Radiology of Rheumatic Diseases

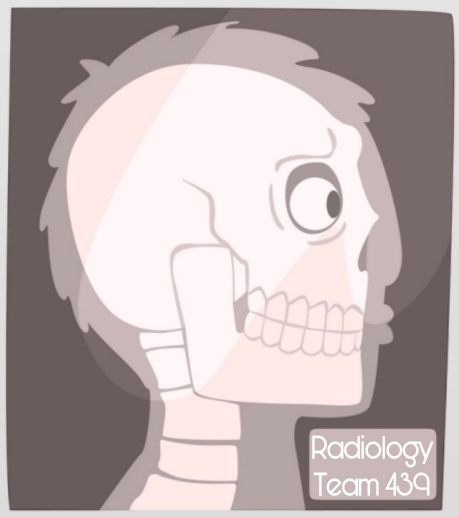
Lecture 16

Objectives

1. Understanding basics of image formation and anatomical landmarks
2. Developing system of analyzing findings:
   a. Where to look " important site"
   b. What to look for " bone density & texture, bone marrow ,articular cortices ,soft tissue"
3. Recognizing imaging features axial spondyloarthritis
4. Introduce Imaging approach to skeletal trauma and Identify important findings including sequelae and complications.
5. Introduce Imaging approach to skeletal inflammatory process "arthritis" and Identify important findings including sequelae and complications

Color index:

Black: Main text
Red: Important
Yellow: Golden notes
Green: Drs notes 439
Dark green: Drs notes 438
Gray: Extra



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Terminology in bone trauma

Pathological fracture

- Green stick & Torus fractures (usually in pediatric).
- Physeal injuries (usually in pediatric).
- Stress fractures (Occurs in patient with repeated minor trauma in certain area, it affects normal bones with excessive stress).

Describe Fracture Alignment[1]

- Dislocation *vs.* Subluxation in dislocation there's disturbance of the alignment of the joint (extension, flexion, rotation), while subluxation is partial displacement.
- Displaced / Non-displaced.
- Angulated
- Depressed.

Describe Fracture Location

- Diaphyseal / Metaphyseal.
- Peri-articular / Intra-articular.

When fracture extends to the surface it might lead to a looser body that goes inside the joint and leads to another complication other than the initial fracture of the bone

Describe Fracture Severity

Open *vs.* Closed the overlying skin

- Simple.
- Comminute / Segmented segmented refers to large fragments of the fracture while comminuted is multiple tiny fractures.

Important concepts in imaging bone trauma

- Two perpendicular views (because the bones are cylindrical).
- Radiograph should include the joint nearest to the trauma.
- The paired bone concept: when we suspect a fracture in an area with two bones (such as forearm) we should look for both radius and ulna.
- The weakest link concept (Adult *vs.* Children) In adult the soft tissues are weaker while in children the bones are weaker. The bones in adults are consolidated unlike pediatrics their bones are fragile
- Comparison films A normal radiographic film to compare it with the abnormal film. More important in the pediatric age group

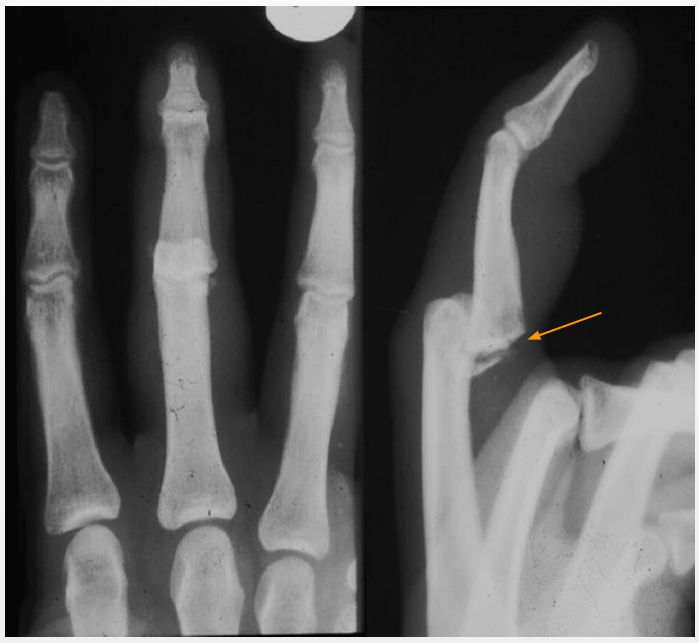
The weakest link

- The weakest link:
  - The soft tissue structures (muscles / ligaments / tendons) in Adults
  - the physeal plate an anatomical landmark within the bone (growth plate) in children.

1) It is important If you have a bone fracture near a joint to evaluate the joint, is there any associated displacement of the two articular surfaces? Is this displacement continuous or it can be reduced by certain movement of the joint?

Two perpendicular views

frontal lateral

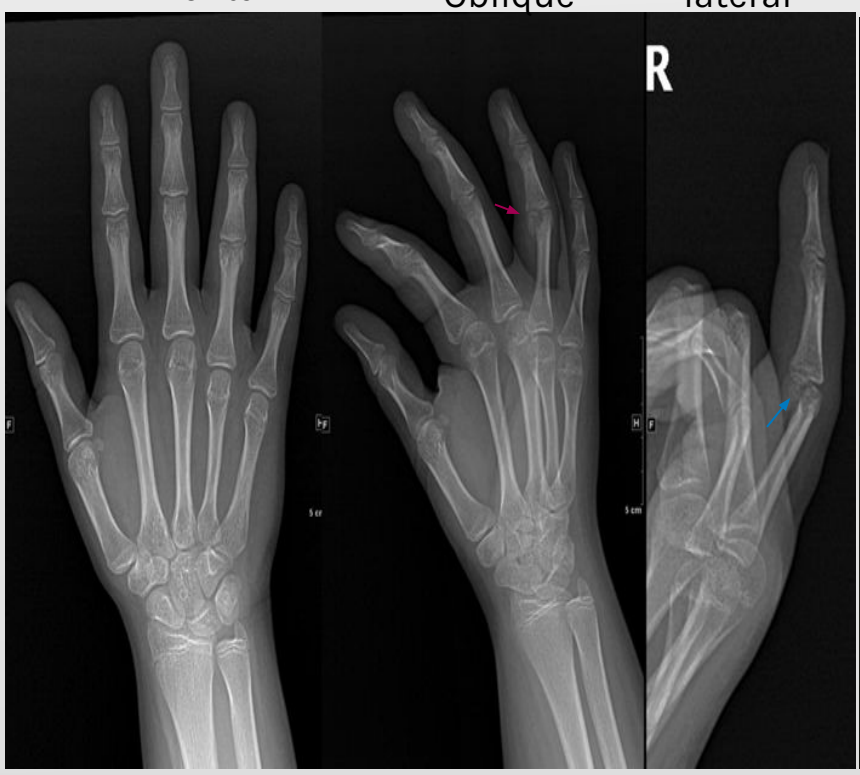


Malalignment and displacement
Not apparent on frontal view but very clear on lateral view
Arrow: chip fracture

lateral frontal

A 6 YO boy with trauma
Arrow: obvious fracture line
Not obvious on the frontal view

frontal Oblique lateral



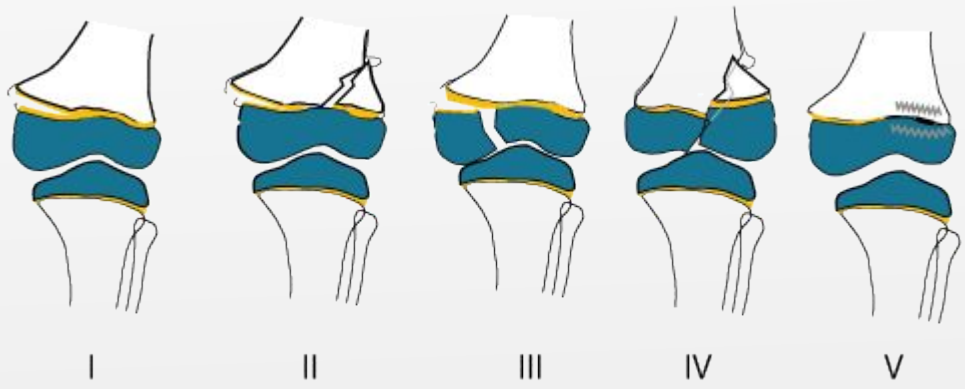
Frontal view looks normal
Oblique view shows fracture and displacement
Lateral view shows anterior angulation

Right left

as if they are aligned in one axis (arrow)
Total dislocation (arrow)

Physeal plate Injury[1]

physeal plate (growth plate) injury (other name: **salter-harris**)

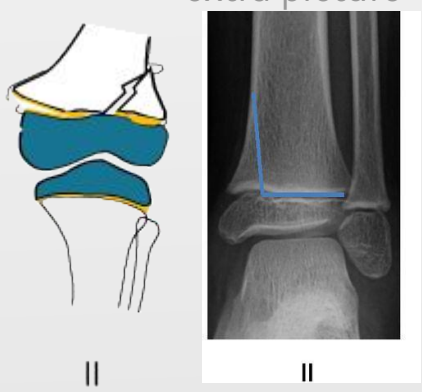


weakest point (child)

extra picture

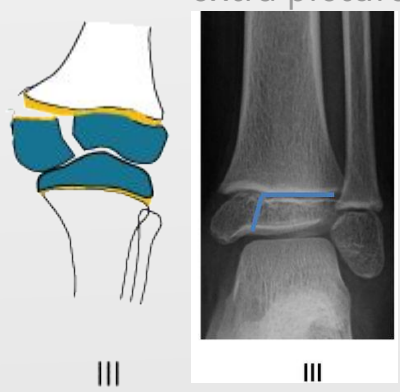
I- Avulsion or adduction or separation, widening of growth plate.

extra picture



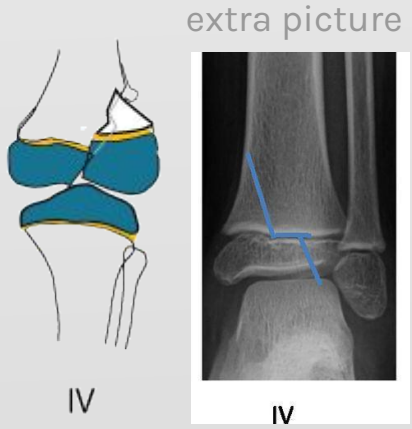
II- widening of the growth plate with a fracture on metaphyseal shaft. (Most frequently seen).

extra picture



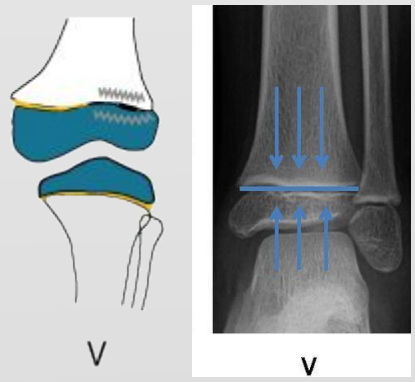
III-Fracture of epiphysis.

extra picture



IV- When both II and III combined in one injury.

extra picture



V- Impaction instead of separation. with force directed opposite to each other, for example child jump from high to floor it can alter the growth of the bone (the worst prognosis)

1) In physeal plate (growth plate) injuries, we divide injuries into five types. The first type is the simplest injury which cause separation of the growth plate, while in the fifth type there is the opposite where there is an impaction injury. In type two it will involve the metaphysis, in type three it will involve the epiphysis and in type four it will involve both.

Physeal plate Injury

Salter-Harris injury type I :

Widened growth plate

normal

Widened growth plate

normal

Salter-Harris injury type II :

11 years old boy with swelling of wrist pain.

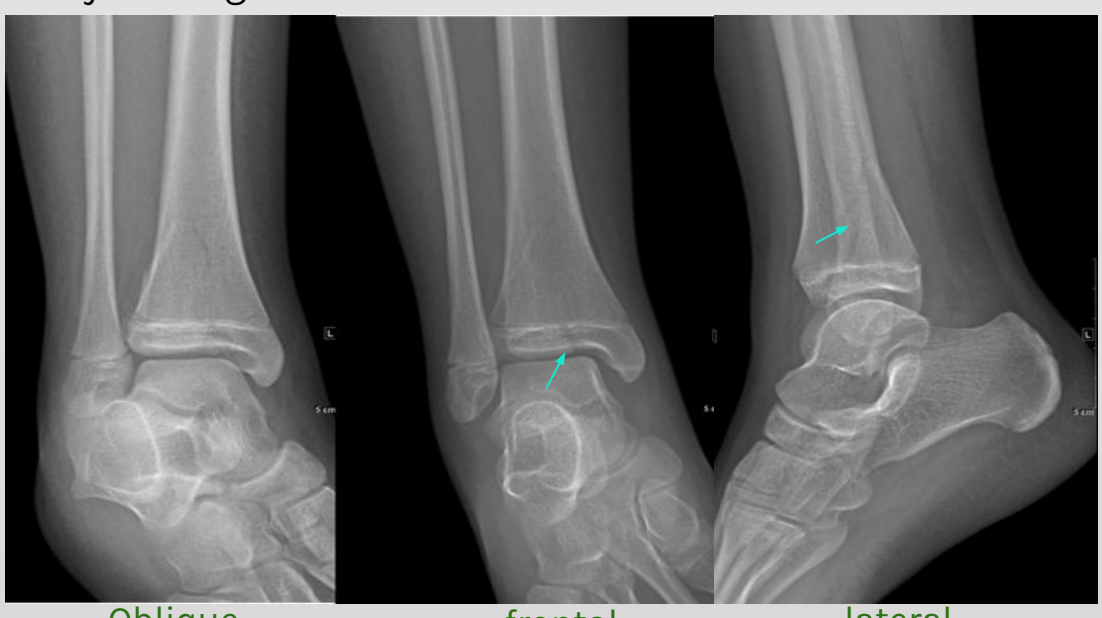
small piece of separated bone

Not closed yet

soft tissue swelling

Salter-Harris injury type III :

A 12 year old girl fell down



Oblique

frontal

lateral

fracture (arrow)

Physeal plate Injury

Salter-Harris injury type IV :

Computed tomography delineate more clear

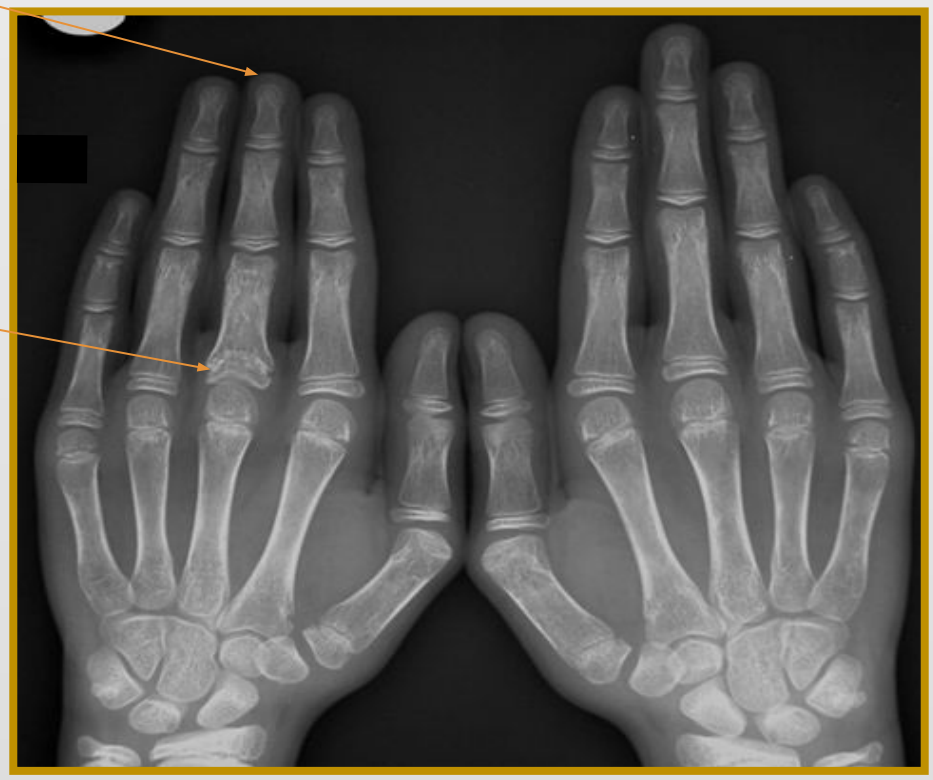
it's IV because of the extension into the metaphysis (arrow)

Salter-Harris injury type V :

Short finger
a complication

Old Fracture
growth plate is lost

A 9 year old boy with pain in his right hand.



Short middle finger because of An old insult in the physeal plate → premature closure of the physeal plate (impaction) → shortening of the bone. So any fracture in growth plate (physeal fracture) results in Salter-Harris injury type V.

Paired bone concept

paired bone concept

radiograph should include the joint nearest to the trauma and paired bone concept
there are 4 paired bones: radius and ulnar, tibia and fibula. if one breaks it becomes shorter The other bone will either fracture or dislocate or bow. so, it's important to look at both bones (paired bone concept)

Fracture Ulna & Dislocated Radius

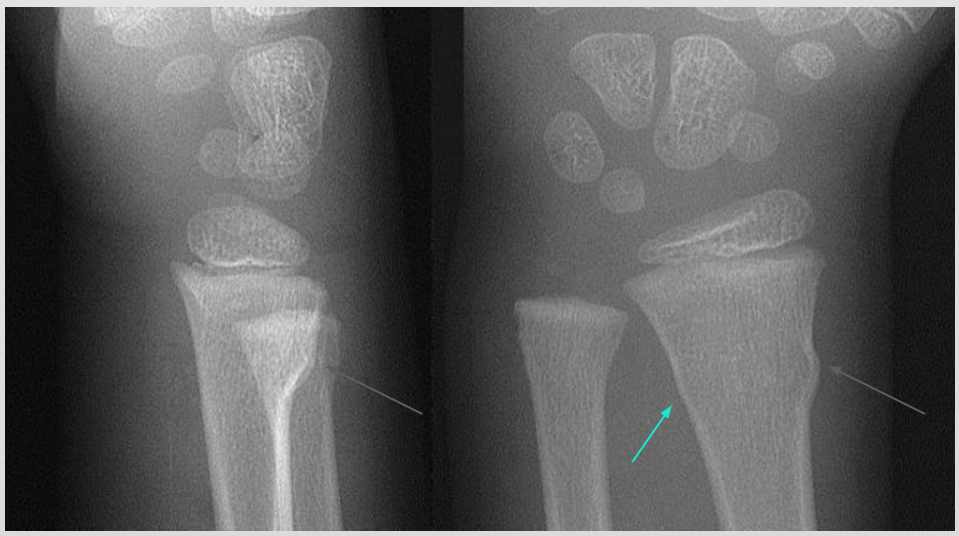
radial and ulnar are fixed by two joints the wrist and the elbow.

Bowing fracture ulna & fractured radius

radial shaft fracture(arrow), so what happened to the ulnar? it became curved (arrow)

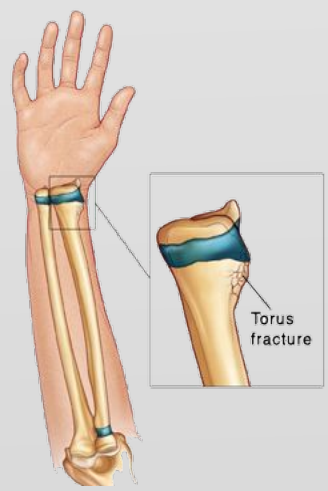
torus fracture

seen in children



cortical bending(arrow)
mild on the other side(arrow).

extra picture



circumferential bending

Paired bone concept

Greenstick fracture (In paediatric)

there is involvement of one side of the bone while the opposite side is intact

looks normal could be missed

it's clear on the lateral view disruption of the cortex(arrow)

Fracture(arrow)
intact(arrow)

Pathological Fractures

Pathological fracture

a diseased or weak bone, any minor trauma can lead to disruption

Fracture occurs in a diseased bones like :

1. enchondroma.
2. Bone cyst
3. osteosarcoma

fracture secondary to enchondroma

1

Fracture (arrow)

cortical thinning (arrow), lytic lesion (arrow)
Enchondroma is a type of benign bone tumor that originates from cartilage. Most often it affects the cartilage that lines the inside of the bones.
Notice the osteolytic (blackish) circular lesion, it led to the small fracture after the bone became weaker.

fracture secondary to bone cyst

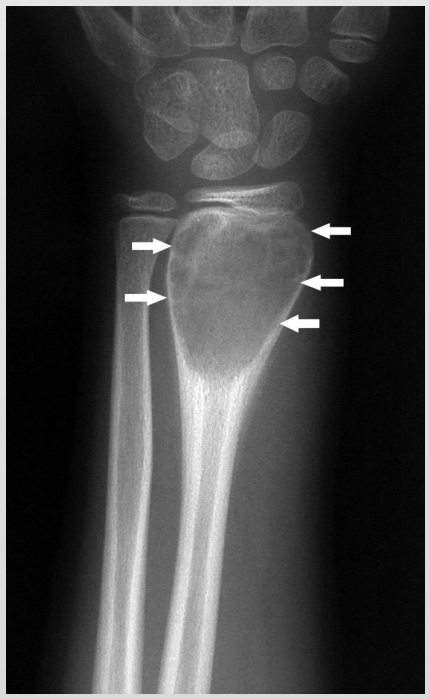
occurs in disease more

2

Fracture

1- bone cyst
2- Cortex thinning.

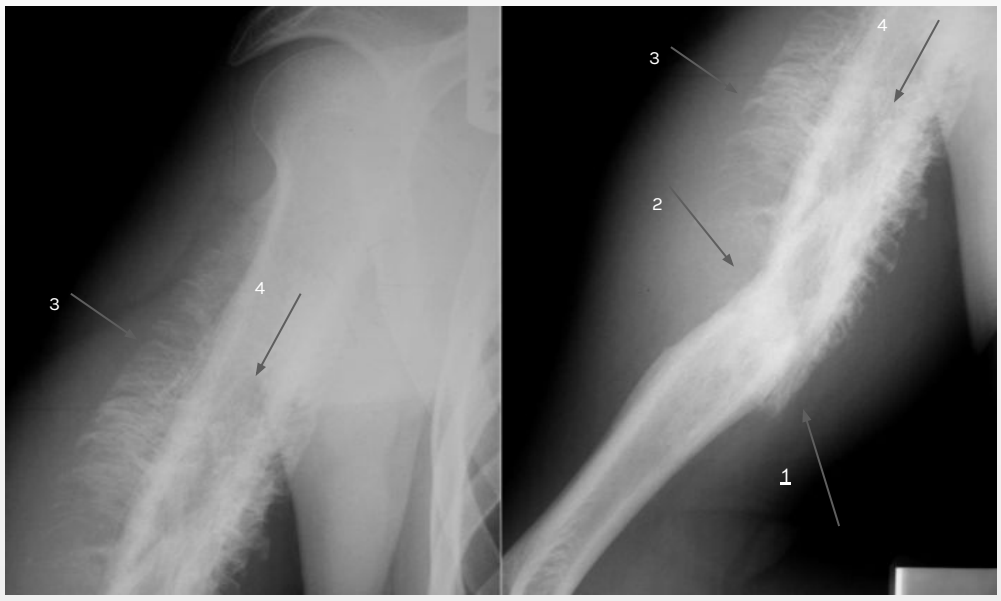
extra picture of cyst



Pathological Fractures

fracture secondary to osteosarcoma

3

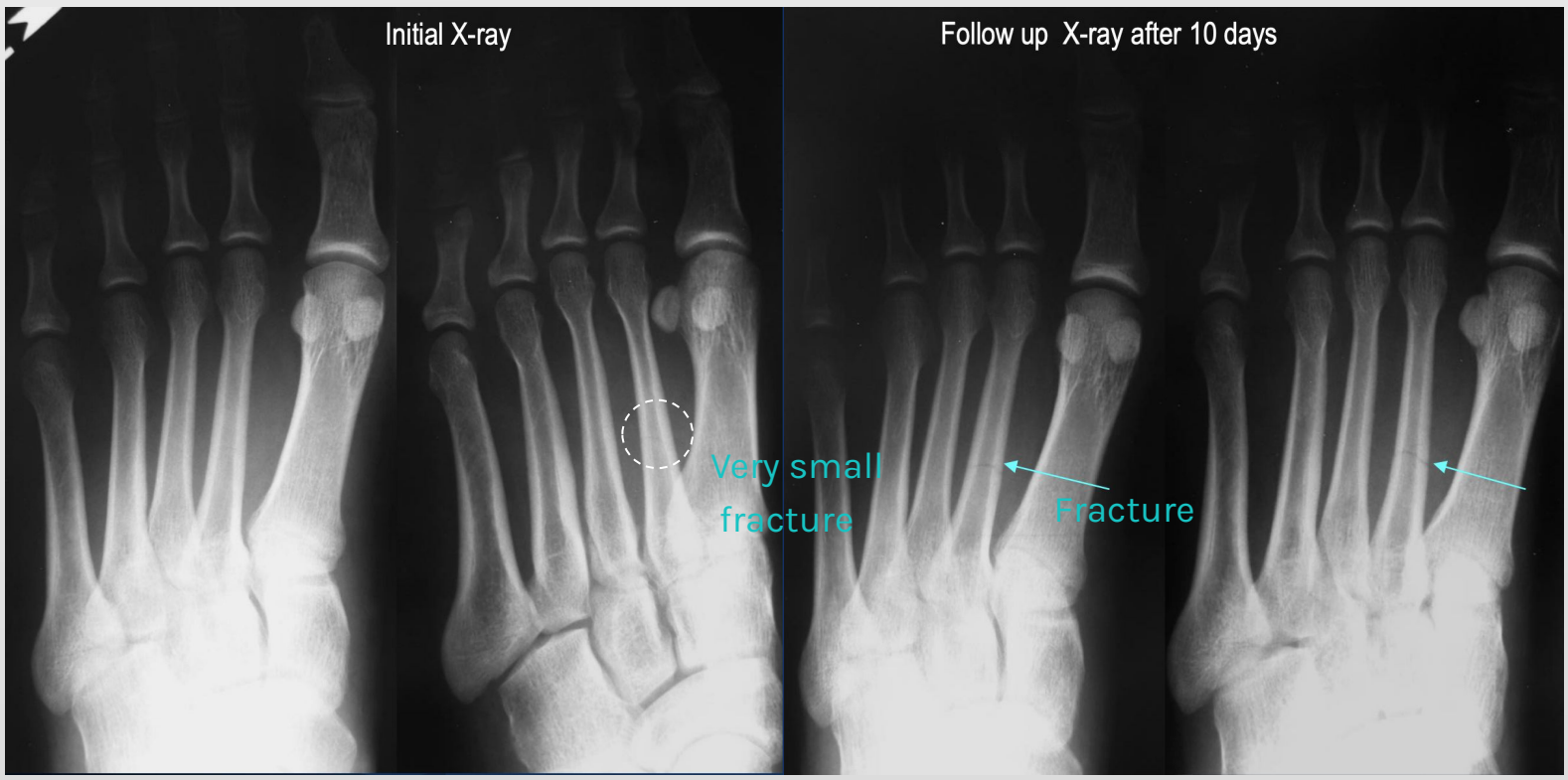


1- Fracture.
2- Fracture.
3- Periosteal reaction.
4- Heterogeneous bone texture.

the cortex is ill defined, the pathology is in the proximal limp while the distal limb is normal. the osteosarcoma is more aggressive

Stress Fractures

Repeated minor trauma on otherwise normal bone causing perpendicular small fracture. Stress fractures are easily missed. Ex: soldiers when they do the military walk they raise their foot and slam it down, with time it may cause a stress fractures. They are very thin and perpendicular to the bone axis

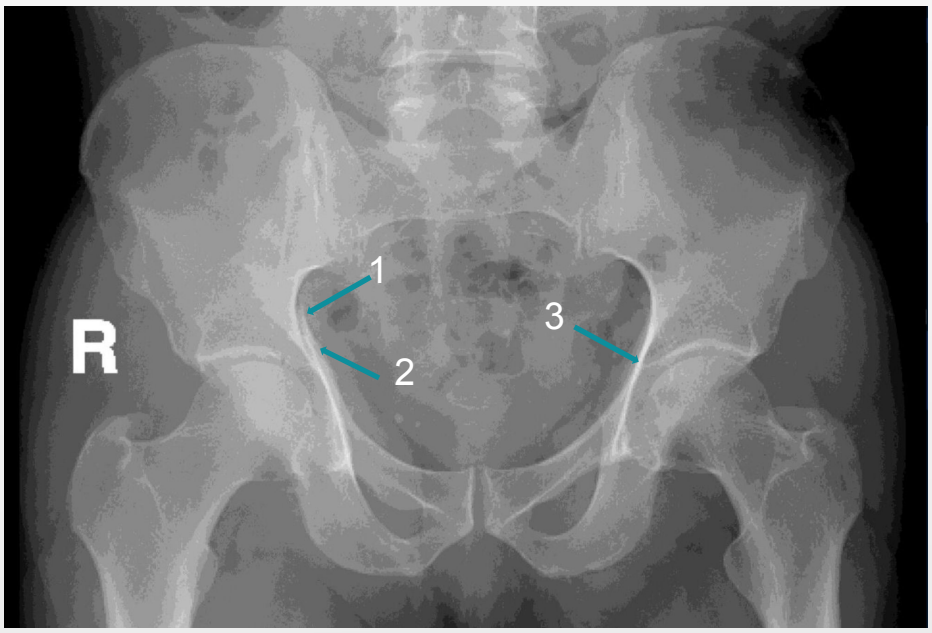


The patient visited complaining of pain as shown in the initial X-ray on the left was dismissed as normal, then come for the follow up with the stress fracture more visible.

Pathological Fractures

Hip Fractures

A 55 years old man with hip pain and limping

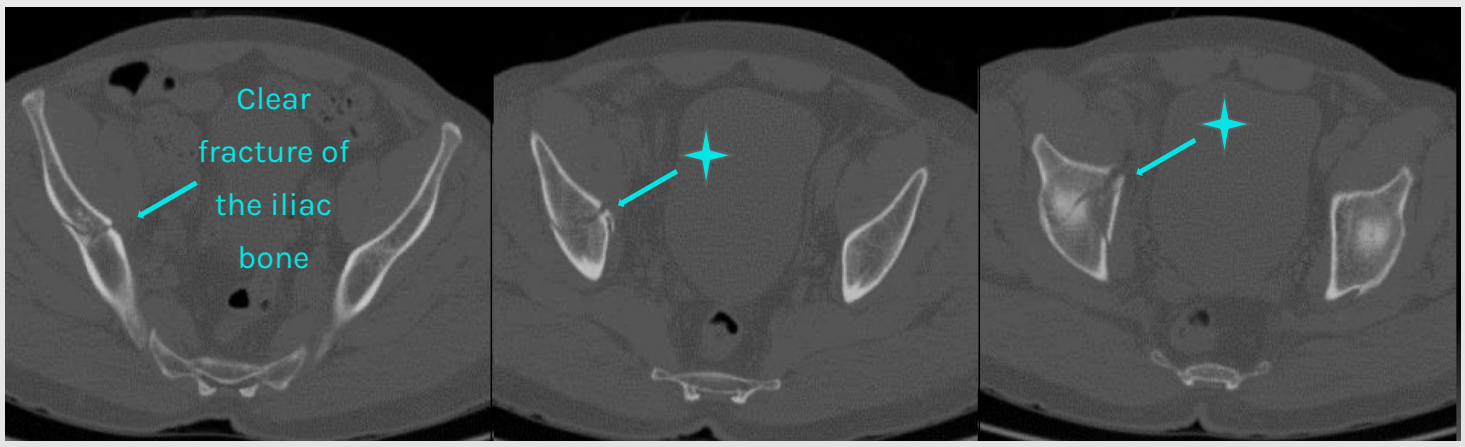


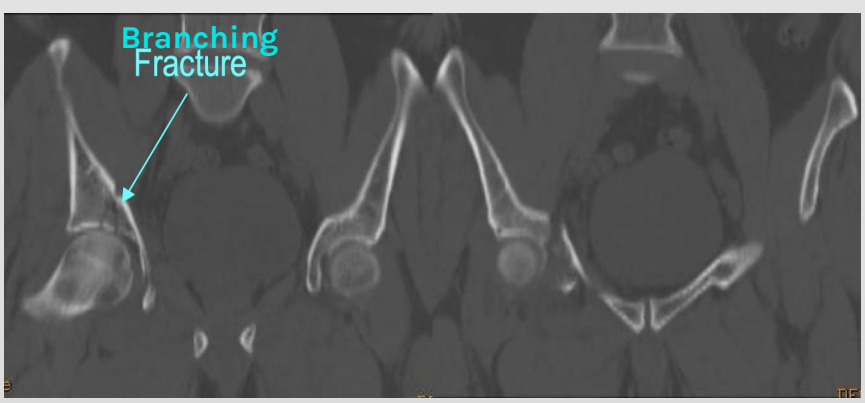
1 Fracture line

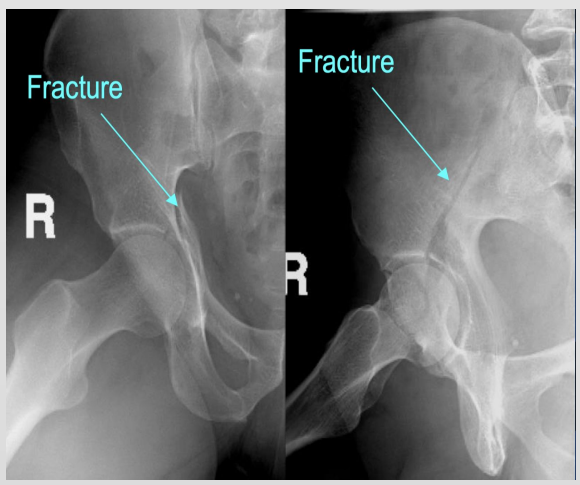
2 Disruption of the cortex outline

3 Normal cortex outline

Correlation with Cross sectional Imaging







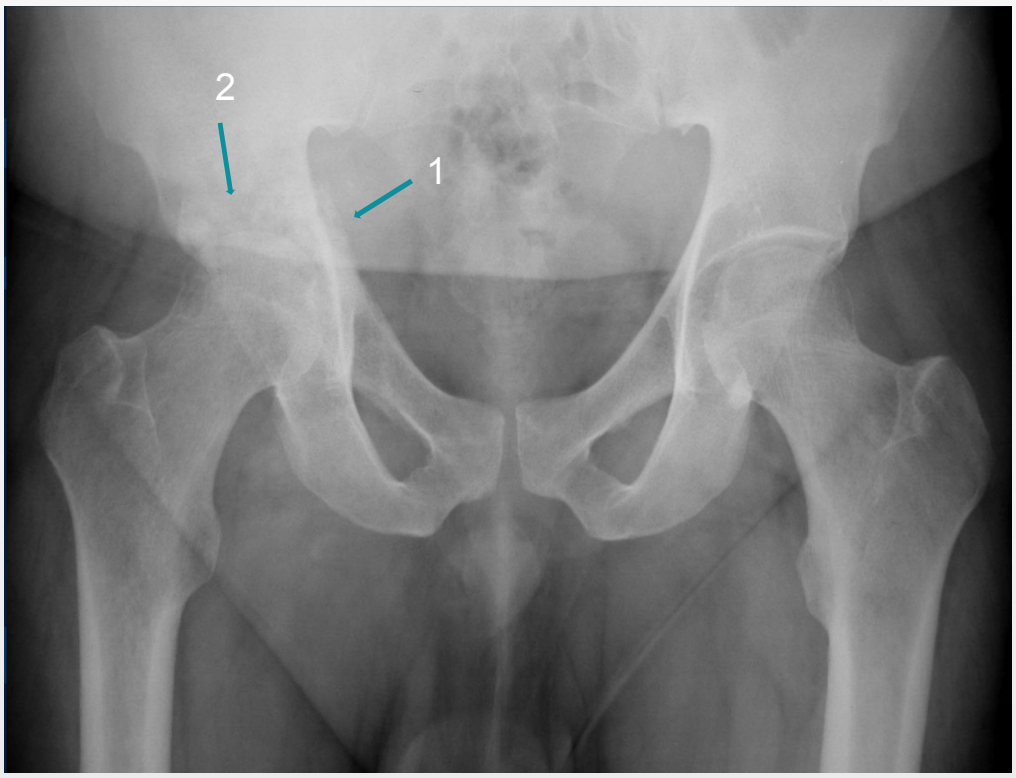
Whenever you have a fracture that is not clear, or an insult to bone bone that isn't clear, cross sectional imaging is the modality that delineate the anatomy and architecture more clearly

Supra-acetabular fracture

Pathological Fractures

Hip Fractures

A 50 years old man with hip pain and limping



1 Disrupted and ill defined fracture line and asymmetry of the cortex outline

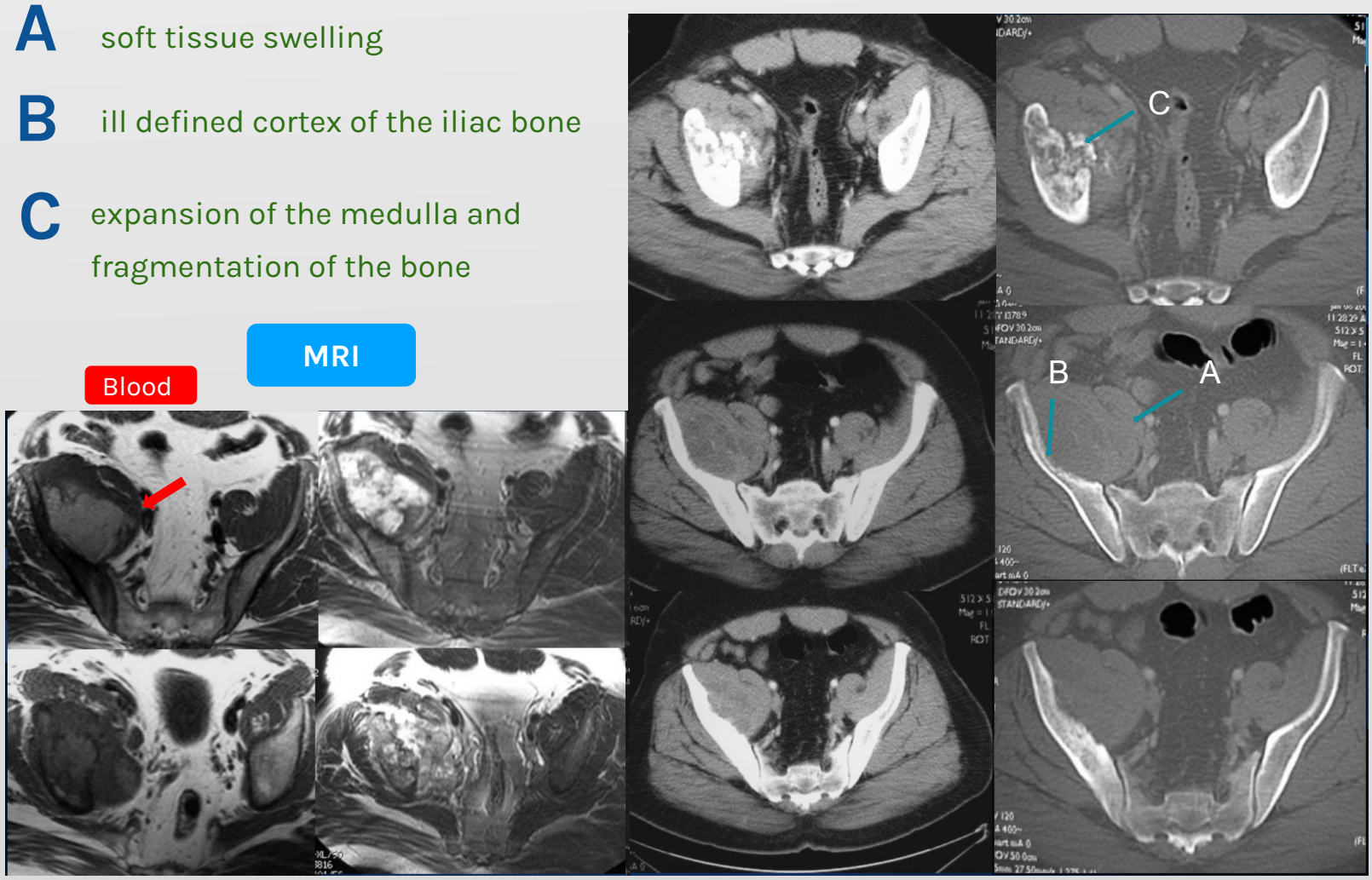
2 Sclerotic area

Fracture secondary to sarcoma

A soft tissue swelling

B ill defined cortex of the iliac bone

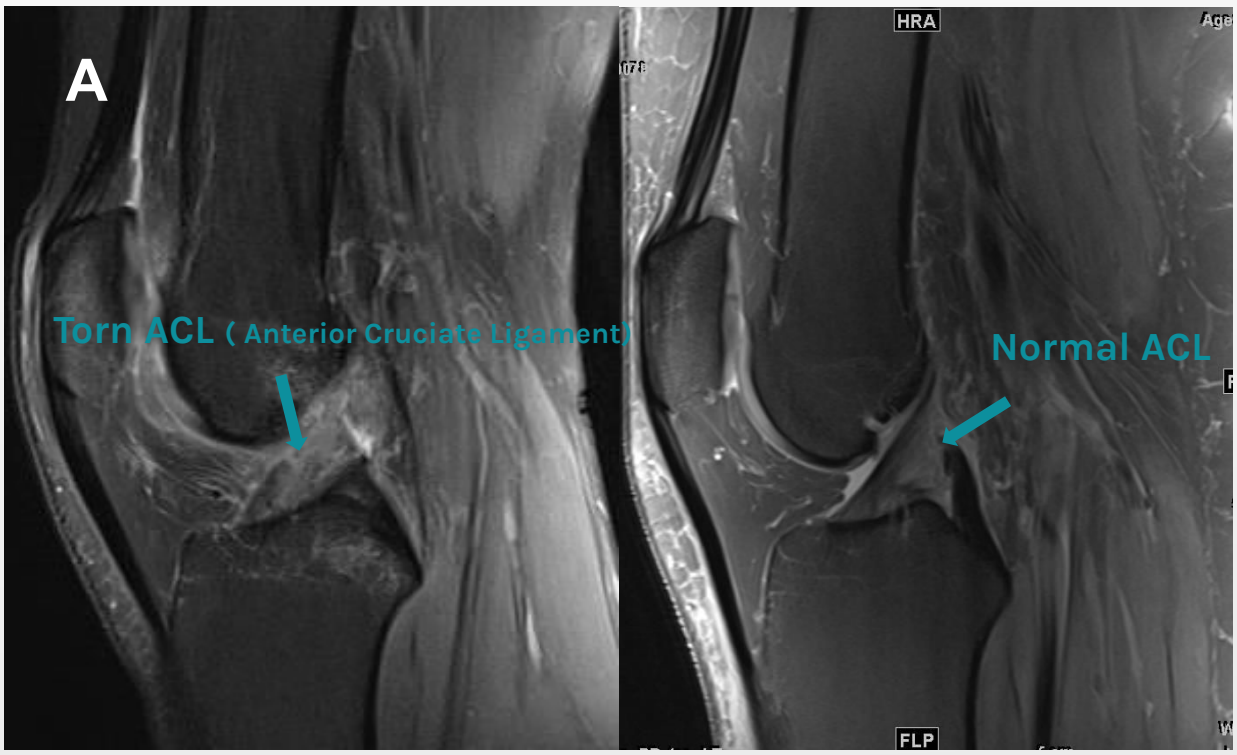
C expansion of the medulla and fragmentation of the bone

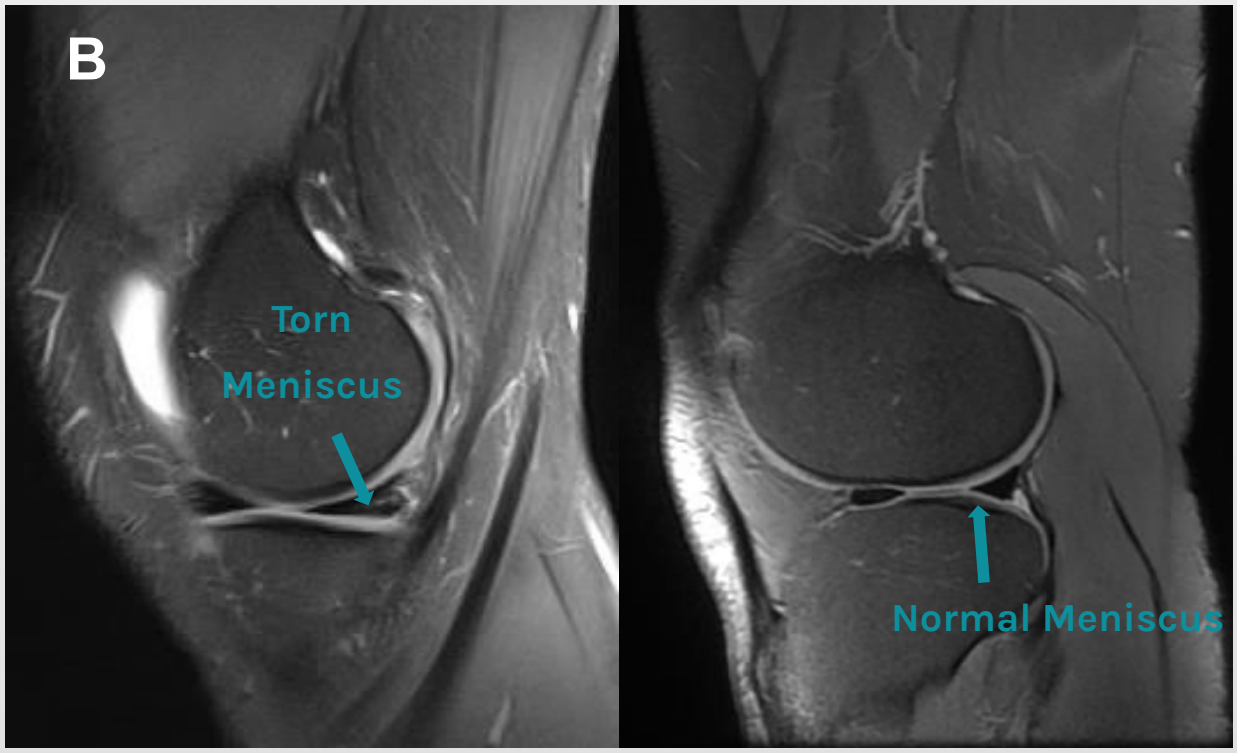


Correlation with Cross sectional Imaging

Pathological Fractures

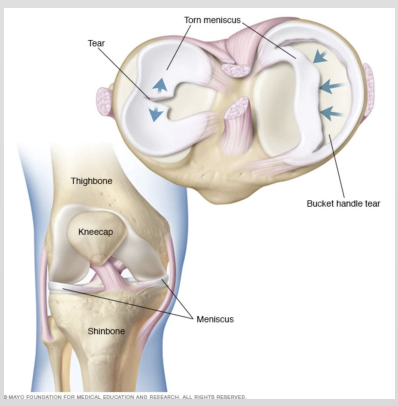
Knee injuries





A ACL injury, you can’t see the ACL clearly & it doesn't have the smooth black band.

B extra picture



Arthritis

Types :

- **Infectious** (like septic arthritis)
- **Metabolic** (like gouty arthritis).
- **Arthritis**
- **Inflammatory** (like Rheumatoid arthritis).
- **Degenerative** (like osteoarthritis).

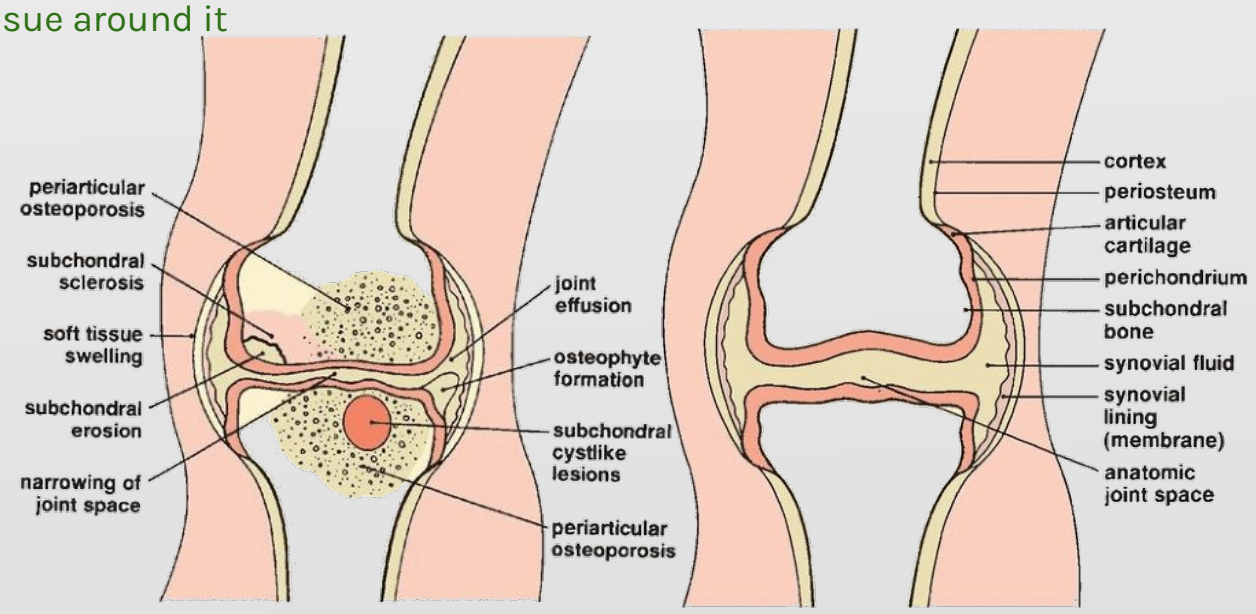
Features to look for:

1. Bone density:
   Osteopenia vs. Osteosclerosis. Periarticular / Generalized
2. Bone cortex :
   Osteolytic vs. Osteoproliferation. Erosive / Osteophyte.
3. Bone alignment:
   Distribution / Deformities.
4. Soft tissue changes:
   Effusion / Density / Calcification.

how to know?
compare it to the
soft tissue around it

Is there dislocation
or subluxation?

Is there any swelling?



1- Joint effusion.
2- Osteophyte formation.
3- Subchondral cystic changes.
4- Periarticular osteoporosis.
5- Subchondral sclerosis.
6- Soft tissue swelling.
7- Subchondral erosion.
8- Narrowing of joint space.

normal

Rheumatoid Arthritis

40 YO woman with joint pain

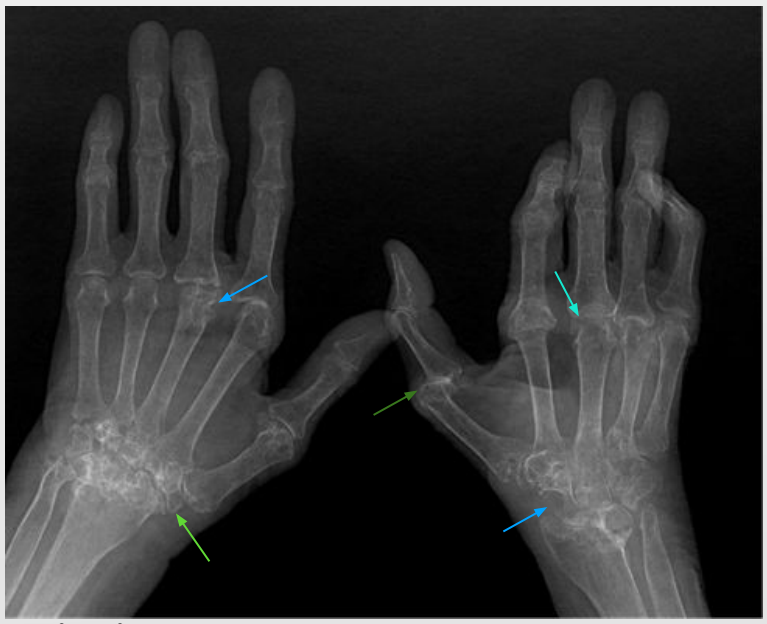
Dorsal view

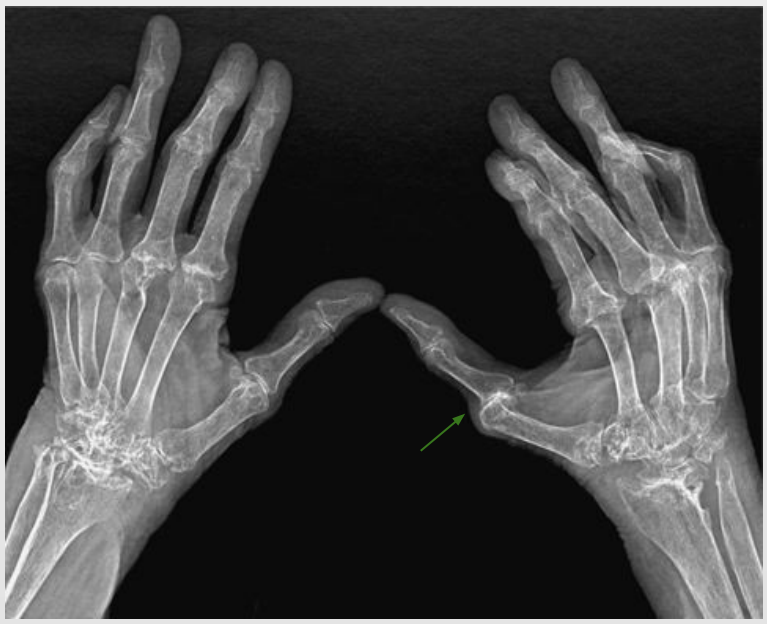
Palmar view

Normal

- Normal bone density & texture.
- Preserved joint space.
- No erosions.
- Normal alignment.
- Normal soft tissue.

A 48 years old female presented with joint pain of the hands & feet X-ray of hand requested

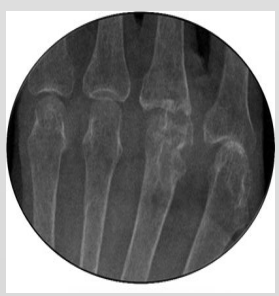


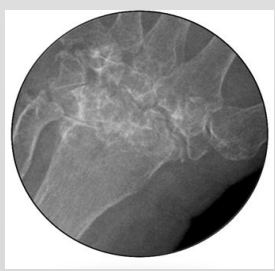


Findings:

- Generalized / Diffuse Osteopenia.
- Joint space narrowing (proximal > distal).
- Periarticular erosions & destruction & collapse of carpal bone.
- Subchondral cystic changes.
- Subluxation.

Zoomed images of the above x-ray





Decreased bone density, Whenever you have a reduction in bone density this indicates inflammatory rather than degenerative.

- eaten bone (arrow)
- loss of metacarpophalangeal articulation(arrow)
- loss of articulation of the radius and the carpal bones(arrow)
- malalignment(arrow)

Rheumatoid Arthritis

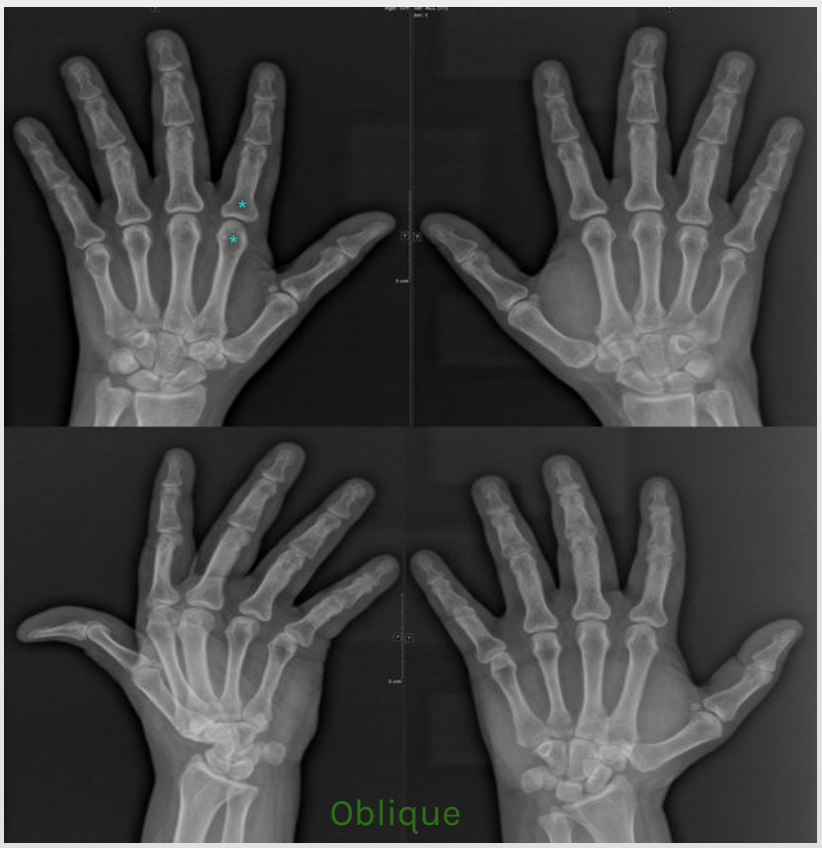
comparison

Normal

Diffuse Osteopenia

-Density almost same as soft tissue.
-No corticomedullary differentiation

53 year old man with **small joint pain** :



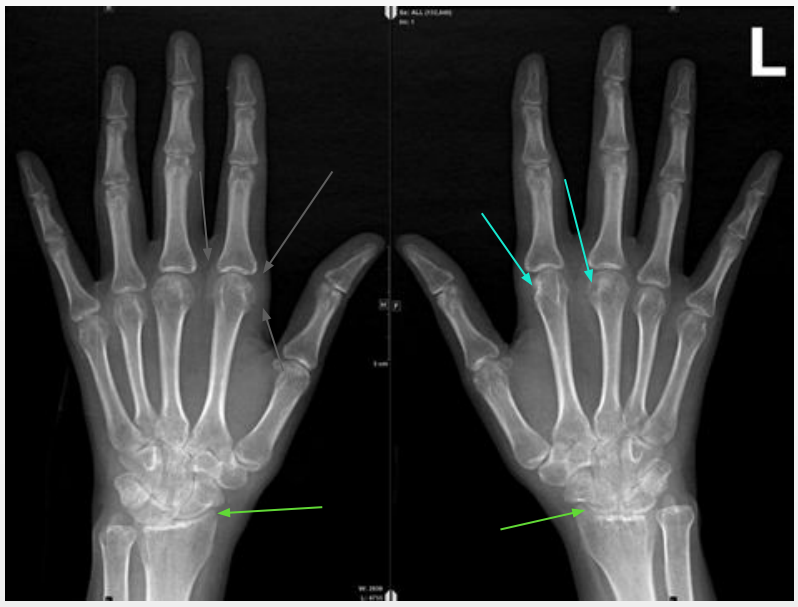
Diffuse osteopenia on top of periarticular / no erosions
generalized decreased bone density but more prominent around the joints

Findings:

- Periarticular osteopenia*star (radiolucent areas). localized
- Preserved joint space.
- No erosions.
- Normal alignment.
- Normal soft tissue.

Rheumatoid Arthritis

29 year old women with **arthralgia** (early changes) :



Dorsal view

Palmar view

Findings:

- Periarticular osteopenia (radiolucency -blackish- bone area around the joint).
- Joint space narrowing (radiocarpal & metacarpophalangeal). arrow
- Periarticular erosions. arrow
- Periarticular soft tissue swelling. arrows
- Normal alignment.
- Early manifestation of RA

Rheumatoid arthritis & deformities (late changes) :

- Osteoporosis.
  - **Early:** Juxta (nearby) articular.
  - **Later:** Diffuse.
- Erosions.
- Cartilage destruction.
- Deformities.

Osteoarthritis

osteoarthritis

Elderly male patient presented with joint pain of the hands. An x-ray of the hand was requested :

Findings:

- ❖ Normal bone density, subchondral sclerosis.
- ❖ Joint space narrowing (Distal interphalangeal).
- ❖ No erosions.
- ❖ Marginal osteophytes, look like sharpening of the joint edges.
- ❖ Distribution: weight bearing joints (hips, knees, back).
- ❖ In the hands: DIPs, PIPs, CMC of thumb.

DIP: distal interphalangeal joint
PIP: proximal interphalangeal joint
CMC: carpometacarpal

Subchondral sclerosis is the hardening of the bone just below the cartilage surface. It shows up in the later stages of osteoarthritis. And it is common in the bones found at the load-bearing joints

Erosive osteoarthritis

findings:

- Normal bone density, subchondral sclerosis/cyst.
- Joint space narrowing (Distal interphalangeal)
- Erosions (proximal & distal).
- Marginal osteophytes, look like sharpening of the joint edges.

Arthritis

Psoriatic arthritis :

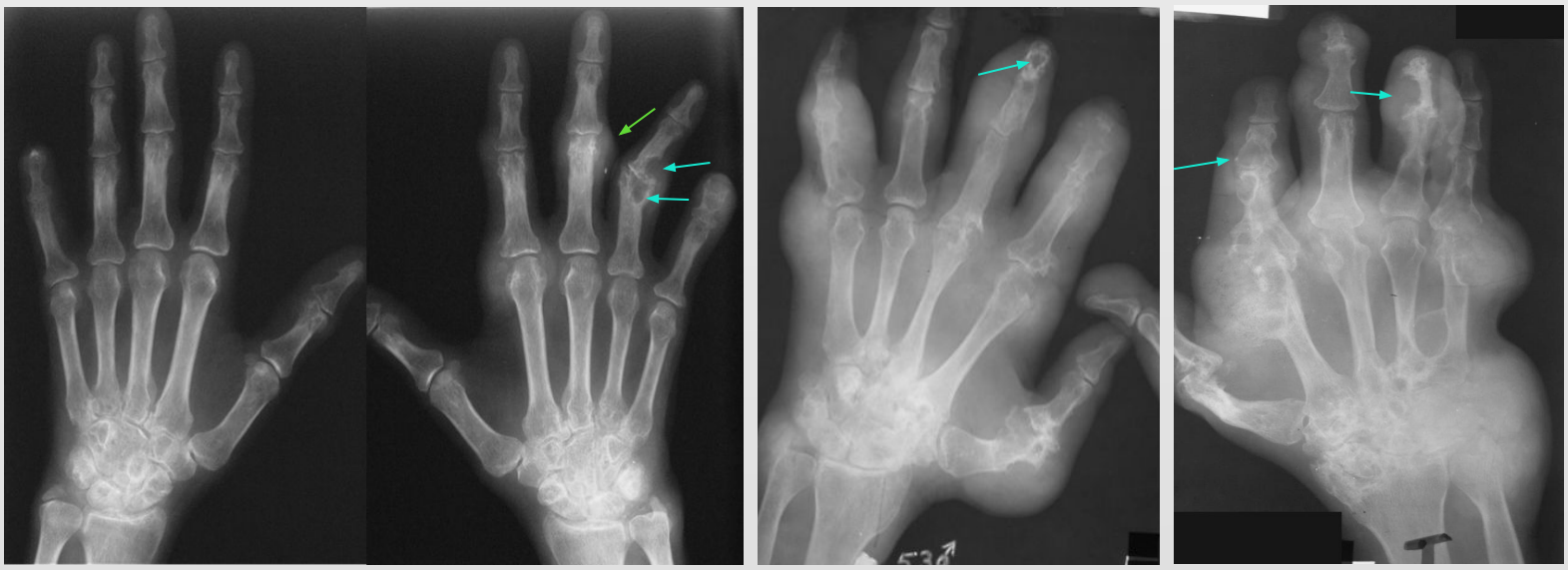
Psoriatic arthritis is a type of arthritis that develops in some people with the skin condition psoriasis. It typically causes affected joints to become inflamed (swollen), stiff and painful. Like psoriasis, psoriatic arthritis is a long-term condition that can get progressively worse.

Findings:

- Normal bone density, subchondral sclerosis/cyst.
- Joint space narrowing (distal & proximal) & fusion. (arrow)
- Erosions (proximal & distal).
- Marginal osteophytes proliferation. (arrow)
- Deformities.

Gouty arthritis :

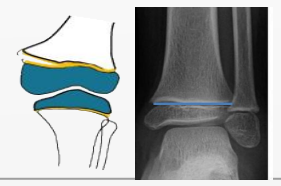
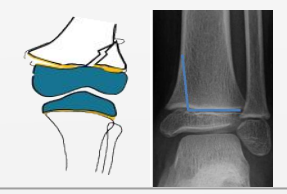
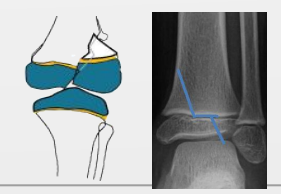
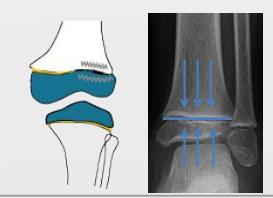
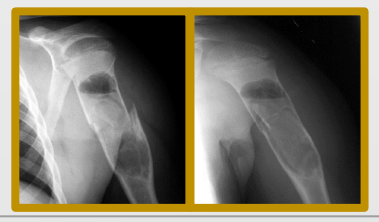
43 year-old male patient presented with pain and swelling in hands and feet, An x-ray of the hand was requested



Findings:

- Normal bone density.
- Preserved joint space.
- Dense periarticular soft tissue tophi. (arrow)
- Erosions (periarticular & marginal **overhanging sign**). (arrow)
- Periostitis & Marginal osteophytes.
- Deformities.

Summary

Important concepts in imaging bone trauma	- Two perpendicular views - Radiograph should include the joint nearest to the trauma. - The paired bone concept - The weakest link concept (Adult → Soft tissue, Children → Bones) - Comparison films		
Physeal plate injury (salter-harris)	**Type I**	Avulsion or adduction or separation, widening of growth plate.	
	Type II	Widening of the growth plate AND a fracture on metaphyseal shaft. (Most frequently seen).	
	Type III	Fracture of epiphysis.	
	Type IV	Both **type II** and **type III** combined in one injury.	
	Type V	Impaction instead of separation. with force directed opposite to each other (the worst prognosis)	
Pathological fractures	**Fracture secondary to enchondroma**		**Fracture secondary to bone cyst** 
	Fracture secondary to osteosarcoma		**Stress fracture** 
Arthritis	**Rheumatoid arthritis**	- Joint space narrowing (proximal > distal). - Periarticular erosions - Periarticular osteopenia - Periarticular soft tissue swelling	
	Osteoarthritis	- Joint space narrowing (distal > proximal). - Subchondral sclerosis/cyst. - Normal bone density - Marginal osteophytes	
	Psoriatic arthritis	- Joint space narrowing (distal & proximal) & fusion. - Marginal osteophytes proliferation	
	Gouty arthritis	- Dense periarticular soft tissue tophi. - Erosions (periarticular & marginal overhanging sign)	

438 Quiz

1- The abnormality seen in the following image is:

a. Bowing fracture.
b. Torus fracture
c. Greenstick fracture
d. Stress fracture
e. Choice

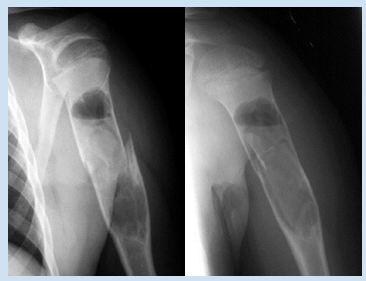
2- A physeal plate fracture results in:

a. Salter-Harris injury type II.
b. Salter-Harris injury type III.
c. Salter-Harris injury type IV.
d. Salter-Harris injury type V.

3- What is the best modality to assess the anterior cruciate ligament:

a. MRI
b. CT
c. X-ray
d. Nuclear imaging

4- A child presented to ER with painful swelling of the left upper arm. No previous history of trauma. X-ray is shown below. What is the most likely diagnosis?



a. Stress fracture of left humerus
b. Osteosarcoma of left humerus
c. fracture of the left humerus 2ry to bone cyst
d. Ewing sarcoma of left humerus

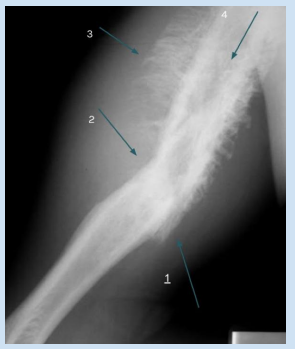
5- Subchondral sclerosis is seen in:

a. Osteoarthritis
b. Rheumatoid arthritis
c. Gouty arthritis
d. Psoriatic Arthritis

Answers
1)C
2)D
3)A
4)C
5)A

439 Quiz

1- Identify the arrow number 3?



a. Periosteal reaction
b. Osteophytes
c. Greenstick fracture
d. Stress fracture

2- What is the diagnosis?

a. Salter-Harris injury type II.
b. Salter-Harris injury type III.
c. Salter-Harris injury type IV.
d. Greenstick

3- A 9 year old boy had a history of deformity in the right hand. X-ray is shown. What is the diagnosis?

a. Metacarpophalengeal dislocation
b. Physeal fracture
c. Septic arthritis
d. Torus fracture

4- Proximal erosive arthropathy is seen in the hands x-ray of middle aged female patient. Which ONE of the following can cause this abnormality?

a. Gout
b. Rheumatoid arthritis
c. Osteoarthritis
d. Psoriasis

Answers
1)A
2)D
3)B
4)B

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