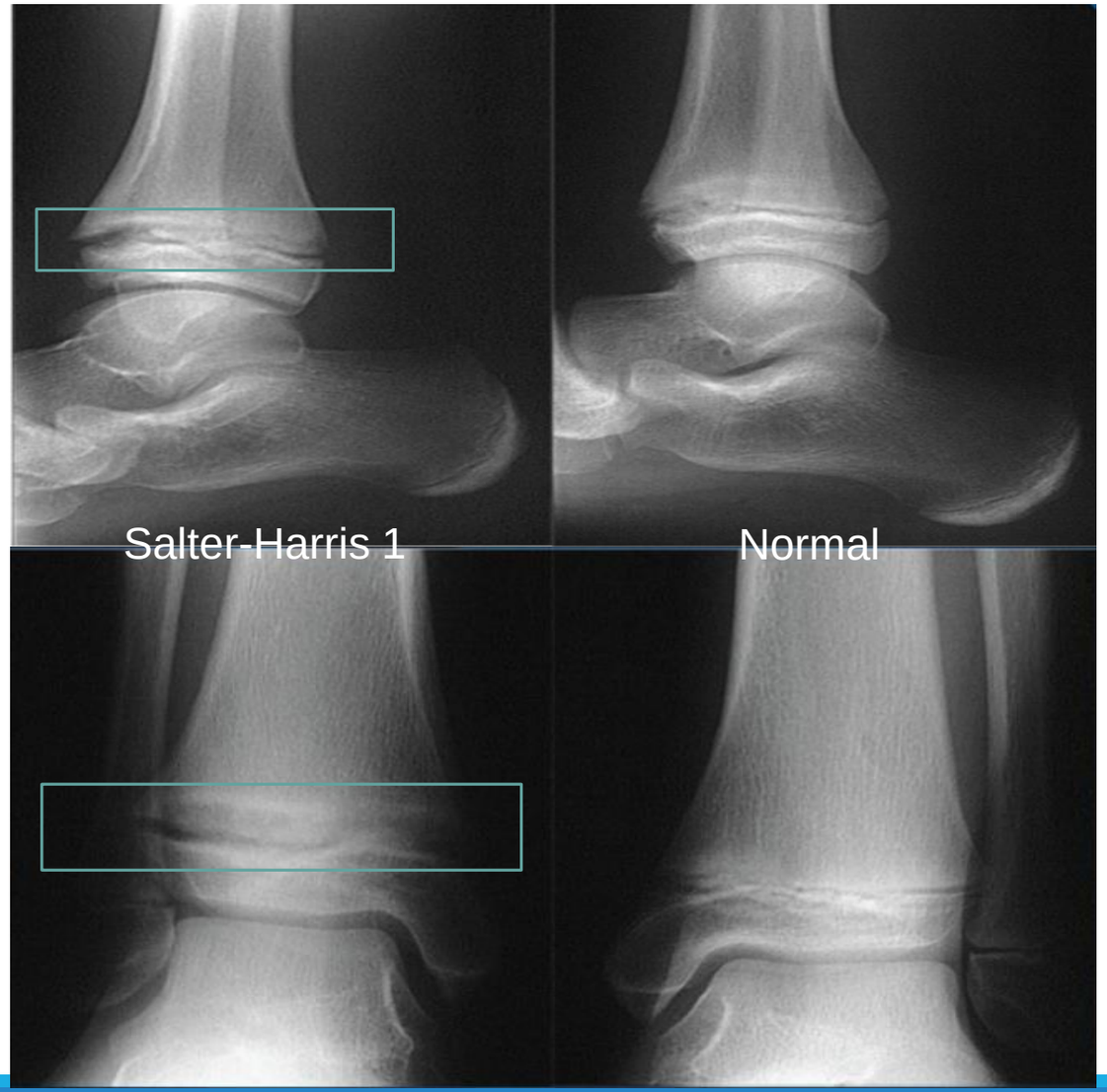
Summary:

1- the bone is intact only there is growth plate separation or widening
2-fracture in metaphysis
3-in epiphysis
4-both
5- bone normal but the growth plate is crushed or narrowed

Stages of fractura in pediatrics :

1- torus : pending of the cortex.
2- greenstick : uncomplete fracture only from one side ,which is complication of torus.
3- bowing.

Traumatic Osteolysis of epiphyseal plate
(Salter-Harris injury Type I)

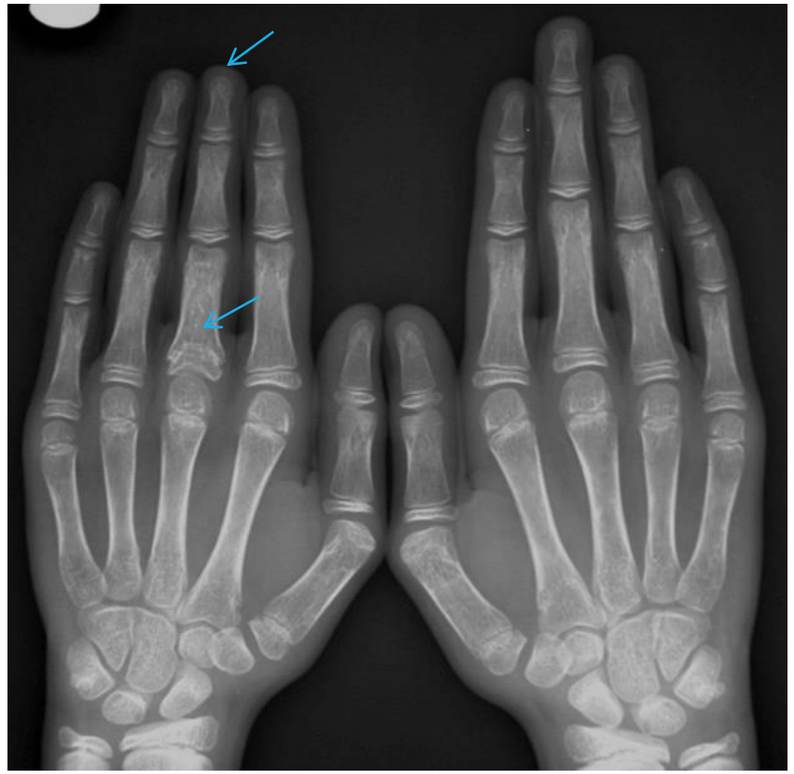


Wide and irregular growth plate Type 1 (separation)

11years old boy with swelling of wrist pain
Growth plate injury
(Salter-Harris injury type II)

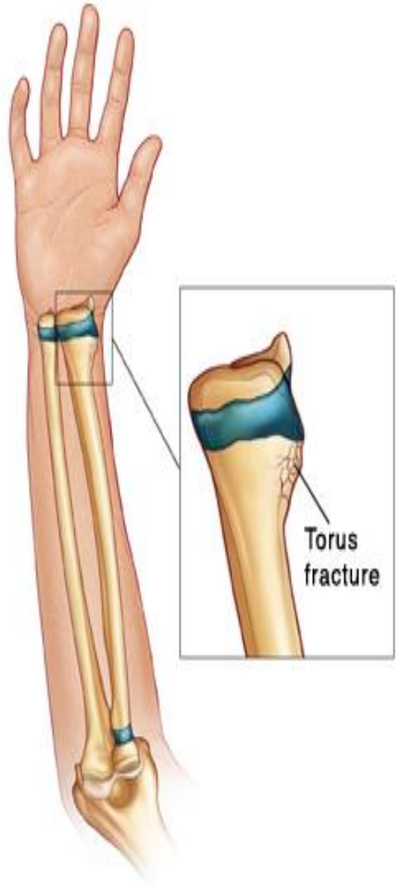
Metaphyseal fracture better seen in lateral view

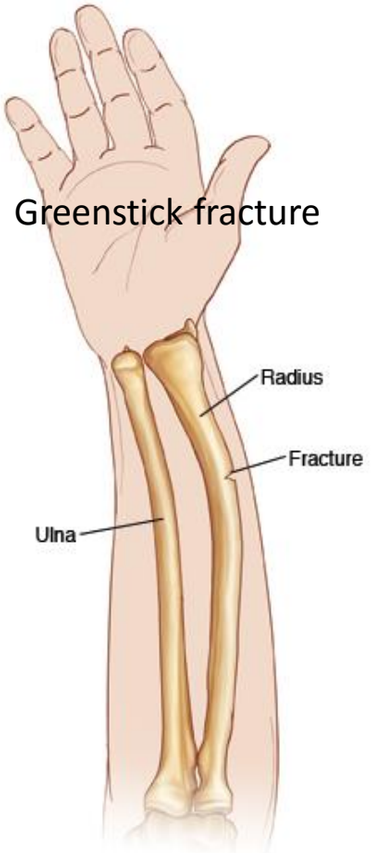
9years old boy with pain
(Salter-Harris injury Type V)



Crush to the middle finger lead to fusion seen by the difference in the length of finger in comparison to the other hand.

Stages of paediatric fracture



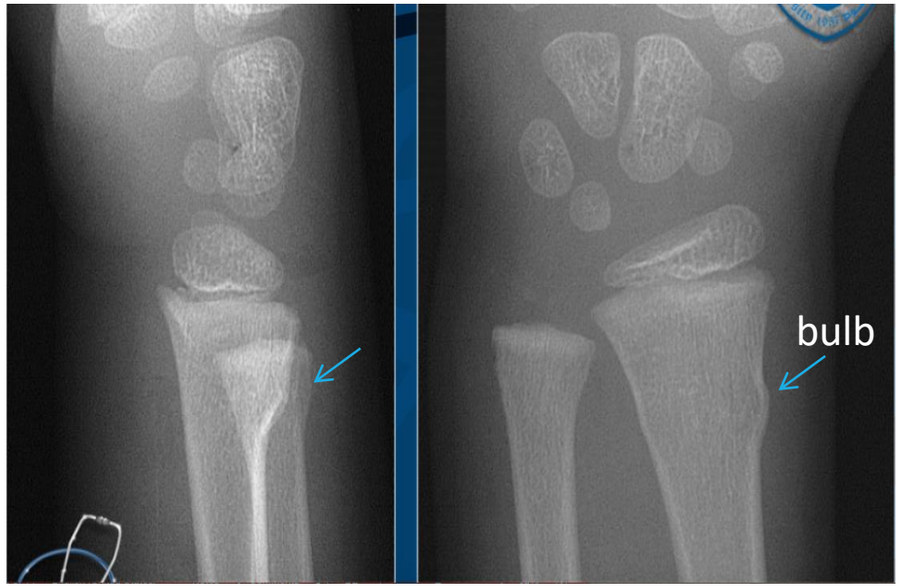


Stages of paediatric fracture:

Imagine if you bend the greenstick at the begging there will be nothing happen. If keep on to bent usually there will be a bulb on one side (torus) if keep on that part of bulb will broken but not fully broken(Greenstick). At the end it will become fully broken(Bowing) .

Torus Fracture

Is Cortical bending/buckling Due to longitudinal force opposing each other, happen in pediatrics .

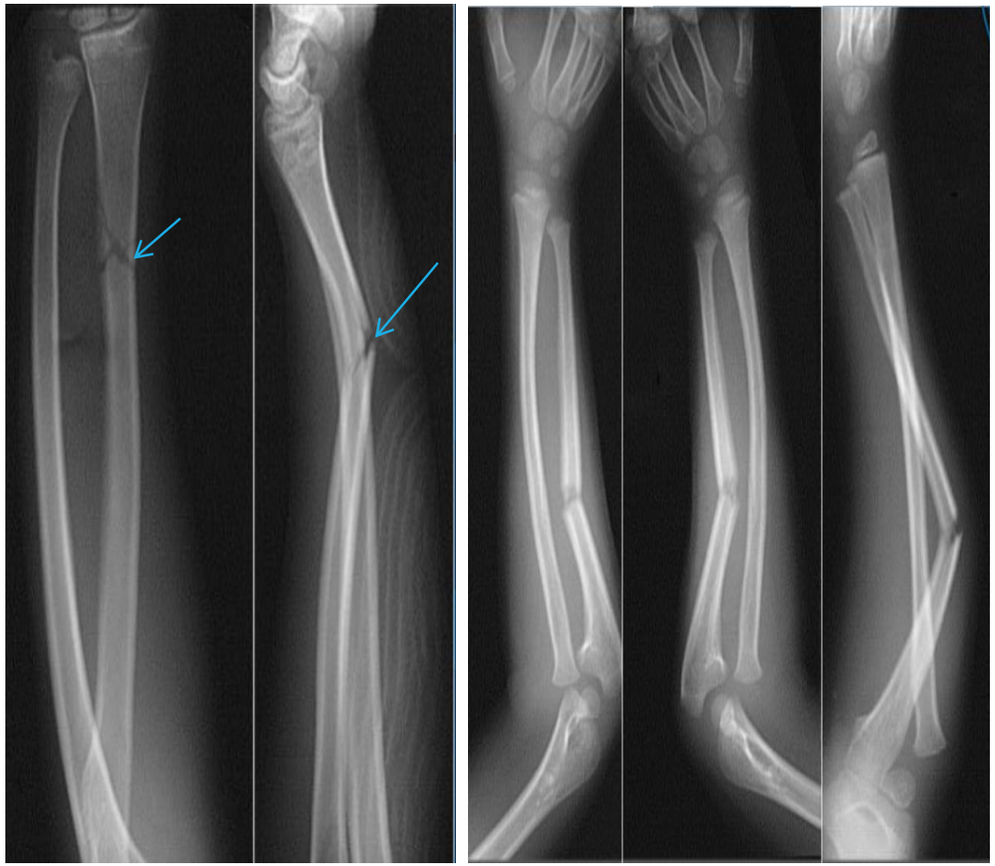


- Margin of the radius, minimal change
- Cortical bending/buckling.
- Due to longitudinal force opposing each other.

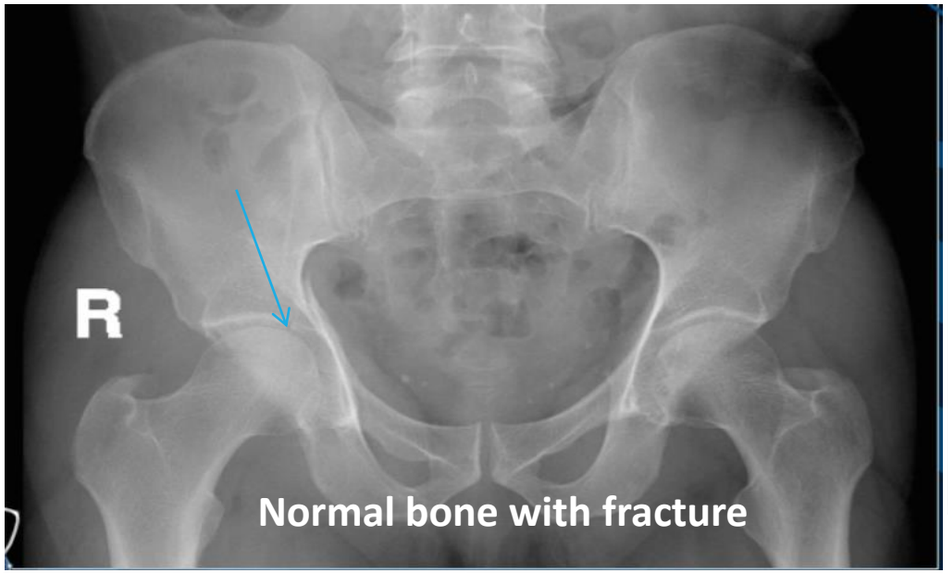
Greenstick fracture

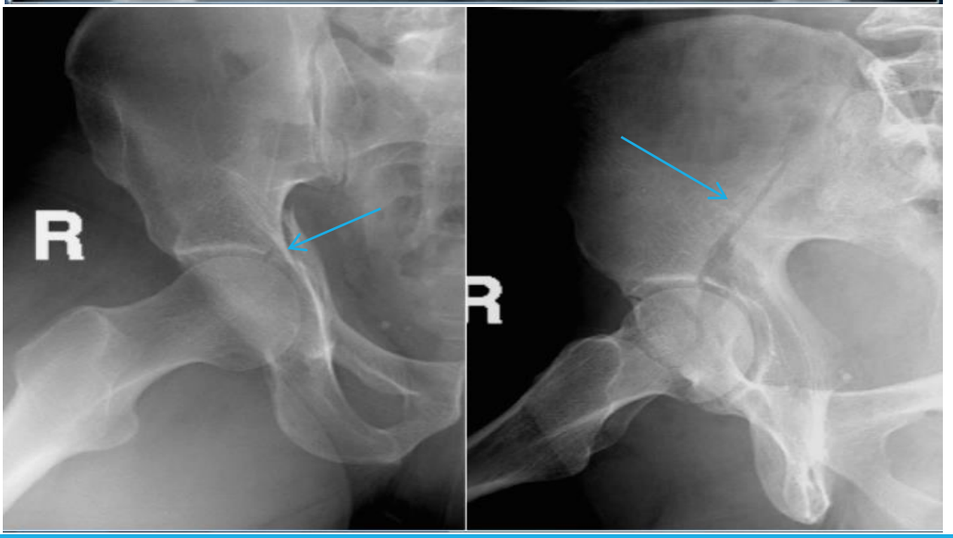
Bowing Fracture

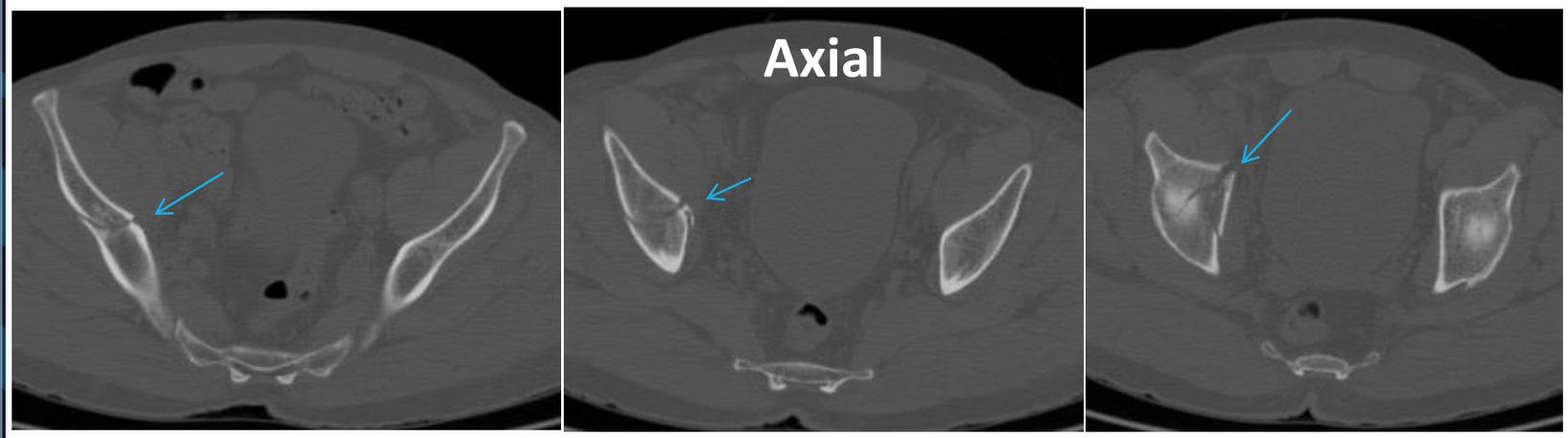
<u>Radius is fractured and ulna is bent</u>

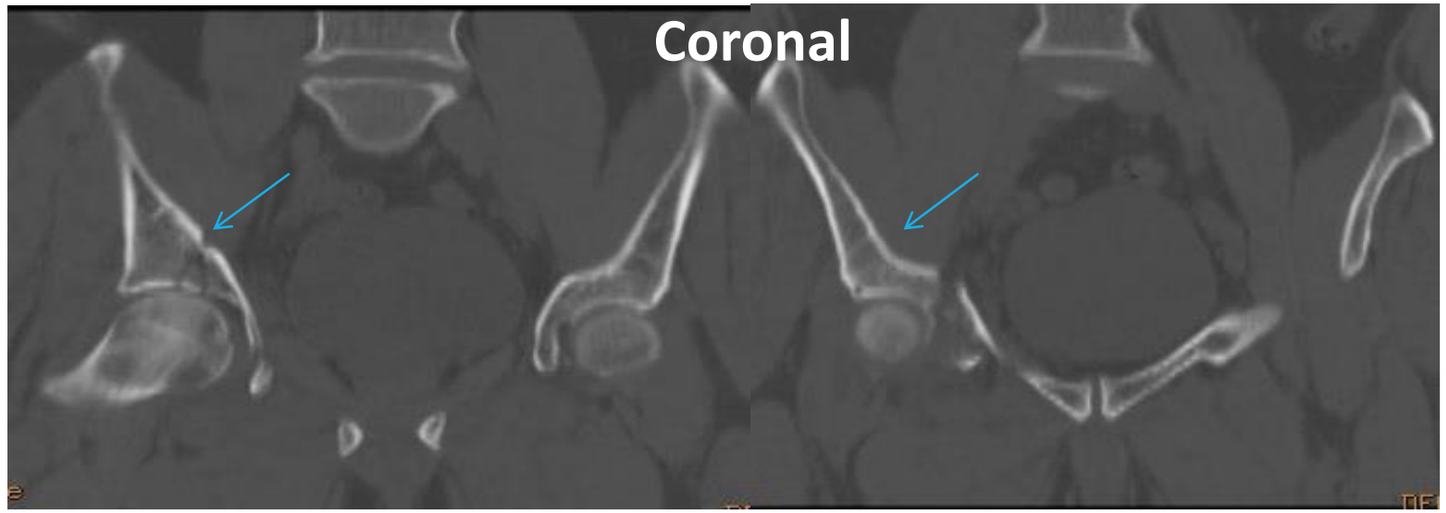


55 years old patient limping with hip pain with Supra-acetabular fracture (case A)









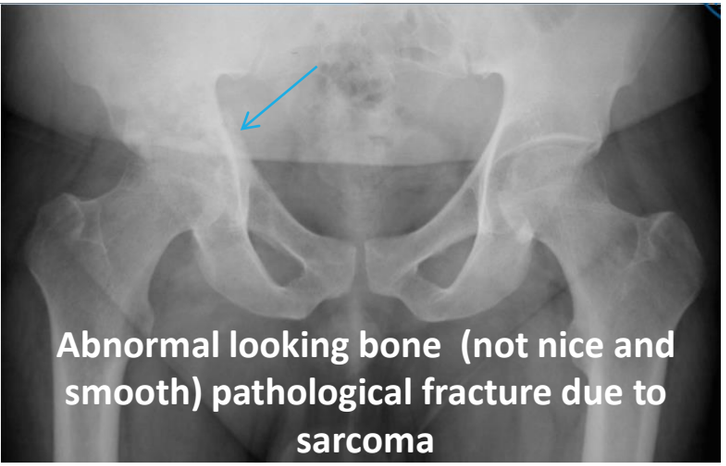
CT: Axial and Coronal / Continuous pain and damage if bone is not removed

50 years old patient limping with hip pain Supra-acetabular fracture (case B)

Bone window: bone is abnormal.

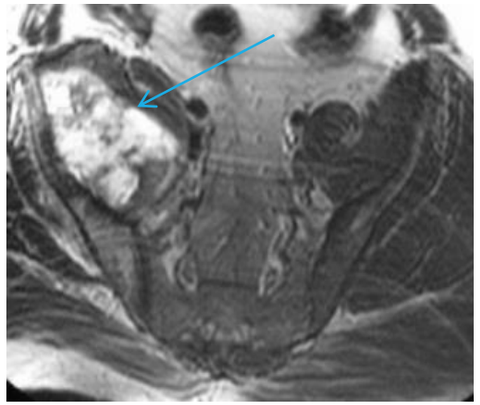
Soft tissue window: mass on right(iliacus muscle involvement) .

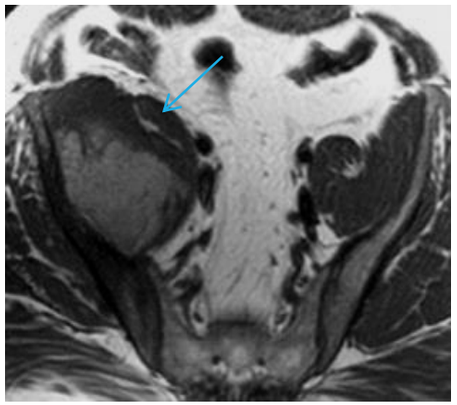
Pathological fracture: tumor associated with soft tissue involvement, **sarcoma** of the bone led to the fracture.

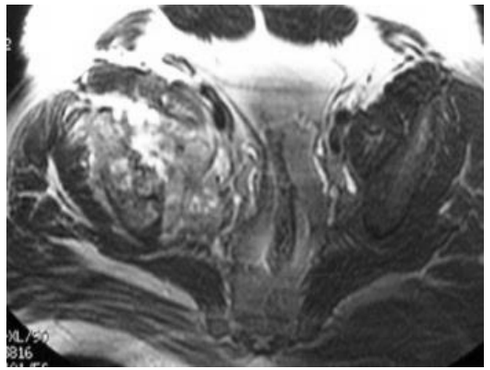


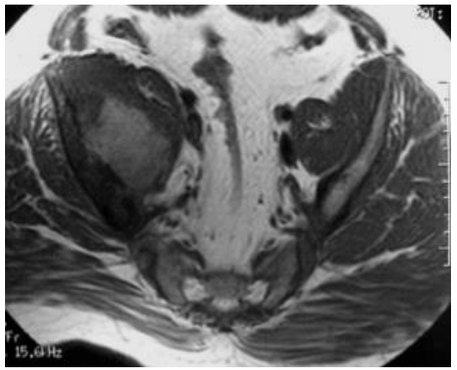
Abnormal looking bone (not nice and smooth) pathological fracture due to sarcoma

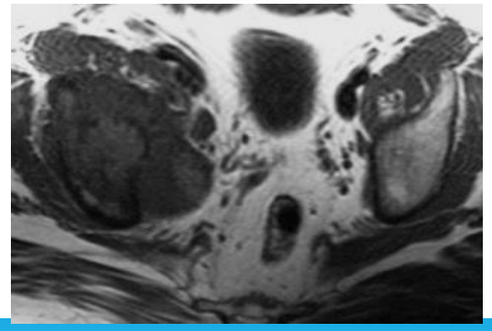
MRI



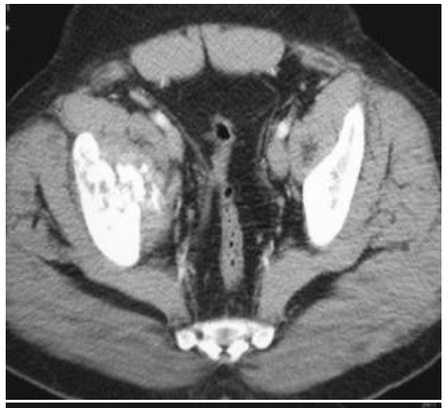


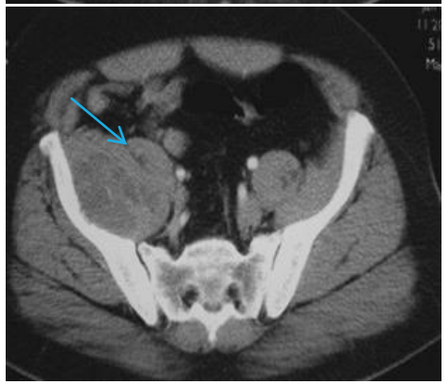




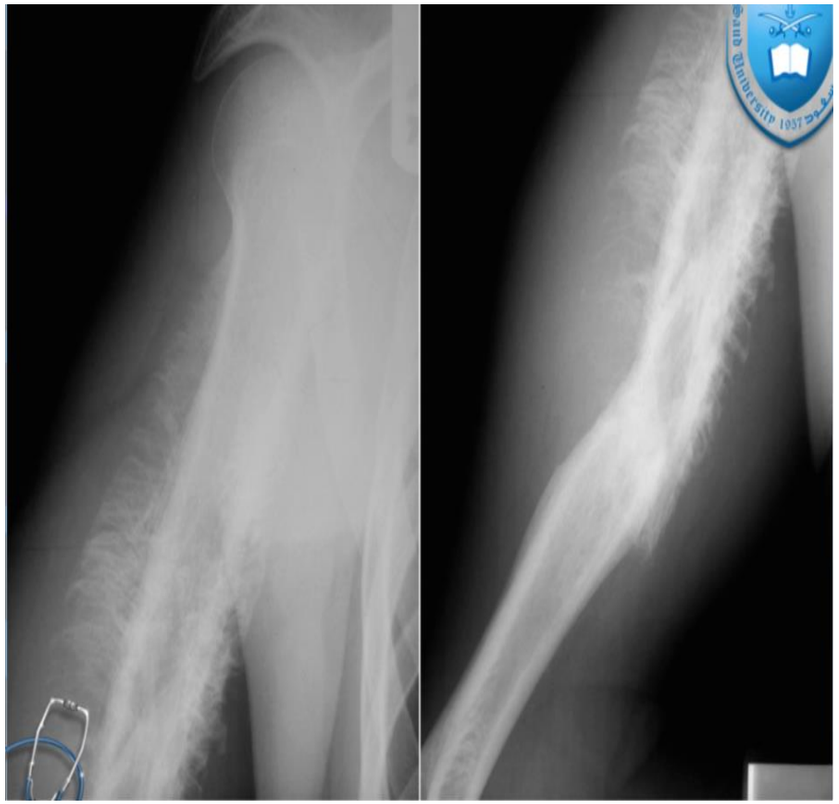


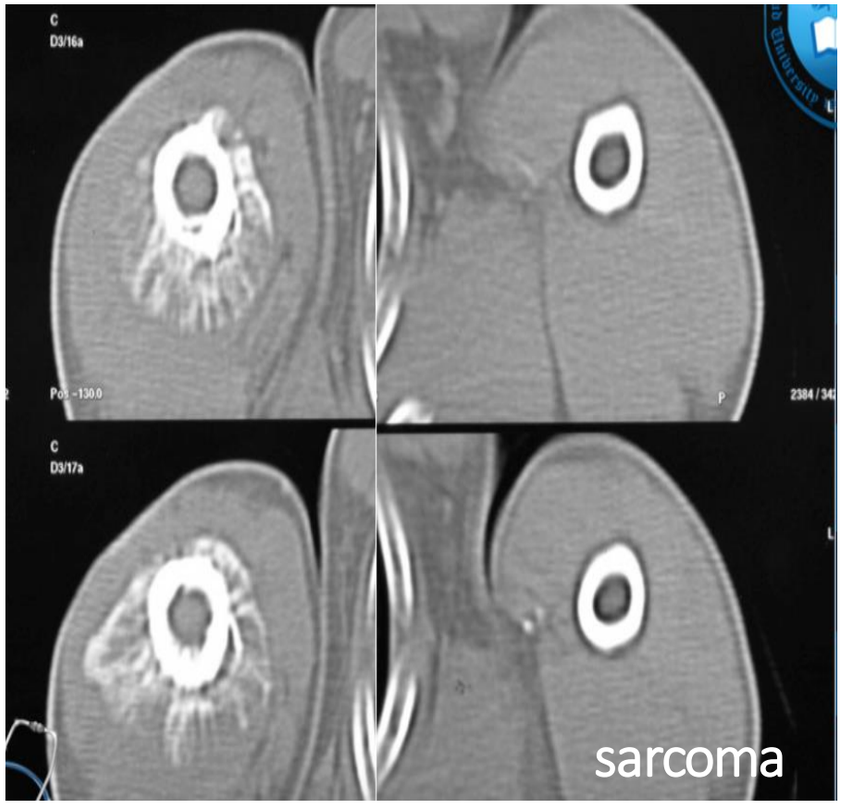
CT





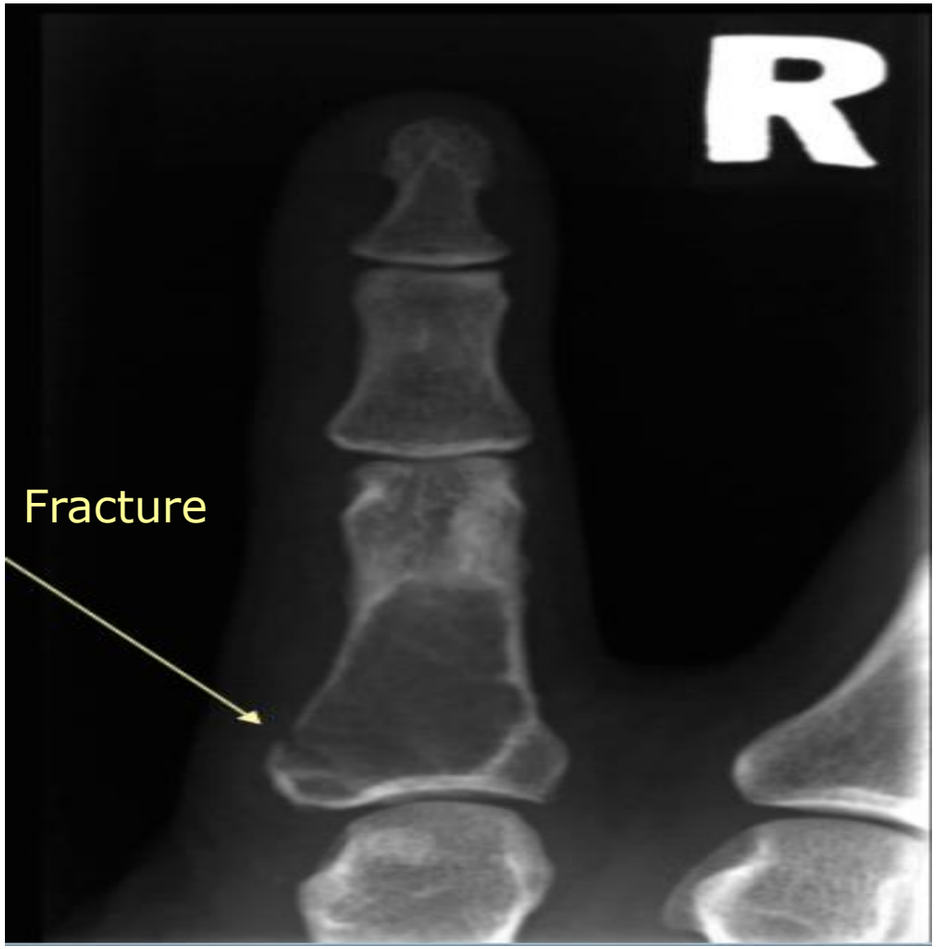
Pathological fracture secondary to sarcoma



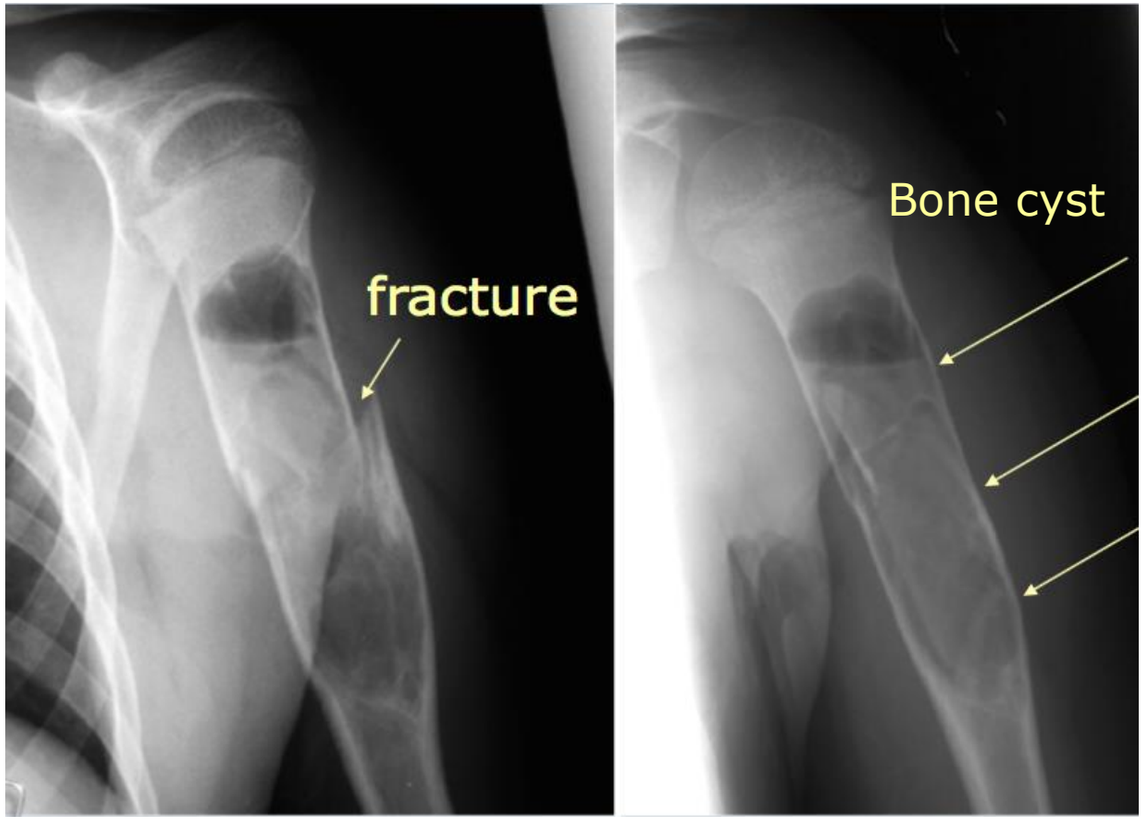


-Periosteal reaction In sarcoma
-Ewing Sarcoma: **sunburst appearance or hair bone end**

20 Years old lady finger pain Pathological fracture due to bone abnormality



Pathological fracture secondary to bone cyst in child



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

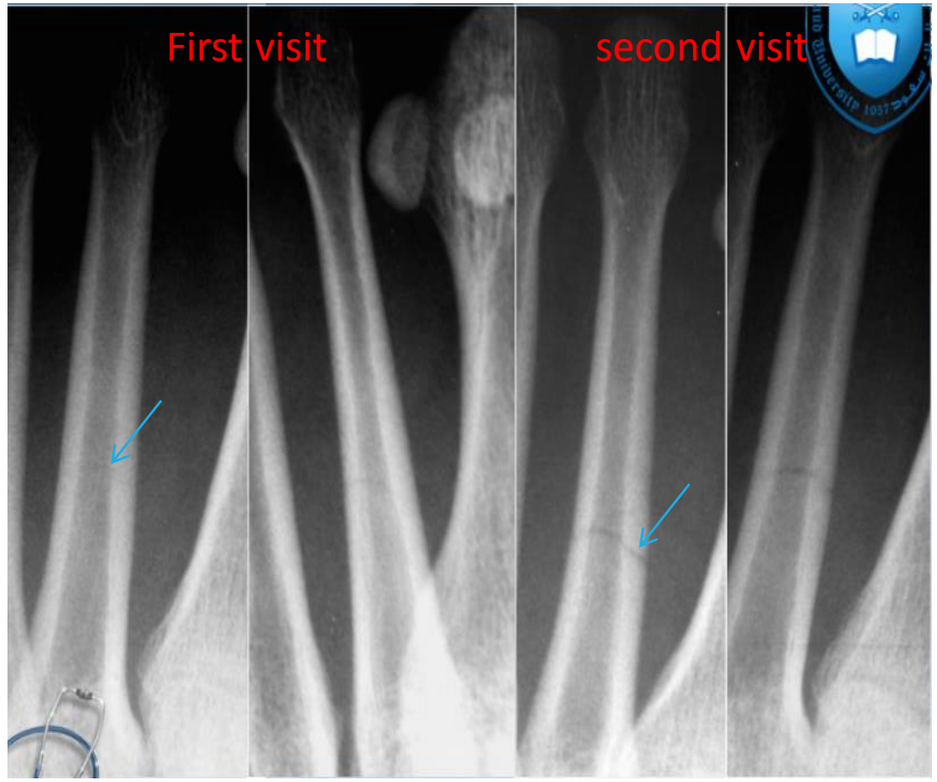
Stress fracture (first visit with pain only on apparent abnormality)

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

The previous patient returned with worsening pain in the forefoot

Stress fracture (after one week)

Fracture in the **shaft of the second metatarsals**
Usually happen in soldiers



Magnified image shows vertical stress fractures on the mid-shaft

SUMMARY

Imaging Modalities
- Musculoskeletal Anatomy
- Image Interpretation
- Musculoskeletal Trauma & Fractures

More images:

- http://radiopaedia.org/encyclopaedia/ cases/musculoskeletal
- http://radiopaedia.org/articles/ musculoskelet al-curriculum

Thank You!

We hope you found this helpful and informative.

Done by:

- Aisha Alsafi
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