



I SPY:

BASICS OF SKELETAL RADIOLOGY AND FRACTURE IDENTIFICATION

Sarah Bolander, DMSc, MMS, PA-C, DFAAPA

OBJECTIVES

1. Recognize common radiographic findings associated with orthopedic injuries of the extremities.
 2. Define terms used to describe the type and pattern of a fractures including transverse, oblique, spiral, greenstick, bowing, torus, etc.
 3. Describe a fracture in terms of site, location, configuration, articular involvement and potential for physeal extension .
 4. Determine amount of fracture displacement including translation and angulation.
 5. Identify and describe worrisome features of bone tumors or lesions to help differentiate potential causes.
-

MUSCULOSKELETAL IMAGING

Choice of Imaging:

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

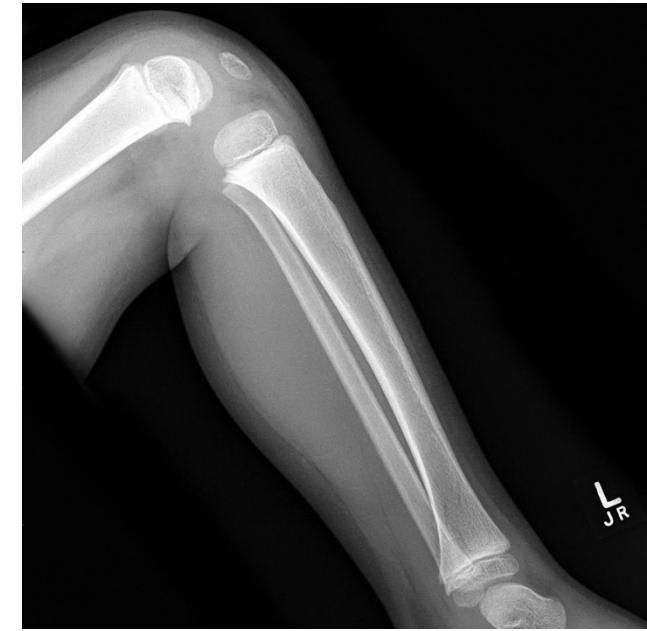
Guidelines for Imaging:

ACR Appropriateness Criteria

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

PATIENT INFORMATION

- Who
 - Correct patient
- What
 - Correct location
 - Correct views
- Orientation
- Quality of film



PRINCIPLE VIEWS

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

SUPPLEMENTAL VIEW



FRACTURE DESCRIPTION

Clinical Presentation is Key:

- Always evaluate the joint above, joint below, and contralateral side.
 - Let exam findings and MOI guide your imaging.
 - If open fracture, start with this description!
-

Fracture Description

Location

Type

Pattern

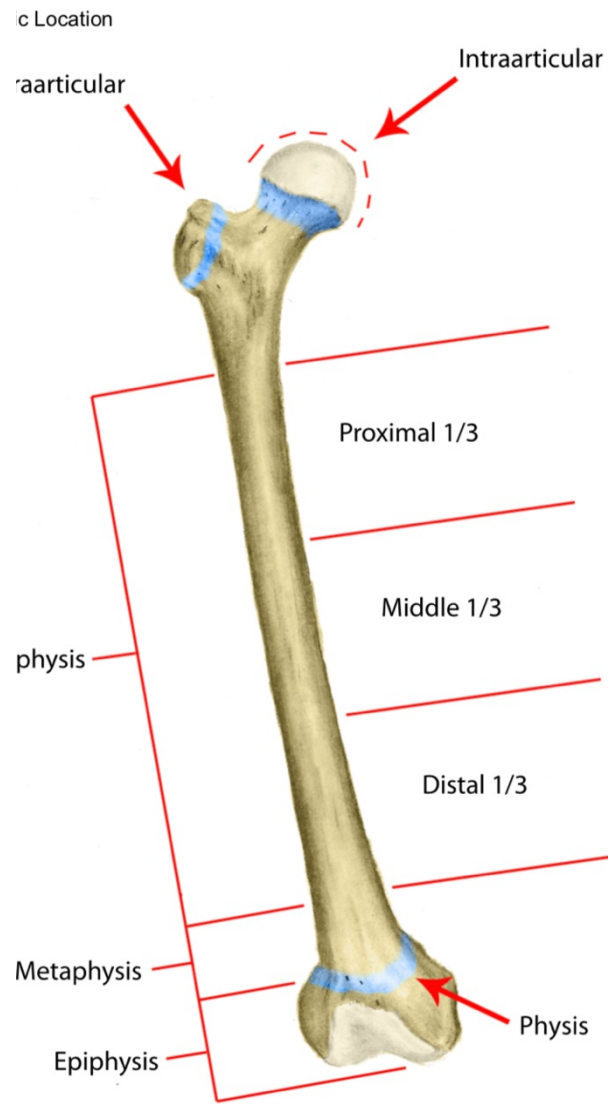
Position

Possible complications: open fractures, physeal involvement, pathologic

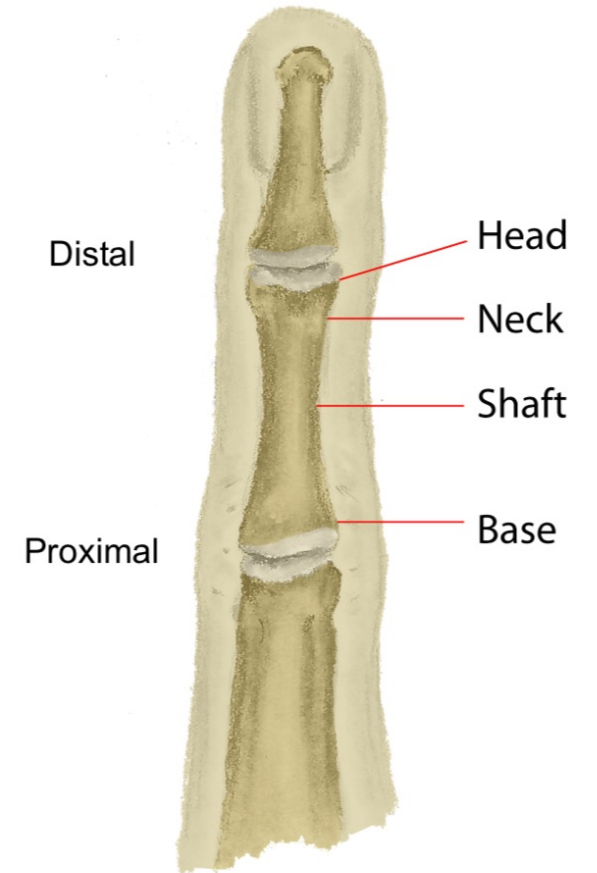
Anything else: additional injuries, artifacts, occult fractures

LOCATION

Which bone? Where in the bone? Joint involvement?



2. Anatomic Location



Illustrations by Sandra Ehrler. Reproduced with Permission.

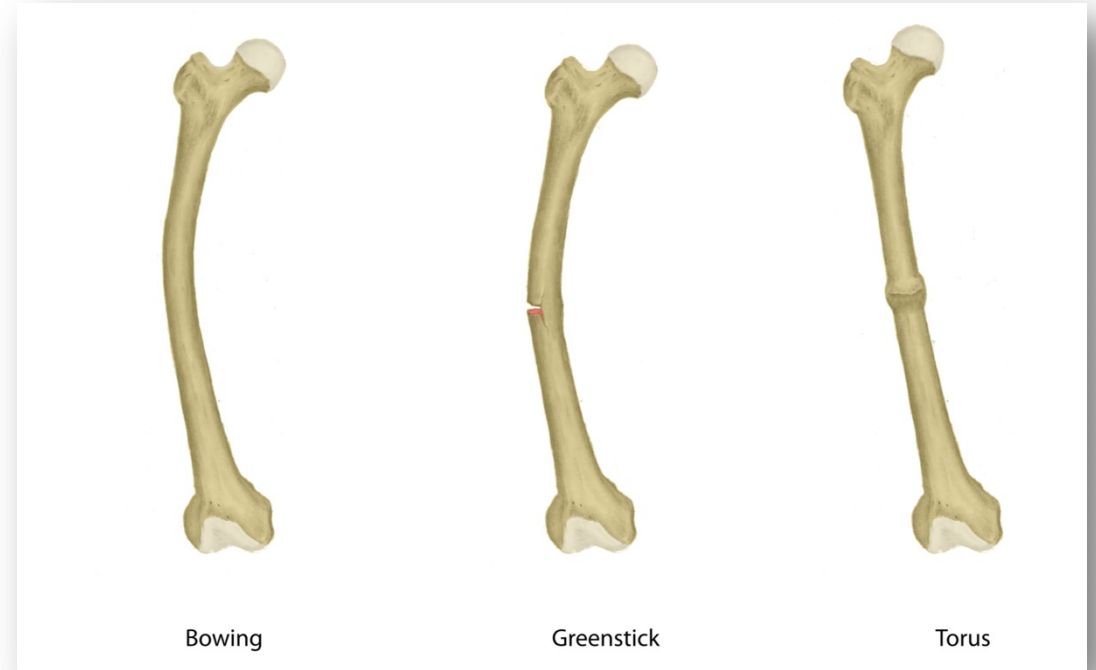
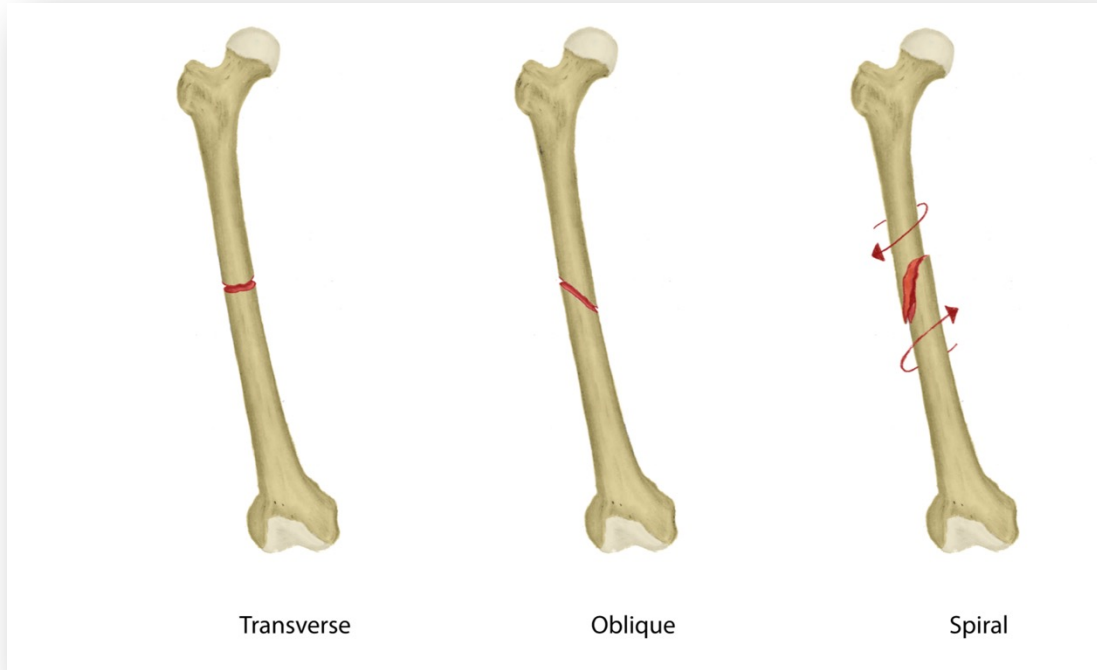


ARTICULAR EXTENSION

Case courtesy of Dr Aditya Shetty,
Radiopaedia.org, rID: 28755



TYPE SEVERITY AND PATTERN



Complete: transverse, oblique, spiral

Incomplete: greenstick, torus, bowing

Unique pattern considerations: compression, impaction, avulsion, stress

FRACTURE PATTERNS

INCOMPLETE:

bowing
greenstick
torus



Bowing



Greenstick



Torus

PERIOSTEUM

Metabolically
more active

- Promotes callus formation
- Remodeling ability

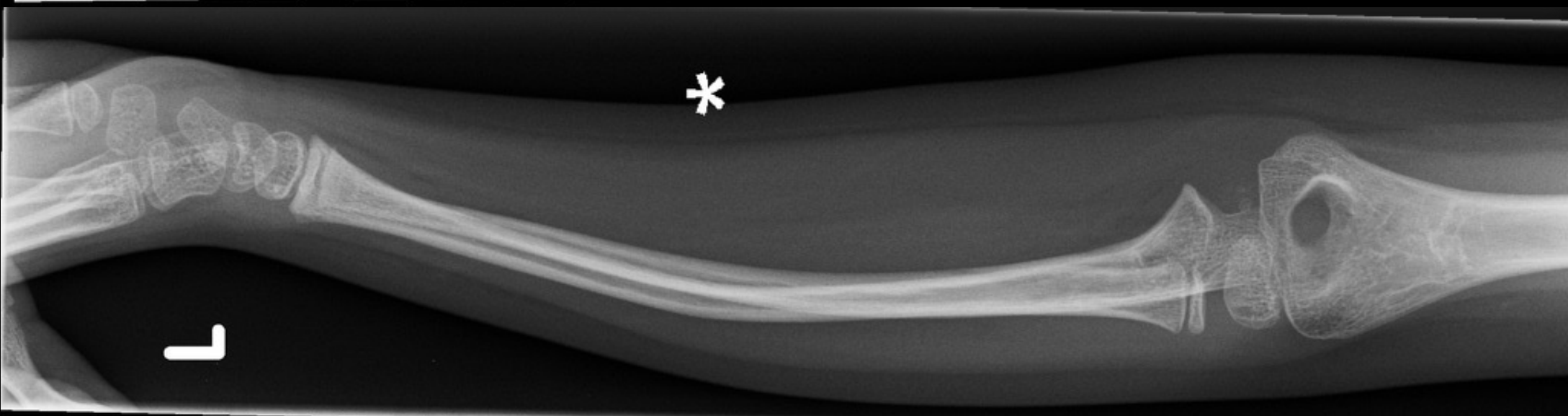
Thicker and
more durable

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





Case courtesy of Dr Hani Salam, Radiopaedia.org, rID: 13297



FRACTURE PATTERNS

COMPLETE:

transverse

oblique

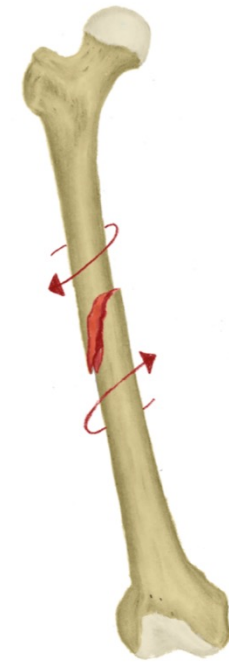
spiral



Transverse



Oblique



Spiral







TYPE SEVERITY IN COMPLETE FRACTURES: NUMBER OF FRAGMENTS

Simple

- **Two fragments**

Comminuted

- **More than two fragments**



Case courtesy of Dr Bruno Di Muzio, Radiopaedia.org, rID: 44044

UNIQUE PATTERN CONSIDERATIONS:

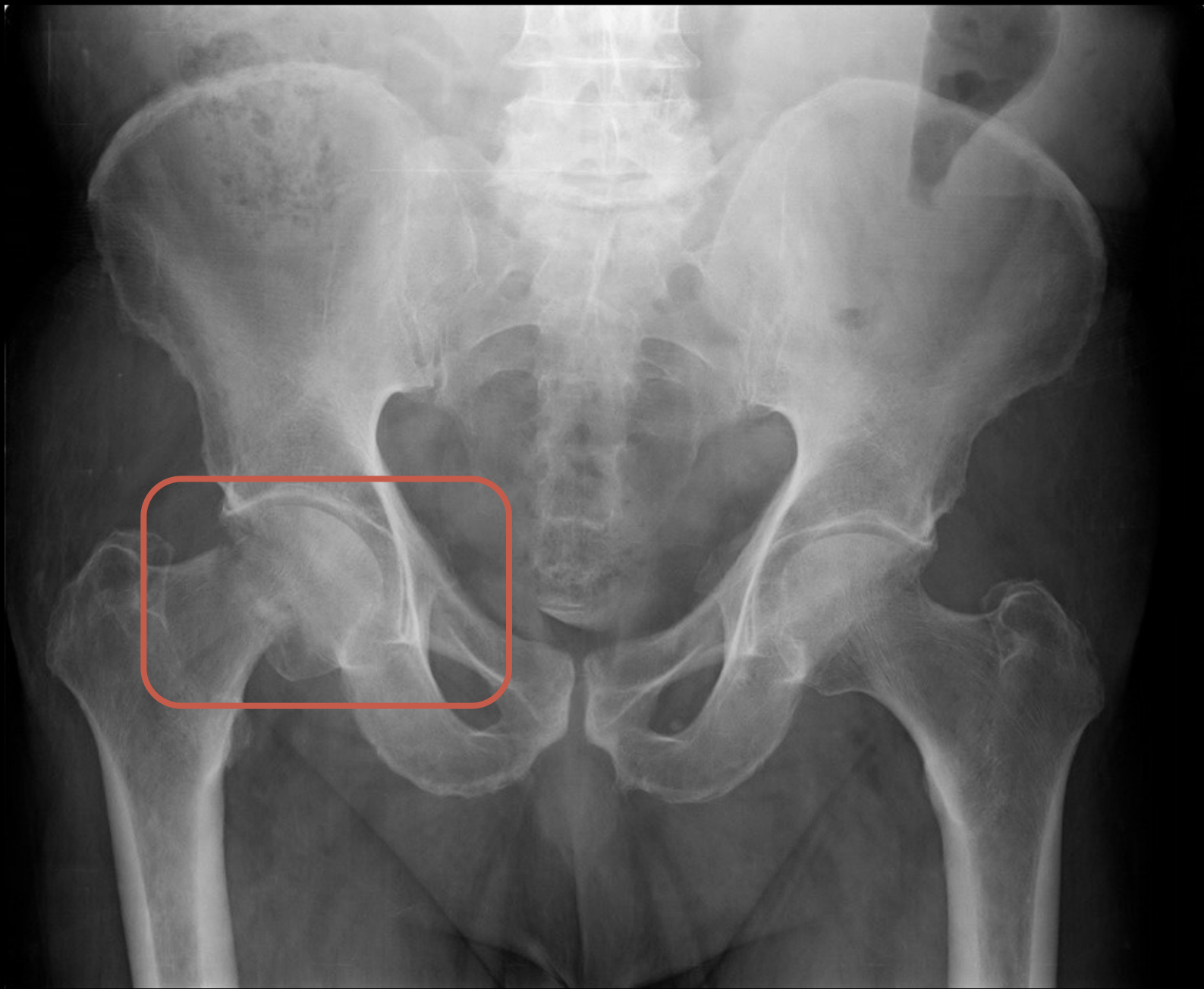
compression

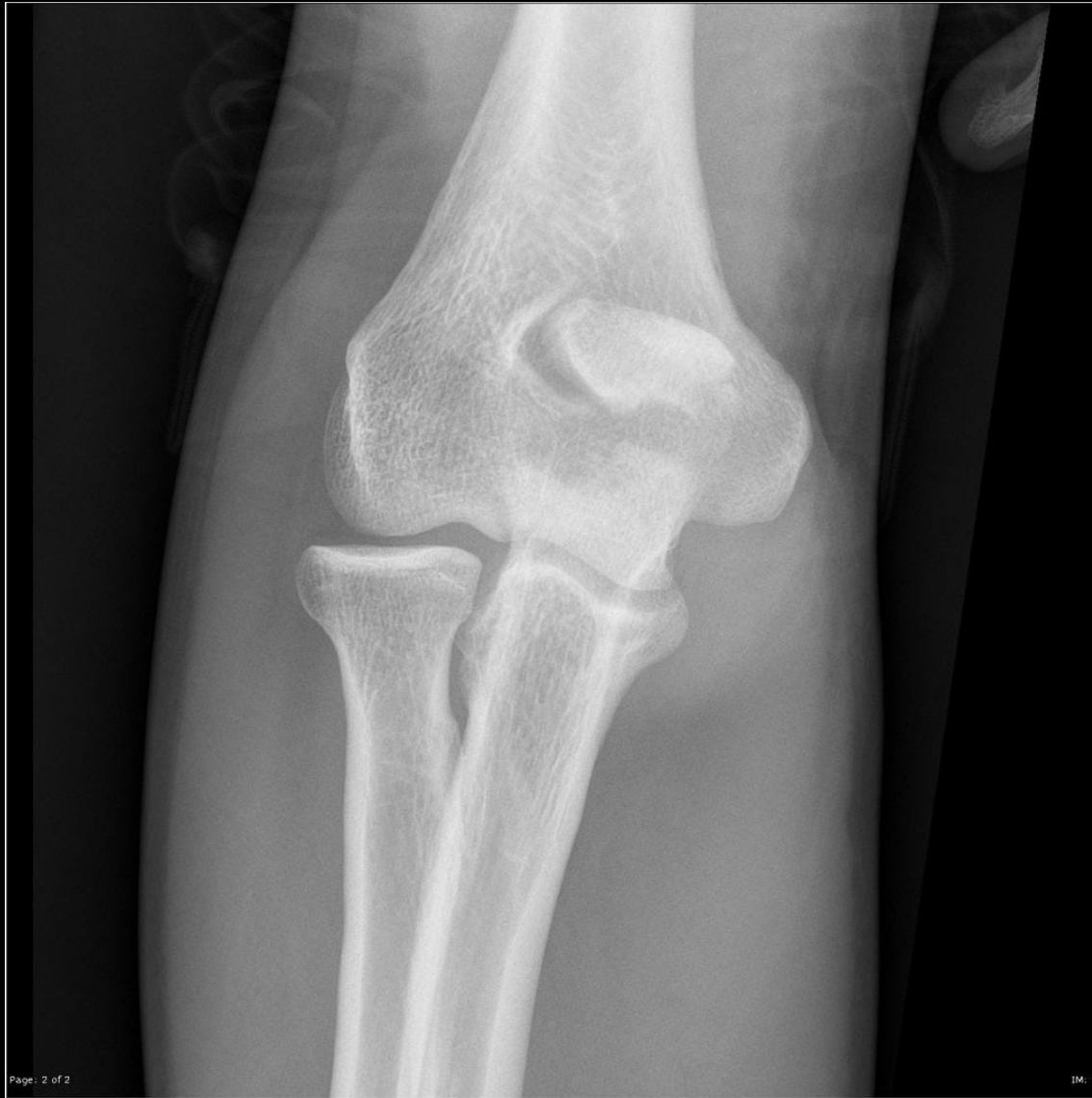
impaction

avulsion

fissure

stress





Case courtesy of A.Prof Frank Gaillard, Radiopaedia.org, rID: 18065



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

APOPHYSEAL INJURIES

Bony prominences arising from separate ossification centres

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

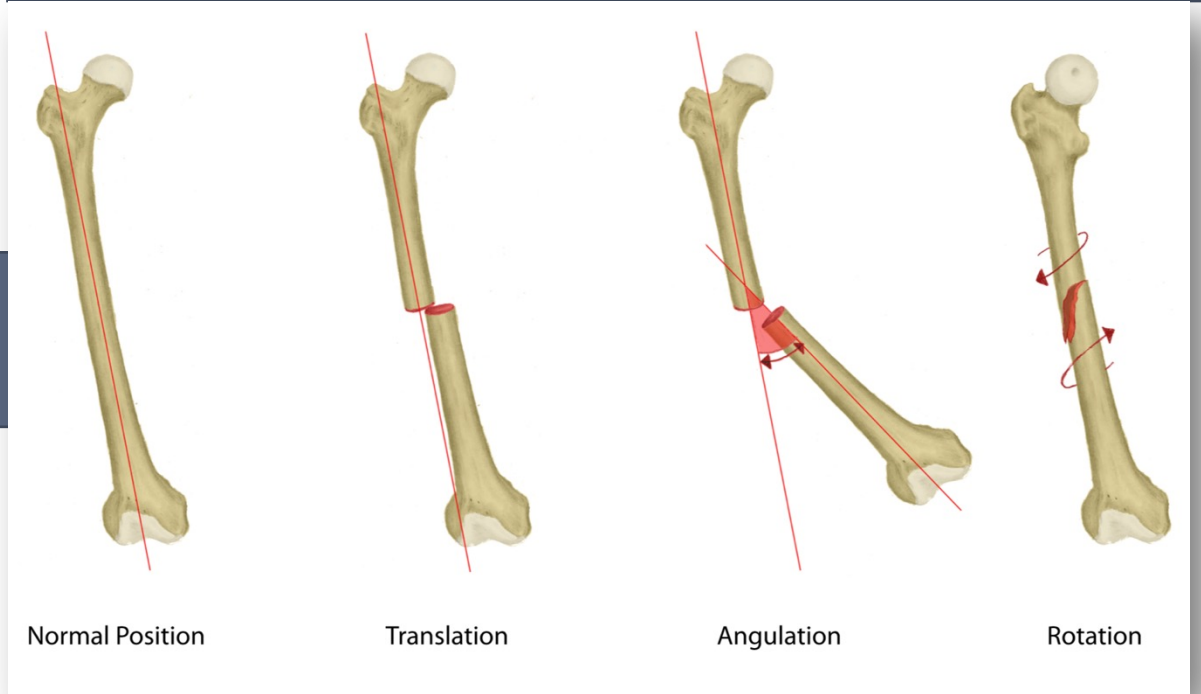


POSITION

*Description of position is based on distal fragment placement.

Non-Displaced vs Displaced?

Translation, Angulation, or Rotation?



Translation (Apposition): Described by % of Width or Measurement

Angulation: Measured in Degrees

Length: Shortening, Distraction, or Impaction









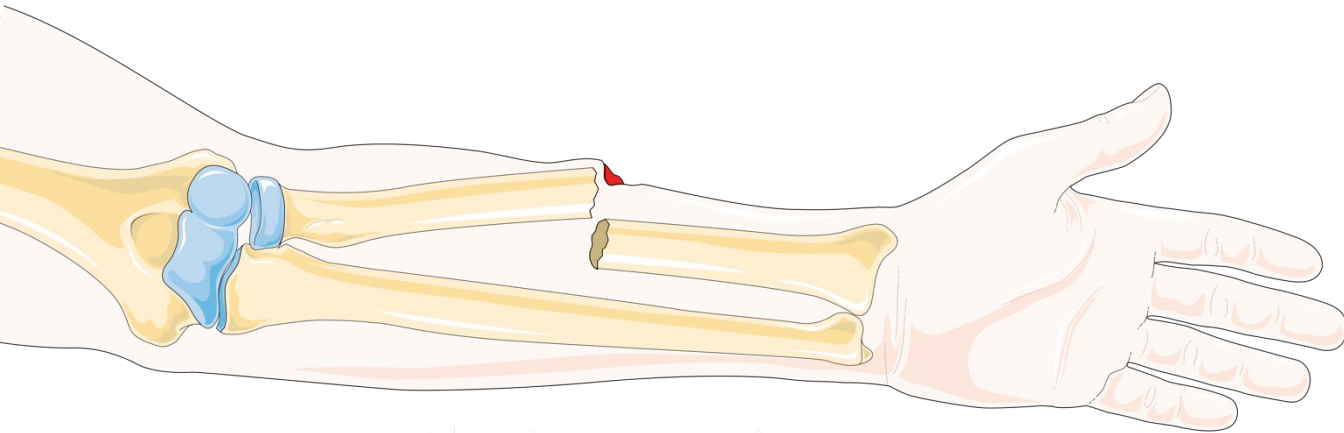
Case courtesy of Dr Jan Frank Gerstenmaier, Radiopaedia.org, rID: 25199

POSSIBLE COMPLICATIONS

Open Fracture,
Physcal Involvement,
Pathologic

CLOSED VS OPEN (COMPOUND)

If open: lead with this finding!



Fracture ouverte



SALTER-HARRIS CLASSIFICATION

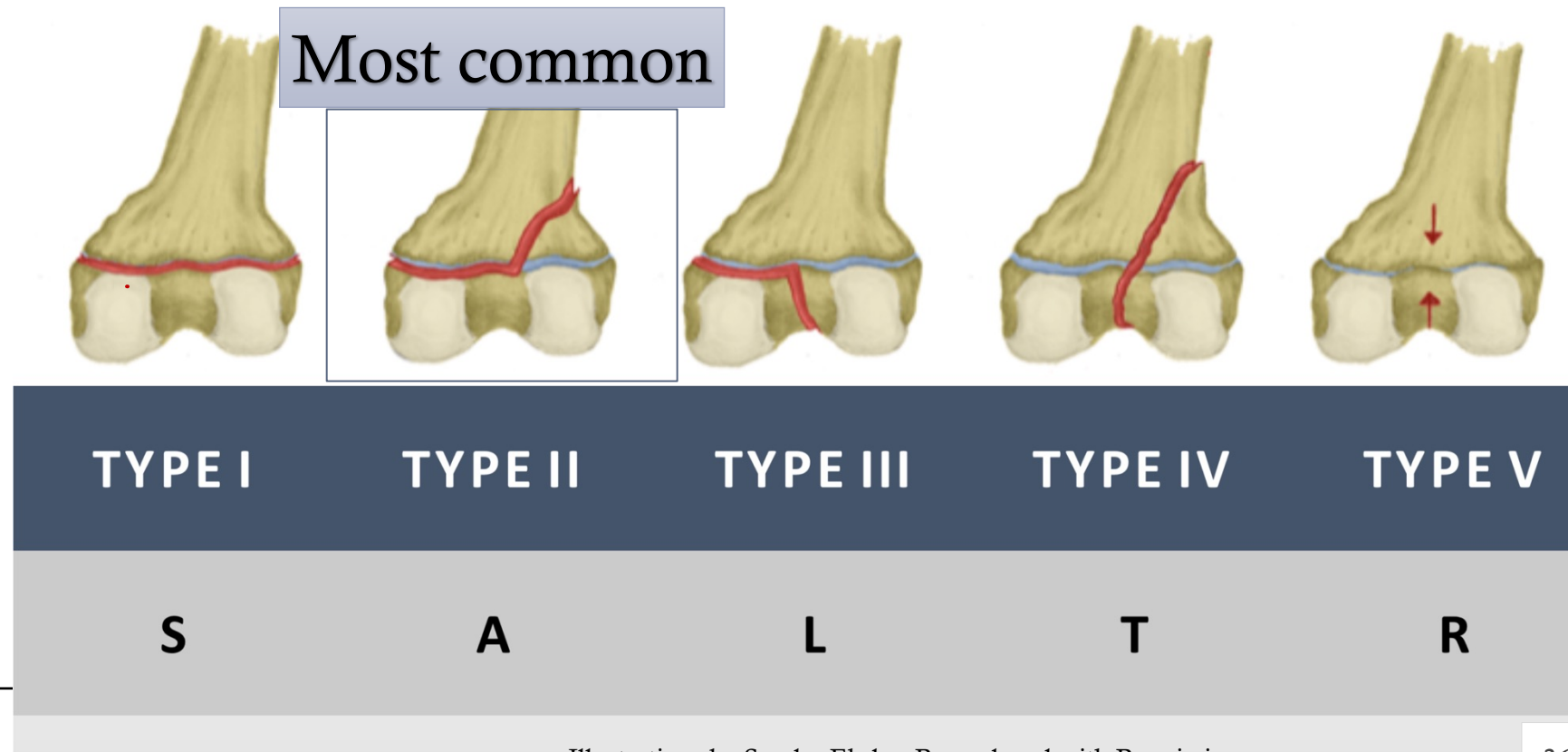
I
Separate

II
Above

III
Lower

IV
Through

V
Reduced



SH TYPE II

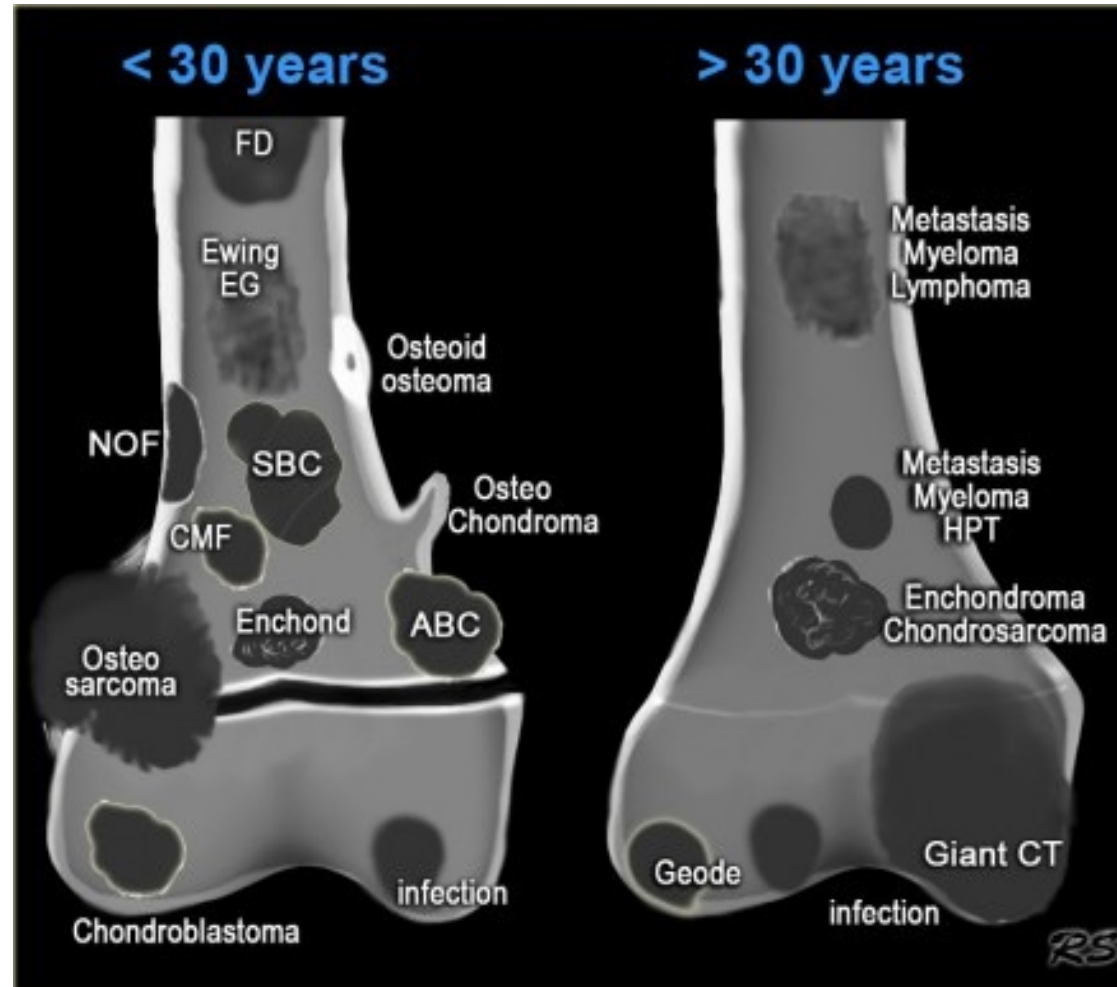


SH TYPE I



SH TYPE IV

BONE TUMORS AND LESIONS CAUSING PATHOLOGIC FRACTURES





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

BONE TUMORS AND LESIONS

Concerning Features:

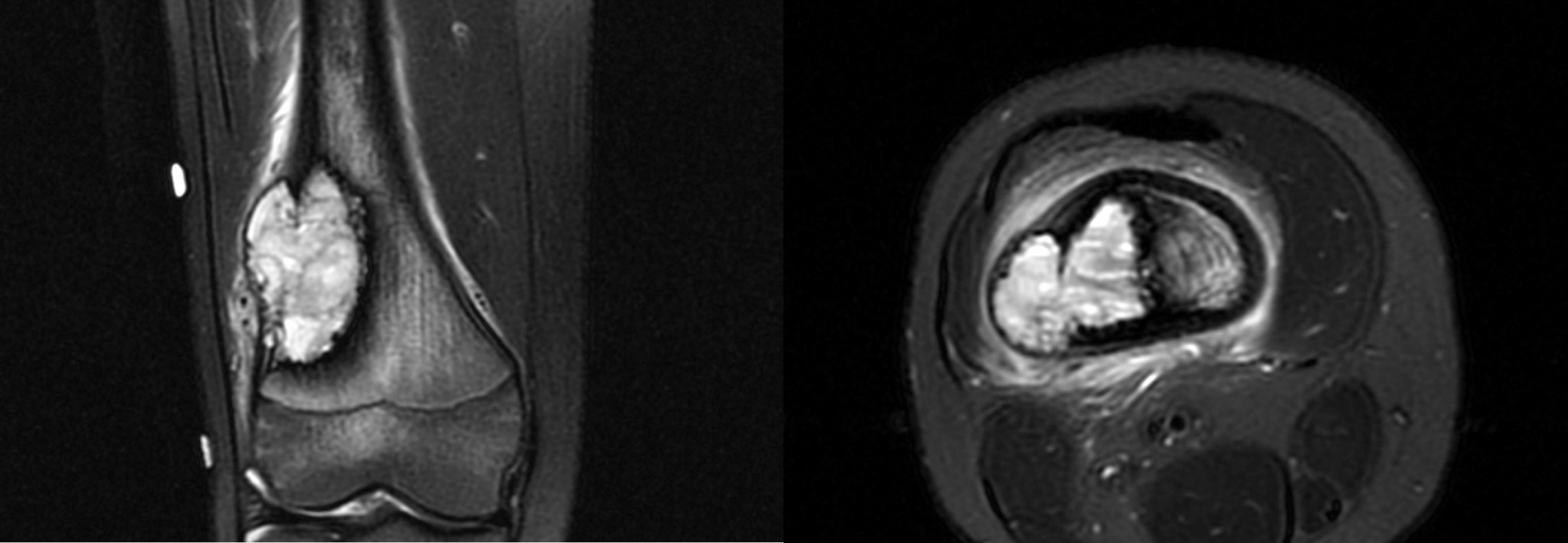
- Indistinct margins
- Abnormal periosteal reaction
- Soft tissue mass/invasion
- Rapid growth





INDISTINCT MARGINS

Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 7527



OSTEOSARCOMA

Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 7527

BORDER

Well-Defined, Narrow Zone of Transition



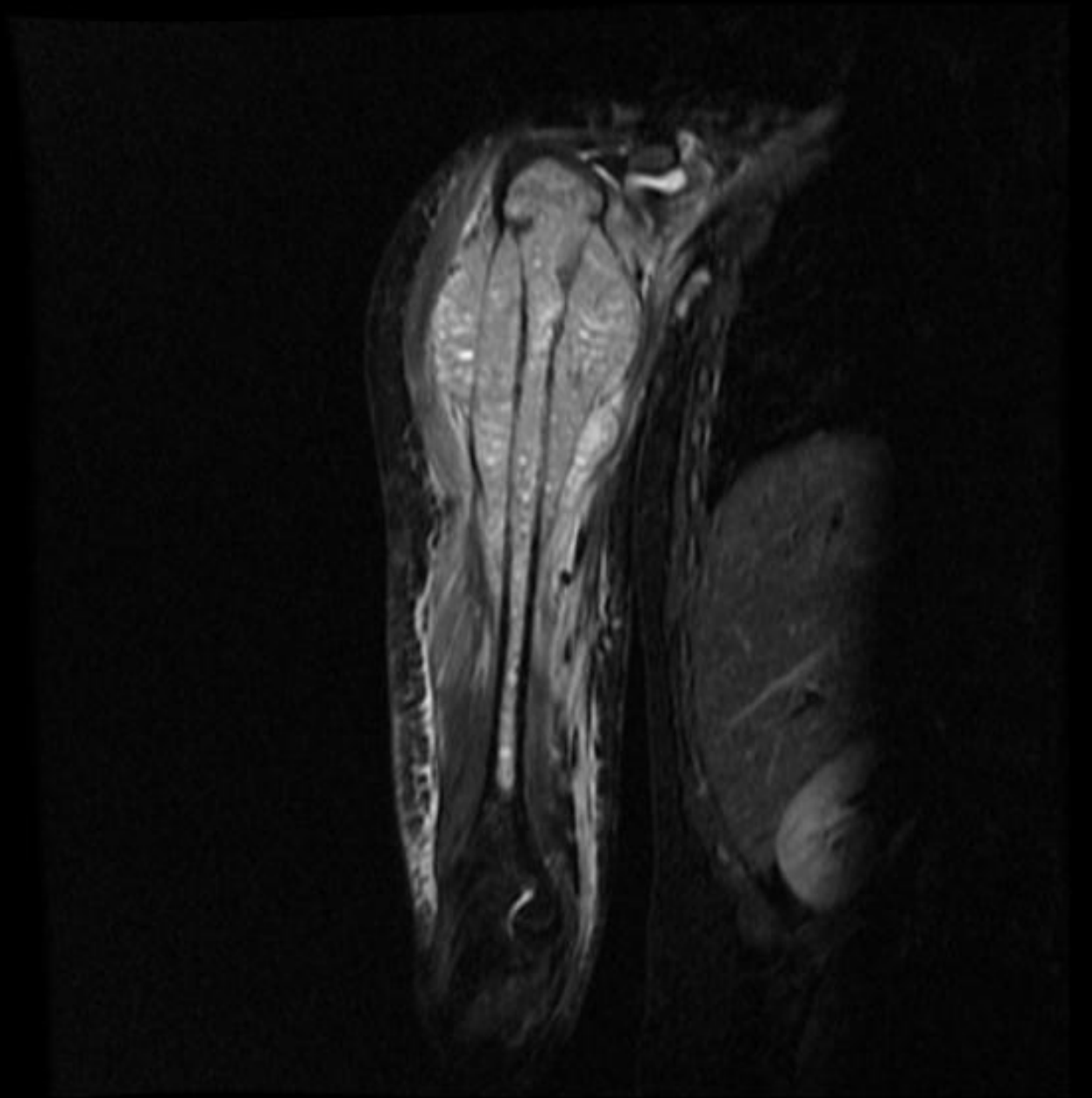
Ill-Defined, Wide Zone of Transition



Case courtesy of A.Prof Frank Gaillard, Radiopaedia.org, rID: 7473

Case courtesy of Dr Hani Salam, Radiopaedia.org, rID: 7874

SOFT TISSUE INVOLVEMENT



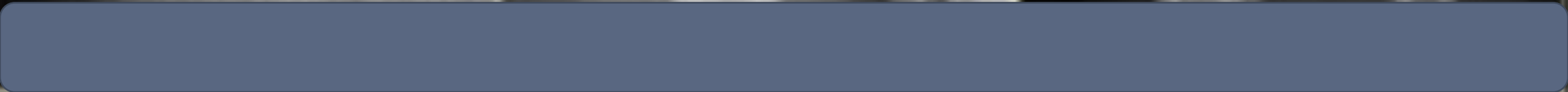
PERIOSTEAL REACTION

R



R





**ANYTHING
ELSE**

Additional Injuries

Artifact

Occult Fracture

ADDITIONAL INJURIES

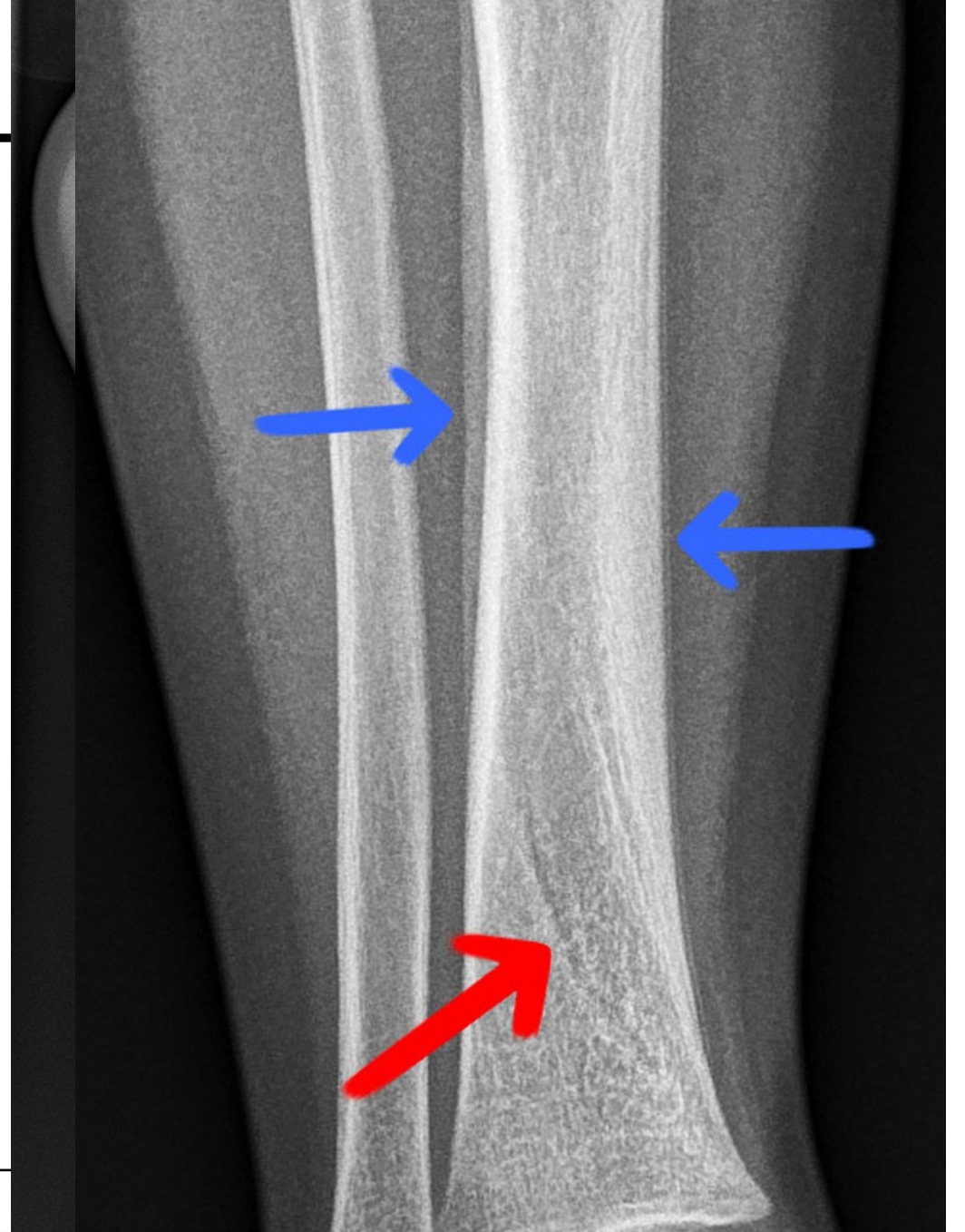


ARTIFACT



OCCULT FRACTURE





Case courtesy of Dr Sebastian Tschauner, Radiopaedia.org, rID: 49123

PRACTICE!

Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

IMAGE #1

Case courtesy of Dr Jeremy Jones, Radiopaedia.org, rID: 6387

Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:



IMAGE #2

Case courtesy of Dr Ahmed Abdrabou, Radiopaedia.org, rID: 2889725704



Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

IMAGE #3

Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 46658



Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

IMAGE #4

Case courtesy of Dr Alexandra Stanislavsky, Radiopaedia.org, rID: 10961



Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

IMAGE #5

Case courtesy of Dr Sajoscha Sorrentino, Radiopaedia.org, rID: 16164

- Location and Site:**
- Type:**
- Pattern:**
- Position:**
- Complications:**
- Complete Description:**



5



IMAGE #6

Case courtesy of Dr Tom O'Grady, Radiopaedia.org, rID: 41772

Location and Site:

Type:

Pattern:

Position:

Complications:

Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

IMAGE #7

Case courtesy of Dr Yair Glick, Radiopaedia.org, rID: 61659

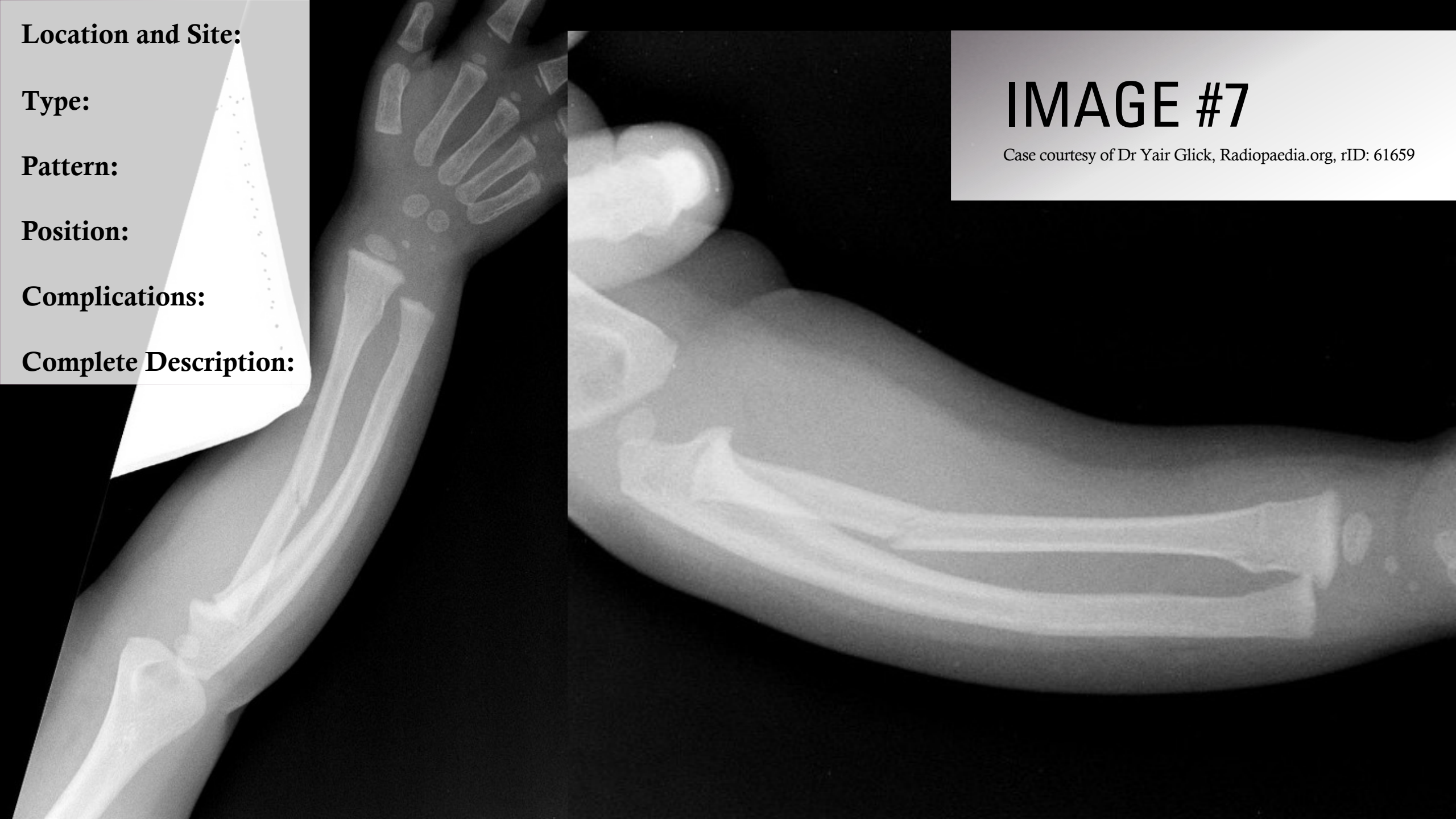


IMAGE #8

L

Case courtesy of Dr Stefan Lazic, Radiopaedia.org, rID: 51225



Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

Location and Site:

Type:

Pattern:

Position:

Complications:

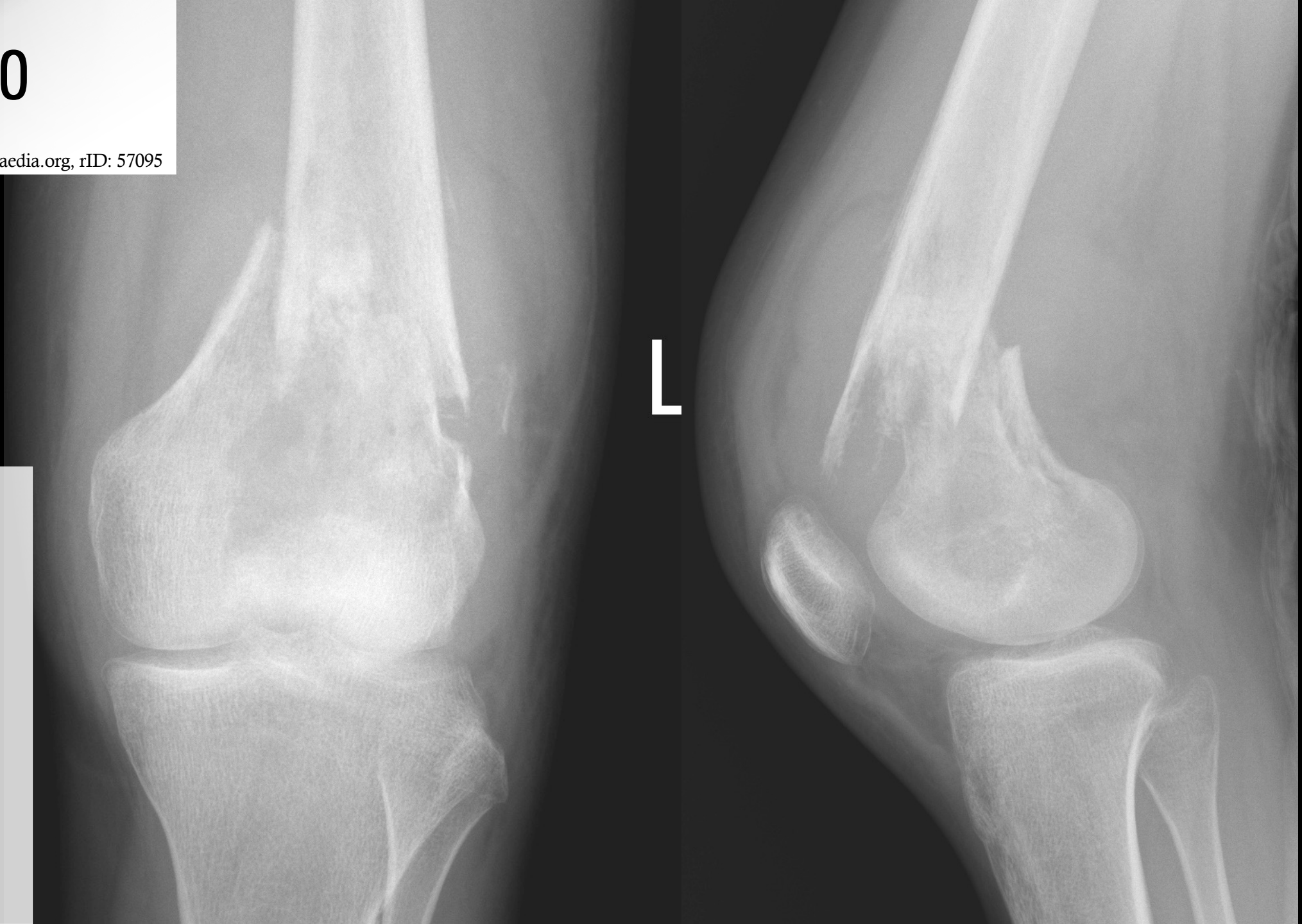
Complete Description:



IMAGE #9

IMAGE #10

Case courtesy of Dr Vincent Tatco, Radiopaedia.org, rID: 57095



Location and Site:

Type:

Pattern:

Position:

Complications:

Complete Description:

SUMMARY

Be systematic

Verify your patient

Obtain quality films

- Multiple correct views
- Joint visualization

Systematically identify fractures

- Compare to unaffected side if needed

Describe fractures accurately

- Location
- Type/Severity
- Pattern
- Position

Implications

***Correlate Findings with
Clinical Exam**

REFERENCES

1. Espinosa JA, Nolan TW. Reducing errors made by emergency physicians in interpreting radiographs: longitudinal study. *BMJ*. 2000;320(7237):737-740. .
 2. Eng J, Mysko WK, Weller GE, et al. Interpretation of emergency department radiographs a comparison of emergency medicine physicians with radiologists, residents with faculty, and film with digital display. *AJR AM J Roentgenol*. 2000;175:1233-1238.
 3. Martin J, Marsh JL, Nepola JV, Dirchl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? *J Orthop Trauma*. 2000;14(6):379-385.
 4. Bolander, S. A systematic approach to describing fractures. *JAAPA*. 2019;32(5):23-29.
 5. Mehta K, McBee MP, Mihal DC, England EB. Radiographic analysis of bone tumors: a systematic approach. *Semin Roentgenol*. 2017; 52(4): 194-208.
 6. Umer M, Hasan OHA, Khan D, Uddin N, Noordin S. Systematic approach to musculoskeletal benign tumors. *Int J Surg Oncol*. 2017; 2(11): e46.
 7. Adelson SL, Chounthirath T, Hodges NL, Collins CL, Smith GA. Pediatric playground-related injuries treated in hospital emergency departments in the United States. *Clin Pediatr*. 2018;57(5):584-592.
 8. Slongo TF, Audige L, AO Pediatric Classification Group. Fracture and dislocation classification compendium for children: the AP pediatric comprehensive classification of long bone fractures. *J Orthop Trauma*. 2007;12(10 Suppl):S135-160.
 9. Smith JR, Kozin SH. Identifying and managing physeal injuries in the upper extremity. *JAAPA*. 2009;22(9):39-45.
 10. Nguyen JC, Markhardy BK, Merrow AC, Dwek JR. Imaging of pediatric growth plate disturbances. *Radiographics*. 2017;37(6):1791-1812.
-

RESOURCES FOR IMAGES AND FIGURES*

- Radiopaedia. <http://radiopaedia.org/>.
- 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>.
- Smithuis R. Radiological Society of the Netherlands. Radiology Assistant Educational site. <http://www.radiologyassistant.nl>.

*Hyperlink or case number available for specific references

THANK YOU

Contact Information:

Sarah Bolander, DMSc, PA-C, DFAAPA

623-572-3611

sbolan@midwestern.edu