

# Language of Fractures: Finding the Words to Describe Musculoskeletal Radiology



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# Disclosures

**I have no relevant relationships with ineligible companies to disclose within the past 24 months.**

**(Note: Ineligible companies are defined as those whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.)**

# Learning Objectives:

- Recognize common radiographic findings associated with orthopedic injuries of the extremities.
- Define common fracture terms used to describe the type and pattern of musculoskeletal injuries.
- Describe a fracture in terms of site, location, configuration, articular involvement and potential for physeal extension.
- Determine amount of fracture displacement including translation and angulation.
- Identify and describe worrisome features associated with pathologic fractures.

# Fracture Description

## Clinical Presentation is Key:

- Always evaluate the joint above, joint below, and contralateral side.
- Let exam findings and MOI guide your imaging.
- Closed vs Open



# Musculoskeletal Imaging

## Choice of Imaging:

- Clinical presentation: history, MOI, clinical presentation
- DDX
- Availability of imaging modalities

## Guidelines for Imaging:

### [ACR Appropriateness Criteria](#)

- Plain radiographs is the initial **imaging of choice** for most MSK conditions

# Principle Views

- Posterior/Anterior (PA) or Anterior/Posterior (AP)
- Lateral
- Obliques
- Supplemental views may be needed: specific to site



# ONE VIEW IS NO VIEW



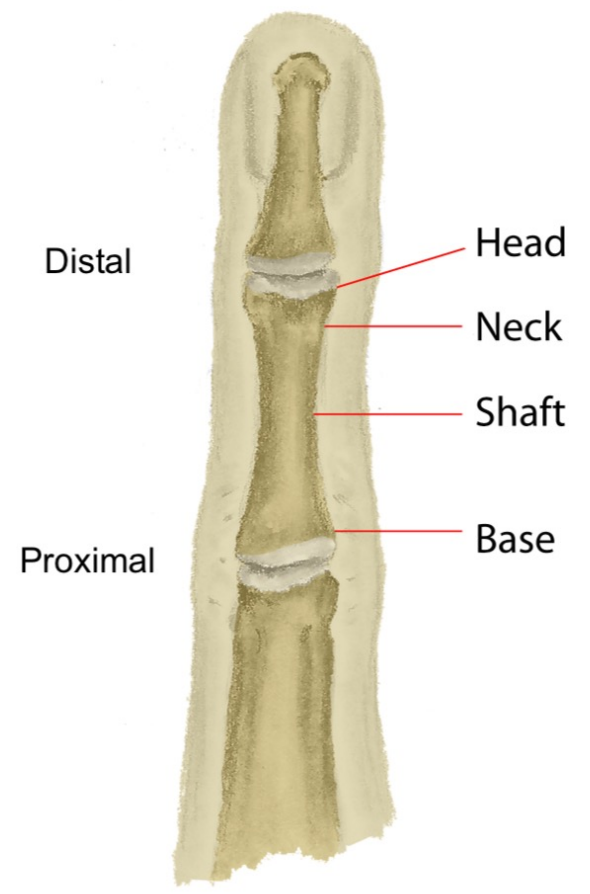
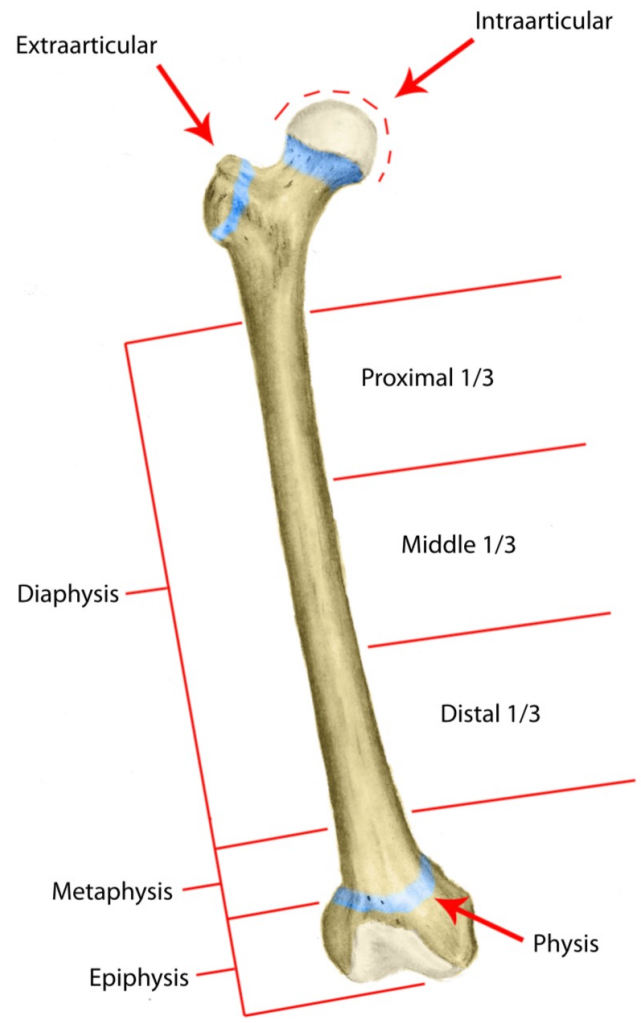
# Fracture Description

Location

Type and Pattern

Position

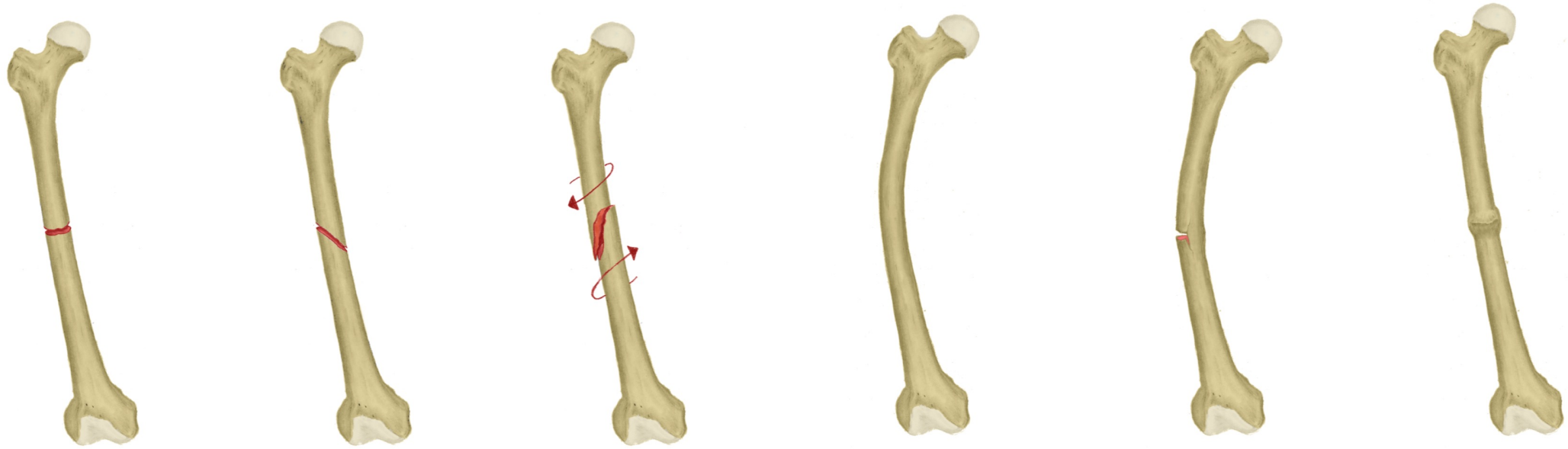
Possible complications



# LOCATION



WHICH BONE?  
WHERE IN THE BONE?  
EXTRA-ARTICULAR VS INTRA-ARTICULAR?



## Type Severity and Pattern

- **Complete:** transverse, oblique, spiral
- **Incomplete:** greenstick, torus, bowing
- **Unique pattern considerations:** compression, impaction, avulsion, stress



# Type Severity in Complete Fractures: Number of Fragments

## Simple

- **Two fragments**

## Comminuted

- **More than two fragments**



Case courtesy of eduardo bravo, Radiopaedia.org, rID: 55586

Case courtesy of Dr Maulik S Patel, Radiopaedia.org, rID: 48712



# FRACTURE PATTERNS

## COMPLETE:

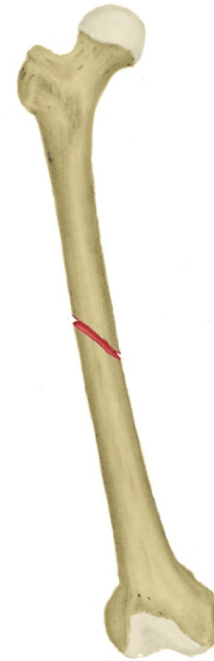
Transverse

Oblique

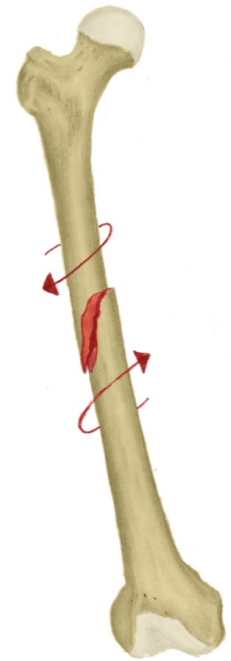
Spiral



Transverse



Oblique



Spiral

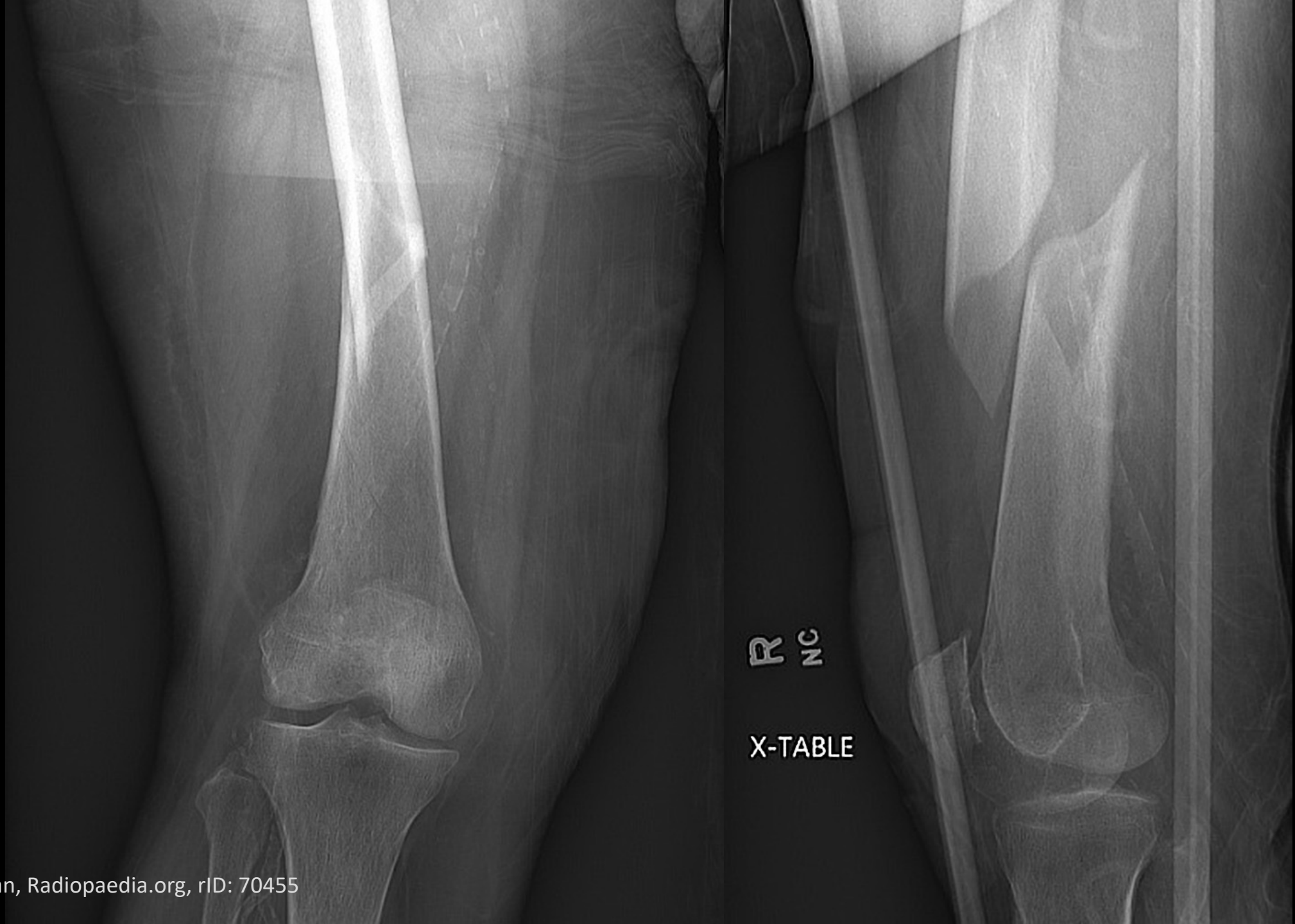
Transverse



Oblique



Spiral



R NC

X-TABLE

# Fracture Patterns

Incomplete:  
Bowling  
Greenstick  
Torus



Bowing



Greenstick



Torus

# Periosteum

## Thicker and more durable

- Less likelihood of displacement
- Unique fracture presentations
  - Buckle/torus
  - Greenstick
  - Plastic deformation/bowing

## Metabolically more active

- Promotes callus formation
- Remodeling ability



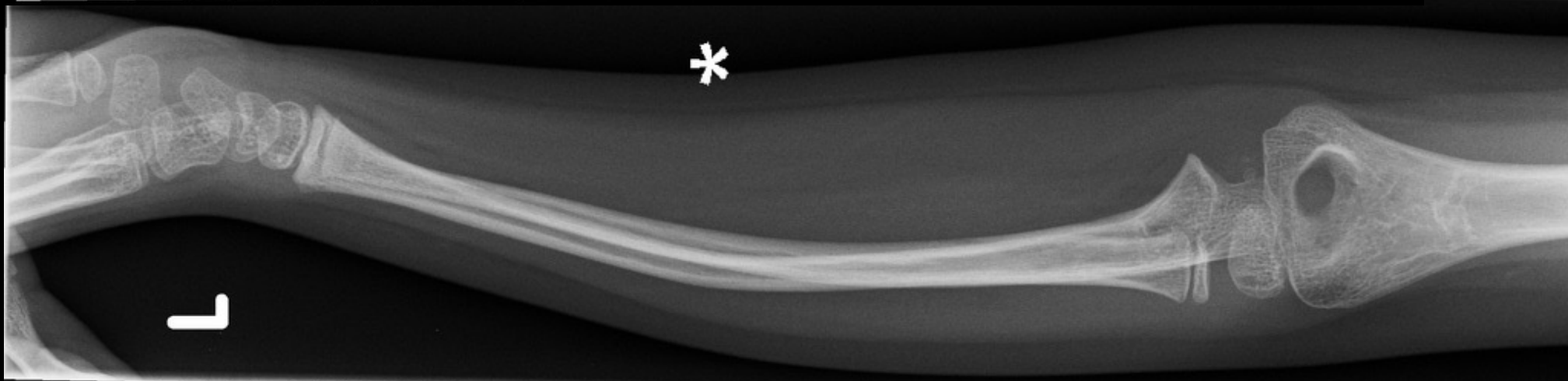
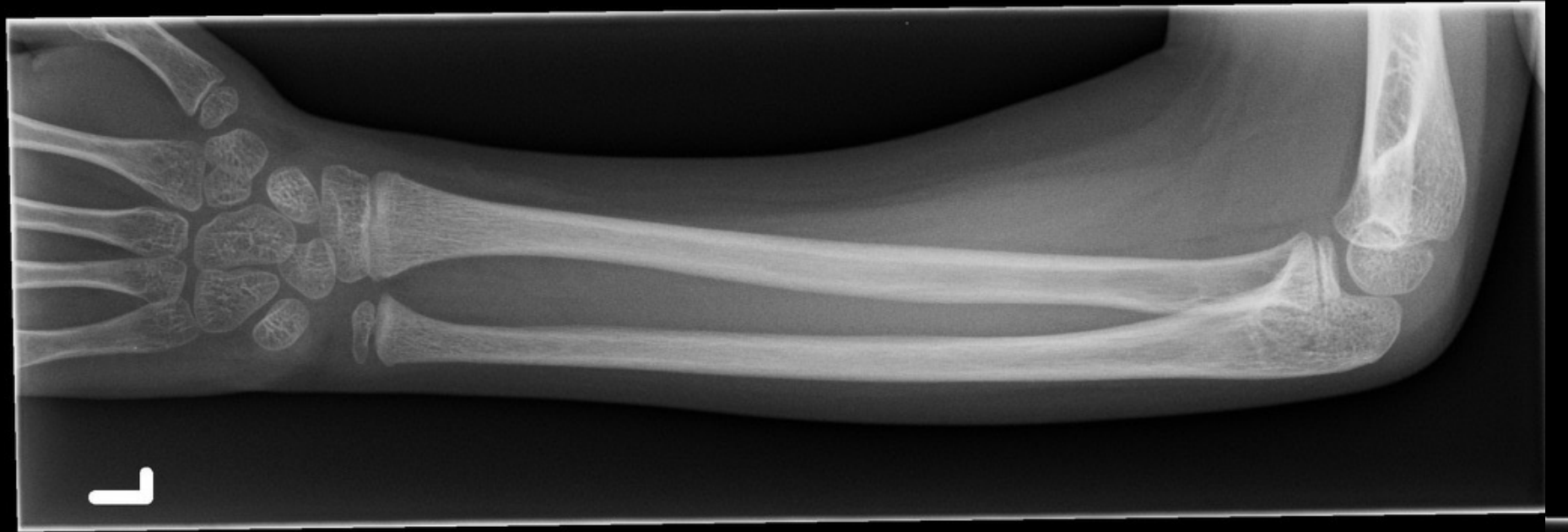
# Greenstick





Torus/Buckle

# Bowing



Unique  
Fracture  
Patterns

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Compression

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Impaction

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Stress

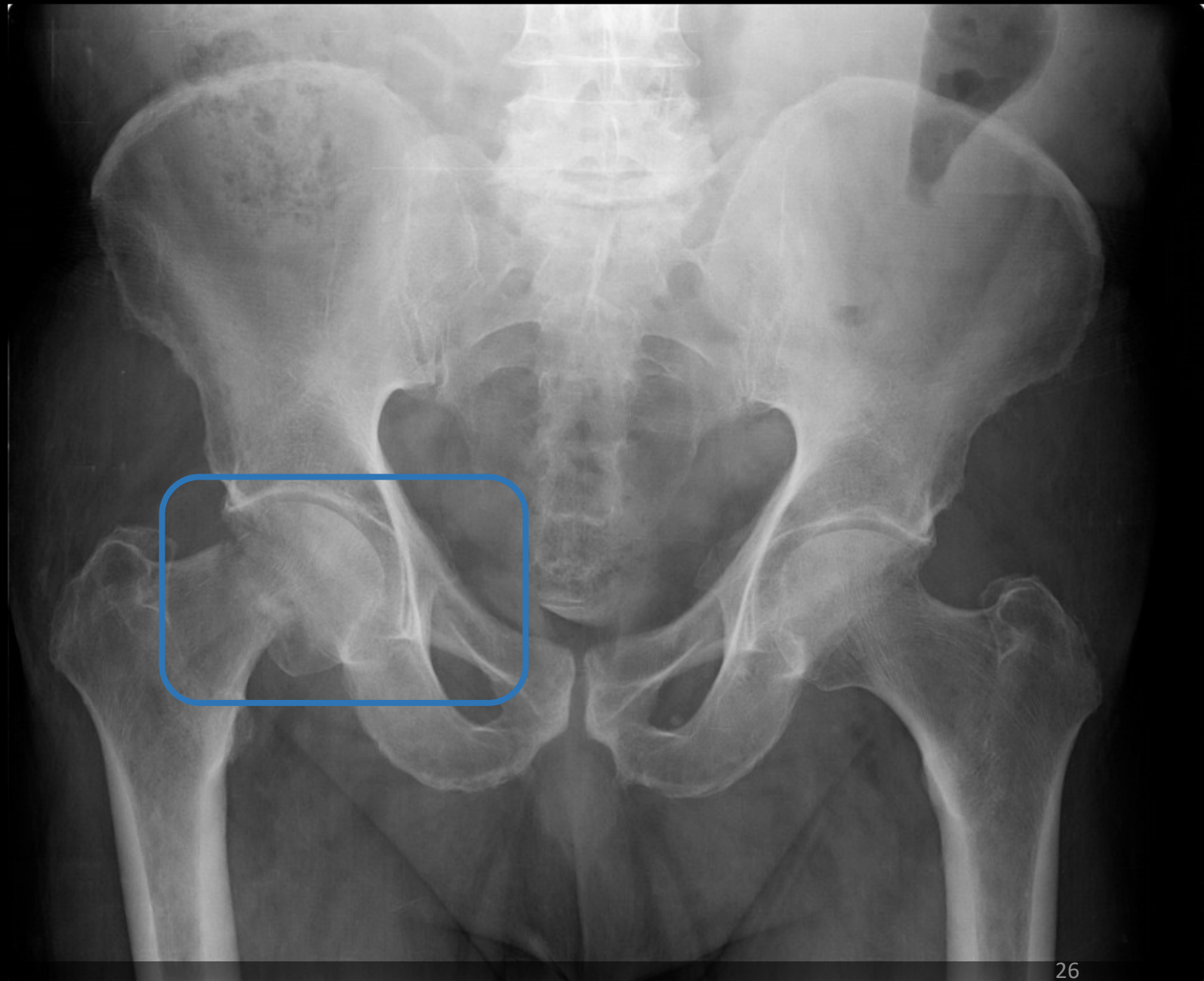
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Avulsion



# Compression

# Impaction



# Stress Fracture

L



L





# Avulsion



Case courtesy of Dr Omar Giyab, Radiopaedia.org, rID: 23593



# Apophyseal Injuries

Apophysis: bony prominences arising from separate ossification centres

- Fibrocartilage
- Fusion over time
- Site of tendon or ligament attachment
- Prone to overuse injuries



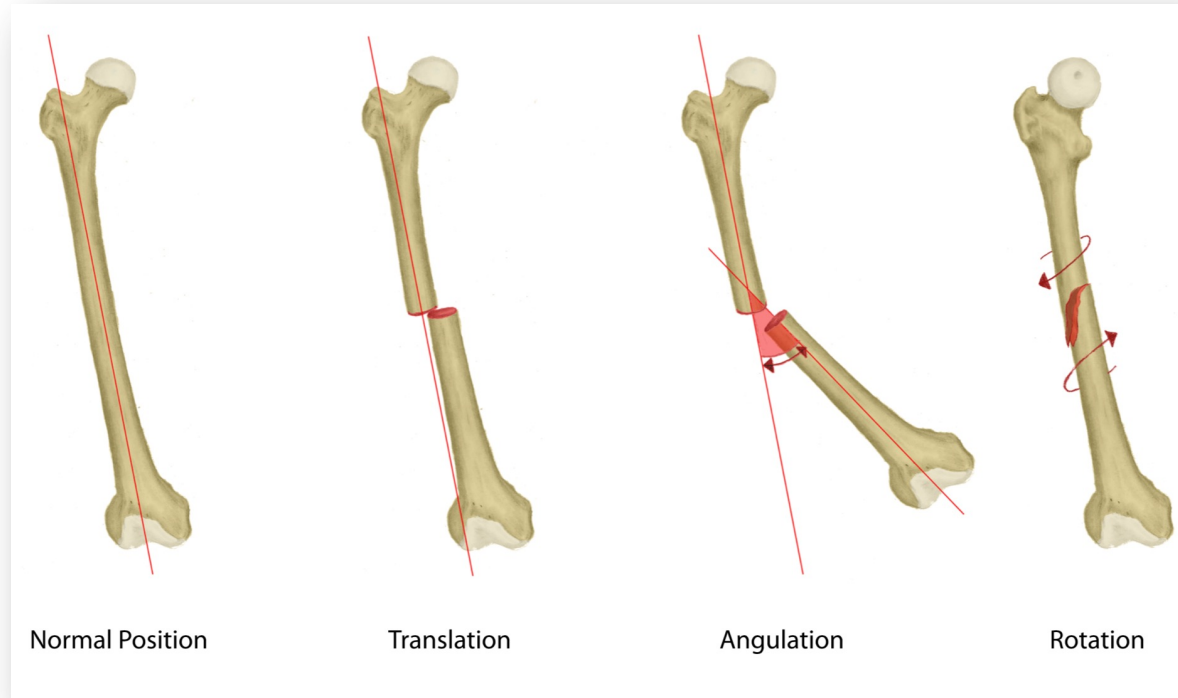
# Position

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Non-Displaced?

Displaced?

# Position



**Translation:** Described by % of Width or Measurement

**Angulation:** Measured in Degrees

**Rotation:** Best seen Clinically

**Length:** Shortening, Distraction, or Impaction

# Position

Description of position is based on distal fragment placement



Non-  
Displaced



# Translation (Displacement)



# ANGULATION





# Rotation





# Shortening



# Varus Vs Valgus Alignment



Description based on distal aspect

Varus:

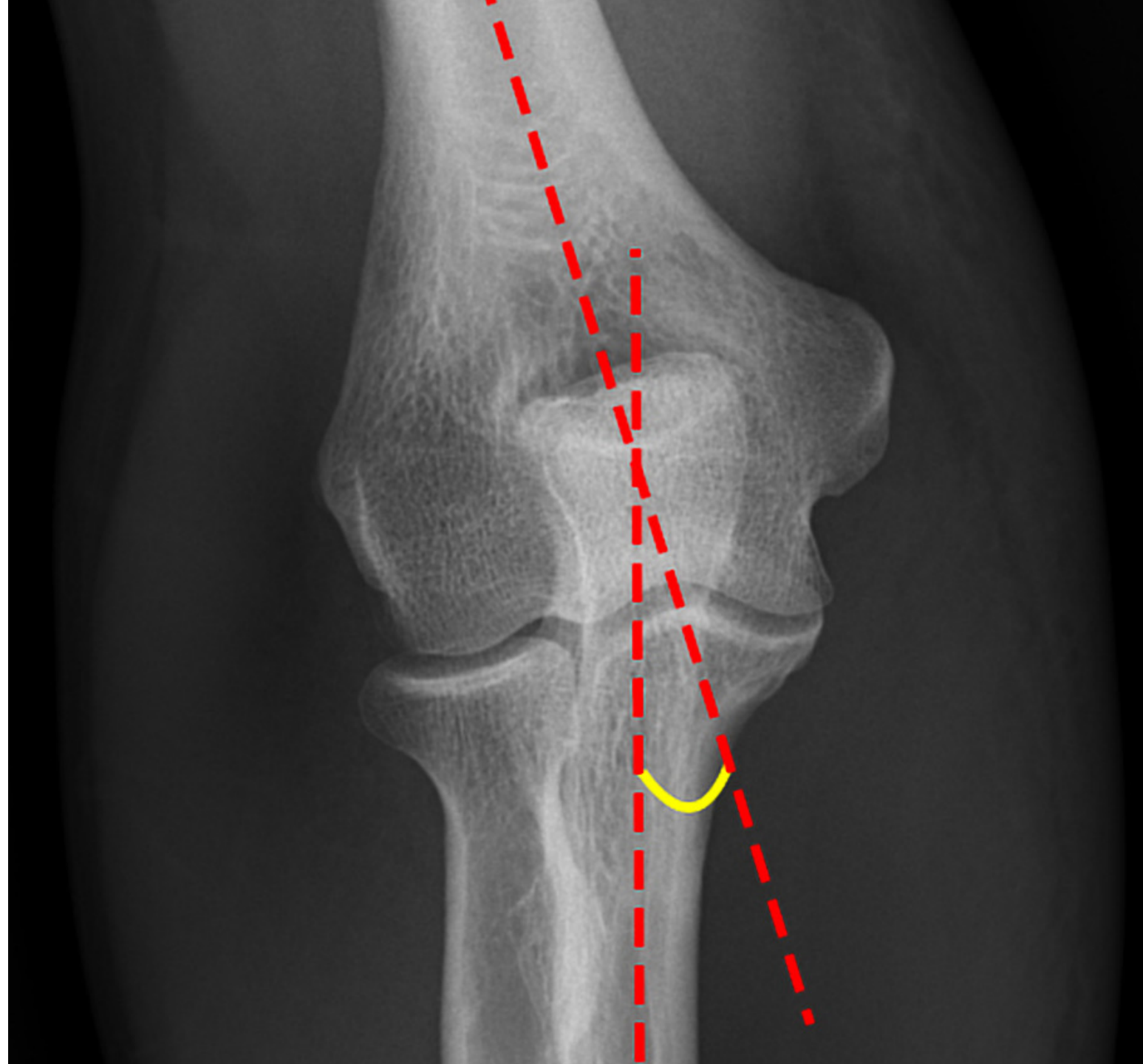
Medial (apex lateral)

Valgus:

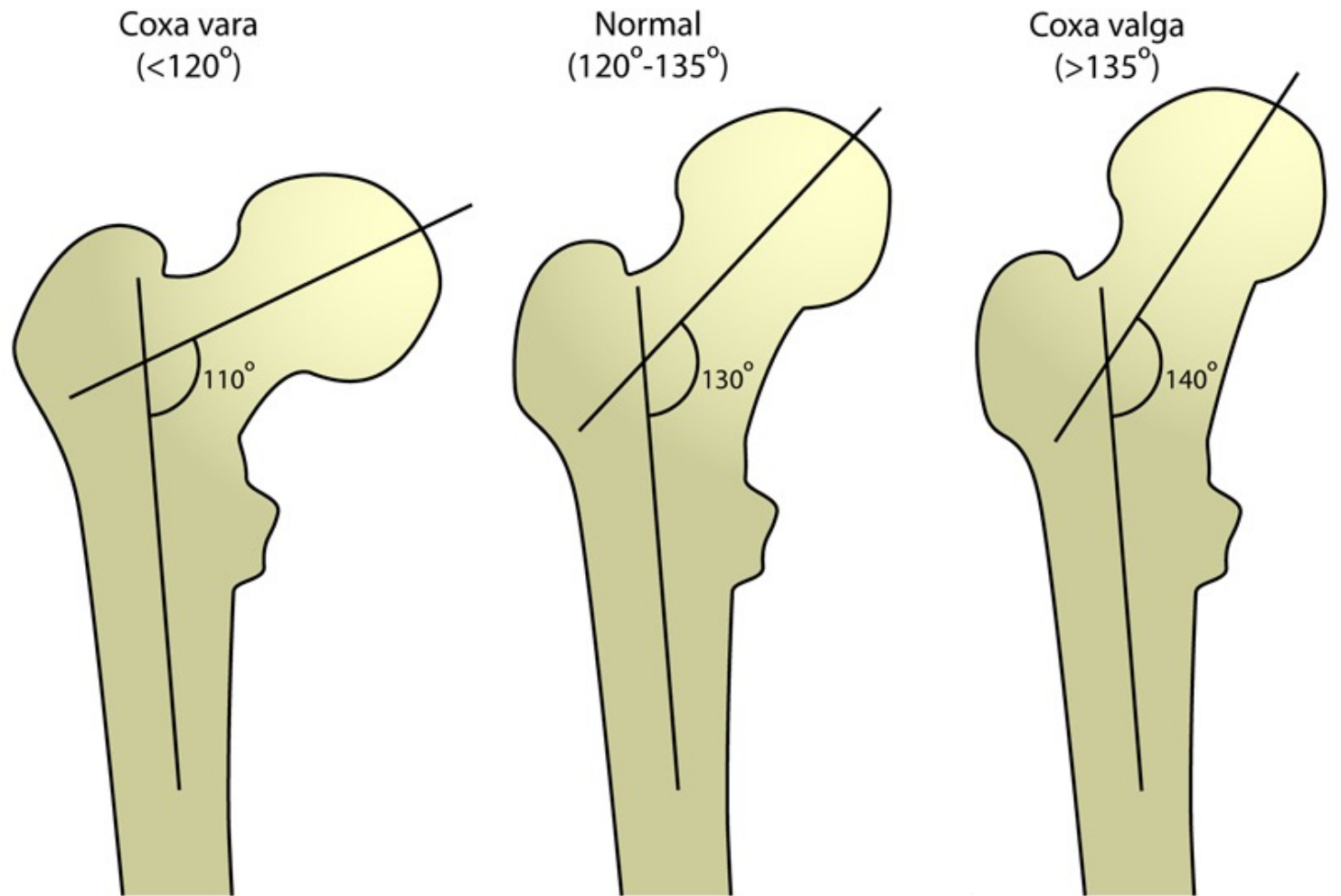
Lateral (apex medial)

# CARRYING ANGLE

- $< 5^\circ$  : Cubitus varus
- $> 15^\circ$ : Cubitus valgus



# Coxa Vara vs Coxa Valga



# Possible Complications

Open fractures

Physiologic involvement

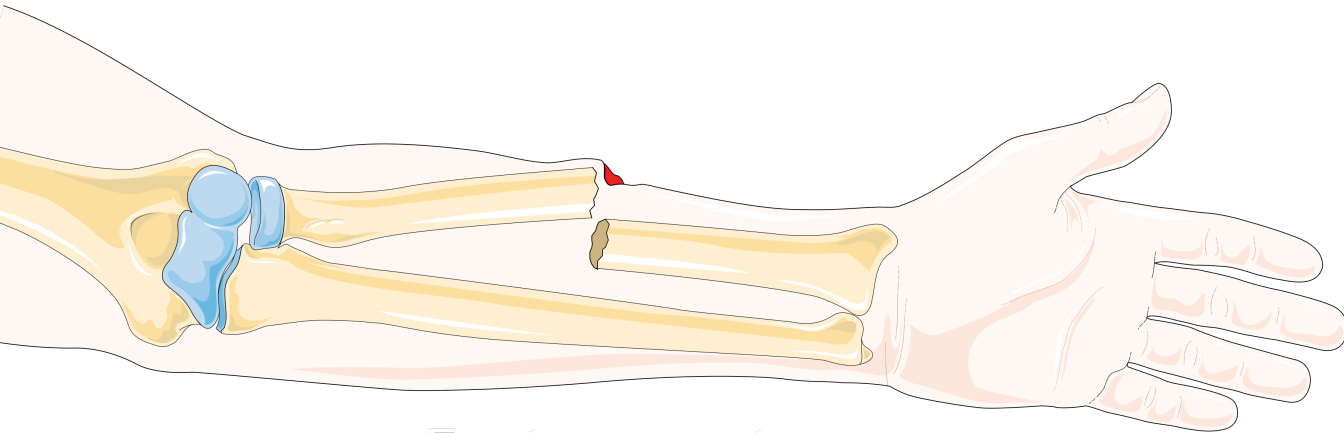
Pathologic

Associated fractures



# Closed VS OPEN (COMPOUND)

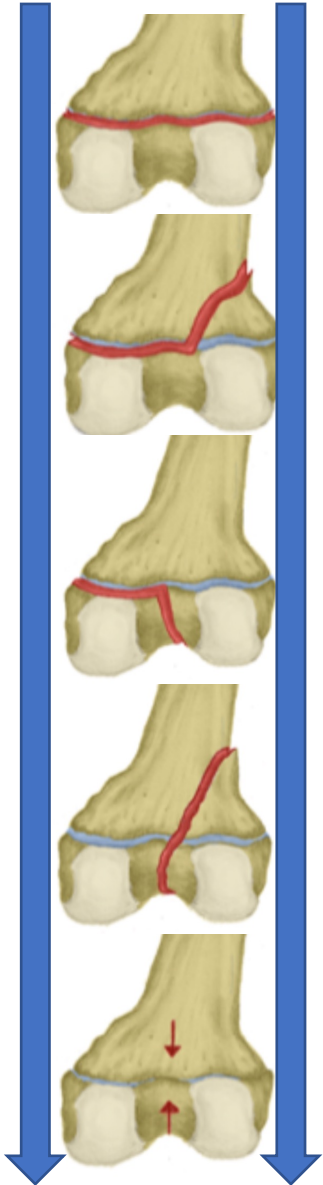
## If open: lead with this finding!



Fracture ouverte



# Salter-Harris Classification



I

**S**eparate (physis only)

II

**A**bove (metaphysis and physis)

III

**L**ower (physis and epiphysis)

IV

**T**hrough (metaphysis, physis, and epiphysis)

V

**R**educed (physis only: crushing injury)

Most common

# SH TYPE II





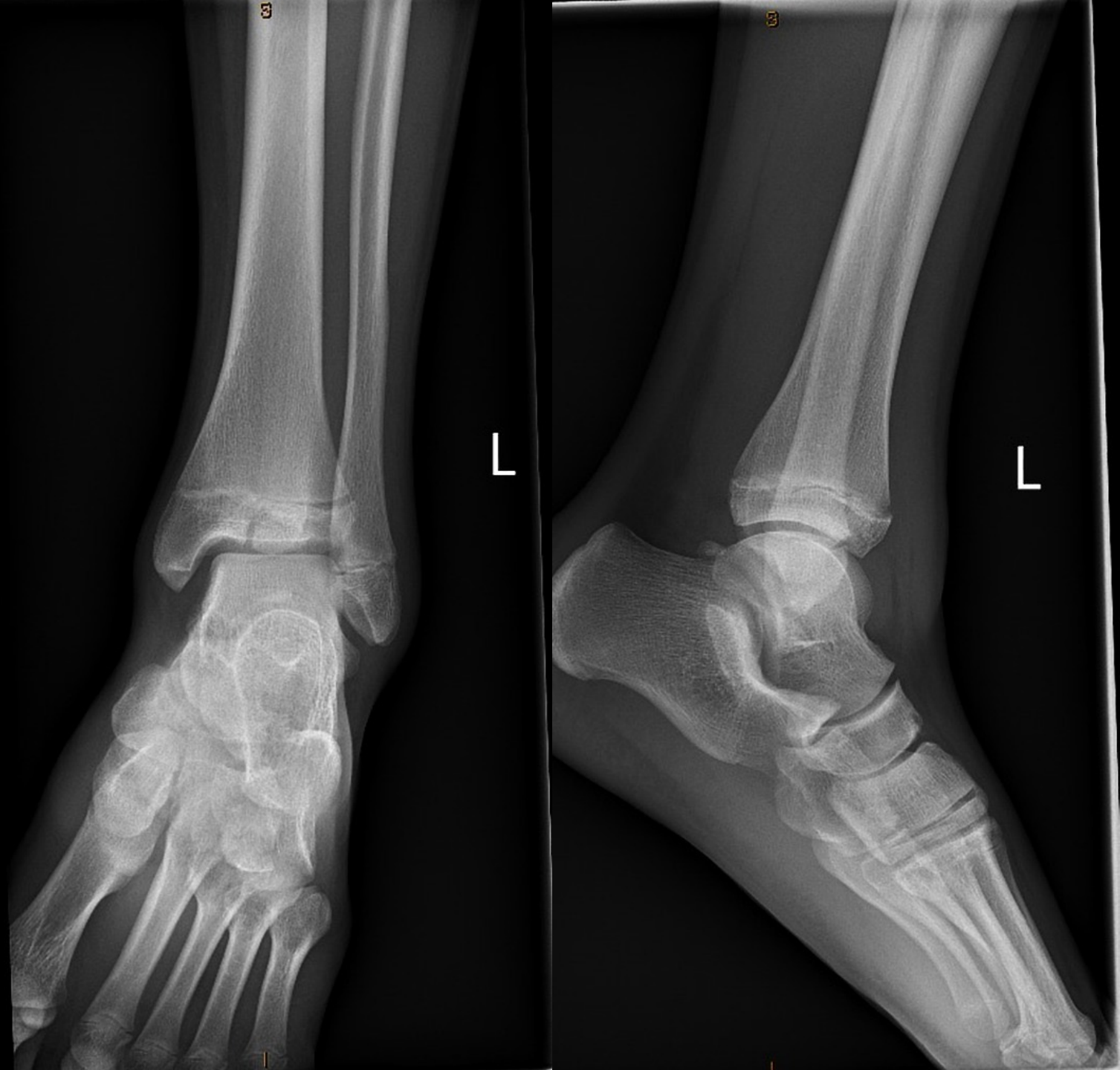
The image displays two X-ray views of a knee joint. The left view is an anterior-posterior (AP) view, showing the distal femur at the top, the patella in the middle, and the tibia at the bottom. The right view is a lateral view, showing the femur, patella, and tibia from the side. In both views, there is a clear, complete horizontal fracture line through the distal femur, just above the condyles, which is characteristic of a SH Type I injury. The rest of the knee joint, including the patella and tibia, appears normal.

# SH Type I



SH TYPE IV

# SH Type III



Case courtesy of Dr Colin-John Perrins,  
Radiopaedia.org, rID: 58038

# Pathologic Fractures

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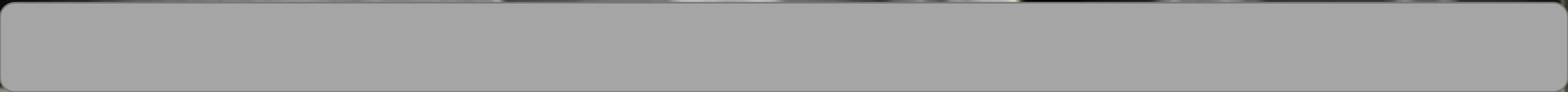
Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 7968





Images courtesy of Henk Jan van der Woude and Robin Smithuis via Radiology Assistant





# Bone Tumors and Lesions

## Concerning Features:

- Indistinct margins
- Abnormal periosteal reaction
- Soft tissue mass/invasion
- Rapid growth



Characteristics of Lesions	Benign or Nonaggressive/Early Malignant	Malignant or Aggressive Benign
Border	Well-defined, Sclerotic margin Narrow zone of transition	Ill-defined Wide zone of transition
Growth Rate	Slow	Rapid
Bone Destruction	Confined Geographic	Infiltrative, cortical destruction Moth-eaten, permeative
Periosteal Reaction	Unilaminar Solid	Multilaminar Interrupted
Soft Tissue Involvement	Absent	Present



# Don't Miss! Associated Injuries



Thank You

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# Resources

- PAOS: <https://paos.org/>
  - AAOS: <http://www.aaos.org/>
  - POSNA: <https://posna.org/>
  - AAFP: <http://www.aafp.org/>
  
  - Radiopaedia: <http://radiopaedia.org/>
  - OrthoBullets: <https://www.orthobullets.com>
  - Radiology Assistant:  
<https://radiologyassistant.nl/>
- Books:
  - Essentials of Musculoskeletal Imaging
    - Johnson TR, Steinback LS
  - Basics of Musculoskeletal Imaging
    - Tehranzadeh J
  - Handbook of Fractures
    - Egol KA, Koval KJ, Zuckerman JD

## Resources for Images and Figures\*

- Radiopaedia. <http://radiopaedia.org/>. Accessed September 6<sup>th</sup>, 2021.
- Sandra Ehrler, MWU PA student, provided original artwork for May 2019 JAAPA article. Illustrations were reproduced for this presentation with permission from JAAPA and illustrator.
- AO Foundation. <https://www2.aofoundation.org>. Accessed August 8<sup>th</sup>, 2021.
- Smithuis R. Radiological Society of the Netherlands. Radiology Assistant Educational site. <http://www.radiologyassistant.nl>. Accessed August 8<sup>th</sup>, 2021.

\*Hyperlink or case number available for specific references

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- Marshall RA, Mandell JC, Weaver MJ, Ferrone M, Sodickson A, Khurana B. Imaging Features and Management of Stress, Atypical, and Pathologic Fractures. *Radiographics*. 2018;38(7):2173-2192. doi:10.1148/rg.2018180073