



433 Teams
ORTHOPEDICS

Lecture (2)

X-ray Interpretation Skills

Ortho433@gmail.com



جامعة
الملك سعود
King Saud University



Introduction

Medical Decision Making is a Triad of:

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

Imaging used normally in orthopedics:

- X-ray (always)
- Ultrasound
- CT Scan (for bone)
- MRI (for soft tissue)
- Nuclear Medicine

X-ray (Best for: Hard tissue such as bones. Often combined with other imaging)

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

Ionizing radiation hazard:

- 1) DNA damage non-fixable = apoptosis.
- 2) DNA damage fixable = cell return normal
- 3) DNA damage witch lead to transformation either non harmful or harmful = tumor

OBJECTIVES

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

ABCs approach:

- Before starting, **identify** the patient
- Make sure to have a full **history**
- Always apply this approach to every film you evaluate.

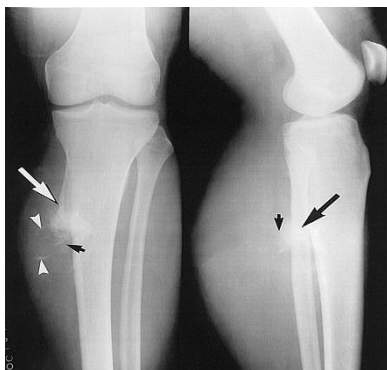
A	- Adequacy
	- Alignment
B	-BONE
C	- Cartilage
S	-SOFT TISSUE

A

ADEQUACY:

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

- **2 views**” minimum”—AP and lateral (3 views preferred)
- If we are targeting a **Shaft (Joint above and joint below)** ex:” tibia” we need to have both knee and 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.

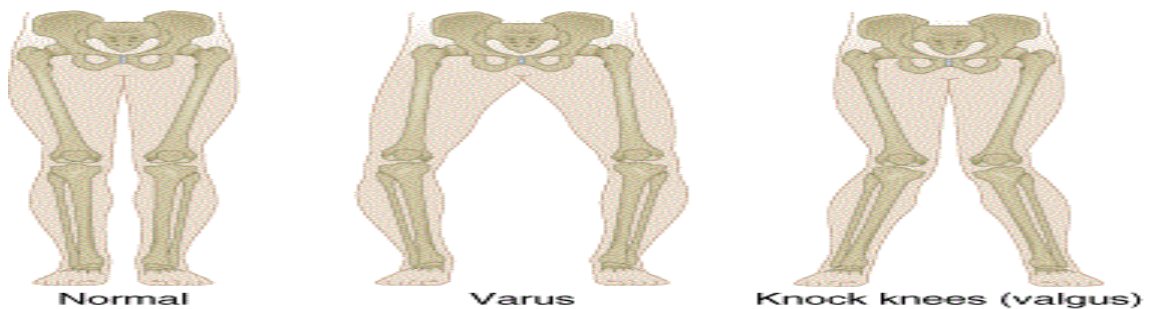


-Pre ABC: no name, no history
 -Adequacy: there are 2 views (AP, lateral), so we are okay till now. Now we check the exposure: we need to have both knee and ankle joints visible but here the ankle is missing so the images are not adequate.

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.
- **In alignment you describe the distal part in reference to the proximal part.** (Example: valgus means the distal part is lateral to the proximal part).
- 2 things to comment on in alignment: first the distal part of the bone relative to the proximal (e.g. tibiovara means the distal part of tibia is medial in relative to the proximal part of tibia), second at the level of the joint, the distal bone relative to proximal bone (e.g. genu valgus, tibia is lateral in relative to femur. Genu=knee).
- **5-10 degree valgus** in the knee is normal.



B

- Identify bone.
 - Examine the whole bone for:
 - Discontinuity (fractures or lytic changes at the cortex).
 - Change in bone shadow = change in **density**.
- If the bone is farther from the film, it is more likely to be displaced anteriorly.
- Describe bone abnormality
- Location (because treatment differs).
 - Shape.


Important: If asked about the normal alignment angle, it is 180 degrees. (If you put zero in the exam, it is WRONG!)

In deformity we describe two elements:

- 1) **Angulation** (magnitude - direction)
- 2) **Translation** which has 2 components:
 - **magnitude** (0% - 90% - 100%)
 - **direction**, if **AP view** > **medial or lateral translation**. If **lateral view** > **ant. & post.** 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 post. > flexion deformity.



Fracture type based on angle: (said by doctor, differs from one source to the other)

- <30 degrees → transverse
- 30 – 60 degrees → oblique
- >60 degrees → spiral

- More correctly, spiral fractures lie on more than one plane, whereas oblique fractures lie on one plane.
- Oblique fractures can be divided into short oblique and long oblique (If you are interested, you can read into it, but it will NOT be included in our exam at our level)



Pre ABC: No ID, no history, no examination.

AP view of RT tibia:

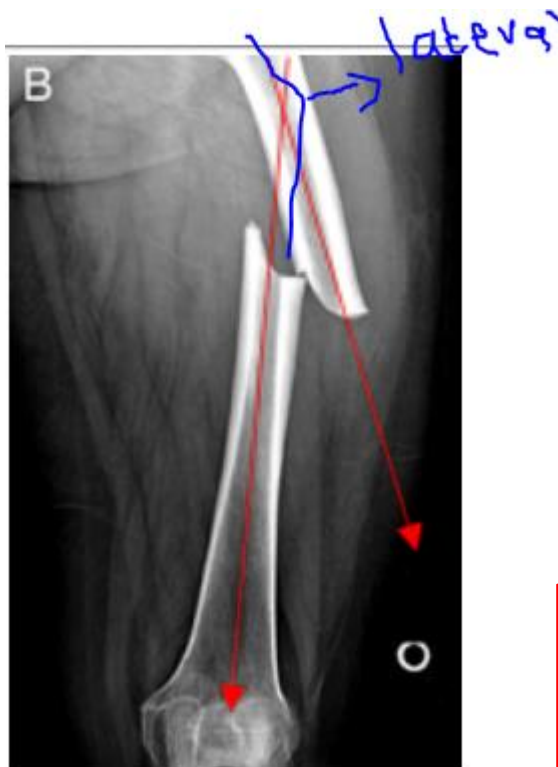
A: image not adequate because we have only one view (AP) and we don't have the joint above and below

B: complete Transverse fracture in mid shaft of RT tibia

Angulation: Distal part of tibia is going lateral so it is valgus deformity around 30 degree. (apex of the angle pointing medially)

Translation: It's the displacement of distal fragment relative to proximal. So here it is 80% medial translation.

(in AP view it is medial or lateral translation, in lateral view it is either anterior or posterior translation)



Pre ABCs: no ID, No history, no examination

A: not enough views and not enough exposure

B: complete oblique fracture at mid shaft or left femur with the apex **lateral (varus)**

Angulation: 35 degree medially angulated

Translation: 90% medial displacement.

C: insignificant

S: insignificant

How to know this image is right or left?

- The femur is normally laterally bowed
- You can see the buttock line
- The medial epicondyle is bigger than the lateral one

Of note: **Overlap is very commonly seen with femoral fractures due to the strong muscles.**



Pre ABCs : no history no examination

A : not adequate because only one view and there is no joint below visible

B: complete RT proximal femur oblique fracture with apex lateral (varus)

Angulation: 60 degree medially

Translation: 90% medial displacement

C: not significant

S: not significant



Pre ABCs: no history no examination available

A: lateral view only available (not adequate)

B: complete spiral fracture of left humerus

Angulation:30 degree, apex anterior

Translation: 100% posterior displacement



Landmarks: thumb and coronoid process (red circle) is always anterior. Olecranon is posterior.

Pre ABCs: Patient identity unknown.No history or examination information. X-ray of forearm.

A: adequate x-ray

B: transverse fracture in **lower third of radius**,
 A) AP > apex of angle **medial**. Valgus deformity (distal part away from midline). **Angulation of 20- 30°**.
 B) lateral view > apex of angle is **anterior**, extension deformity, **angulation 30°**.
 N.B. in lateral view you describe the deformity as extension/flexion not varus/valgus.



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

A: not adequate because above and below the joint is not fully visible.

B: AP view: **hyperdense well circumscribed lesion with some hypodense areas in metaphysis of distal right femur.**
lateral view: lesion is occupying the full thickness.

C: decreased joint space at the lateral side.

S: Insignificant **Diagnosis:** Osteosarcoma

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**



Figure 1



Figure 2



1-Medial side is more affected because of the weight, osteoarthritis because of the narrow space and bone spur(osteophytes).
2-Valgus knee deformity and narrowing space in the lateral side of the knee.

Pre ABCs: Patient identity unknown. No history or examination information. X-ray of pelvis.

A: not adequate because only one view.

B: left femoral head is deformed and distorted.

C: left femoral head is deformed and distorted, **no joint space, cartilage is worn out, sclerosis, multiple osteophyte.**

The right side has arthritis but not as bad as the other side.

S: insignificant



S

Soft Tissue

- Soft tissues simply to look for soft tissue **swelling and joint effusions.**
- There can be signs of:
 - Trauma
 - Occult fracture (a condition with clinical signs of fracture but no radiographic evidence)
 - Infections
 - Tumors

Review: ABC

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

Examples:

Example #1

- Inadequate x-ray only one view distal and proximal not visualized.
- 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!**

- With lateral radiographs, the displacement and apex is described as anterior or posterior.



Example #2.... Where are the fractures?

- Pre ABC: no name, no history
- Adequate in term of length, and not adequate number of views.
- Discontinuity:
 - 1- Fracture in the 2nd metacarpal bone, in diaphysis metaphysis junction, transverse 50% radially translation, no angulation
 - 2- fracture in the 3rd metacarpal at the proximal diaphysial part, oblique, 70% anterior radial translation (overlap, it should be lateral view), 20 degree ulnar angulation
 - 3- fracture in the 4th metacarpal bone, radial



LANGUAGE OF FRACTURES

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 fracture.**
- **Anatomic location of fracture.**
- **Fracture line.**
- **Relationship of fracture fragments.**
- **Neurovascular status.**

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.

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

Other notes: (Important!)

- Aneurysmal Bone Cyst:

- 1- Septae
- 2- Ballooning
- 3- Skeletally immature patient
- 4- Stop by the physis
- 5- Hypodense lesion

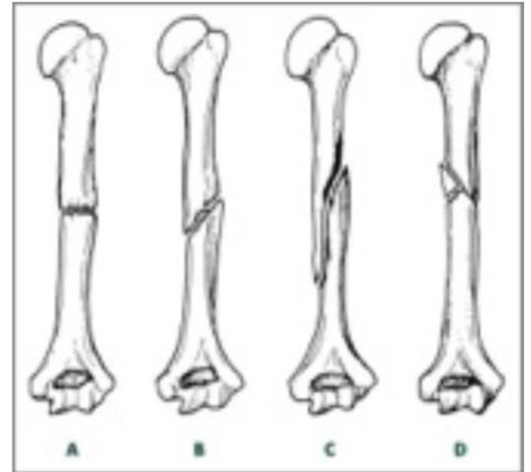
- OA:

- 1- Osteophytes
- 2- Narrowing of joint space

- If joint space is opening on one end, it is a **LIGAMENTOUS INJURY.**

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** "Less than 20%"
- **B is an oblique fracture** "20% - 60%"
- **C is a spiral fracture** "Above 60%"
- **D is a comminuted fracture** "With two or more bone fragments are present"
- There is also an impacted fracture where fracture ends are compressed together.



FOR EXAMPLE... WHERE IS THIS LOCATED?

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

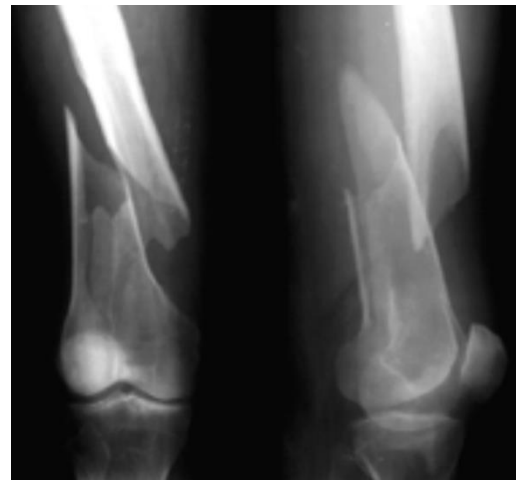
A: not adequate because no joint below joint above

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

AP: Apex of angle **medial**, valgus deformity, **angulation 20°**. **100% lateral translation**.

Lateral view: **110% posterior translation**, **25 degree posterior angulation**

C: insignificant **S:** insignificant



- This is a closed L distal femur fracture.
- The main thing I want you to take from this example is the description of location.

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

EXAMPLES

ANS: **TRANSVERSE FRACTURE**

- Transverse fractures occur perpendicular to the long axis of the bone.
- To fully describe the fracture, this is a closed midshaft transverse humerus fracture.



ANS: **SPIRAL FRACTURE**

- Spiral fractures 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.



ANS: **COMMINUTED FRACTURE**

- Comminuted fractures 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
- Apposition
- Displacement
- Bayonette apposition
- Distraction
- Dislocation

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.

OTHER TERMS

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



20 DEGREE OF
ANGULATION

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:

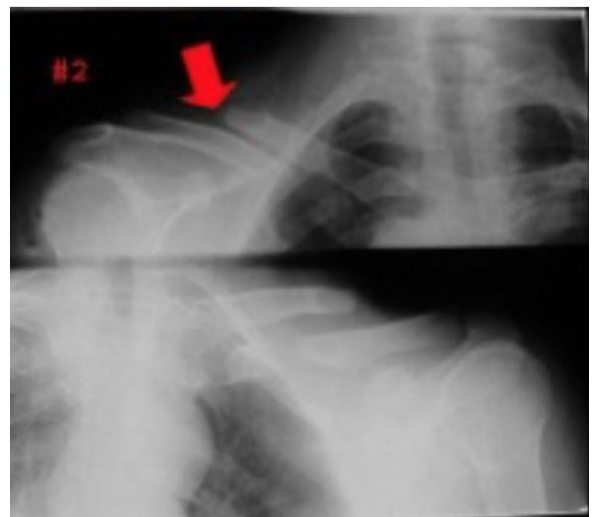
- There are 2 fractures on this film.
- **Closed distal radius fracture with complete displacement.** Also there is an ulnar styloid fracture which is also displaced
- The displacement is especially prominent on the lateral view highlighting the importance of multiple views.
- There may be intra-articular involvement as joint space is close by.
- **lateral view:** dorsal translation. **AP view:** Ulnar translation.

**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.**
- Landmarks to help identify the direction of dislocation: Fibula always posterior, patella anterior & condyles posterior.

**BAYONETTE APPOSITION**

“Overlap of fracture fragment”



NEUROVASCULAR 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.**
 - **Fracture line (transverse, oblique, spiral, comminuted).**
 - **Relationship of fracture fragments (angulation, displacement, dislocation, etc).**
 - **Neurovascular status.**

DESCRIBE:

ANSWER: THIS IS A R. MIDDLE PHALANX FRACTURE

- Oblique fracture of midshaft of R 4th middle phalanx with minimal displacement and no angulation.
- Remember to comment if open vs. closed & neurovascular status



ANSWER

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

Side note: Bayonette apposition is just a fancy word for overlapping. ;)



Done by:	Meshal Alohali Yazeed Alharbi
Revised by:	Rahma Alshehri
Team Leader:	Abdulrahman Albasseet Mariam bawazir

