Radiology
Team 438

Imaging of musculoskeletal system

Lecture 15

Objectives

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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 & what to look for
  - bone density & texture, bone marrow, acular cortices, important sites
- recognize features of certain disease entity

outlines

Color Index: Important | Doctor's Notes | Extra | Female slides | male slides

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Special Thanks to Ibrahim Aldakhil

Editing file

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.

CT

Useful in evaluating bone texture & extent of the disease or trauma.

MRI

Useful to detect earliest change in bone marrow and soft tissue characterization like hyperemic or neoplastic changes and to assess Tendons, muscles, Joint capsule, ligaments Ex: Knee ligaments.

Ultrasound

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

Nuclear Medicine

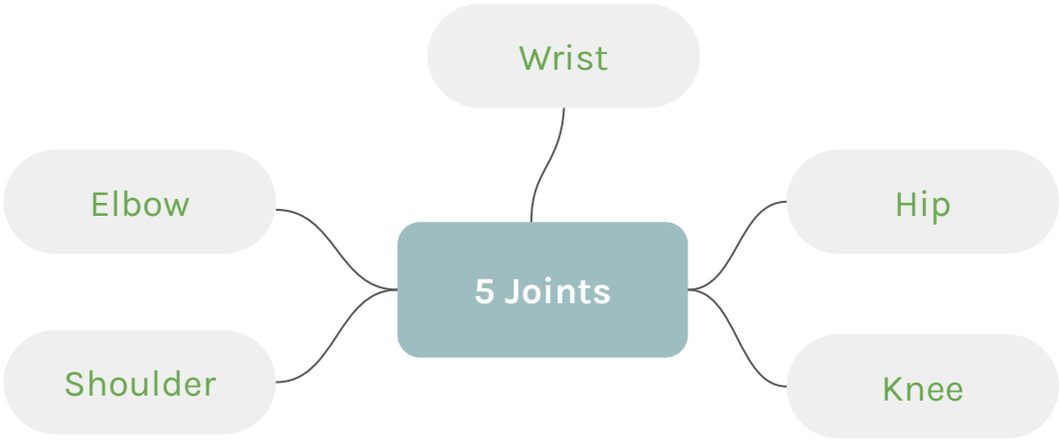
Bone scan is very sensitive (can detect early changes) but is relatively **non-specific**.

"Where to look & What to look for"

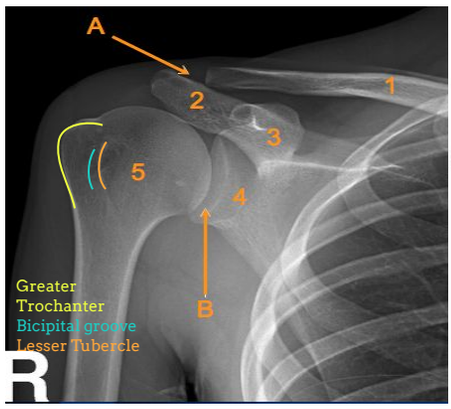
➔ Look to the important sites, look for:

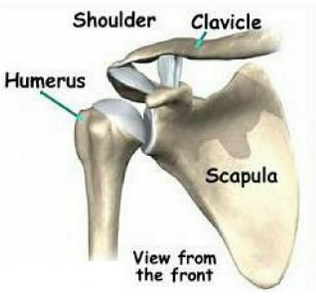
1. Bone density.
2. Bone texture.
3. Bone marrow.
4. Distortion/displacement of normal structure.
5. Articular cortices.
6. Soft tissue.

Image of Musculoskeletal system anatomy



1. Shoulder joint





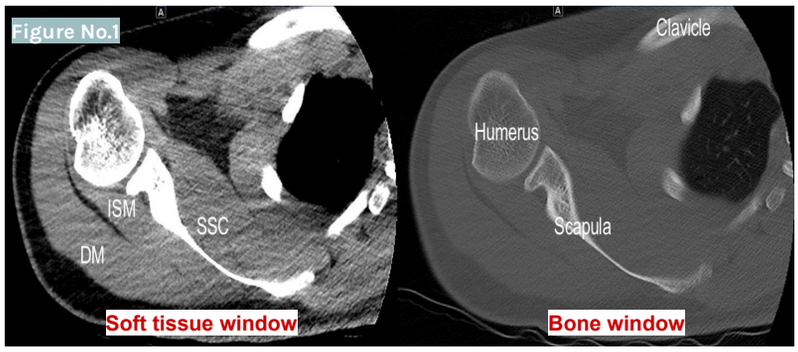
A. Acromioclavicular Joint.
B. Glenohumeral Joint (Facet).
1. Clavicle.
2. Acromion Process.
3. Coracoid Process.
4. Glenoid Process.
5. Humerus

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.

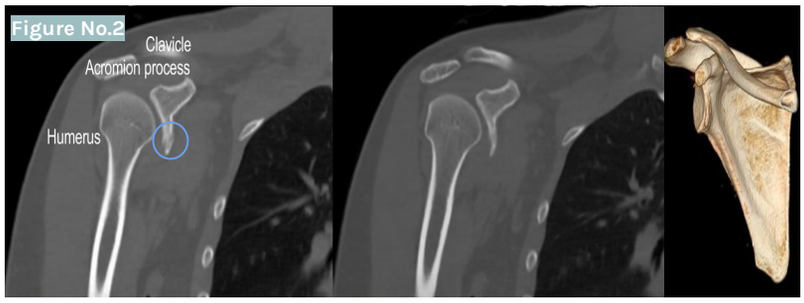
CT scan of the shoulder joint

Figure No.1



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

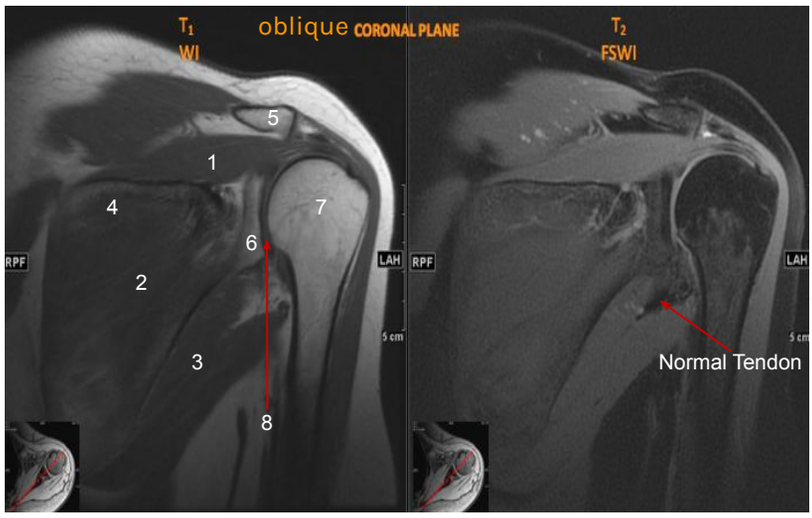
Figure No.2



- 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)

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

MRI of the shoulder joint



bone is white
fat in the bone

fluid is white

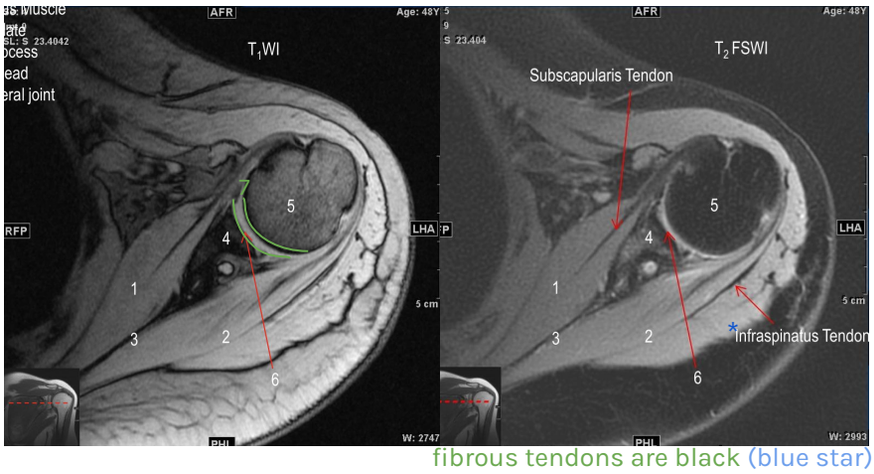
- In MRI we have T1 and T2. T refers to timing.
- **T1**: Fat is bright, it's the regular setting. Bone is bright (fatty marrow) and fluid appears black.
- **T2**: Fat is also bright however we change the saturation of the picture by **suppressing the fat** signal, and the liquid will appear white. We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

We can also have the bone appear black to highlight early changes of the bone marrow (e.g. edema)

1. Shoulder joint cont.

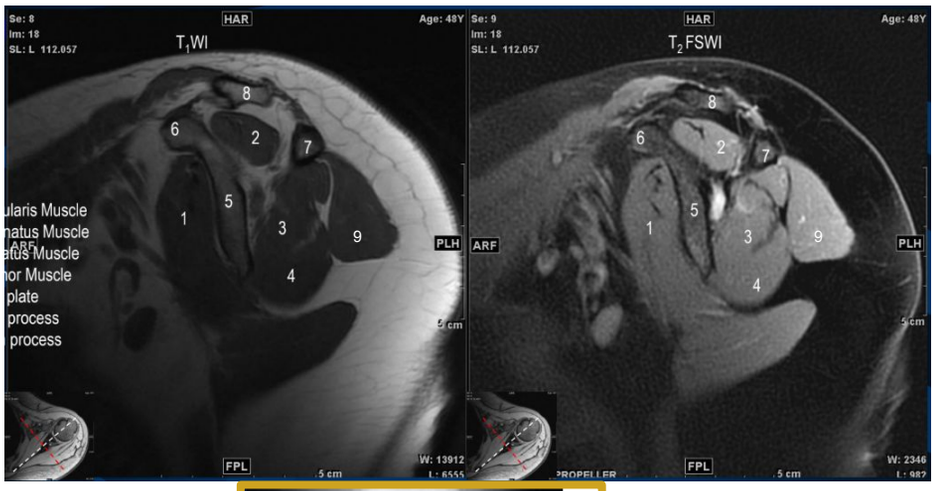
1. Subscapularis Muscle. Anterior
2. Infraspinatus Muscle. Posterior (supra and infra are posterior)
3. Scapular Plate.
4. Glenoid Process.
5. Humeral Head.
6. Glenohumeral Joint.
7. Glenoid labrum, possible area of injury in patient with recurrent dislocation

MRI (axial plane)



fibrous tendons are black (blue star)

MRI (oblique sagittal plane)

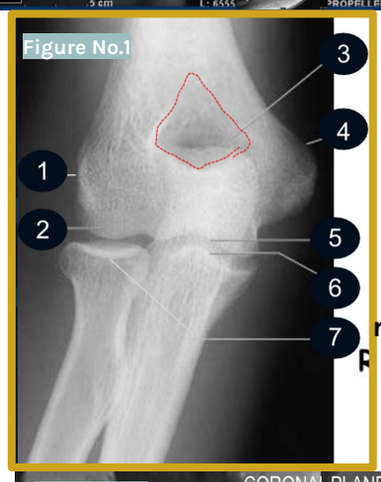


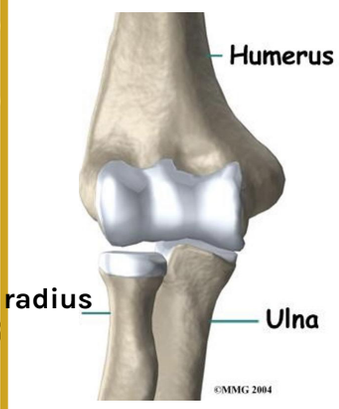
1. Subscapularis Muscle.
2. Supraspinatus Muscle.
3. Infraspinatus Muscle.
4. Teres Minor Muscle.
5. Scapular Plate.
6. Coracoid Process.
7. Acromion Process.
8. Clavicle
9. Part of the Deltoid muscle.

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

2. 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

Joint effusion

2. Elbow joint

5-year old child

head of the radius: not yet seen
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

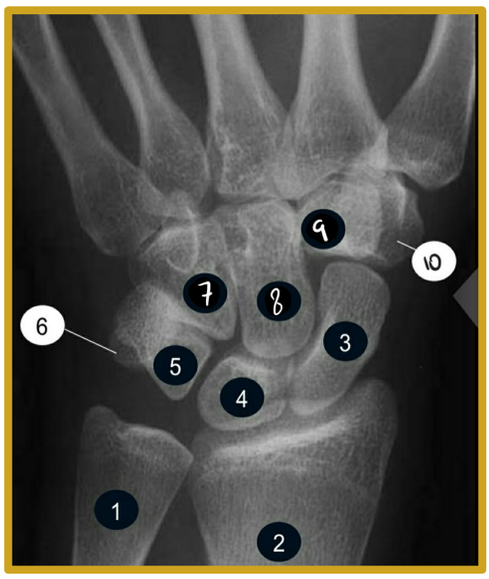
Adult

- 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).

3. Wrist joint

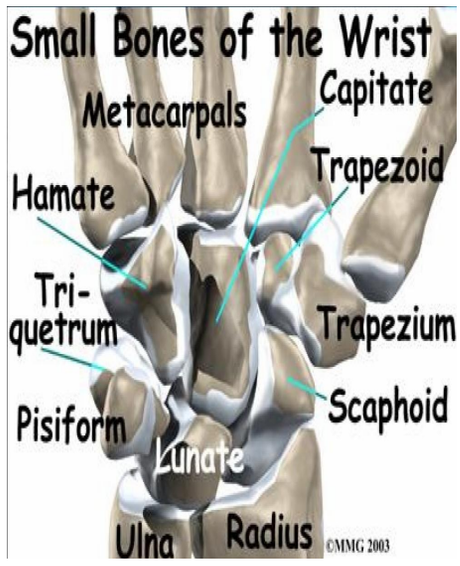
so long to pinky, here comes the thumb

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

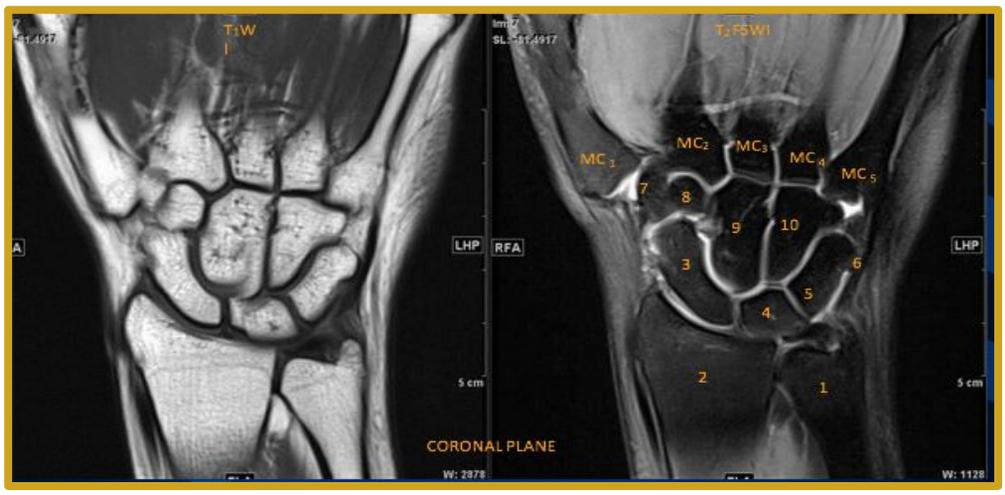
you should know them:)



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

Elbow & Wrist

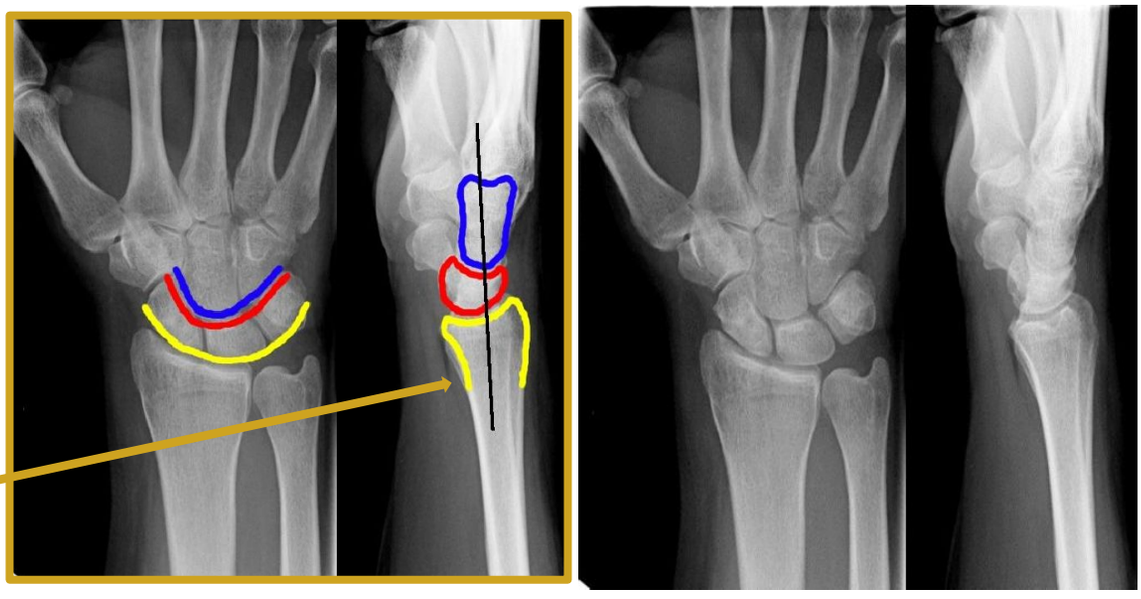
1	Ulna	6	Pisiform
2	Radius	7	Trapezium
3	Scaphoid	8	Trapezoid
4	Lunate	9	Capitate
5	Triquetrum	10	Hamate



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



- 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

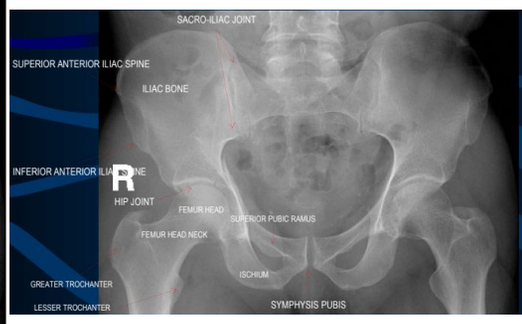
The alignment is like a cup of coffee setting on the plate and on the table

- These three lines should remain unbroken.

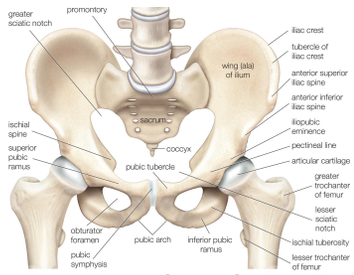
4. Hip joint

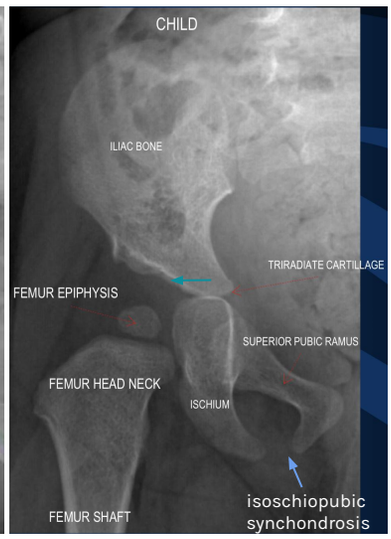
What bones that forms the pelvic bone? iliac bone, pubic ramus, ischial ramus (Ischium)

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



- 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.





(Pediatric Patient)
growth plate
normal, unite at puberty

Hip joint age variations

Adult

Plate closed

child 9 years old

Growth Plate (normal)

child 2 years old

Femoral Epiphysis
Ischopubic Synchodrosis (normal)

5. Knee joint

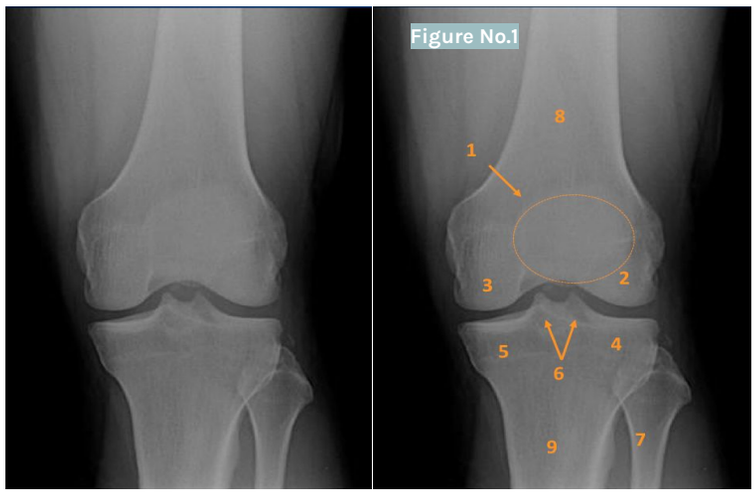


Figure No.1

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.

MRI (coronal plane)

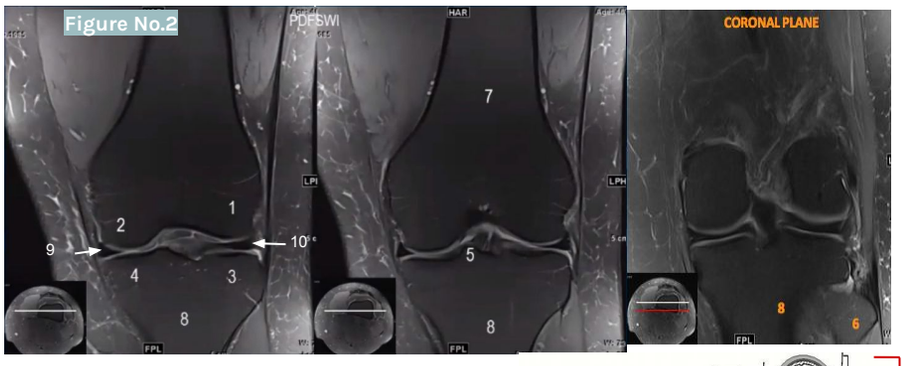
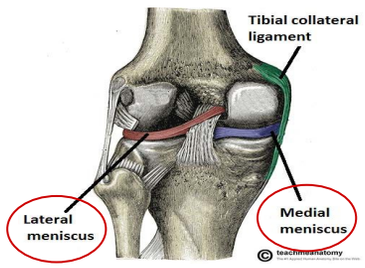
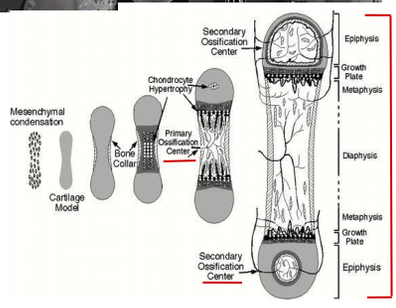


Figure No.2

1. Lateral Condyle.
2. Medial Condyle.
3. Lateral Tibial Plateau.
4. Medial Tibial Plateau.
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.

MRI (sagittal plane - midpart)

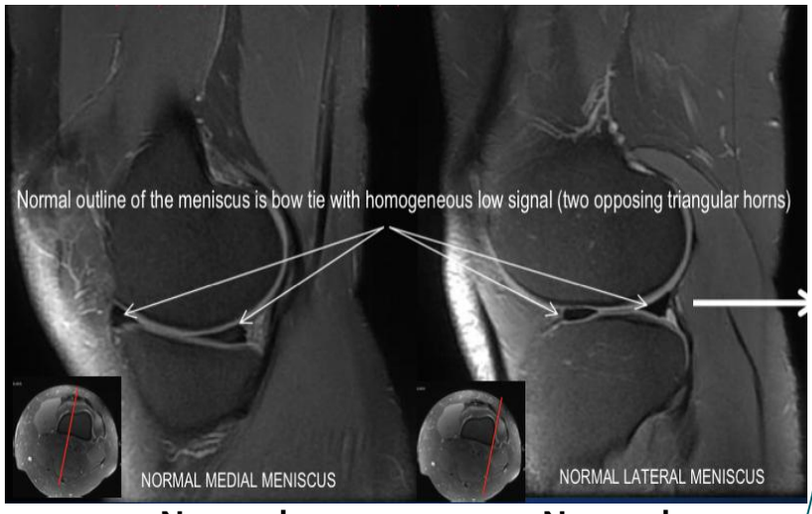
central portion (to see the cruciate ligaments)

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 tibia

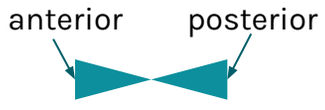
MRI (sagittal plane - medial and lateral)

peripheral portion (to see the menisci)



Normal
Medial Meniscus

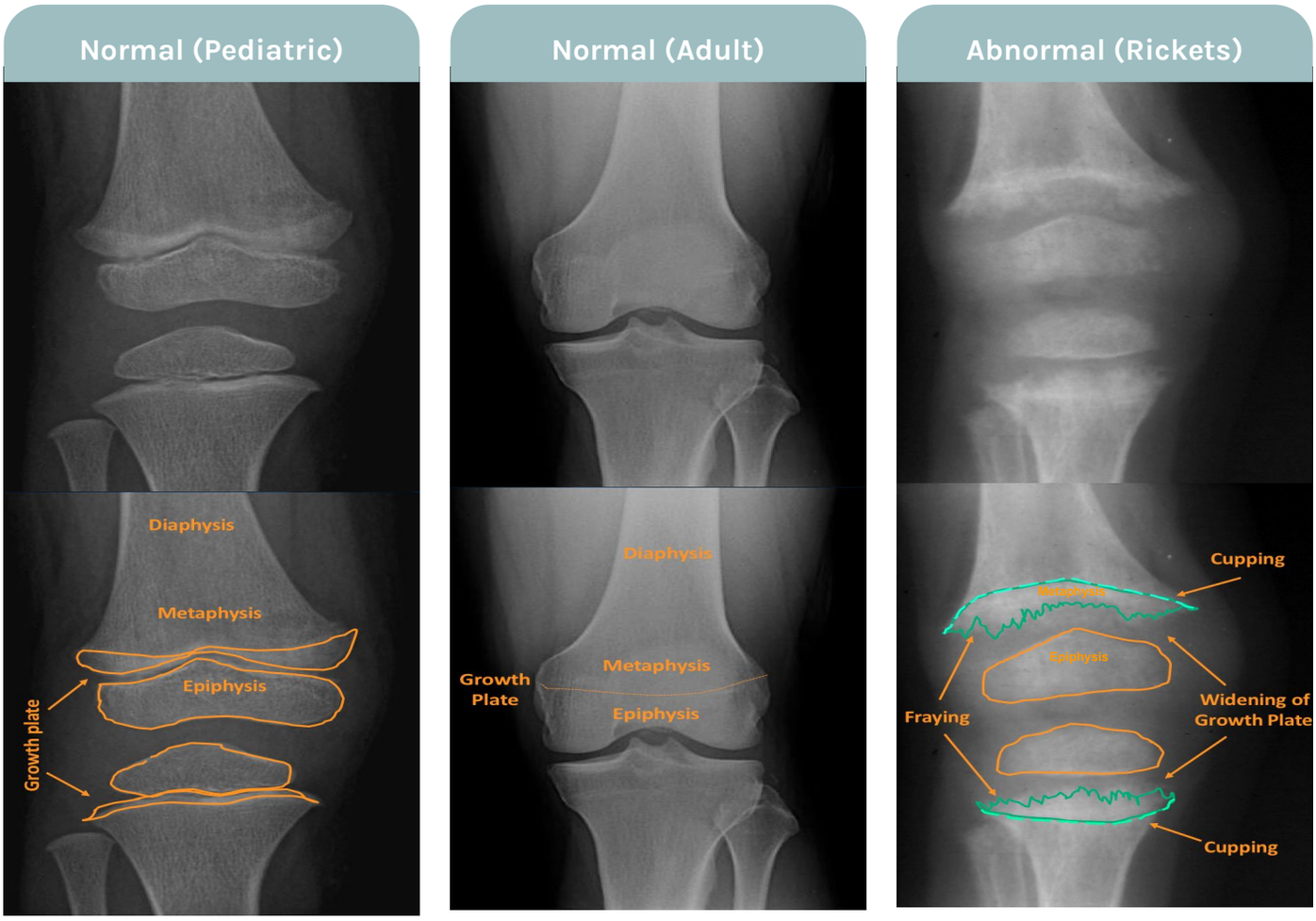
Normal
Lateral Meniscus



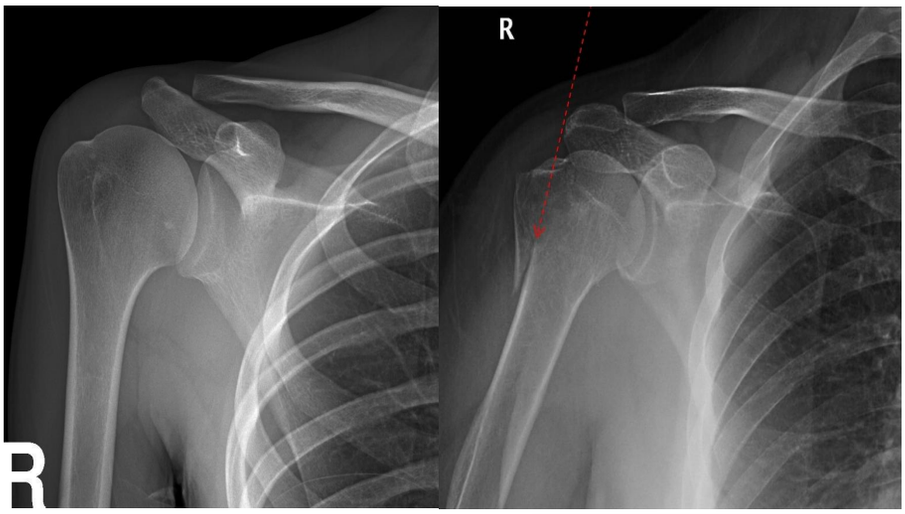
this is called (bow tie appearance)

Development and abnormalities of knee joint

What to look for?
1. important sites 2.bone density 3.bone texture 4.distortion/ displacement of normal structures



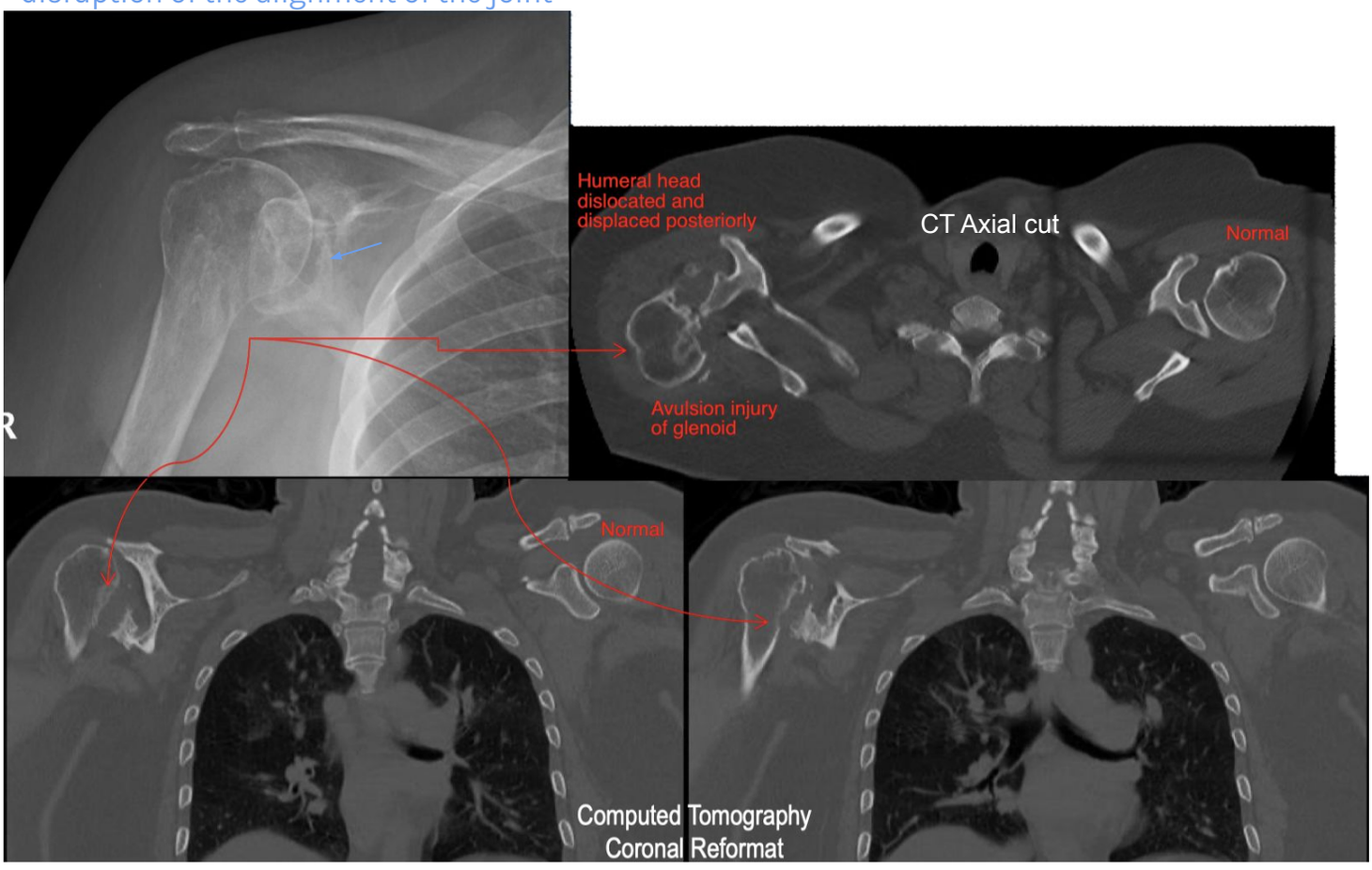
- In children you can see growth plate as a black line.
- In adults it is fused.
- It's hyperlucent with defined line that usually present in patient with metabolic disorder (rickets).



Normal **Fracture Humerus**

Heterogeneous texture with old humeral fracture

disruption of the alignment of the joint



red arrows in CT: old fracture

A: humeral head dislocated and displaced posteriorly

- lll-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)

So what to look for?
cortex, the outline, corticomedullary differentiation, trabecule.

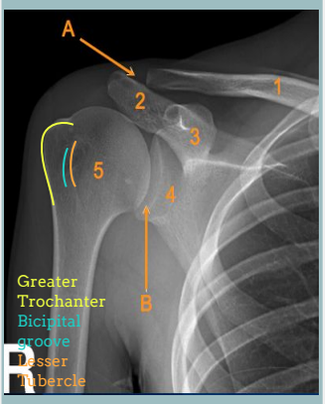
Normal

Hyperparathyroidism

Summary

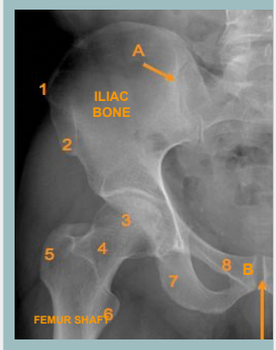
Image of Musculoskeletal system anatomy

Shoulder joint



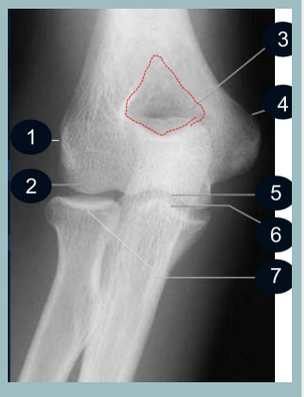
A. Acromioclavicular Joint.
B. Glenohumeral Joint (Facet).
1. Clavicle.
2. Acromion Process.
3. Coracoid Process.
4. Glenoid Process.
5. Humerus

Hip joint



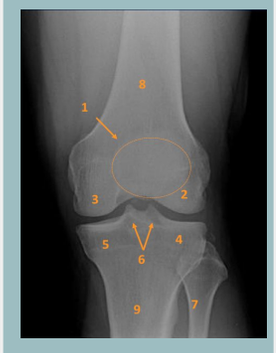
A. Sacroiliac joint
B. Symphysis Pubis.
1. Superior Anterior Iliac Spine.
2. Inferior Anterior Iliac Spine.
3. Femur Head.
4. Femur Neck.
5. Greater Trochanter.
6. Lesser Trochanter.
7. Ischium.
8. Superior Pubic Ramus.

Elbow joint



1. Lateral Epicondyle.
2. Capitulum.
3. Olecranon Fossa.
4. Medial Epicondyle.
5. Trochlea.
6. Coronoid Process.
7. Radius Head.

Knee joint



1. Patella.
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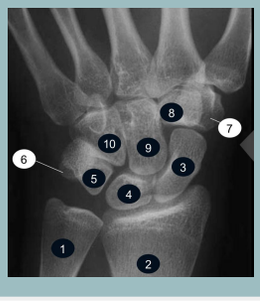
5. Medial Tibial Plateau.
6. Tibial Eminence.
7. Fibula.
8. Femur.
9. Tibia.

Wrist joint



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

quiz

1- What is the modality of choice to detect earliest change in bone marrow and soft tissue?

a. X-ray.
b. CT.
c. MRI.
d. Ultrasound.

2- Which of the following is NOT part of rotator cuff muscles?

a. Supraspinatus Muscle.
b. Infraspinatus Muscle.
c. Teres Minor Muscle.
d. Teres Major Muscle.

3- In evaluation the pathology what to look for?

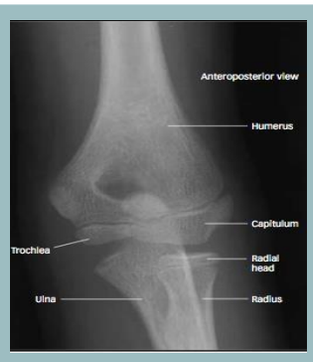
a. Cortex.
b. The outline .
c. Corticomedullary differentiation.
d. Trabeculae.
e. All the above.

4- If the X-ray didn't show clear pathology, what will you order next?

a. CT.
b. MRI.
c. Nuclear scan.
d. Ultrasound.

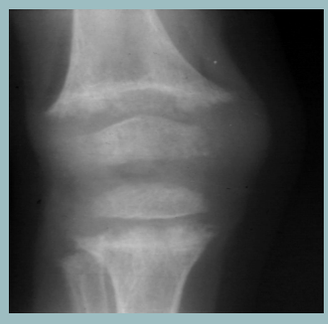
5- This image shows elbow joint of .....

a. 5 y/o Child.
b. 11 y/o child.
c. Adult.



6- This image shows the knee of adult boy what is your diagnosis ?

a. Normal .
b. Fracture.
c. Rickets.
d. Inflammation.



Answers
1)c
2)d
3)e
4)a
5)b
6)c