



3- X-ray Interpretation Skills

Objectives:

- 1- Review a systematic approach to interpreting orthopedic x-rays.
- 2- Review the language of fracture description.

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References: slides + Toronto notes + 433 team + 435 team group A

introduction

Medical Decision Making is a Triad of:

- History – from patients/records.
- Physical Examination.
- Confirming Studies – Imaging, Labs, etc.

Imaging:

- X-ray.
- Ultrasound.
- CT Scan.
- MRI.
- Nuclear Medicine.

X-ray: Best for hard tissue (bones) and is often combined with other imaging modality.

- Radiation Source.
- Patient Exposed.
- Capture Image (films or digital).
- Interpret Image.
- Ionizing Radiation.
- Radiation damages cells.
- Patient Blocks Transmission of Radiation
 - Soft tissues (absorbs/blocks Less).
 - Bones (absorbs/blocks More).
- Interpret Image
 - Radiologist.
 - Orthopedics.

Ionizing radiation hazard:

DNA damage non-fixable = apoptosis.

DNA damage fixable = cell return normal

DNA damage which lead to transformation either non harmful or harmful = tumor

ABCs approach for X Ray

A	Adequacy you should have lateral and AP views
	Alignment
B	BONE
C	Cartilage = joints
S	SOFT TISSUE for example swellings and calcification

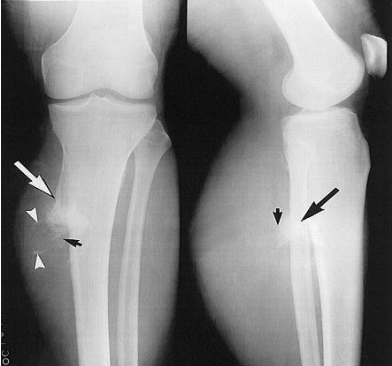
At the end when I adopt this system I can tell for example: I'm looking at x-ray which is optimal(adequate) and that x-ray shows fracture in the femur and that fracture is displaced and the fragments are aligned, and the joint is dislocated and there is swelling.

ABCs approach

A: ADEQUACY

TWO THINGS TO MAKE SURE THAT WE HAVE IN THE FILM:

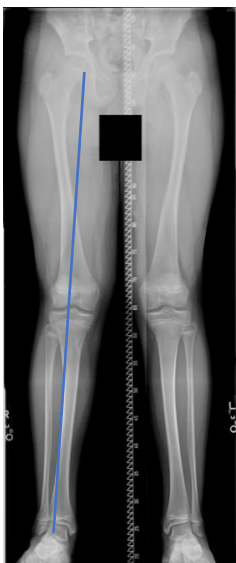
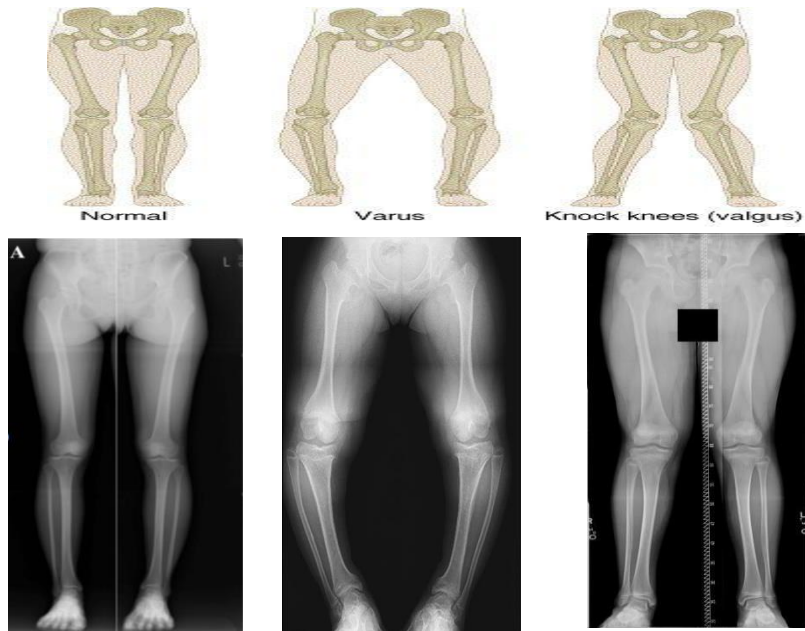
- 2 views" minimum"—AP and lateral (3 views preferred): the more the better
 - The 2 views should be perpendicular to each other.
 - The 3rd view is oblique.
- If we are targeting a Shaft (Joint above and joint below) ex:" tibia" we need to have both the knee and the ankle joints visible. , If we are targeting a Joint (midshaft above and midshaft below) ex "knee joint" we need to have midshaft of femur and midshaft of tibia/fibula visible.
- All x-rays should have an adequate number of views.
- All x-rays should have adequate penetration.

ADEQUACY	ABCs of the picture
	<p>A: inadequate and normal alignment</p> <p>B: abnormal tibia (there is a lesion).</p> <p>C: knee joint, symmetrical joint space, no abnormality.</p> <p>S: there is swelling.</p>

A: ALIGNMENT

Anatomic relationship between bones on x-ray:

- Bone alignment vs other side.
- Bone alignment relative to proximal and distal bones.
- Normal x-rays should have normal alignment.
- Fractures and dislocations may affect the alignment on the x-ray.




You can draw a line from the hip joint to the ankle if the line cross the knee from the middle it's a good alignment

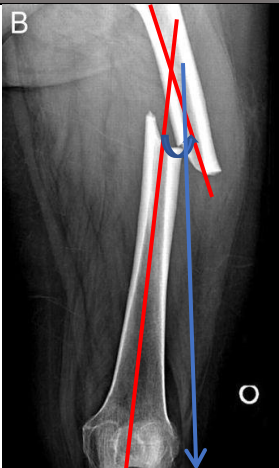
B: Bones

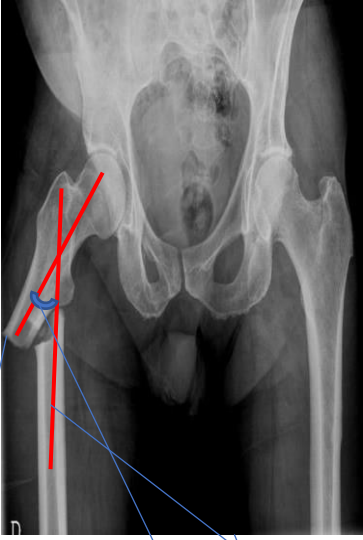
- Identify bone
- Examine the whole bone for:
 - Discontinuity => fractures
 - Change in bone shadow consistency => change in density.
- Describe bone abnormality
 - Location if long bone you can describe the segment whither it's upper or middle or lower.
 - Shape

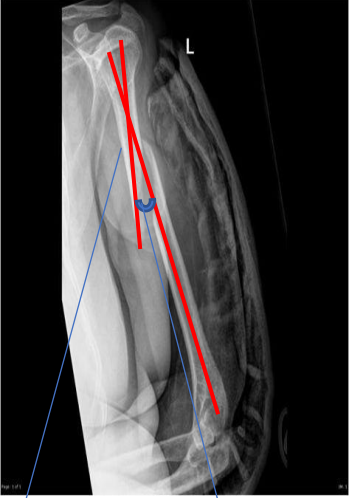
➤ **In deformity we describe two elements:**

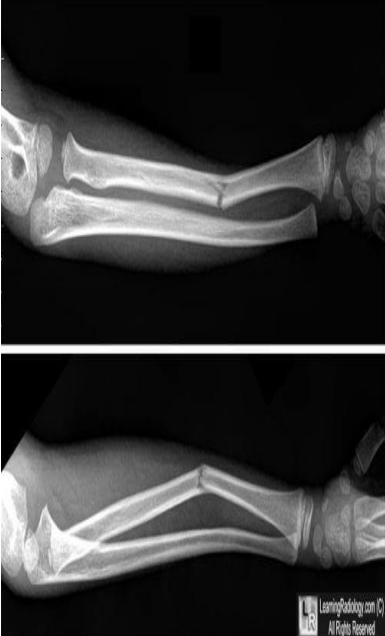
- Angulation (magnitude - direction)
- translation which has 3 components:
 - magnitude (0% - 90% - 100%)
 - direction, if AP view > medial or lateral translation. IF lateral view > anterior & posterior, remember: we describe distal relative to proximal.
 - **In AP view:** deformity is described as either Varus or Valgus, if apex of angle lateral > varus deformity. if apex medial > valgus deformity.
 - **In LATERAL view:** deformity is described as either extension or flexion. if apex of angle anterior > extension deformity, if apex posterior > flexion deformity


Bone (Tibia)	ABCs of the picture
	<p>A: inadequate not aligned (only one view), I need the lateral view</p> <p>B: tibia bone fracture in the mid shaft we can't tell is it right or left, BC it is not label</p> <p>C: joints are good.</p> <p>S: no swelling or soft tissue changes</p> <ul style="list-style-type: none"> ○ It is complete fracture BC lateral and medial lines are fractured. ○ There is medial displacement ○ 75 % displaced or 25 % apposition.

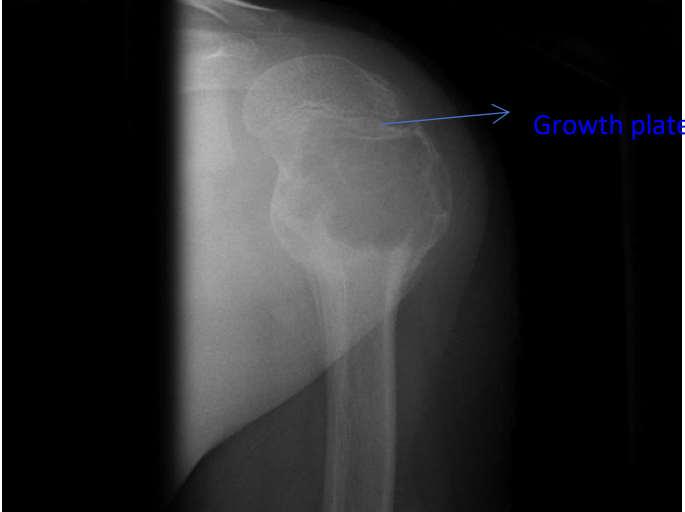
Bone (Femur)	ABCs of the picture
 <p>○ This is the apex facing laterally so the distal part is Angulated 20 degree laterally .</p>	<p>A: inadequate not aligned (only one view and it's not showing one joint above and one joint below)</p> <p>B: femur bone fracture in the mid shaft we can't tell is it right or left</p> <p>C: can not comment on cartilage.</p> <p>S: no swelling or soft tissue changes 80% displacement medially .</p>

Bone (Femur)	ABCs of the picture
 <p data-bbox="92 797 655 900"> Apex facing laterally medial displacement Laterally angulated 30 degree </p>	<p data-bbox="687 327 1382 398">A: Inadequate not aligned (only one view and it's not showing one joint above and one joint below)</p> <p data-bbox="687 443 1353 477">B: right femur bone fracture in the upper segment.</p> <p data-bbox="687 521 1121 555">C: can not comment on cartilage.</p> <p data-bbox="687 600 1165 633">S: no swelling or soft tissue changes.</p> <p data-bbox="687 678 1043 790"> medially displaced laterally angulated distal part is tilted medially </p>

Bone (Humerus)	ABCs of the picture
 <p data-bbox="92 1541 632 1612"> The apex facing medially 30 degree medially angulated </p>	<p data-bbox="687 1099 1326 1171">A: Inadequate not aligned, ones there is an angle there is no alignment.</p> <p data-bbox="687 1216 1382 1288">B: left humerus bone fracture in the upper segment or mid junction between upper and the middle.</p> <ul data-bbox="831 1294 1209 1364" style="list-style-type: none"> ○ This is spiral fracture . ○ Laterally displaced 100 % <p data-bbox="687 1408 1126 1442">C: can not comment on cartilage.</p> <p data-bbox="687 1487 1353 1559"> S: no swelling There is a splint in the posterior aspect of the bone </p>

Bone (Radius)	ABCs of the picture
	<p>A: adequate: 2 views, joint above & below, exposure is adequate. Alignment: valgus (lateral) Displacement of fracture: nothing Angulation: posterior (dorsal) (apex is going anterior, fracture fragment is going posteriorly to the ulna or olecranon)</p> <p>B) Incomplete fracture. (green stick fracture).</p> <ul style="list-style-type: none"> ○ BC lateral line is intact ○ BC bone are soft ○ In the forearm say ulnar or radial angulated <p>C: can't comment on the cartilage.</p> <ul style="list-style-type: none"> ○ This is child BC I can see growth plate <p>S:NO swelling.</p>

Bone (Femur)	ABCs of the picture
 <p data-bbox="92 1671 501 1702">Lateral epicondyle sclerotic lesion</p>	<p>A: inadequate: 2 views, exposure is inadequate = no joint above or below.</p> <p>B: sclerotic round shape lesion in the lower part or the right femur.</p> <p>there is radiolucency.</p> <p>C: can't comment on the cartilage.</p> <p>S: no swelling.</p>

Bone (Humerus)	ABCs of the picture
 <p style="color: blue;">Growth plate</p>	<p>A: inadequate but aligned ,BC no joint above and joint blew +no lateral view.</p> <p>B: humerus bone with lytic bone lesion in the upper segment, cortex is intact. what in the upper part close to humerus head is normal growth plate not a fracture, most likely is a tumor.</p> <ul style="list-style-type: none"> ○ No fracture ○ Lytic lesion in the proximal humerus <p>C: joints are good</p> <p>S: no swelling.</p>

C: Cartilage

- Cartilage
 - joint spaces on x-rays
 - you cannot actually see cartilage on x-rays
- Widening of joint spaces → signifies ligamentous injury and/or fractures
- Narrowing of joint spaces → arthritis



Figure 1

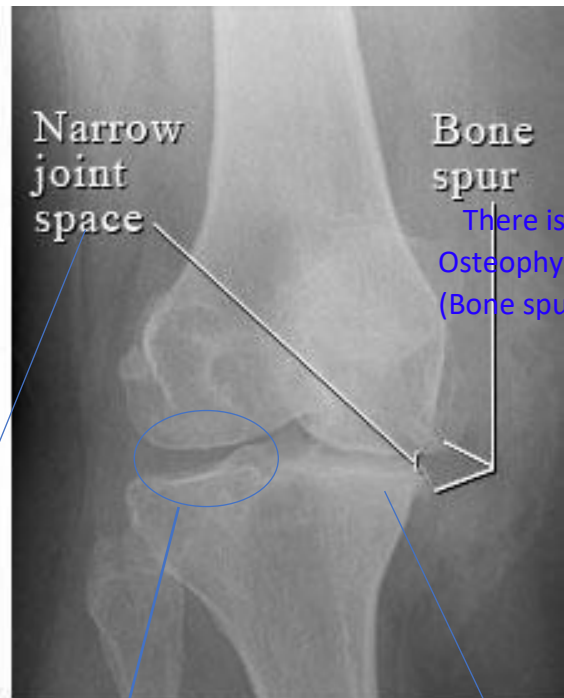
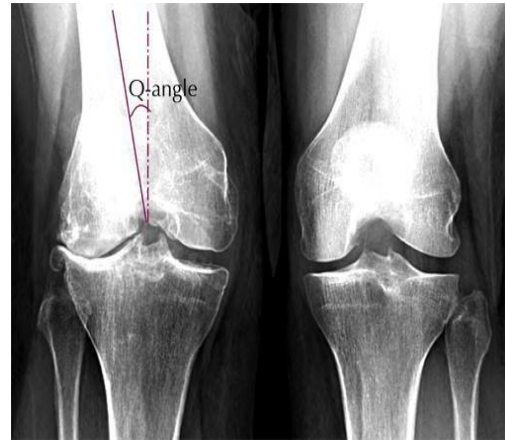
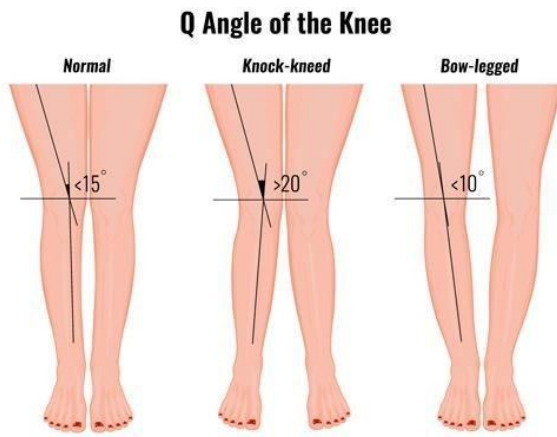


Figure 2



BC of osteophytes

There is sclerosis

Subcortical sclerosis



Loss of joint space

Cartilage (Hip joint)		
<p>Pre ABCs: patient identity unknown. no history no examination.</p>		<p>A: not adequate because only one view.</p> <p>B: left femoral head is deformed and distorted, no joint space, cartilage is worn out, sub cortical sclerosis, multiple osteophyte.</p> <p>the right side has arthritis but not as bad as the left side.</p> <p>S: insignificant</p>
<p>Valgus knee deformity and narrowing space in the lateral side of the knee.</p>		<p>Medial side is more affected because of the weight sub cortical sclerosis, osteoarthritis because of the narrow space and bone spur (osteophytes).</p>

S: Soft Tissue

- Soft tissues implied to look for soft tissue swelling and joint effusions.
- There can be signs of:
 - Trauma.
 - Occult = **hidden** fracture.

- Infections.
- Tumors.

ABCs Review	
A	Assess adequacy of x-ray which includes proper number of views and penetration. Assess alignment of x-rays.
B	Examine bones throughout their entire length for fracture lines and/or distortions.
C	Examine cartilages (joint spaces) for widening.
S	Assess soft tissues for swelling/effusions.

Examples

Fat bad sign



Example #1:

This x-ray demonstrates a lateral elbow x-ray. Bone is normal There is swelling anteriorly which is displaced known as a pathologic anterior fat pad sign There is swelling posteriorly known as a posterior fat pad sign Both of these are signs of an occult fracture although none are visualized on this x-ray Remember, soft tissue swelling can be a sign of occult fracture!

The swelling maybe caused by intra-articular fracture leading to hemorrhage. Which will lead to fat displacement from the bone lead fat bad sign

Example #2:

- If you follow ABCs, you will notice there are problems with alignment on this x-ray (A)
- (B)...You will notice there are fracture lines through the 2nd, 3rd, and 4th metacarpals
- These are 2nd, 3rd, and 4th, midshaft metacarpal fractures.
- A teaching point: Notice the ring on this film. Always remove rings of patients with fractured extremities because swelling may preclude removal later.
- In hand x-rays we can describe instead of medial and lateral we can say ulnar and radial.
- In this x-ray it's laterally(radially) displaced.



Language of fracture

- Important for use to describe x-rays in medical terminology.
- Improves communication with orthopedic consultants
- **Things you must describe (clinical and x-ray):**

OPEN VS CLOSED:

Must describe to a consultant if fracture is open or closed.

- **Closed fracture:**
 - Simple fracture.
 - No open wounds of skin near fracture.
- **Open fracture:**
 - Compound fracture
 - Cutaneous (open wounds) of skin near fracture site. Bone may protrude from skin
 - Open fractures are open complete displaced and/or comminuted(with fragments)

OPEN FRACTURES:

- Orthopedic emergency.
- Requires emergency orthopedic consultation.
- Bleeding must be controlled.
- **Management:**
 - IV antibiotics.
 - Tetanus prophylaxis.
 - Pain control.
 - Surgery for washout and reduction.

ANATOMIC LOCATION:

- Describe the precise anatomic location of the fracture.
- Include if it is left or right sided bone.
- Include name of bone.
- Include location:
 - Proximal-Mid-Distal
 - To aid in this, divide bone into 1/3rds

FOR EXAMPLE...WHERE IS THIS LOCATED?

This is a closed L distal femur fracture.

The main thing I want you to take from this example is the description of location.

ANATOMIC LOCATION:

Besides location, it is helpful to describe if the location of the fracture involves the joint space— intra-articular

**ABCs of the picture**

Pre ABCs: patient identity unknown. No history or examination information. X-ray of femur.

A: Not adequate because no joint below and joint above.

B: metaphyseal spiral fracture with comminution, (or fracture in the distal shaft of femur).

AP: Apex of angle medial, valgus deformity, Angulation 110%, 100% lateral translation.

lateral view: 110% posterior translation, 25-degree posterior angulation.

C: insignificant

S: Insignificant

ANATOMIC LOCATION:

Besides location, it is helpful to describe if the location of the fracture involves the joint space “intra-articular”.

Intra-articular fracture of base 1st metacarpal



Pre ABCs: patient identity unknown. No history or examination information. X-ray of hand.

A: Inadequate because only one view.

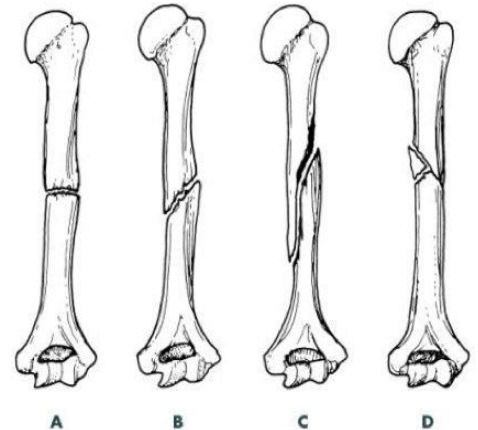
B: Multiple fragmental fracture of base 1st metacarpal bone.

C: insignificant

S: Insignificant

FRACTURE LINES:

- Next, it is imperative to describe the type of fracture line
- There are several types of fracture lines:
 - A: is a transverse fracture
 - B: is an oblique fracture
 - C: is a spiral fracture
 - D: is a comminuted fracture *في جزء من العظم منفصل عن العظم الاساسي*
- There is also an impacted fracture where fracture ends are compressed together.
- *Oblique and transverse could be controversial but usually the cut off point is the degree, we can say if the angle is more than 30 degrees it's oblique if less than 30 degrees it's transverse.*



Examples (what type of fracture line is this??)

This is a Transverse fracture occur perpendicular to the long axis of the bone.

To fully describe the fracture, this is a closed midshaft transverse humerus fracture.



This is a Spiral fracture occur in a spiral fashion along the long axis of the bone
They are usually caused by a rotational force.

To fully describe the fracture, this is a closed distal spiral fracture of the fibula

If there are two shadows, it's most likely spiral.



This is a Comminuted fracture are those with 2 or more bone fragments are present.

Sometimes difficult to appreciate on x-ray but will clearly show on CT scan.

To fully describe the fracture, this is a closed R comminuted intertrochanteric fracture.



Fracture fragments

Terms to be familiar with when describing the relationship of fracture fragments:

- Alignment
- Angulation look for the apex and discrip
- Apposition
- Displacement medial , lateral , ulnar , radial
- Bayonet apposition = above each other.
- Distraction there is gap
- Dislocation for the joint

Displacement and Apposition are against each other. If there is 30% displacement that means there is 70% apposition.

ALIGNMENT/ANGULATION:

- Alignment is the relationship in the longitudinal axis of one bone to another.
- Angulation is any deviation from normal alignment.
- Angulation is described in degrees of angulation of the distal fragment in relation to the proximal fragment --- to measure angle draw lines through normal axis of bone and fracture fragment.

20 DEGREE OF ANGULATION



OTHER TERMS

- Apposition: amount of end to end contact of the fracture fragments.
- Displacement: use interchangeably with apposition.
- Bayonet apposition: overlap of fracture fragments.
- Distraction: displacement in the longitudinal axis of the bones.
- Dislocation: disruption of normal relationship of articular surfaces.

DESCRIBE FRACTURE FRAGMENTS:

ANSWER:

- This is a closed midshaft tibial fracture. But how do we describe the fragments?
- This is an example of partial apposition; note part of the fracture fragments are touching each other.
- Alternatively, you can describe this as displaced 1/3 the thickness of the bone.
- Remember apposition and displacement are interchangeable we tend to describe displacement.
- Final answer: Closed midshaft tibial fracture with moderate (30%) displacement.



ANSWER:

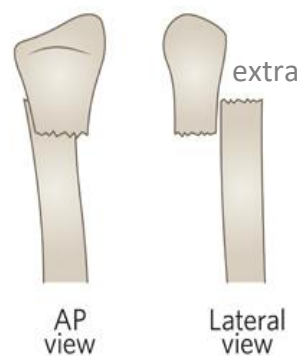
- There are 2 fractures on this film.
- Closed distal radius fracture with complete displacement. Also, there is an ulnar styloid fracture which is also displaced
- The displacement is especially prominent on the lateral view highlighting the importance of multiple views.
- There may be intra-articular involvement as joint space is close by.
- Remember, remove all jewelry from extremity fractures



Impaction when they get into each other

DISLOCATION:

- Note the dislocation; the articular surfaces of the knee no longer maintain their normal relationship.
- Dislocations are named by the position of the distal segment.
- This is an Anterior knee dislocation.

**BAYONET APPPOSITION:**

NEUROVASCULAR STATUS: you have to know the status.

- Finally, when communicating a fracture, you will want to describe if the patient has any neurovascular deficits.
- This is determined clinically.

LANGUAGE OF FRACTURES:

- To review, when seeing a patient with a fracture and the x-ray, describe the following:
 - Open vs closed fracture.
 - Anatomic location of fracture (distal, mid, proximal) and if fracture is intra-articular. Or left or right
 - Fracture line (transverse, oblique, spiral, comminuted).
 - Relationship of fracture fragments (angulation, displacement, dislocation, etc).
 - Neurovascular status.

DESCRIBE THIS R MIDDLE PHALANX FRACTURE:

ANSWER:

- Oblique fracture of midshaft of R 4th middle phalanx with minimal displacement angulation.
- Remember to comment if open vs closed & neurovascular status



DESCRIBE TO ORTHO ATTENDING:

ANSWER

- This one is a bit more challenging!
- R midshaft tibia fracture displaced 1/2 the thickness of the bone without angulation bayonette appositioning of the fracture fragments.
- R midshaft fibular fracture with complete displacement
- And comment if the fracture is open vs closed & neurovascular status.

