Radiological anatomy of the skeletal system

Lecture 15

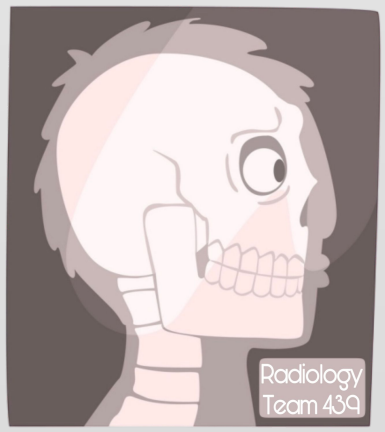
Objectives

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 “Where to look (imp sites) & What to look for (bone density and texture , bone marrow, articulate cortices & soft tissue)”
- Recognize features of certain disease entity

Outlines

Color index:
Black: Main text
Red: Important
Yellow: Golden notes
Green : Drs notes 439
Blue : Drs notes 438
Gray: Extra



Imaging of MSK

Conventional Radiography	The **cornerstone** imaging modality in evaluating MSK system. The **basic and most important initial** modality for evaluating MSK system whether trauma, neoplastic, inflammatory, haematological disease or arthritis.
Ultrasound	• Soft tissues components • Tendons/ligaments/muscles. • Detect fluid collections around joints or within muscles. e.g. edema • Soft tissue masses and cysts. e.g. intramuscular hematoma • Safe, no ionizing radiation thus used widely
CT	• Useful in evaluating **bone texture** & extent of the disease or trauma. • Obtain images in axial plain and can rebuild it to sagittal or coronal planes
MRI	• Useful to detect earliest change in **bone marrow** and **soft tissue characterization** like hyperemic or neoplastic changes and to assess Ultrasound Tendons, muscles, Joint capsule, ligaments **Ex: Knee ligaments.** • Can obtain images in various planes • Can show cellular level changes, more sensitive in picking up the early changes in comparison to CT
Nuclear Medicine	Bone scan is very sensitive (can detect early changes) but is relatively **non-specific.**

"Where to look & What to look for"

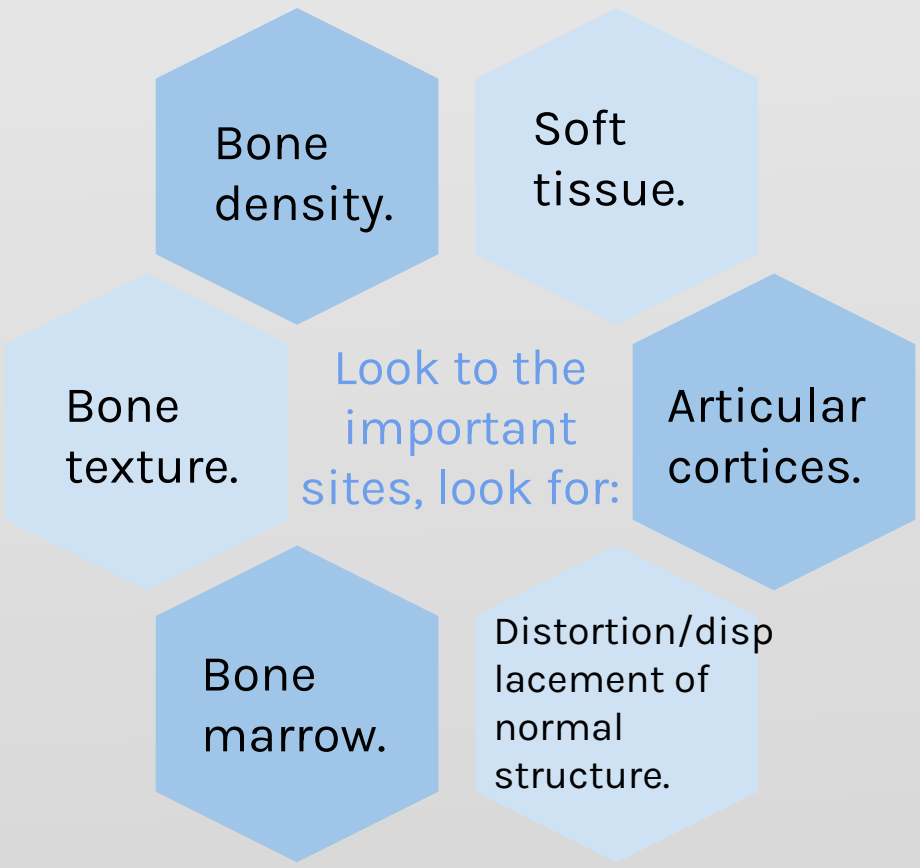
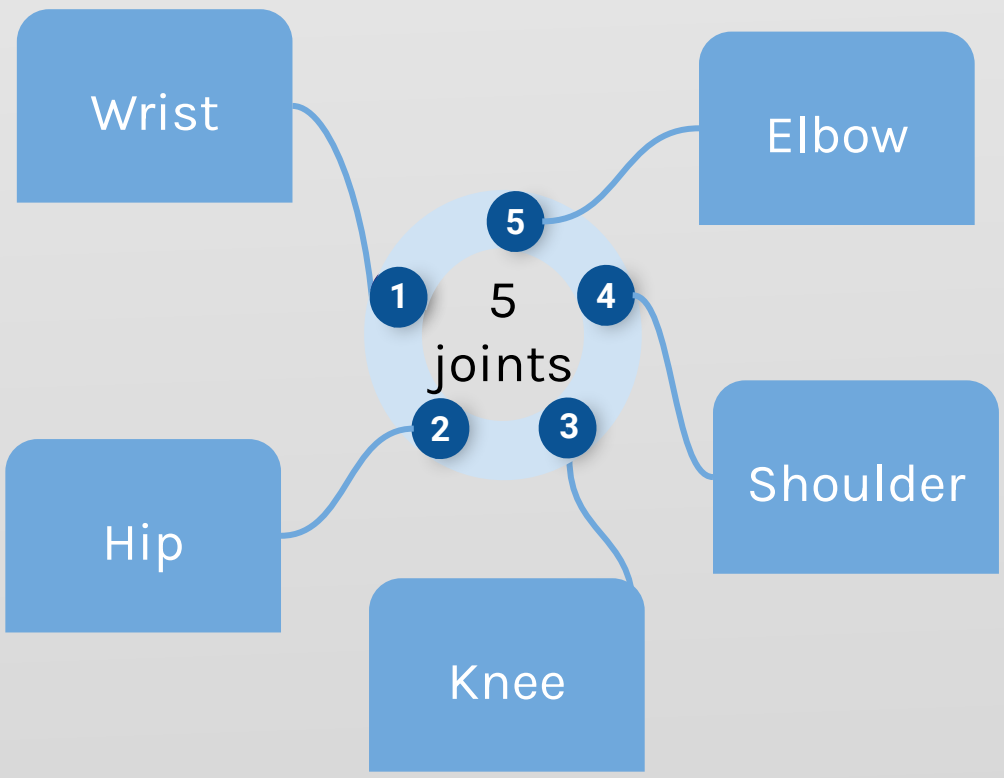


Image of Musculoskeletal system anatomy

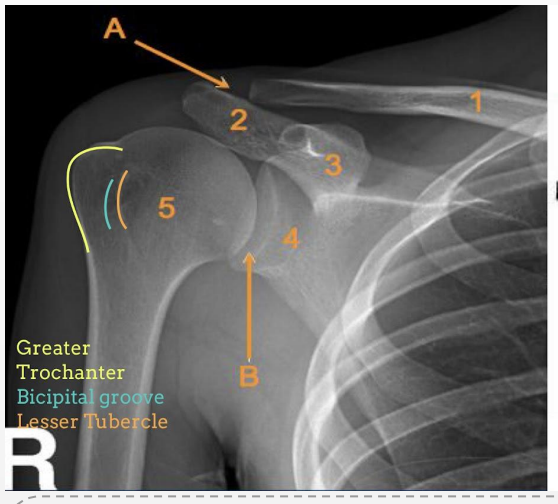


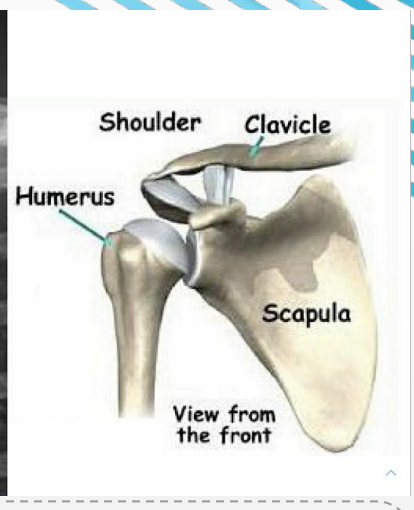
Shoulder

Shoulder joint

A. **Acromioclavicular Joint.** Fibrous joint
B. **Glenohumeral Joint (Facet).** Synovial joint

1. Clavicle.
2. Acromion Process. Posteriorly
3. Coracoid Process.
4. Glenoid Process. Anteriorly
5. Humerus





3 bones form the shoulder joint:
1 - Glenoid Process of scapula.
2- Acromion Process (articulates with the lateral aspect of the clavicle).
3- Humeral Head.

To have a clear image of these joints we have to put the patient in a slightly oblique position. The glenoid lies obliquely to see the space between the joints. 10-15 degrees rotation in the frontal projection.

- Regarding cross sectional CT it shows better architectural structures, we can see cortex, trabeculae, and soft tissues around joint space
- Wide window will show several elements within the organ
- Narrow window will show only bone and soft tissues

CT scan of the shoulder joint

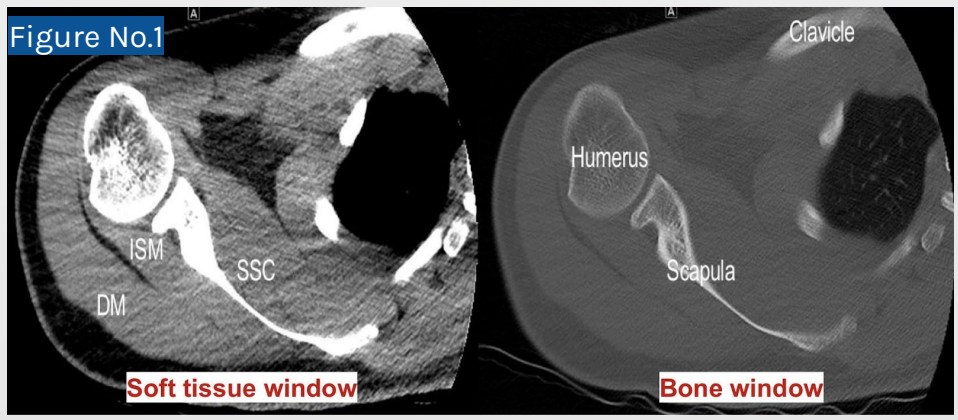


Figure No.1

- ISM = Infraspinatus muscle.
- DM = Deltoid muscle
- SSC = Subscapularis muscle.

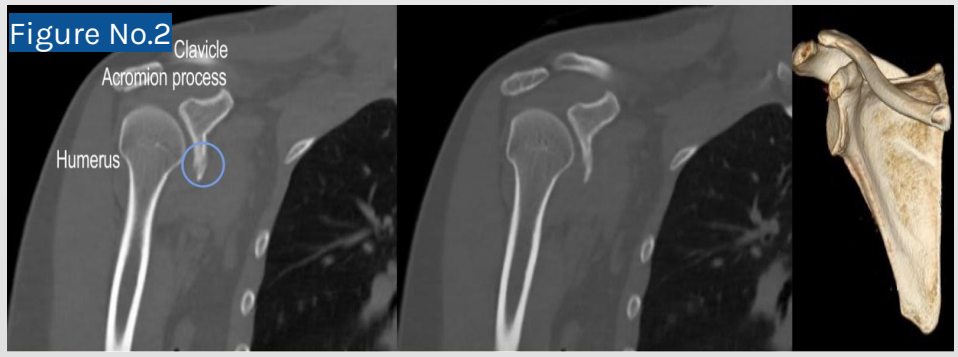
Figure No.2

- It shows reconstructed coronal images

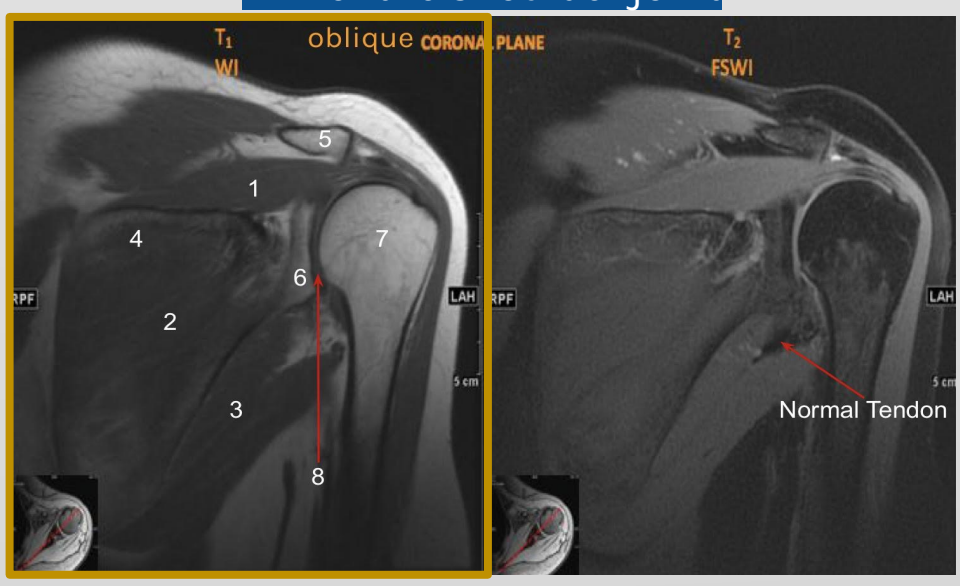
and we can modify the image according to our needs, we use it before surgery to give the plan of surgery and gives an idea about muscles.

- Disruption of the cortex: Bone injury/fracture involving the glenoid process inferiorly (blue)

(commonly associated with repeated dislocation of the joint)



MRI of the shoulder joint



1. **Supraspinatus Muscle.**
2. **Infraspinatus Muscle.**
3. Teres Minor Muscle.
4. Scapular Plate.
5. Clavicle.
6. Glenoid Process.
7. Humerus.
8. Glenohumeral Joint.

In MRI we have T1 and T2. T refers to timing.
- T1: Fat is bright, it's the regular setting. Bone is bright (fatty marrow) and fluid appears black.
- T2: Fat is also bright however we change the saturation of the picture by suppressing the fat signal, and the liquid will appear white. We call it T2FSAT. We can also have the bone appear black to highlight early changes of the bone marrow (e.g. edema)

bone is white fat in the bone

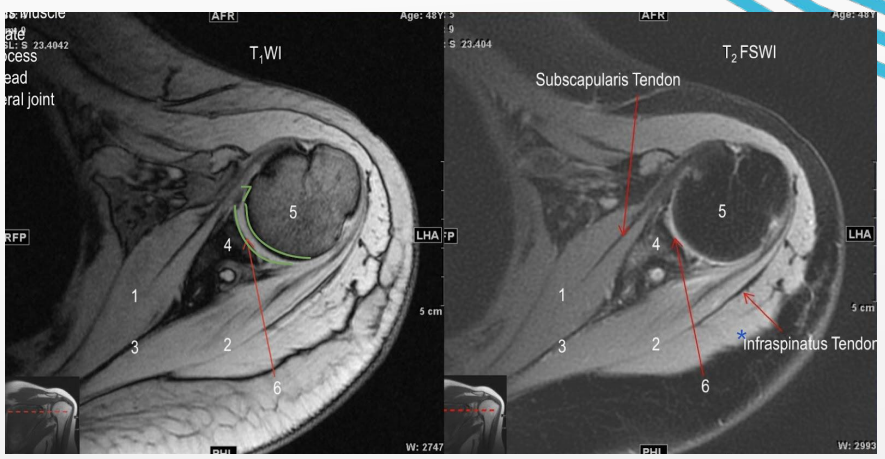
fluid is white

Shoulder & Elbow

Shoulder joint cont.

1. Subscapularis Muscle. **Anterior**
2. Infraspinatus Muscle. **Posterior**
(supra and infra are posterior)
3. Scapular Plate.
4. Glenoid Process.
5. Humeral Head.
6. Glenohumeral Joint.
7. Glenoid labrum, possible area of injury in patient with recurrent dislocation

MRI (axial plane)



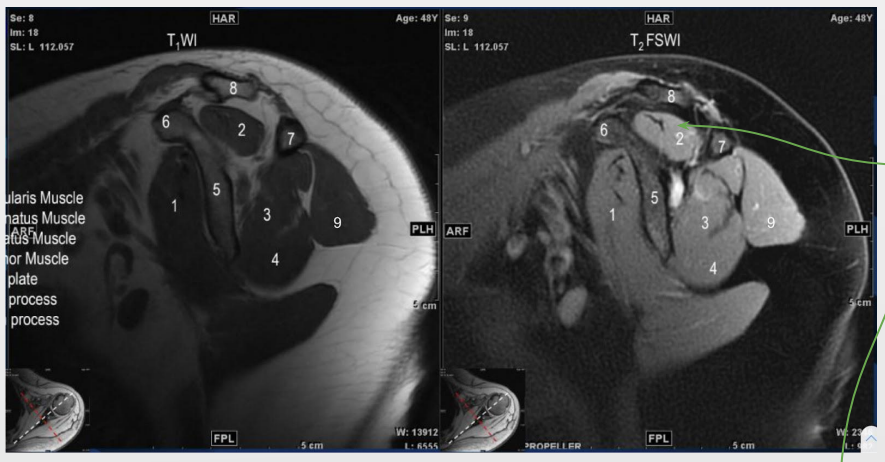
fibrous tendons are black (blue star)

1. **Subscapularis Muscle.** Anteriorly
2. **Supraspinatus Muscle.**
3. **Infraspinatus Muscle.**
4. **Teres Minor Muscle.**
5. Scapular Plate.
6. Coracoid Process.
7. Acromion Process.
8. Clavicle
9. Part of the Deltoid muscle.

Rotator cuff muscles (responsible for the movement of the shoulder joint)

Important: (SITS)
Supraspinatus muscle
Infraspinatus muscle
Teres minor
Subscapularis

MRI (oblique sagittal plane)

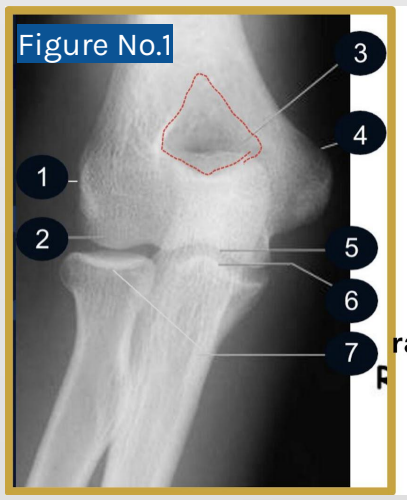


Supraspinatus Tendon (fibrous tissue which doesn't have much nitrogen)

Elbow joint

Figure No.1

- No. 3 (Olecranon Fossa) is dark which indicates lower density but it's normal in this area.
- Here it's very important to differentiate medial and lateral sides, from the eminence that you could feel it medially it's related to medial epicondyle (more prominent) and the mild curvature is related to the lateral epicondyle (it's above the condyle that's why they name it epicondyle).
- The ulna has 2 processes the short one is coronoid and the large one is olecranon which goes posterior to the olecranon fossa of distal humerus.



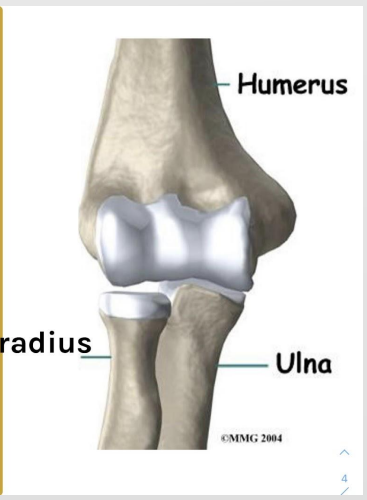
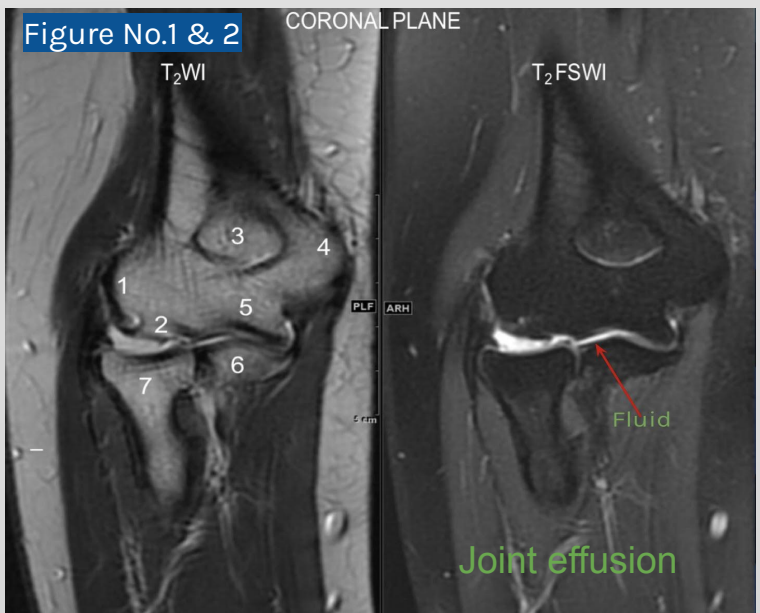


Figure No.1 & 2

1. Lateral Epicondyle.
2. Capitulum.
3. Olecranon Fossa. accommodate part of the ulna when the hand is extended
4. Medial Epicondyle.
5. **Trochlea.**
6. Coronoid Process.
7. Radius Head.

Note: we suppress the fat to differentiate the fat from the fluid

T1: outline anatomy
T2: changes in the bones



Elbow & Wrist

Elbow joint

5-year old child

head of the radius: not seen yet
trochlea: not yet ossifies
capitulum is seen

11-year old child

don't mistake growth plate for a fracture fuse at the age of puberty

Adult

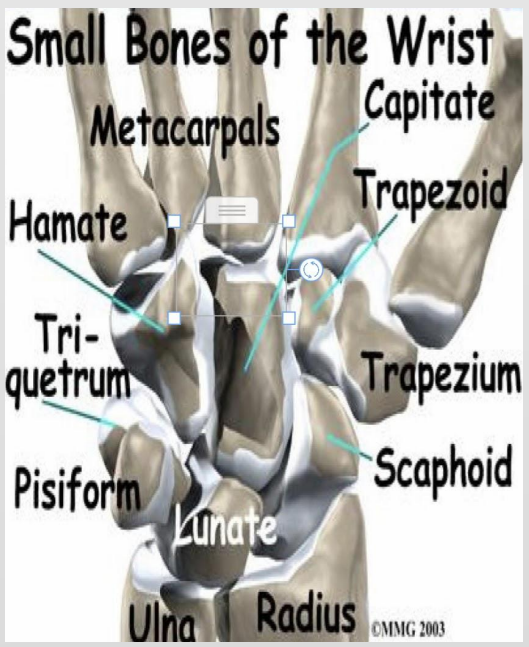
It's important to differentiate between the joint of different age groups, normally we have the shaft, metaphysis and the epiphyseal center which is responsible for growth in children, it will be a cartilaginous matrix which will appear black (it is not ossified yet in children).

Wrist joint

so long to pinky, here comes the thumb

1. Ulna.
2. Radius.
3. Scaphoid.
4. Lunate.
5. Triquetrum **(rectangle)**
6. Pisiform **(rounded, most anteriorly, smallest, overlying triquetrum bone)**
7. Hamate **(triangular)**
8. Capitate.
9. Trapezoid.
10. Trapezium.

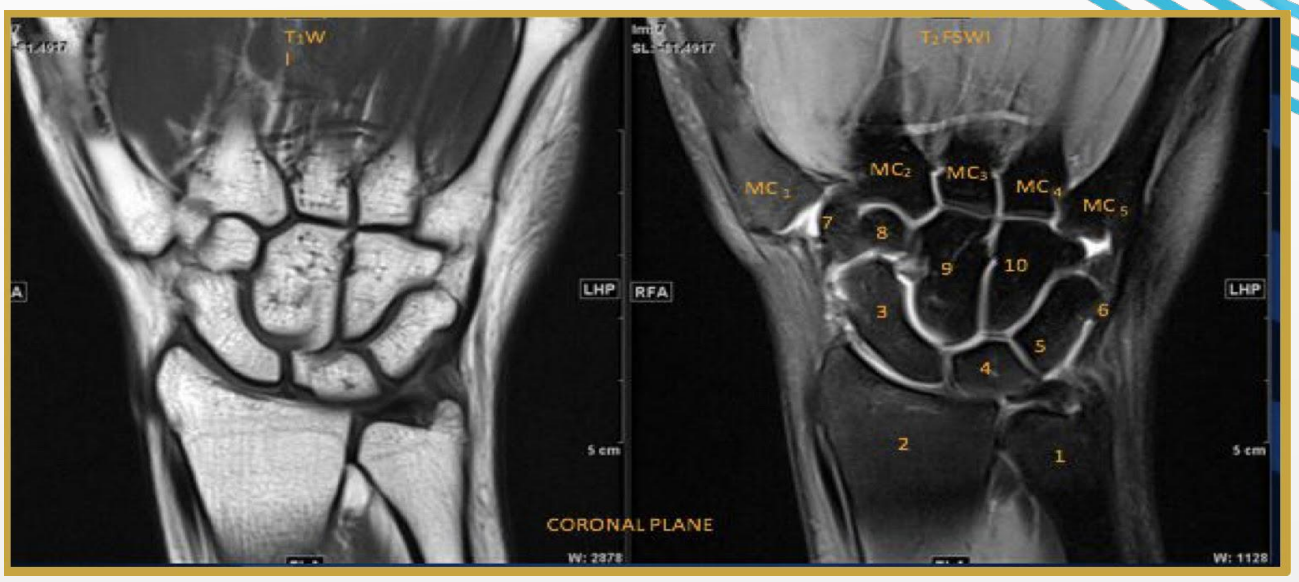
3, 4, 5, 6 = Proximal
7, 8, 9, 10 = Distal



We have 8 carpal bones arranged in 2 rows pisiform is the most anterior

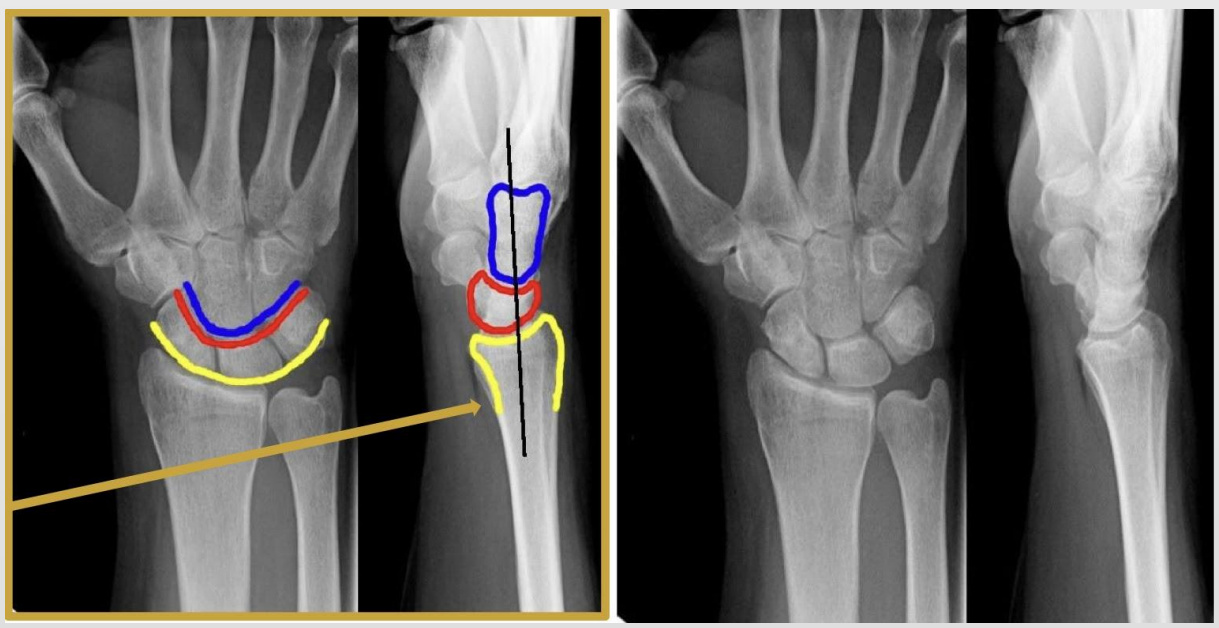
Wrist

1. Ulna
2. Radius
3. Scaphoid
4. Lunate
5. Triquetrum
6. Pisiform
7. Trapezium
8. Trapezoid
9. Capitate
10. Hamate



We do MRI to detect early changes in which settings?

In T2 it will show any change within the bone marrow. Normally the bone is black, but if there is any pathology it will appear white. The basic issue here is that we need T1 for basic anatomical landmark and T2 to highlight the early changes within the bone like neoplasm...etc. MRI can detect hidden fractures in x-ray, it also can evaluate the tendons which isn't possible with x-ray and CT. MRI is has the advantage in soft tissue characterization (Eg, Bone marrow), but if we are interested in the bone texture, trabeculae, cortex, corticomedullary differentiation then CT is better than MRI



- the carpal bones are lined in two rows, these rows are lined in curvatures and parallel to each other

- Three carpal arcs should be traced:

1. Along the **proximal row of carpal bones;** proximal aspect (yellow). Scaphoid, Lunate, Triquetrum.
2. Along the proximal row of carpal bones; distal aspect (red).
3. Along the capitate and hamate proximally (blue).

The alignment is usually drawn between radius, Lunate and Capitate

The alignment is like a cup of coffee setting on the plate and on the table

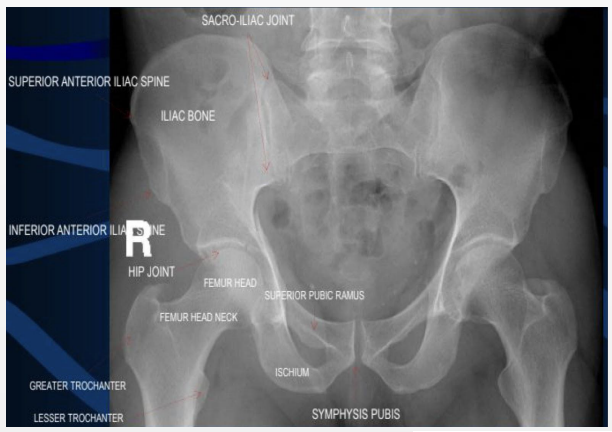
- These three lines should remain unbroken.

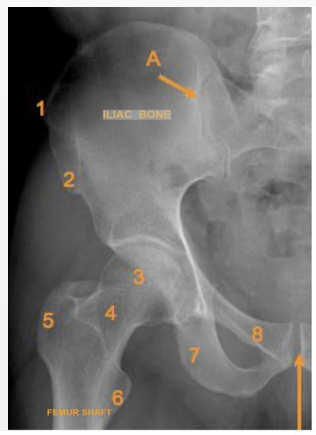
Hip

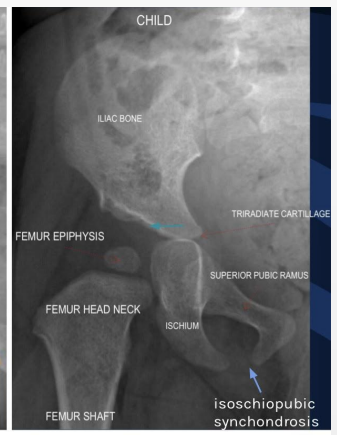
Hip joint

What bones that forms the pelvic bone? iliac bone, pubic ramus, ischial ramus (Ischium)

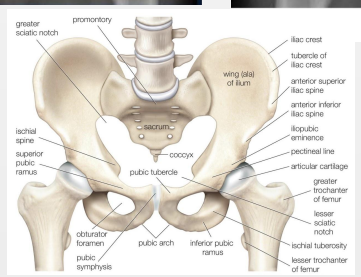
A. Sacroiliac Joint (synovial joint)
1. Superior Anterior Iliac Spine.
2. Inferior Anterior Iliac Spine.
3. Femur Head.
4. Femur Neck.
5. Greater Trochanter.
6. Lesser Trochanter.
7. Ischium.
8. Superior Pubic Ramus.
9. Symphysis pubis (fibrous joint)







(Pediatric Patient)



growth plate
normal, unite at puberty

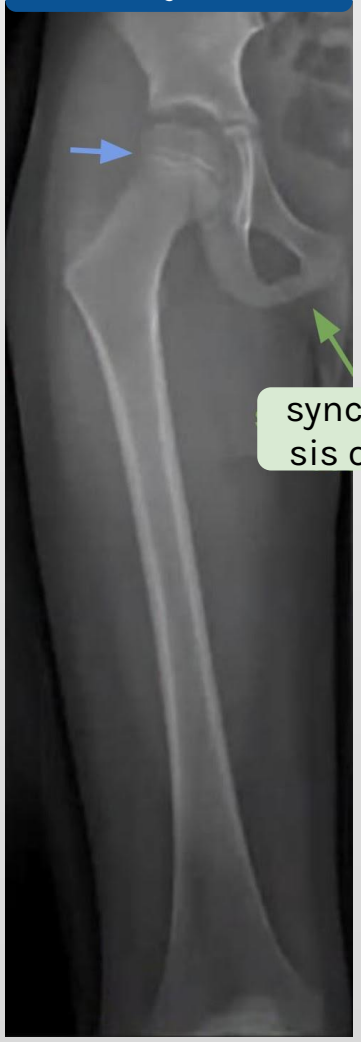
- Femur Head structures forming the joint: (the acetabular fossa of iliac bone + femur head).
- In pediatrics, the pelvic bone is made of three parts.
- femur epiphysis is not connected yet.

Hip joint age variations

Adult

Plate closed

child 9 years old



synchondro sis ossifies

Growth Plate (normal)

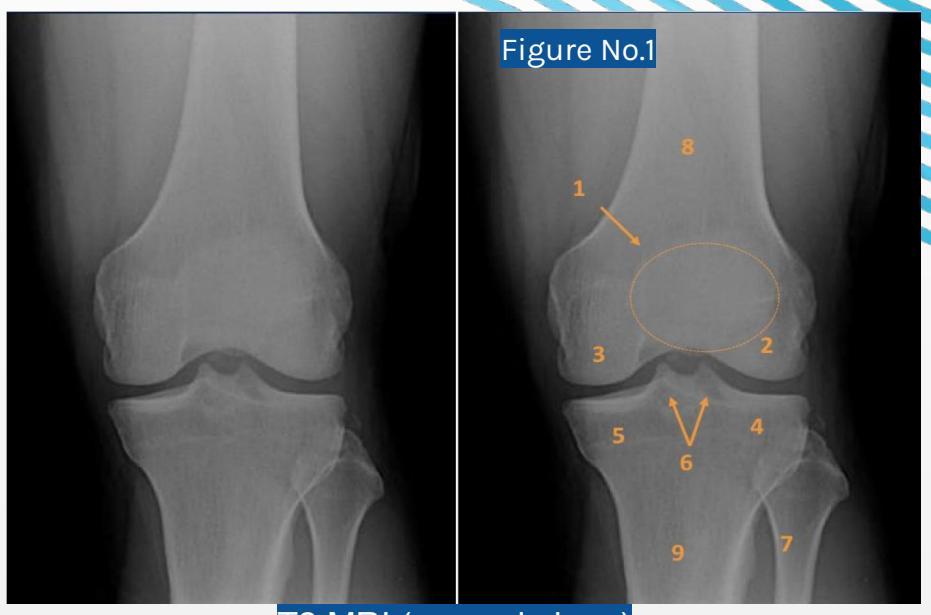
child 2 years old

Femoral Epiphysis

Ischopubic Synchodrosis (normal)

Knee

Knee joint



T2 MRI (coronal plane)

Figure No.1

1. Patella.
2. Lateral Condyle.
3. Medial Condyle.
4. Lateral Tibial Plateau.
5. Medial Tibial Plateau.
6. Tibial Eminence or tibial spines.
7. Fibula.
8. Femur.
9. Tibia.

T2 is fat sat, if it was T1 I'll see the all fat black but here in between the fat lobules yo see the septie are thin lines whitish

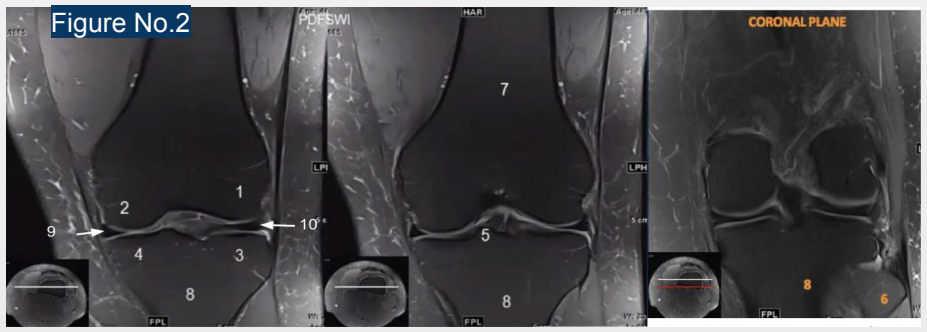
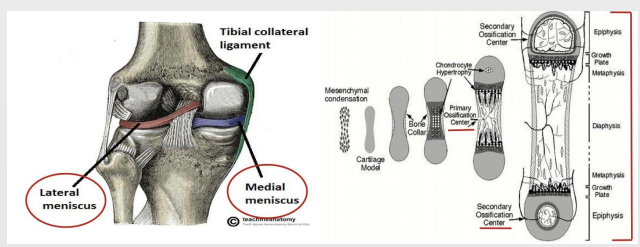


Figure No.2

1. Lateral Condyle.
2. Medial Condyle.
3. Lateral Tibial.
4. Medial Tibial blateau.
5. Tibial Eminence.
6. Fibula.
7. Femur.
8. Tibia.
9. Medial meniscus.
10. Lateral meniscus.

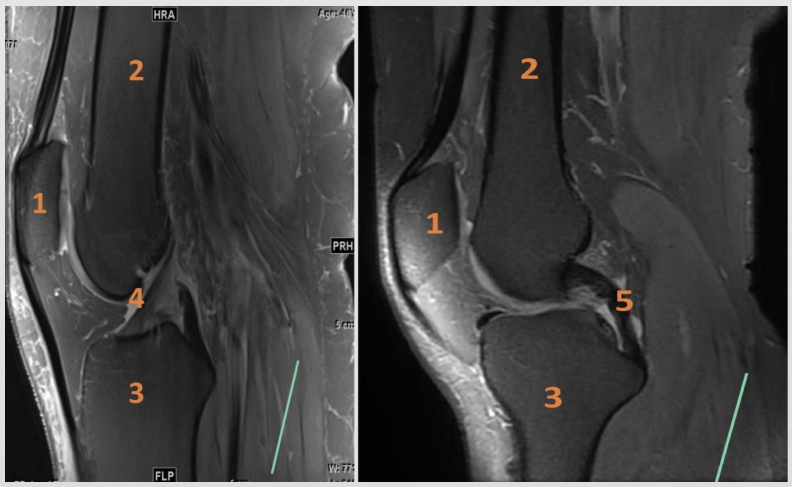
- Cortex appears as dense black signal Bone marrow appears as bright white in TI and T2, but black in T2 fat saturated (it is homogeneously suppressed to highlight early changes such as effusion, trauma, infection, neoplasms, etc)
- the larger condyle is the medial one.



- Inside the joints we have the articular cartilage and and menisci
- Menisci are two fibrocartilaginous that semicircular appearance act as a cushion to prevent erosion or impaction on the bone

MRI (sagittal plane - midpart)

Central portion (to see the cruciate ligaments)

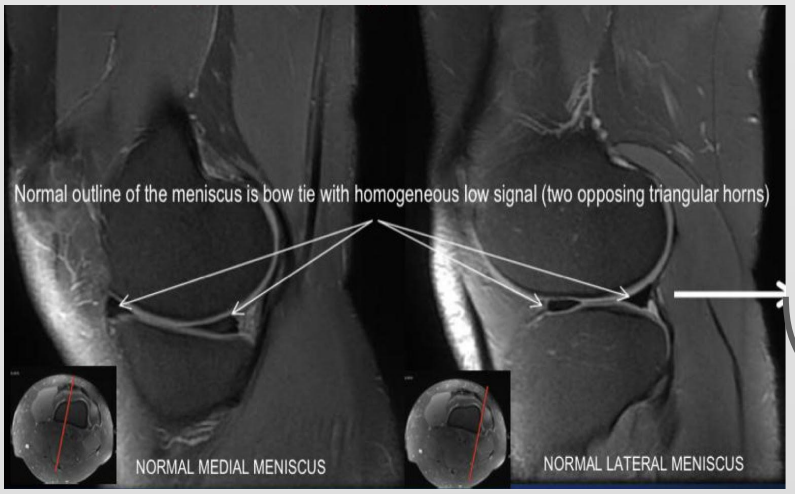


1. Patella.
2. Femur.
3. Tibia.
4. ACL (anterior cruciate ligament).
5. PCL (posterior cruciate ligament).

ACL is oriented obliquely toward anterior aspect of tibia PCL is toward post tiba

MRI (sagittal plane - medial and lateral)

Peripheral portion (to see the menisci)



Normal Medial Meniscus

Normal Lateral Meniscus

this is called (bow tie appearance)

The menisci in Sagittal section appear as two triangles that touching each other in the centre
What's imp is that no signals intensity so you see it **BLACK**, if you lost this blackening that means there is a tear

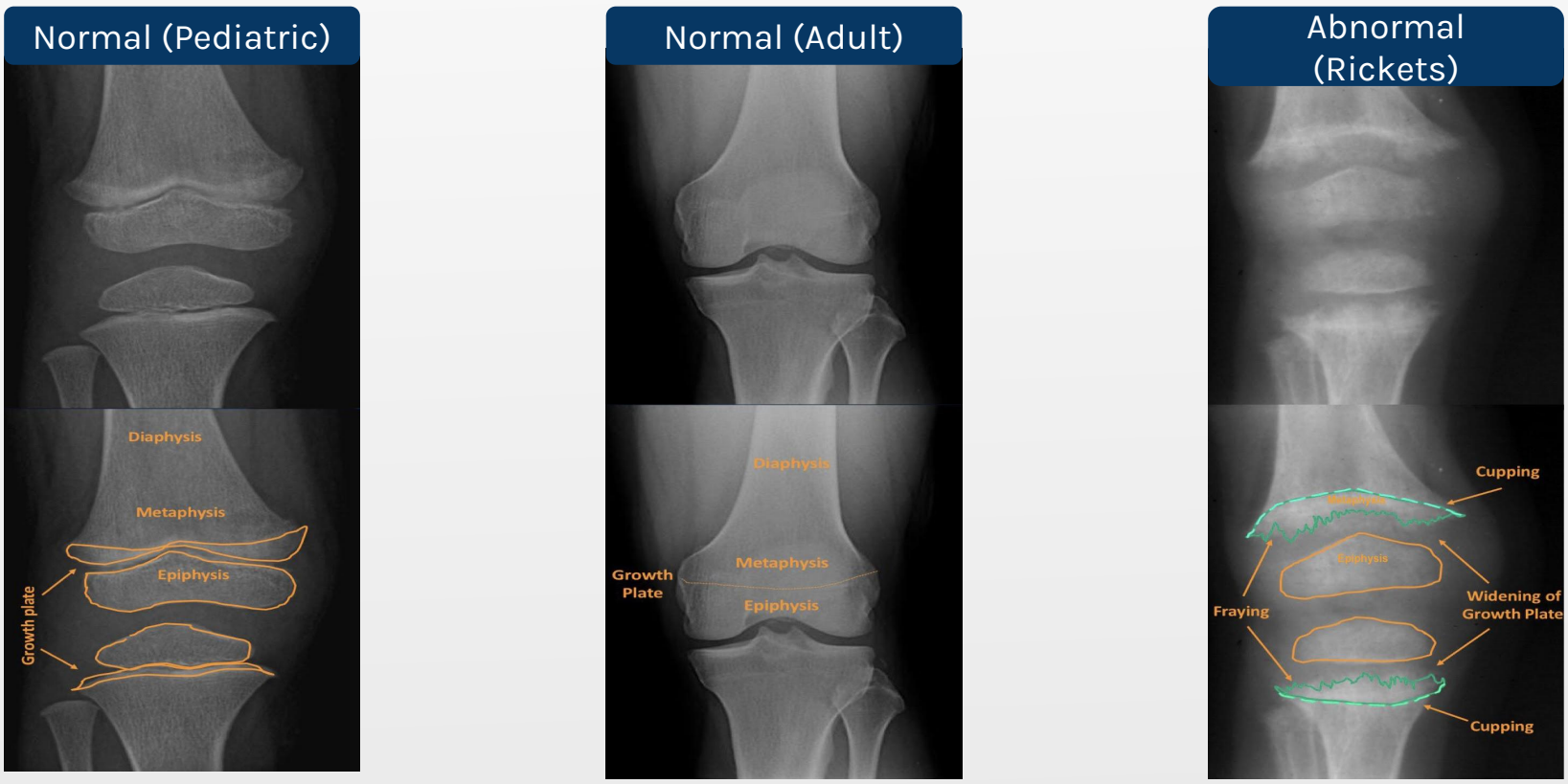
Interpretation

Development and abnormalities of knee joint

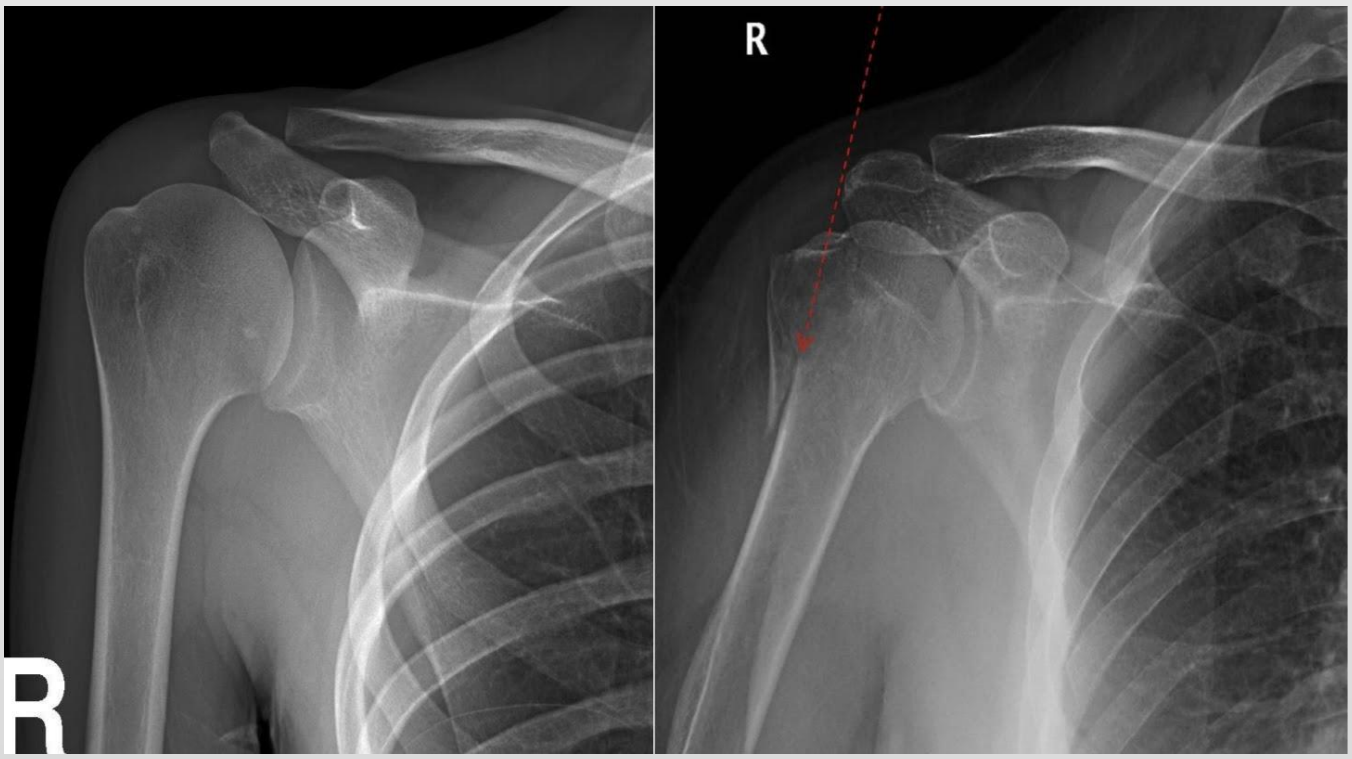
What and where to look for?

1. important sites 2.bone density 3.bone texture 4.distortion/ displacement of normal structures

Cortical outline, cortical medullary differentiation, soft tissues



- In children you can see growth plate as a black line.
- In adults it is fused.
- It's hyperlucent with defined line that usually present in patient with metabolic disorder (rickets). Not calcified due fit. D deficiency so you see widening of growth plate



Normal

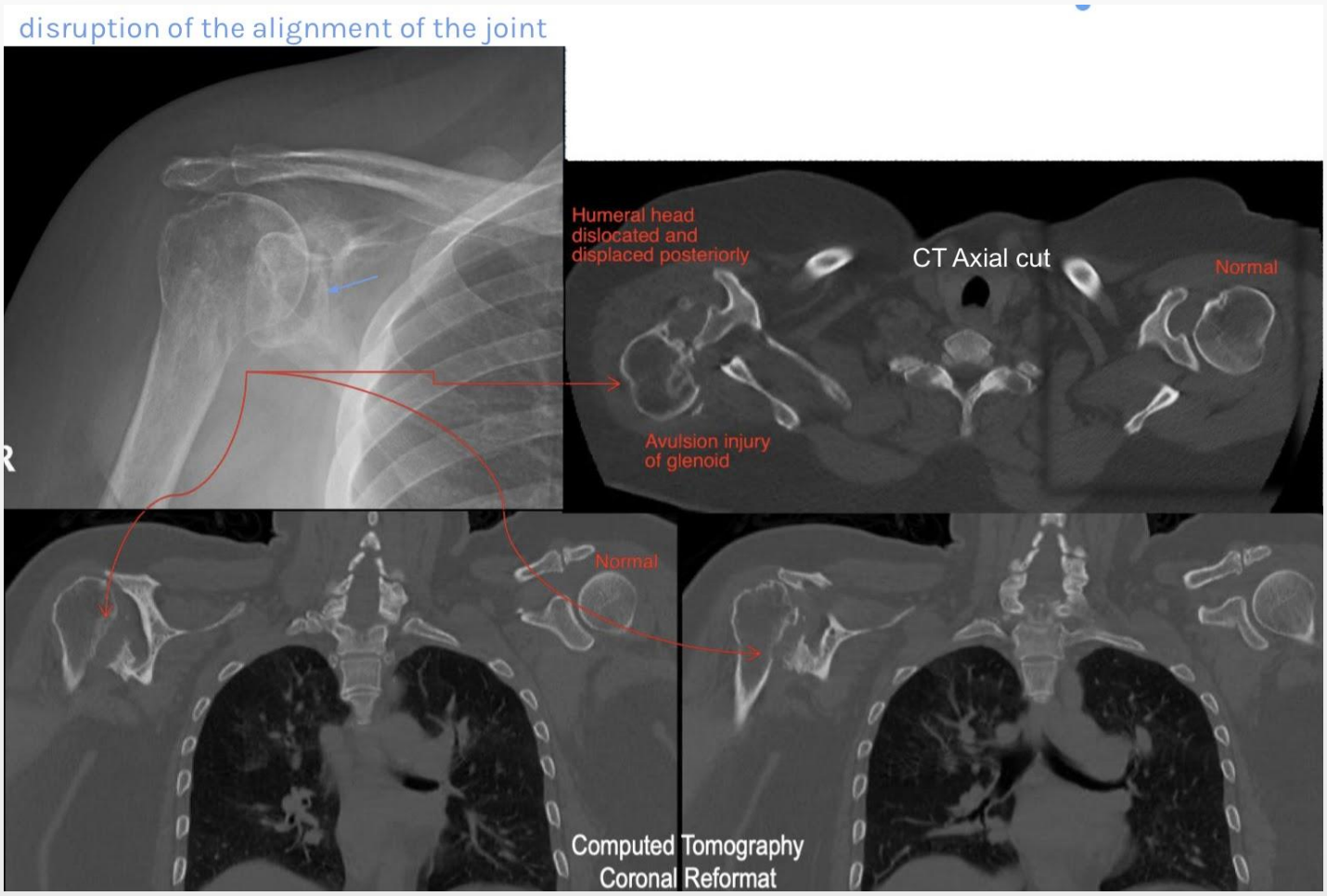
Fracture Humerus

You see the red arrow showing lucent line suggests fracture from greater tuberosity

We lost the continuation of the cortex

Interpretation

Heterogeneous texture with old humeral fracture



red arrows in CT: old fracture
A: humeral head dislocated and displaced posteriorly leaving the glenoid process free

- Ill-defined glenoid outline
- ill-defined continuation of the cortex along the neck of the humeral head
- irregularity of the superior aspect of the greater tuberosity

The cortex is not the same in the right image, in the left image you can see the trabeculae with smooth outline but the trabeculae in the right image are more of an irregular outline of the cortex (not as sharp) because of Bone resorption
So what to look for?
cortex, the outline, corticomedullary differentiation, trabecule.

Normal

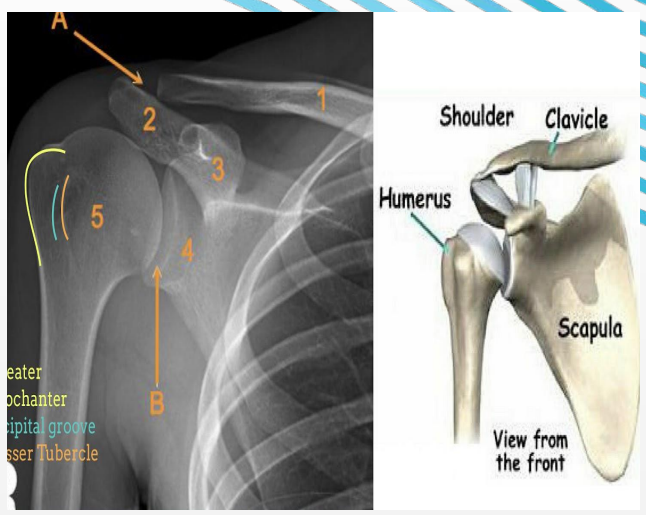
Hyperparathyroidism

Summary

Shoulder joint

A. **Acromioclavicular Joint.**
B. **Glenohumeral Joint (Facet).**
C. Clavicle.
D. Acromion Process.
E. Coracoid Process.
F. Glenoid Process.
G. Humerus

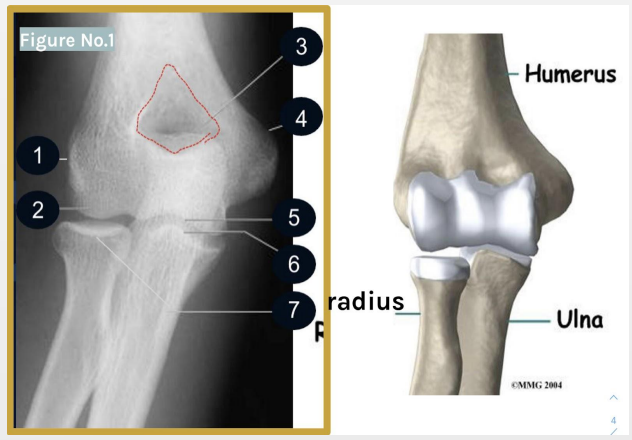
3 bones form the shoulder joint: 1 - Glenoid Process of scapula.
2- Acromion Process (articulates with the lateral aspect of the clavicle).
3- Humeral Head.



Elbow joint

1. Lateral Epicondyle.
2. Capitulum.
3. Olecranon Fossa. accommodate part of the ulna when the hand is extended
4. Medial Epicondyle.
5. Trochlea.
6. Coronoid Process.
7. Radius Head.

Note: we suppress the fat to differentiate the fat from the fluid

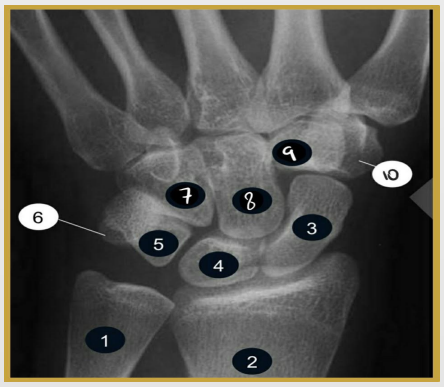


Wrist joint

1- Ulna.
2- Radius.
3- Scaphoid.
4- Lunate.
5- Triquetrum.
6- Pisiform.
7- Hamate.
8- Capitate.
9- Trapezoid.
10- Trapezium.

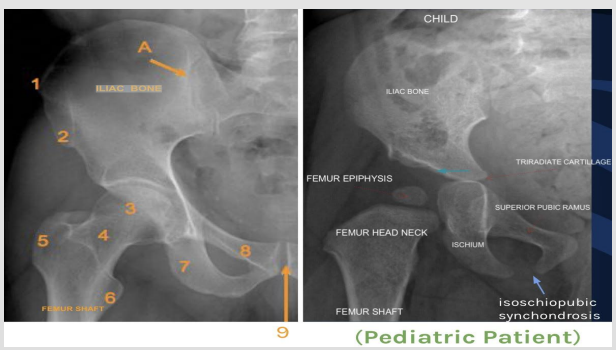
3, 4, 5, 6 = Proximal
7, 8, 9, 10 = Distal

- We have 8 carpal bones arranged in 2 rows pisiform is the most anterior



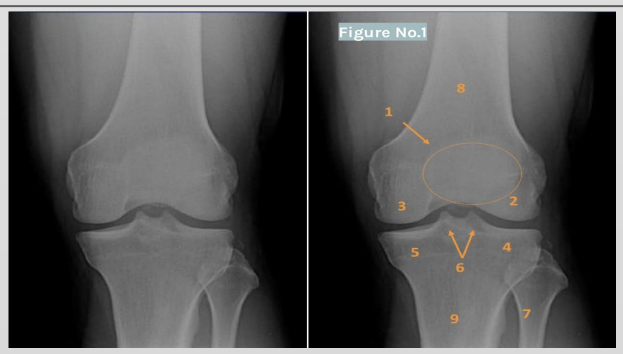
Hip joint

A- Sacroiliac Joint
1- Superior Anterior Iliac Spine.
2- Inferior Anterior Iliac Spine.
3- Femur Head.
4- Femur Neck.
5- Greater Trochanter.
6- Lesser Trochanter.
7- Ischium.
8- Superior Pubic Ramus.
9- Symphysis pubis



Knee joint

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.



Quiz

1- which of the following carpal bones are aligned with the radius on the lateral x- ray ?

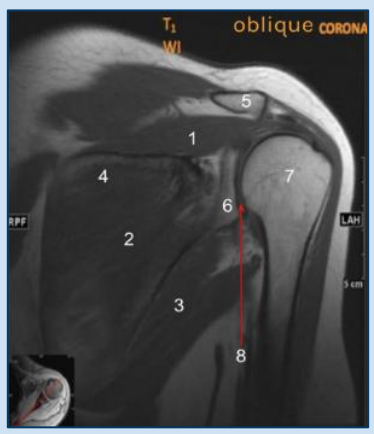
a. Capitate and lunate
b. Hamate and scaphoid
c. Scaphoid and lunate
d. Trapezium and trapezoid

2- what is the name of the bone labeled in (3)?

a. Lunate
b. Triquetrum
c. Capitate
d. Scaphoid

3-name the muscle labeled (1) ?

a. Infraspinatus
b. Supraspinatus
c. Teres minor
d. Teres major



4- this alignment at the level of

a. Scaphoid and hamate
b. Triquetrum and capitate
c. Lunate and capitate
d. Trapezium and trapezoid

5- which one of the following appears dark in T1WI and bright in T2WI

a. Water
b. Blood
c. Bone
d. Fat

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

Team leaders

- Reem Alamri
- Alwateen Alaradi
- Bandar Alharbi

Team members

- Reema Alhadlq
- Farah Albakr
- Sara Alrashidi
- Nouf Albrikan
- Renad Alosaimi
- Duaa Alhumoudi
- Norah Almasaad
- Salem Alshihri
- Arwa Alkahtani
- Ibrahim Alabdulkarim
- Mohamed Albabtain
- Abdulaziz Alamri
- Abdulrahman Alswat
- Munib Alkhateb
- Mohammed Alkathiri
- Omar Alhalabi
- Homoud Algadheb
- Nasser Almutawa

Work done by