



3- X-Ray interpretation skills

Objectives:

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

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References: 435 team, Doctors' notes, 436 slides, 433 team, Toronto notes

Introduction

★ Medical Decision Making is a Triad of:

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

★ Imaging:

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

X-ray:

- Ionizing Radiation Source → (radiation damages cells).
- Capture Image → (films or digital).
- Patient Blocks Transmission of Radiation:
 - Soft tissues (absorbs/blocks **Less**) → Black
 - Bones (absorbs/blocks **More**) → White
- Who interpret Image? Radiologist or Orthopedics.

Best for: hard tissue like (bones). It is often combined with other imaging modality.

ABCs Approach

Apply ABCs approach to **every** orthopedic film you evaluate.


Pre ABC → <u>identify</u> patient, <u>read</u> provided info.	
A	1- Adequacy 2- 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.

★ A: Adequacy:

Two things to make sure that we have in the film:


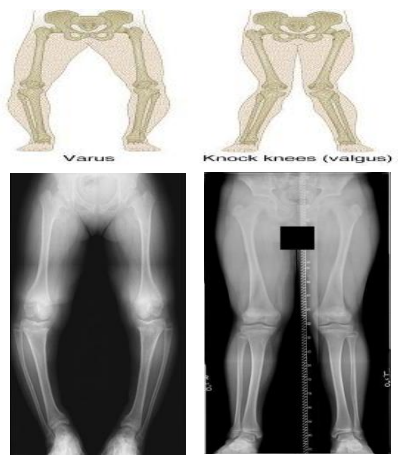
- **2 views "minimum": AP and lateral.** (3 views preferred) → 3rd view is oblique. The more the better.
- **2 Joints: Joint above and joint below.** If we are targeting a Shaft ex: "tibia" we need to have both the knee and the ankle joints visible. If we are targeting a Joint (mid-shaft above and mid-shaft below), ex: "knee joint" we need to have mid-shaft of femur and mid-shaft of tibia/fibula visible.
- All x-rays should have adequate penetration. Depends on the quality of x-ray. You've to see the cortical margin.

★ ADEQUACY	ABCs of the picture
 <p>Inadequate although there is two views. Why? Here there's <u>Only one joint</u> ✗ I need to see the ankle.</p>	<p>A: <u>inadequate</u> and normal alignment. B: abnormal “proximal” tibia (there is a lesion “mass”). C: knee joint, symmetrical joint space, no abnormality. 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.

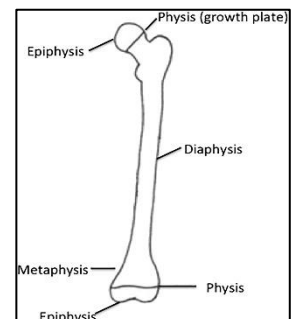
1- You look at the alignment of the whole limb. 2- Alignment of a specific bone to look for any fractures or deformities. 3- Compare distal to proximal part.

- Normal x-rays should have normal alignment.
- Fractures and dislocations may affect the alignment on the x-ray.

★ ALIGNMENT	Extra
 <p>You can draw a line from the hip joint to the ankle to assess alignment. If the line crosses the knee from the middle it's good alignment.</p>	<p>Extra</p>  <p>Varus Knock knees (valgus)</p>

★ **B: Bones:**

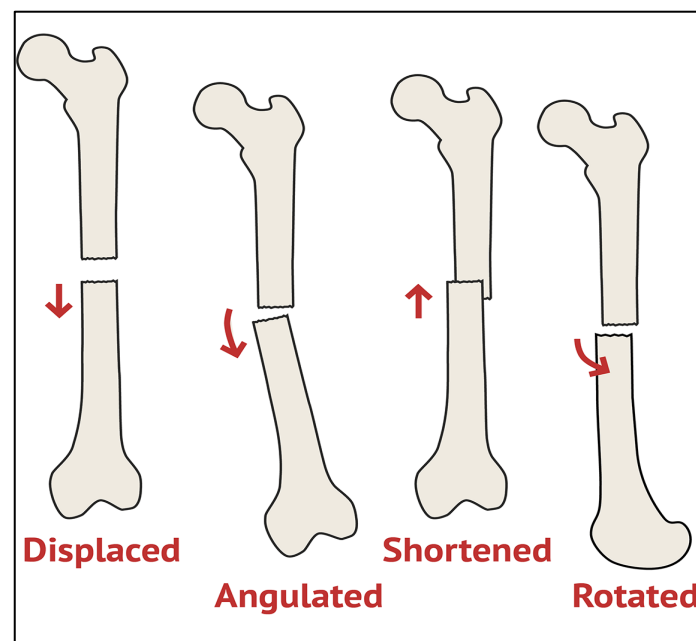
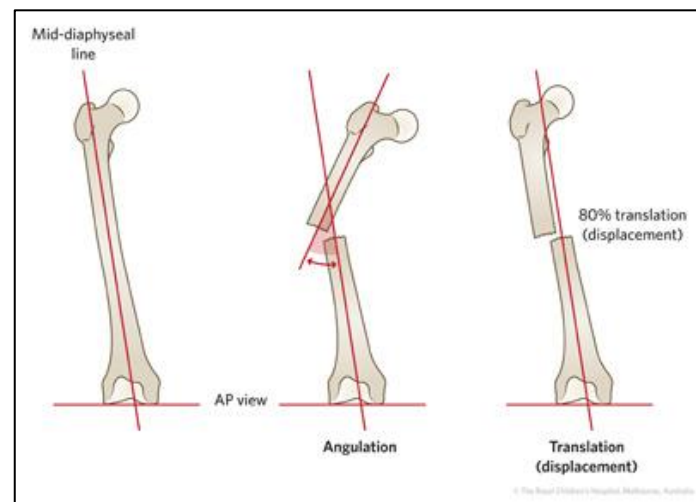
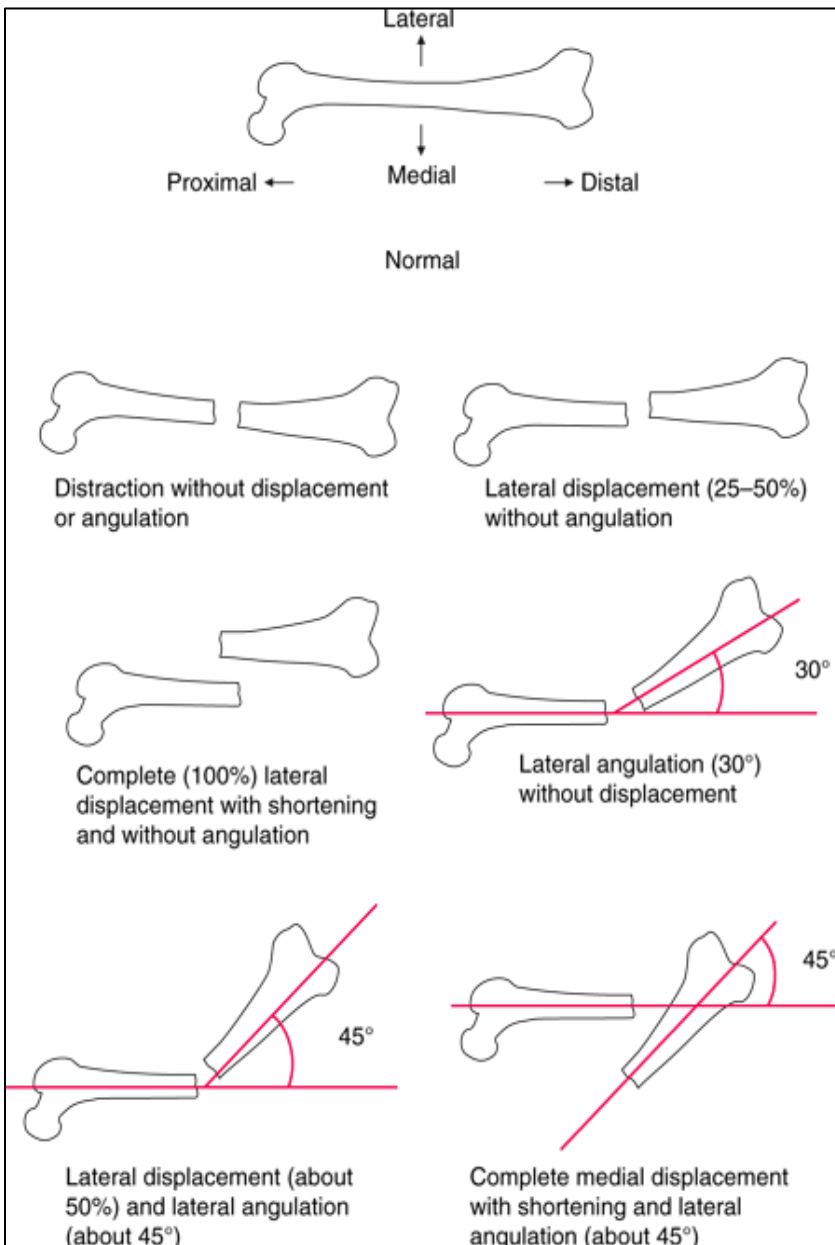
1. Identify bone. Which bone? Tibia? Femure?
2. Examine the whole bone for:
 - a. Discontinuity => fractures. Not always maybe normal for example Child's growth plate.
 - b. Change in bone shadow consistency => change in density. Osteolytic lesion: ↓ density.
Osteosclerotic: ↑ density.
3. Describe bone abnormality:
 - Location. If long bone you can describe the segment whether it's (upper or middle or lower), (proximal, middle, distal), (epiphysis, diaphysis, metaphysis)
 - Shape.





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

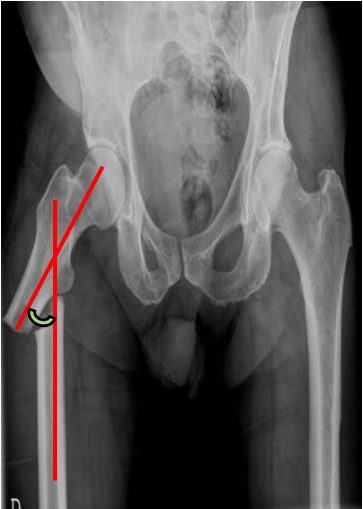
- ◆ **Alignment** is the relationship in the longitudinal axis of one bone to another.
- ◆ **Angulation** is any deviation from normal alignment:
 - Angulation is described in degrees of angulation of the distal fragment in relation to the proximal fragment --- to measure angle draw lines through normal axis of bone and fracture fragment.
 - Medial angulation can be termed 'varus', and lateral angulation can be termed 'valgus'.
- ◆ **Apposition**: amount of end to end contact of the fracture fragments.
- ◆ **Displacement**: use interchangeably with apposition.
 - In AP view you comment by medial or lateral. In lateral view → anterior or posterior displacement.
- ◆ Bayonet apposition: overlap of fracture fragments.
- ◆ **Distraction**: displacement in the longitudinal axis of the bones.
- ◆ **Dislocation**: disruption of normal relationship of articular surfaces.

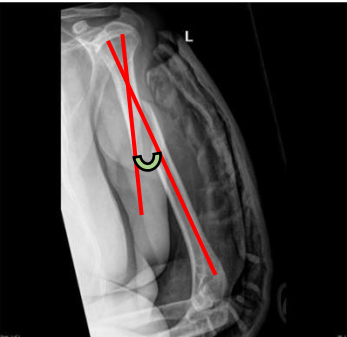
*Extra for better understanding:

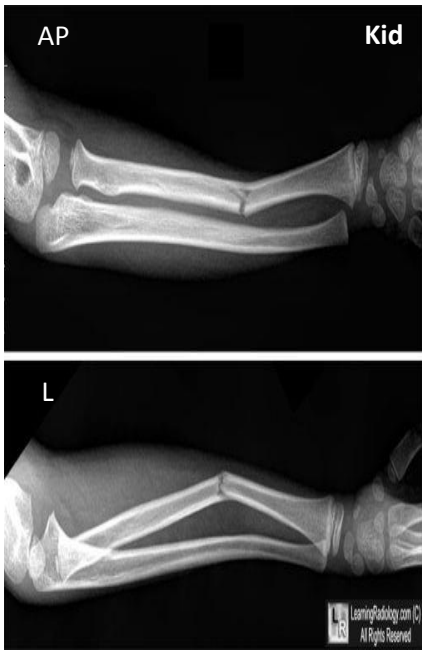



★ Bone (Tibia)	ABCs of the picture
	<p>A: Inadequate (only one view) not aligned (fracture). B: Tibia bone fracture in the mid shaft. We can't tell if it's right or left because it is not labeled. C: Joints are good. S: No swelling or soft tissue changes.</p> <ul style="list-style-type: none"> ○ It is a complete fracture. ○ There is medial displacement. ○ 75% displaced or 25% apposition.


★ Bone (Femur)	ABCs of the picture
	<p>A: Inadequate (only one view and it's not showing one joint above and one joint below), not aligned (varus). B: Femur bone fracture in the mid shaft. We can't tell if it's right or left. C: Cannot comment on cartilage. S: No swelling or soft tissue changes.</p> <ul style="list-style-type: none"> ○ 80% displacement medially. ○ Apex facing laterally → Laterally angulated. <p>Apex: Angle tip = رأس العظم البروكسيمال →</p>

★ Bone (Femur)	ABCs of the picture
	<p>A: Inadequate (only one view and it's not showing one joint above and one joint below), not aligned. B: Right femur bone fracture in the upper segment. C: Cannot comment on cartilage. S: No swelling or soft tissue changes.</p> <ul style="list-style-type: none"> ○ Medially displaced. (100%) ○ Laterally angulated about 30 degrees. "Apex facing laterally" ○ Distal part is tilted medially.

★ Bone (Humerus)	ABCs of the picture
	<p>A: Inadequate not aligned, once there is an angle there is no alignment. B: Left humerus bone fracture in the upper segment or mid junction between upper and the middle. <ul style="list-style-type: none"> ○ This is a spiral fracture. ○ Laterally (posterior) displaced 90%. ○ Medially angulated → Apex facing medially. C: Cannot comment on cartilage. 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).</p> <p>B: Incomplete fracture. (Green-stick fracture) because:</p> <ul style="list-style-type: none"> ○ Lateral line is intact. ○ Bones are soft. <p>In the forearm say ulnar or radial angulated.</p> <ul style="list-style-type: none"> ○ Displacement of fracture: nothing. ○ Angulation: AP → medially angulated. L → posterior (dorsal) (apex is going anterior, fracture fragment is going posteriorly to the ulna or olecranon) <p>C: Can't comment on the cartilage.</p> <ul style="list-style-type: none"> ○ This is child that's why I can see growth plate <p>S: NO swelling.</p>

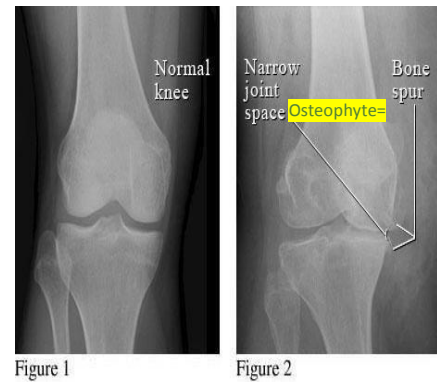
★ Bone (Femur)	ABCs of the picture
	<p>A: Inadequate: 2 views, exposure is inadequate = no joint above or below.</p> <p>B: Sclerotic round shape lesion in the lower part of the right femur (Lateral epicondyle). There is area of radiolucency.</p> <p>C: Can't comment on the cartilage.</p> <p>S: No swelling.</p> <p>○ : Patella + medial condyle shadow. Not lesion.</p>

★ Bone (Humerus)	ABCs of the picture
	<p>A: Inadequate but aligned.</p> <p>B: Humeral bone with lytic bone lesion in the upper (proximal) 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. <p>C: Joints are good.</p> <p>S: No swelling.</p>

★ C: 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. More pressure = ↑ surface area (osteophyte).



Arthritis in the knee & hip joint

Signs of osteoarthritis: Must know these 4

Asymmetric narrow joint space, osteophyte, sub-chondral sclerosis and cyst.

★ 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.

★ **Review ABCs** ★

Pre ABC → identify patient, read provided info.

A	1- Adequacy: Proper number of <u>views</u> & <u>penetration</u> .
	2- Alignment
B	Bone: Examine bones throughout their entire length for fracture lines and/or distortions.
C	Cartilage: Examine cartilages (joint spaces) for widening.
S	Soft tissue: Assess soft tissues for swelling/effusions.

Language of fracture

- ◆ Important for use to describe x-rays in medical terminology.
- ◆ Improves communication with orthopedic consultants

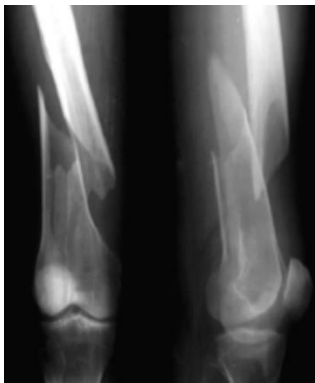
#Things you must describe (clinical and x-ray):

1– Open vs Closed fracture	
★ Closed fracture:	★ Open fracture:
<ul style="list-style-type: none"> ○ Simple. ○ No open wounds of skin near fracture. 	<ul style="list-style-type: none"> ○ Compound fracture¹. ○ Cutaneous (open wounds) of skin near fracture site. Bone may protrude from skin. ○ Open fractures are open complete displaced and/or comminuted "مفتتة". ○ An orthopedic emergency. Bleeding must be controlled. <p>Management: 1- IV antibiotics. 2- Tetanus prophylaxis. 3- Pain control. 4- Surgery for washout and reduction.</p>

2– Anatomic Location of fracture

- 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**

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



A closed L distal femur fracture.

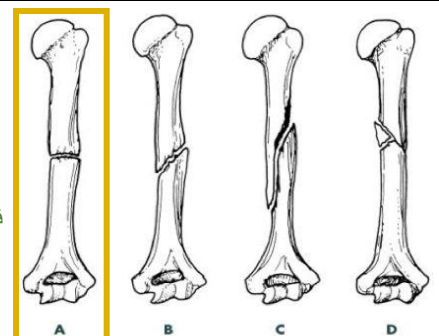


Intra-articular fracture of base 1st metacarpal

3– Fracture line

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.



¹ an injury in which a broken bone pierces the skin.



Transverse fracture

Occur perpendicular to the long axis of the bone.

This is a closed mid- shaft transverse humerus fracture.



Spiral fracture

Occur in a spiral fashion along the long axis of the bone.



They are usually caused by a rotational force.

This is a closed distal spiral fracture of the fibula.

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



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**.

This is a closed R comminuted intertrochanteric fracture.

4- Relationship of fracture fragments

Terms to be familiar with – mentioned at the beginning of the lecture ↑

20 degree of **angulation**



Partial **apposition** (part of the fracture fragments are touching each other).



Closed mid-shaft tibial fracture with moderate (30%) displacement.



There are 2 fractures on this film:
 1. Closed distal **radius** fracture with complete displacement.
 2. **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.

- o Remember, remove all jewelry from extremity fractures.



Bayonette apposition	Dislocation
 <p data-bbox="470 347 730 459">Clavicle is completely displaced with overlapping.</p>	<p data-bbox="802 141 1374 212">The articular surfaces of the knee no longer maintain their normal relationship.</p> <p data-bbox="826 237 1453 313">✓ Dislocations are named by the position of the distal segment.</p>  <p data-bbox="906 707 1374 741">This is an Anterior knee dislocation.</p>

5– Neurovascular status

- 1- Finally, when communicating a fracture, **Describe** if the patient has any neurovascular deficits.
- 2- This is determined clinically.

1- DESCRIBE THIS R MIDDLE PHALANX FRACTURE:

ANSWER:

Oblique fracture of mid-shaft of R 4th middle phalanx with minimal displacement and no angulation.

- Remember to comment if open vs closed & neurovascular status



2- DESCRIBE THE FRACTURE:

ANSWER:

R midshaft tibia fracture displaced 1/2 the thickness of the bone without angulation; also, there is bayonette appositioning of the fracture fragments.

R midshaft fibular fracture with complete displacement.

- Comment if the fracture is open vs closed & neurovascular status.



Exercise #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.

- o Remember, soft tissue swelling can be a sign of occult fracture!
- o (Capsule of the joint pushes the soft tissue maybe collection of fluid?)
- o The swelling maybe caused by intra-articular fracture leading to hemorrhage. This will lead to fat displacement from the bone lead to fat pad sign.



Exercise #2

If you follow ABCs, you will notice there is are problems with alignment on this x-ray (A).

B: You will notice there are fracture lines through the 2nd, 3rd, and 4th metacarpals.

- o These are 2nd, 3rd, and 4th, mid-shaft metacarpal fractures.

In hand x-rays we can describe instead of medial and lateral we can say ulnar and radial.

- o In this x-ray it's laterally (radially) displaced.

A teaching point: Notice the ring on this film. Always remove rings of patients with fractured extremities because swelling may preclude removal later.

