

REVIEW OF ESSENTIAL X-RAY INTERPRETATION SKILLS

THOMAS V GOCKE, DMSC, ATC, PA-C, DFAAPA
PRESIDENT & CO-FOUNDER
ORTHOPAEDIC EDUCATIONAL SERVICES, INC.
BOONE, NC
TOM@ORTHOEDU.COM
WWW.ORTHOEDU.COM



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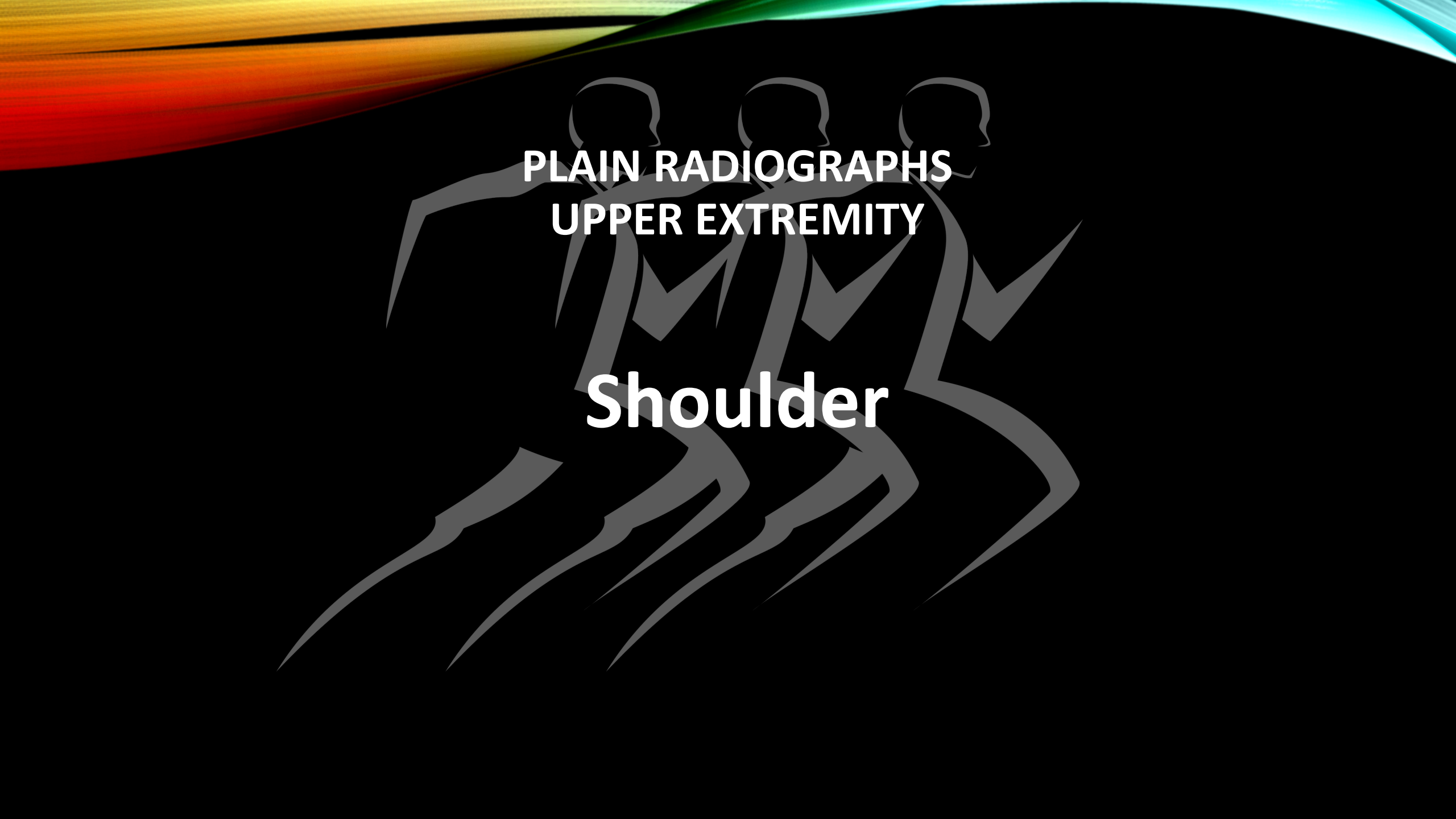
- ***American Academy of Surgical Physician Assistants – Editorial Review Board***

- ***Associate Professor, Rocky Mountain University of Health Professions - Financial***

LEARNING OBJECTIVES

At the end of this lecture attendees will be able to

- Describe general bony anatomy of the musculoskeletal system
- Describe and interpret plain radiographs for the Glenohumeral joint
- Describe and interpret plain radiographs for Acromioclavicular joint
- Describe and interpret plain radiographs of the Ankle joint
- Describe and interpret plain radiographs of the Foot
- Describe and interpret plain radiographs of the Cervical & Lumbar spine



**PLAIN RADIOGRAPHS
UPPER EXTREMITY**

Shoulder

Shoulder

- Radiographs: 3 views
 - Anterior - Posterior (AP) View
 - Axillary View
 - Transcapular view
 - “Y” view or Mercedes view
 - Internal – External Rotation views (Grashy)

SHOULDER

- Plain Radiographs:
 - X-ray does not look at soft-tissue assessment
 - Arthrogram can assess redundant joint capsule and tears in the RTC
- CT scan
 - assess intra-articular and complex proximal humerus fractures
 - Reconstruction vs. thin slices: Ask Radiologist
- Ultra-sound (US):
 - great for soft-tissue masses & RTC tear assessment
- MRI:
 - MR-arthrogram much better studies for assessment of soft-tissue injuries

Shoulder

- Anterior-posterior (AP) View

- Looks at anterior GH joint and AC joint
- Assess Glenohumeral position
- Degenerative changes: AC & Glenoid
- Fractures

- Normal findings

- Humeral head and glenoid are generally level with on another
- Humerus overlaps small amount with glenoid “Crescent sign”
- Humeral head apposes Glenoid



Shoulder

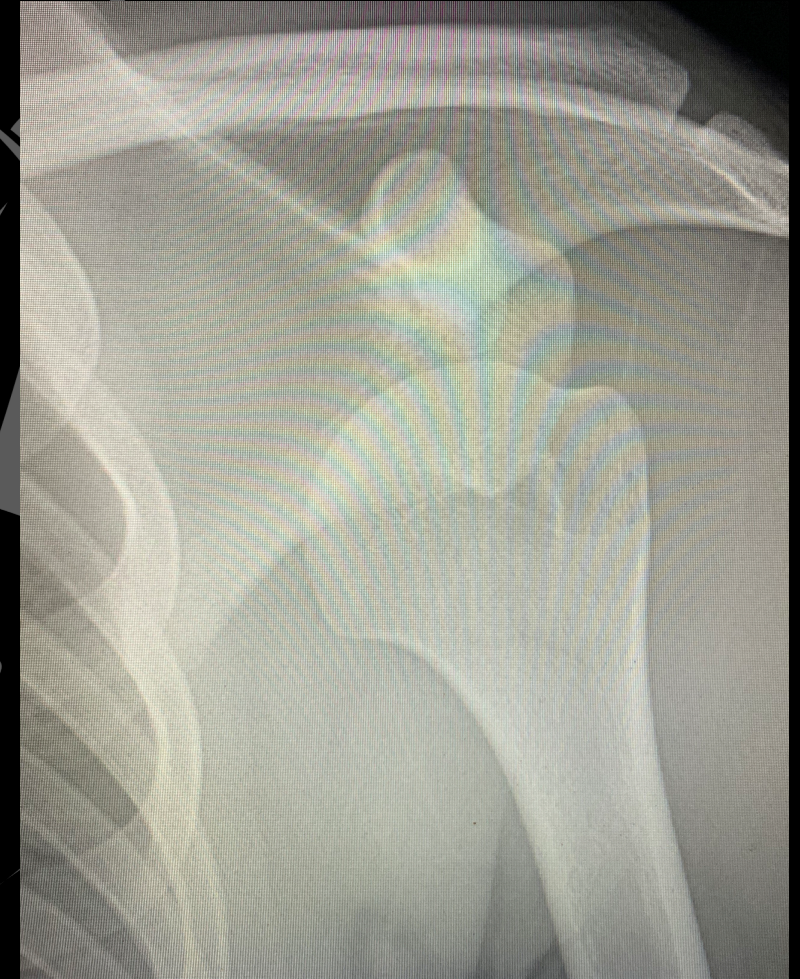
Anterior-posterior (AP) View

- Anterior dislocation

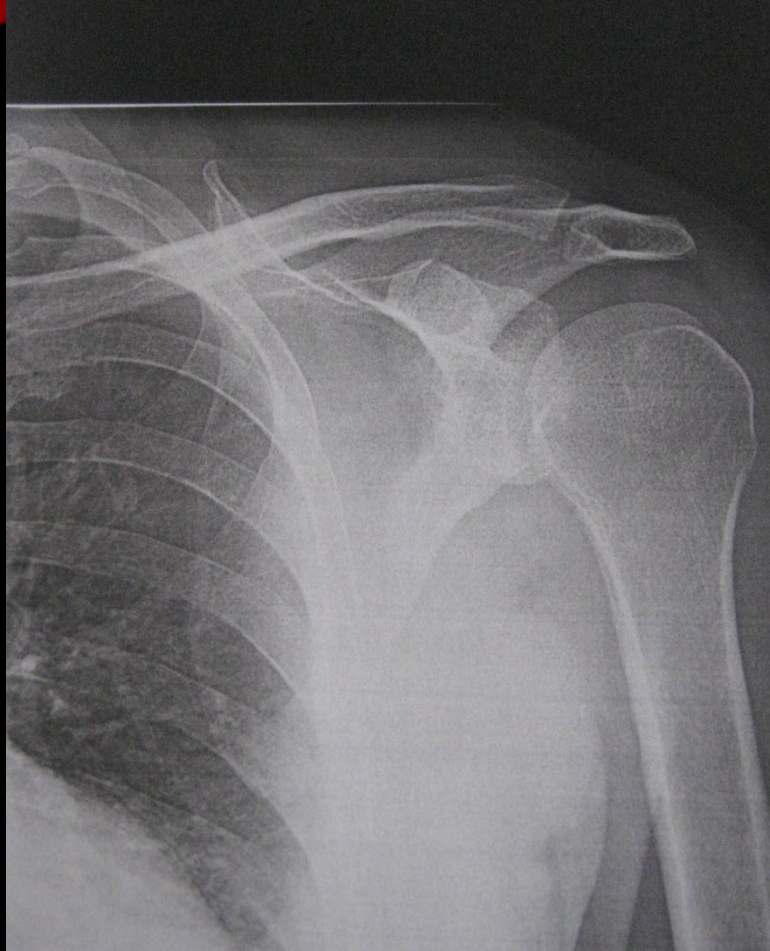
- Humeral head anterior and inferior to glenoid
- Humeral head looks bigger on AP x-ray

- Posterior dislocation

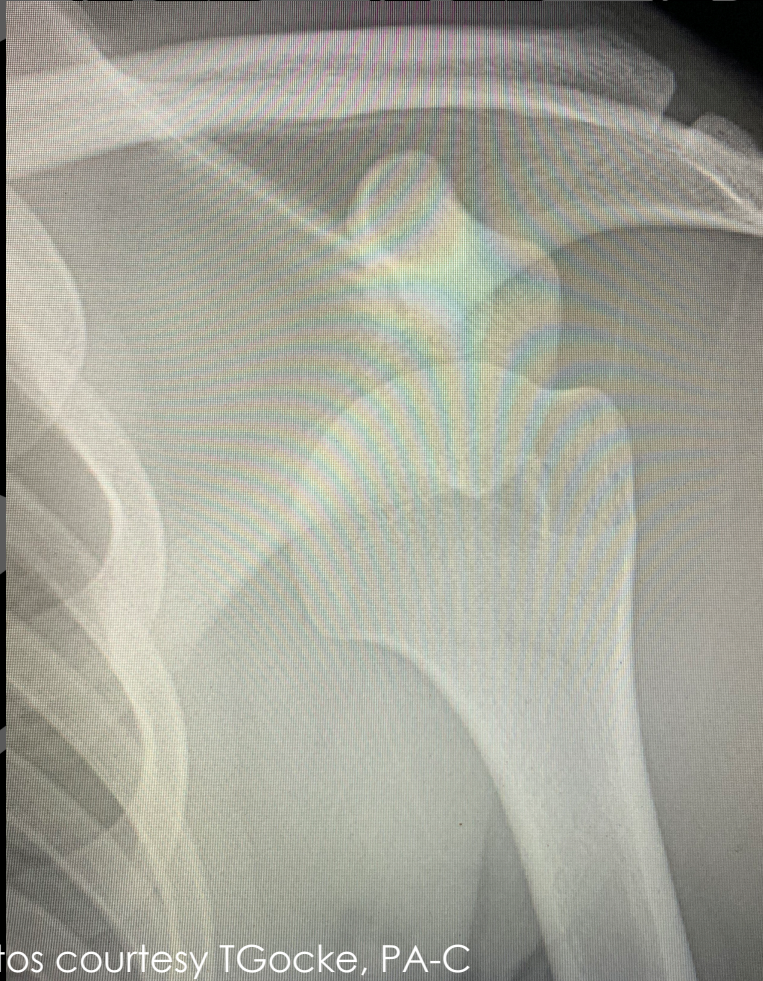
- Humeral head goes posterior to glenoid and looks like GH joint pulled apart
- Loose “Crescent sign” appearance in normal joint
- Humeral head looks smaller on AP x-ray



AP-NORMAL



Anterior Dislocation



Photos courtesy TGocke, PA-C

RADIOGRAPHIC EXAM

- Axillary View
 - Shot thru the armpit
 - Shows humeral head position in glenoid
 - Best able to identify Hills-Sach and bony Bankhart lesions
 - Remember: Coracoid process always points ANTERIOR



RADIOGRAPHIC EXAM

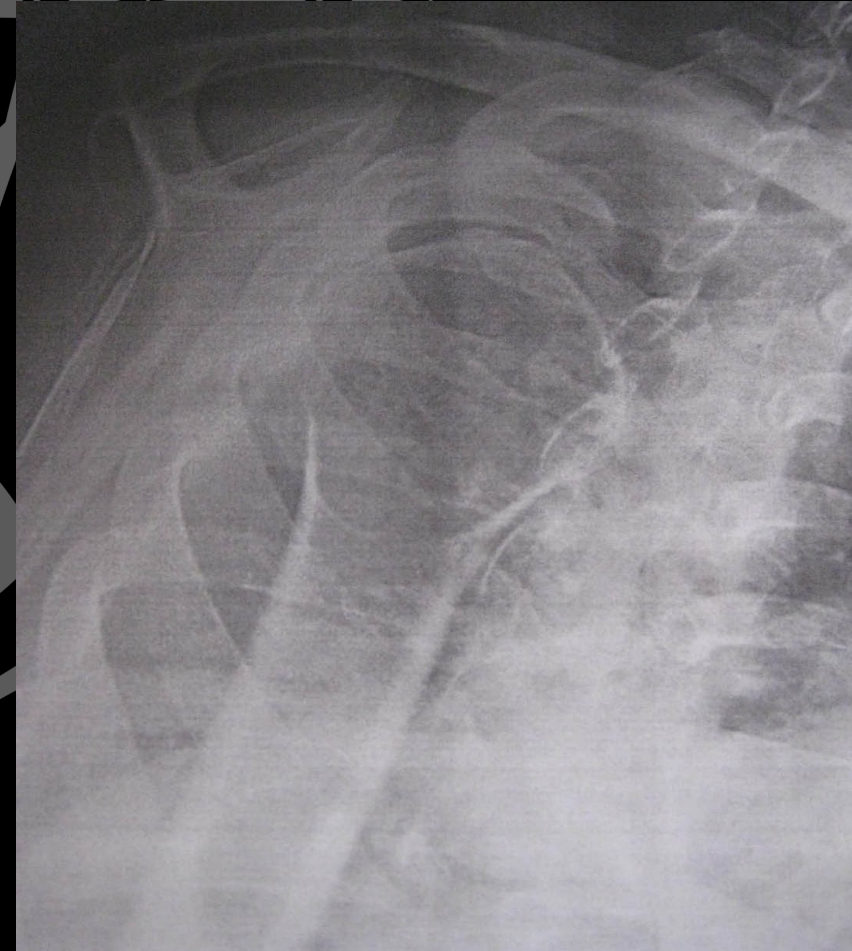
- Transcapular View: “Y” or Mercedes view
 - Formed by the Coracoid process, spine of the acromion and the scapular body
 - Assessment of GH joint dislocation and relocation after reduction
 - Identify Subacromial spurs
 - X-ray shot in the same plain as the scapular body



TRANSCAPULAR VIEW

NORMAL

DISLOCATION



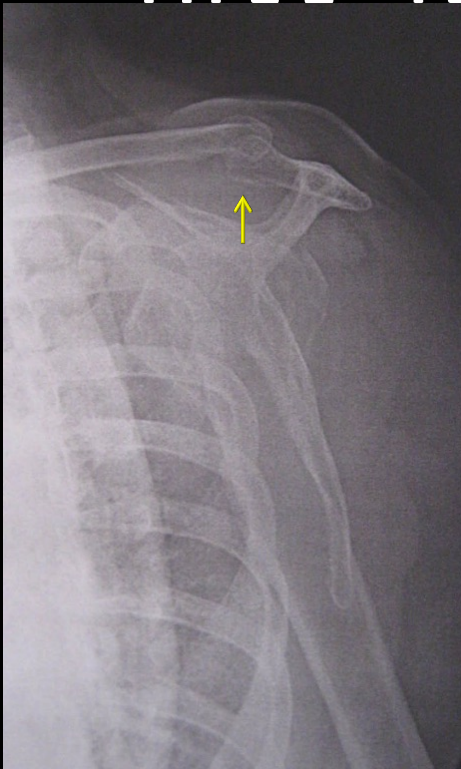
Photos courtesy TGoetze, PA-C

TRANSCAPULAR VIEW “ACROMIAL SPUR”

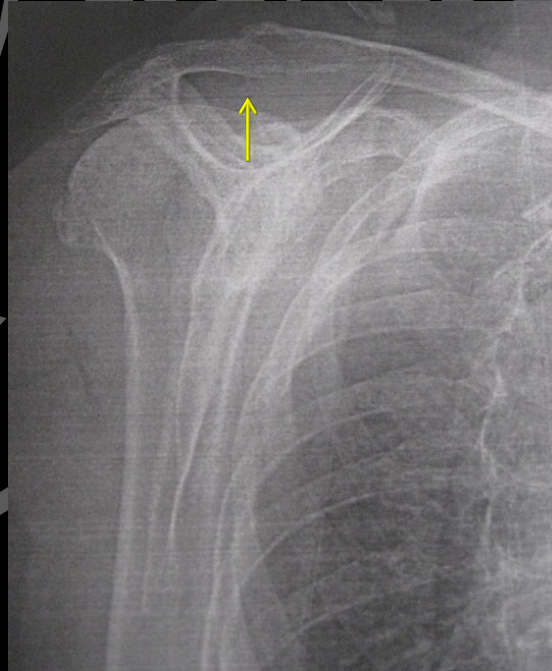
- Subacromial Spurs:
 - Osteophyte in the subacromial space
 - Decrease space for G-H range of motion
 - Subacromial bursae and Rotator Cuff tendon impinge
 - Spur graded by width
 - Type 1 - flat
 - Type 2 - 5mm
 - Type 3 - > 5mm

TRANSCAPULAR VIEW: “ACROMIAL SPUR”

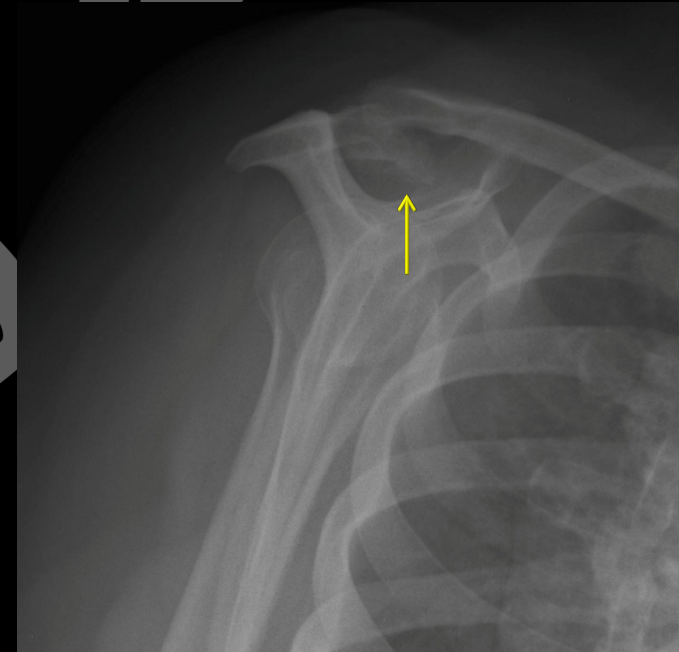
TYPE 1 – FLAT

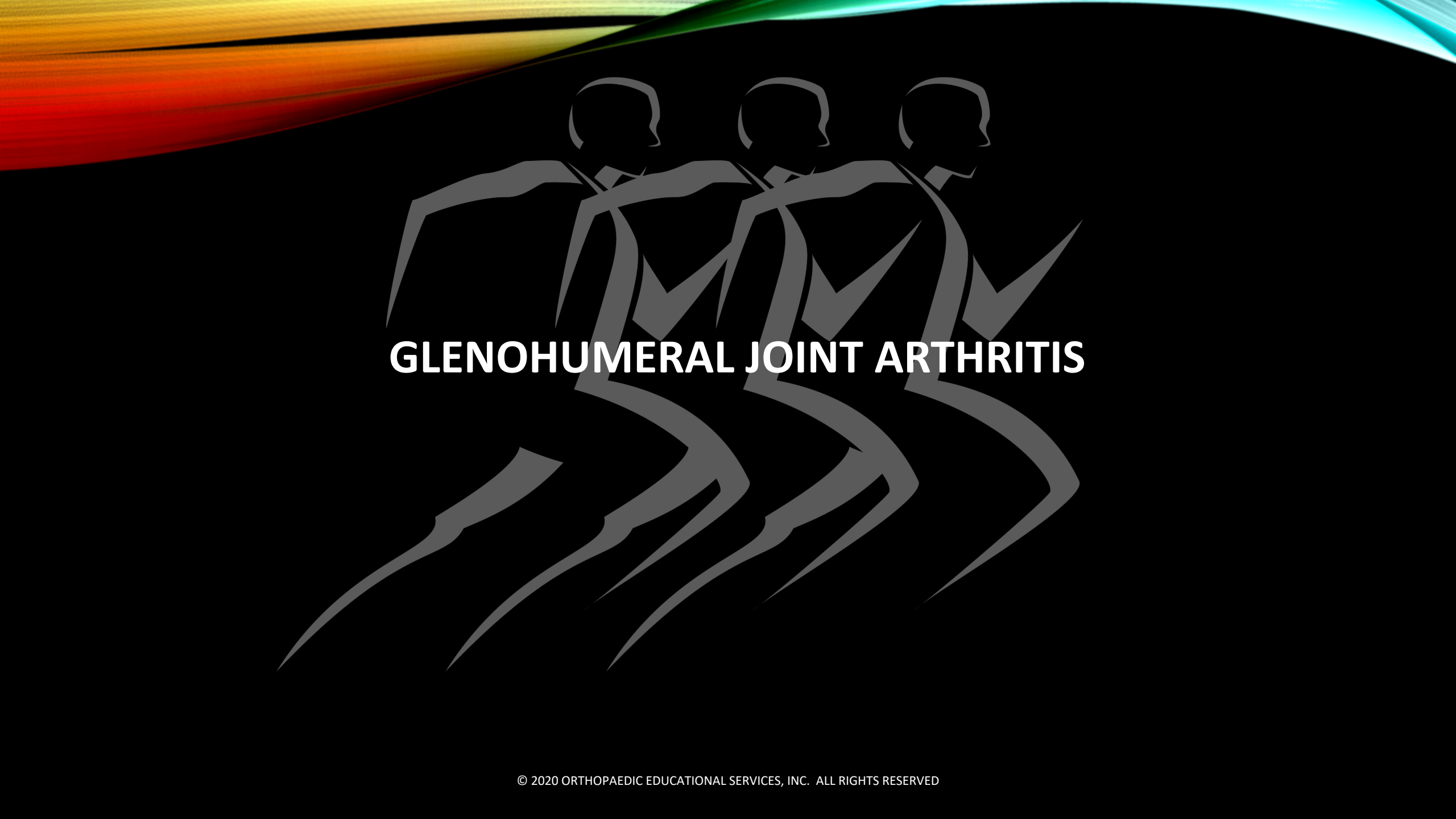


TYPE 2 – 5MM



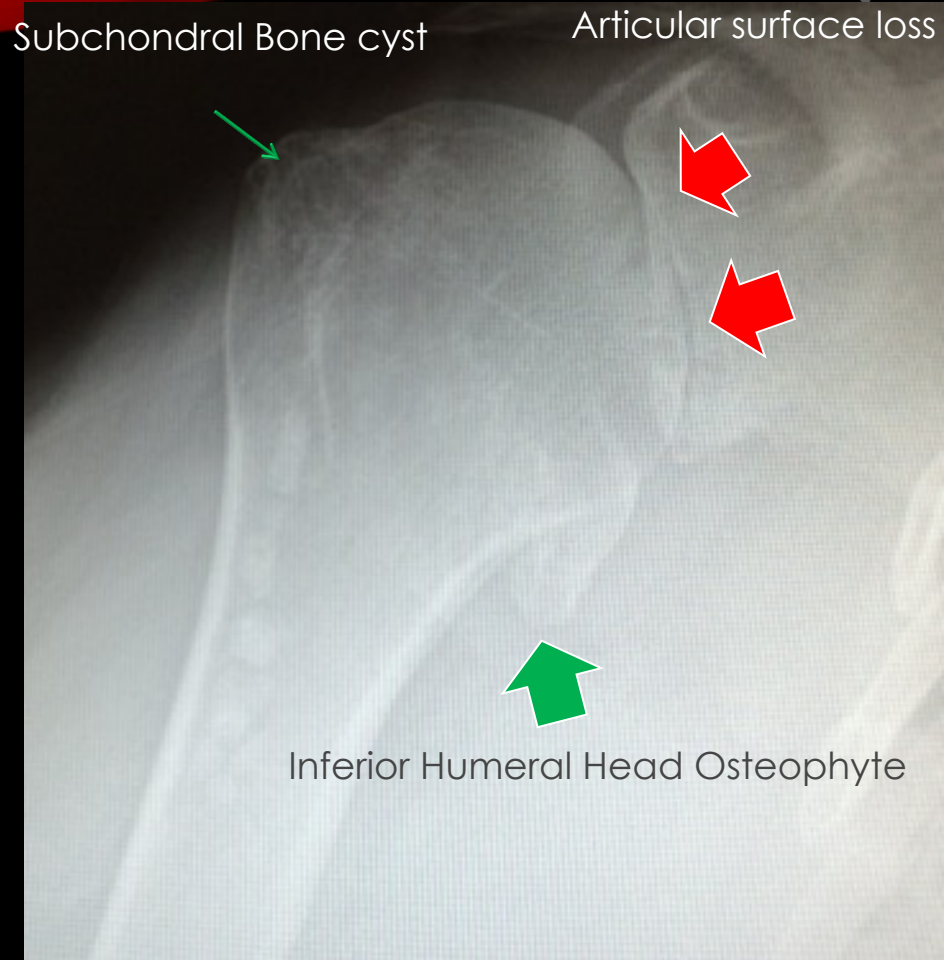
TYPE 3 > 5MM





GLENOHUMERAL JOINT ARTHRITIS

GLENOHUMERAL JOINT ARTHRITIS



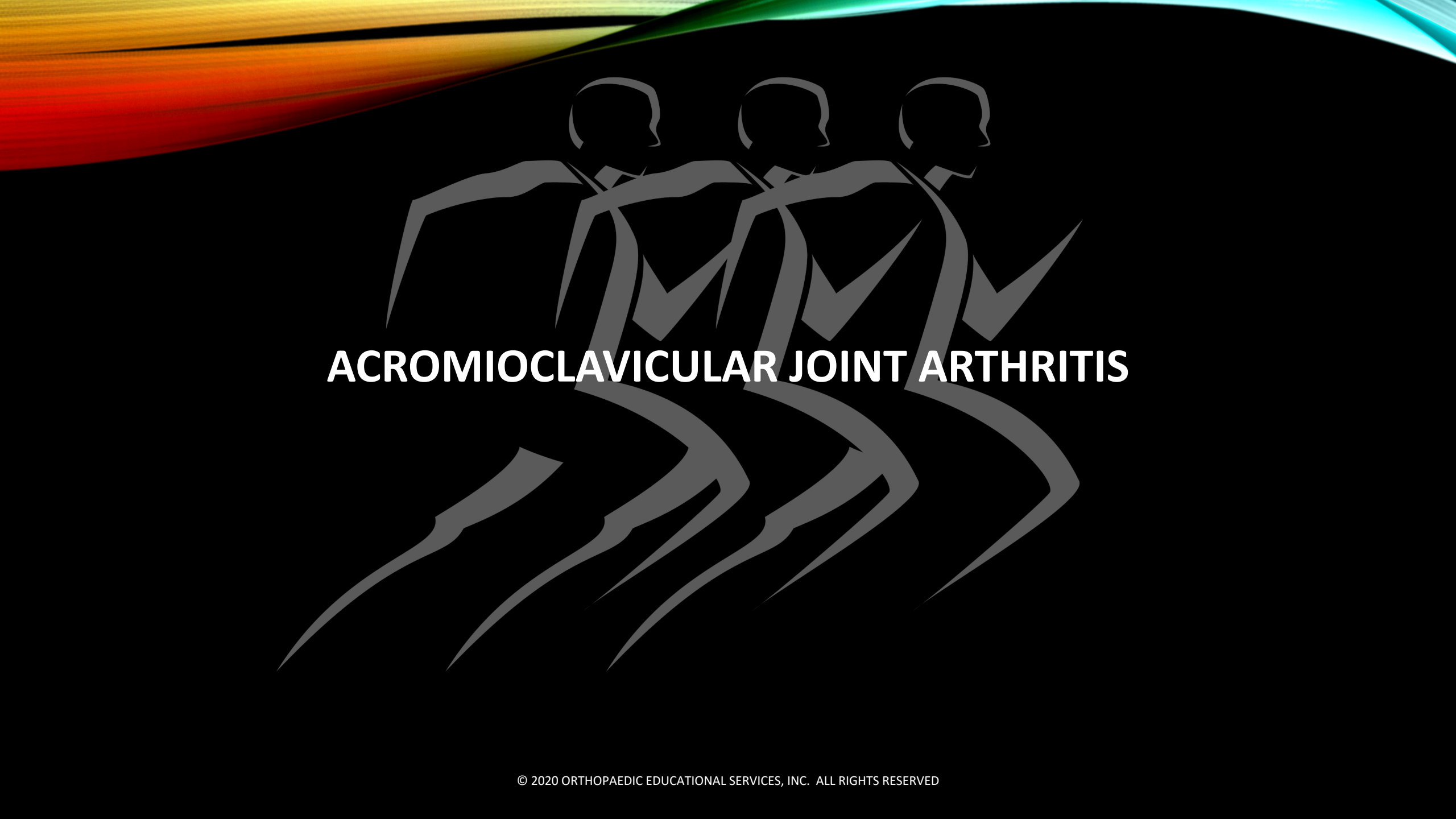
Radiographic Examination
X-ray: AP/AXILLARY/GRASHEY

Findings

- Subchondral cystic changes Humeral head and Glenoid Fossa
- Posterior Humeral head subluxation with posterior Glenoid wear pattern
- Osteophytes inferior Glenoid and Humeral head
- Superior Humeral Head migration – RTC tear



GLENOHUMERAL JOINT ARTHRITIS



ACROMIOCLAVICULAR JOINT ARTHRITIS

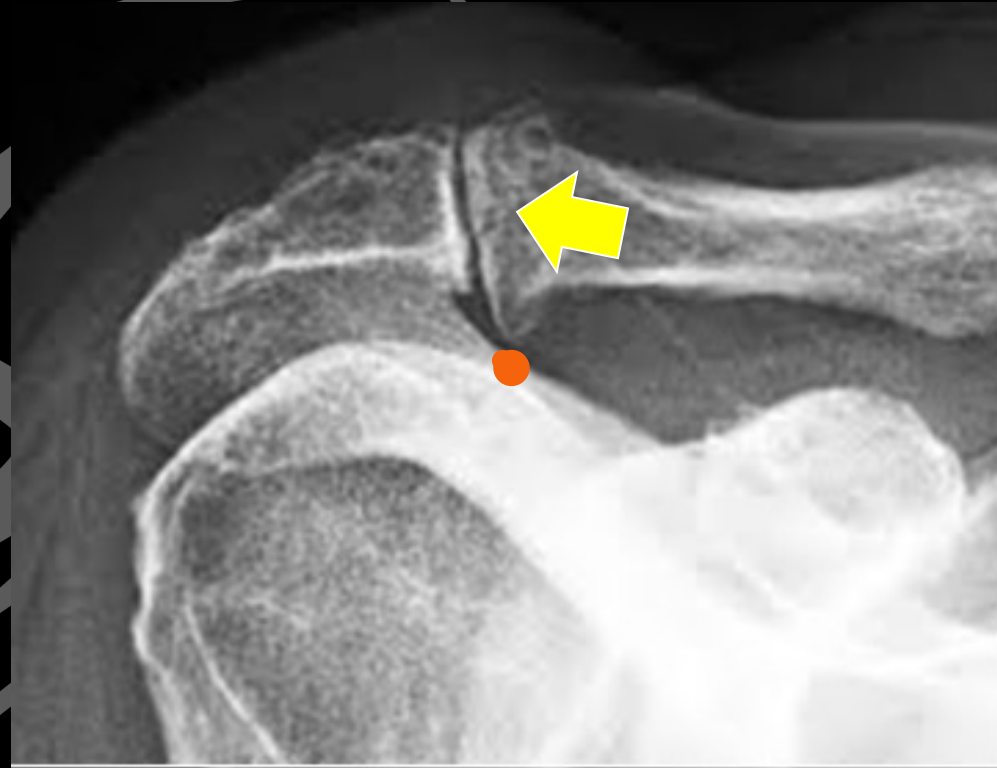
ACROMIOCLAVICULAR JOINT ARTHRITIS

- Commonly affected by traumatic and degenerative conditions
- Chronic degenerative changes result from repetitive activity
 - Osteolysis commonly associated with weight lifting or heavy labor activities
- Symptoms similar to RTC impingement syndrome
- AC joint changes cosmetic appearance 2nd to osteophyte formation
- Contributing Factors:
 - Repetitive overhead activities
 - Wt lifters – Swimmers – Throwers

ACROMIOCLAVICULAR JOINT ARTHRITIS

Radiographs

- AP/Axillary/Outlet
 - Narrowing AC joint
 - Osteophytes – more common inferior vs. superior
 - Old fx
- MRI/CT – not always necessary

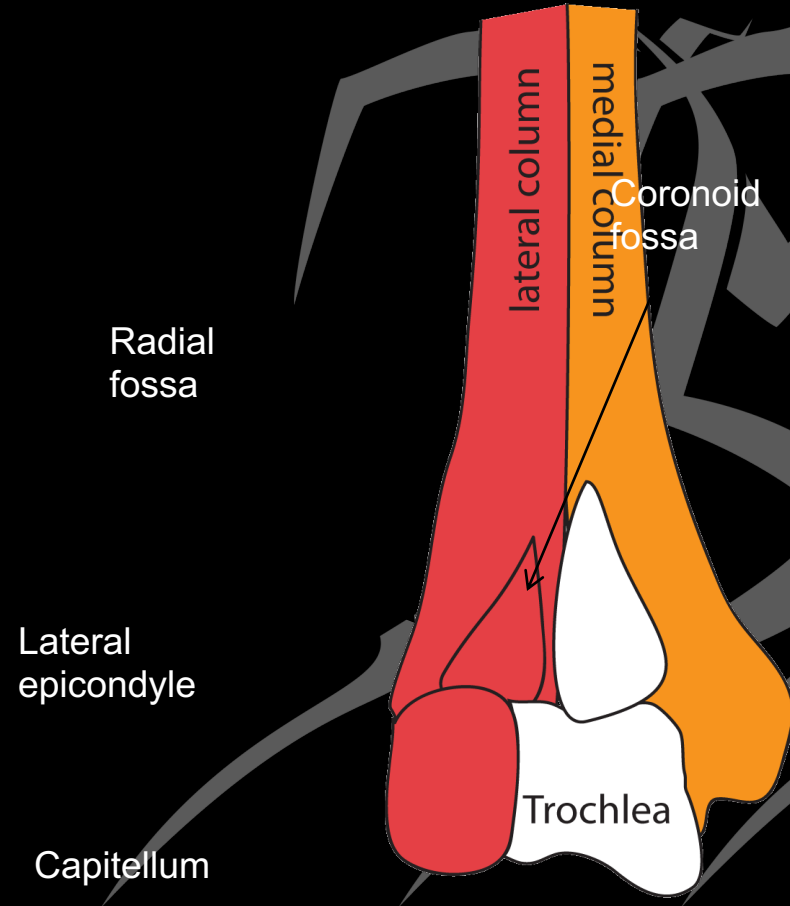




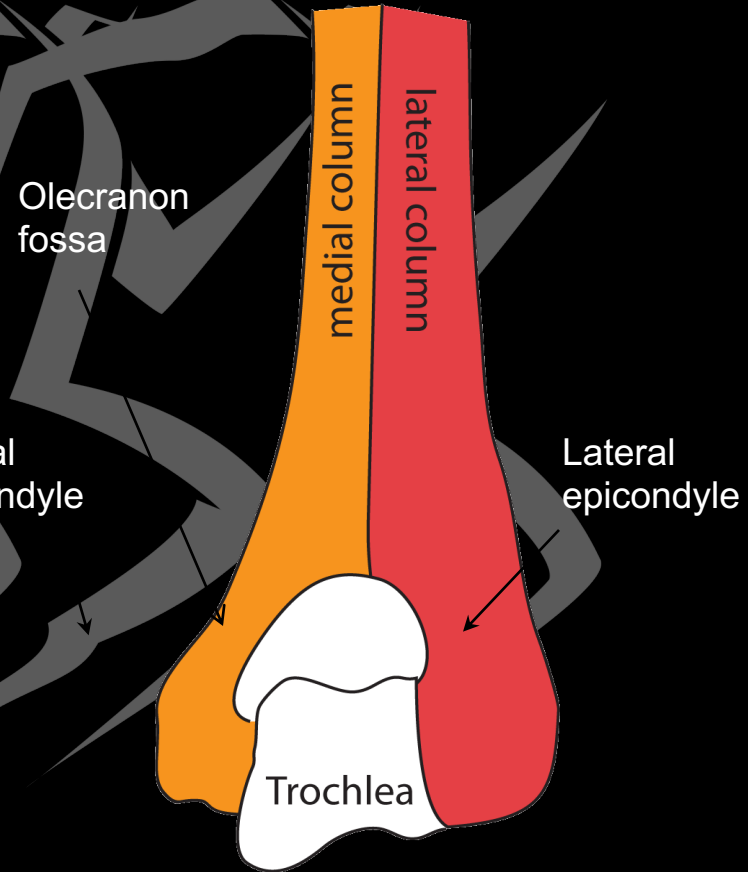
ELBOW

BONY LANDMARKS

ANTERIOR VIEW



POSTERIOR VIEW



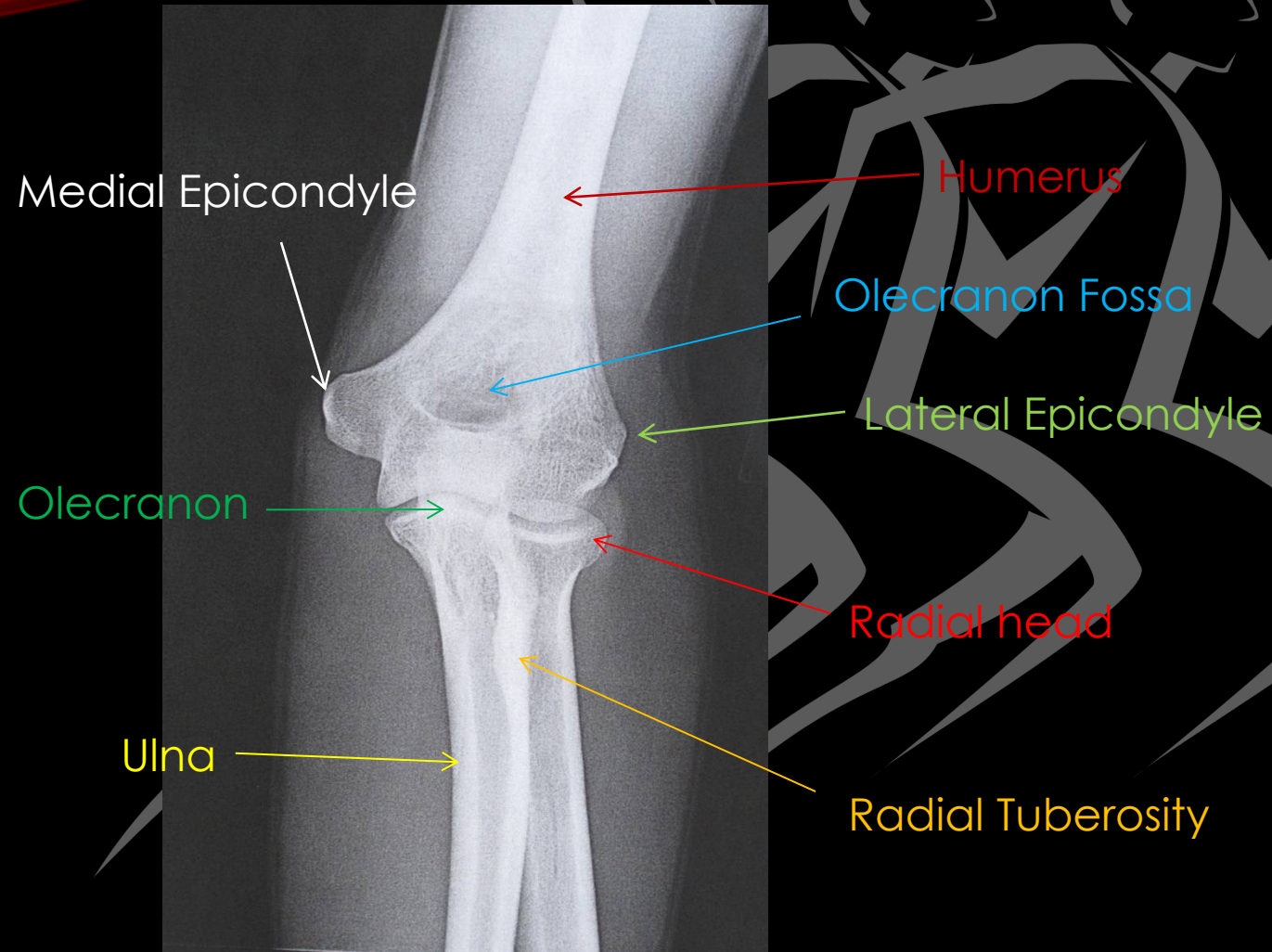
SUPRACONDYLAR HUMERUS FX

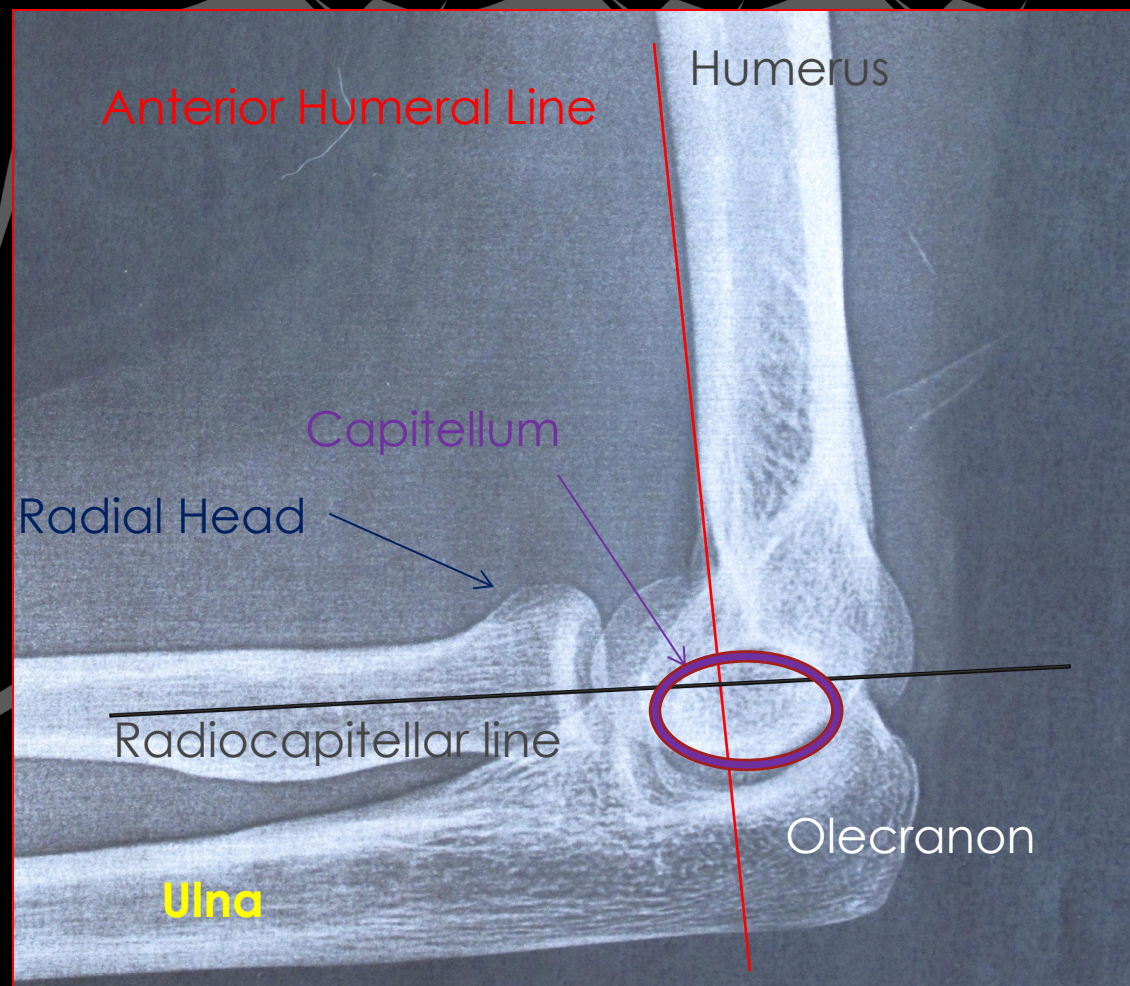
Epidemiology

- 30% all Elbow fx
 - Supracondylar
 - Single Column fx- Lateral
 - Bi-column fx- heavy damage
 - Young men & older female
 - Falls from standing height/high energy
- X-ray Images
 - AP, and Lateral
 - Comminuted, intra-articular – usually gets a CT Scan



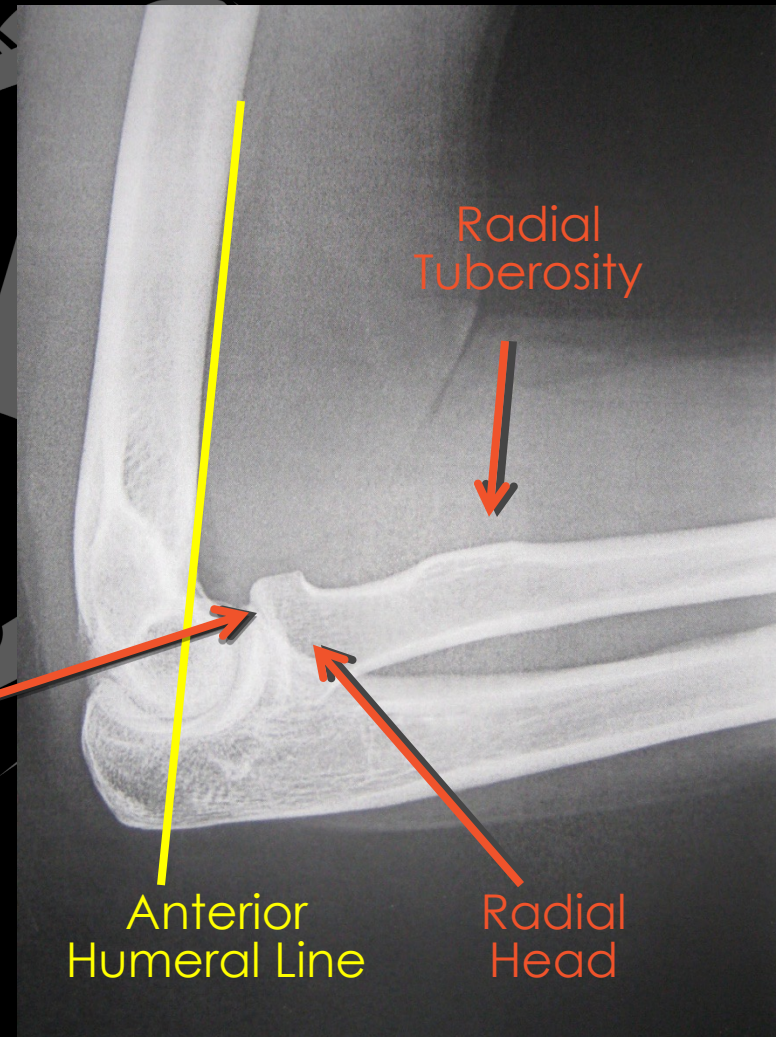
ELBOW ANATOMY





GENERAL ELBOW ANATOMY

- Ligament
 - Radial Collateral
 - Ulnar Collateral
 - Annular (radial head)
- Tendon
 - Bicep—distal insert radial tuberosity
 - Triceps
 - Coranoid Process



RADIOLOGY

Fat Pad Sign



Synovial space

Effusion

Fat pad

Fat pad

PEDS ELBOW FX



RADIAL HEAD FX

Radiographs

- AP, lateral & radial head view
 - Radial head view: oblique lateral
 - Helps see subtle fx radial head
 - Check for Fat Pad signs
 - Fx Tolerances: Rule of 3's (Radin & Riseborough, *JBJS-A*, 1966)
 - 1/3 radial head fx
 - 3mm displacement/diastasis
 - >30 degrees angulation
- CT Scan
 - Needed with comminuted fx radial head
 - Helps with surgical preplanning

RADIOLOGY

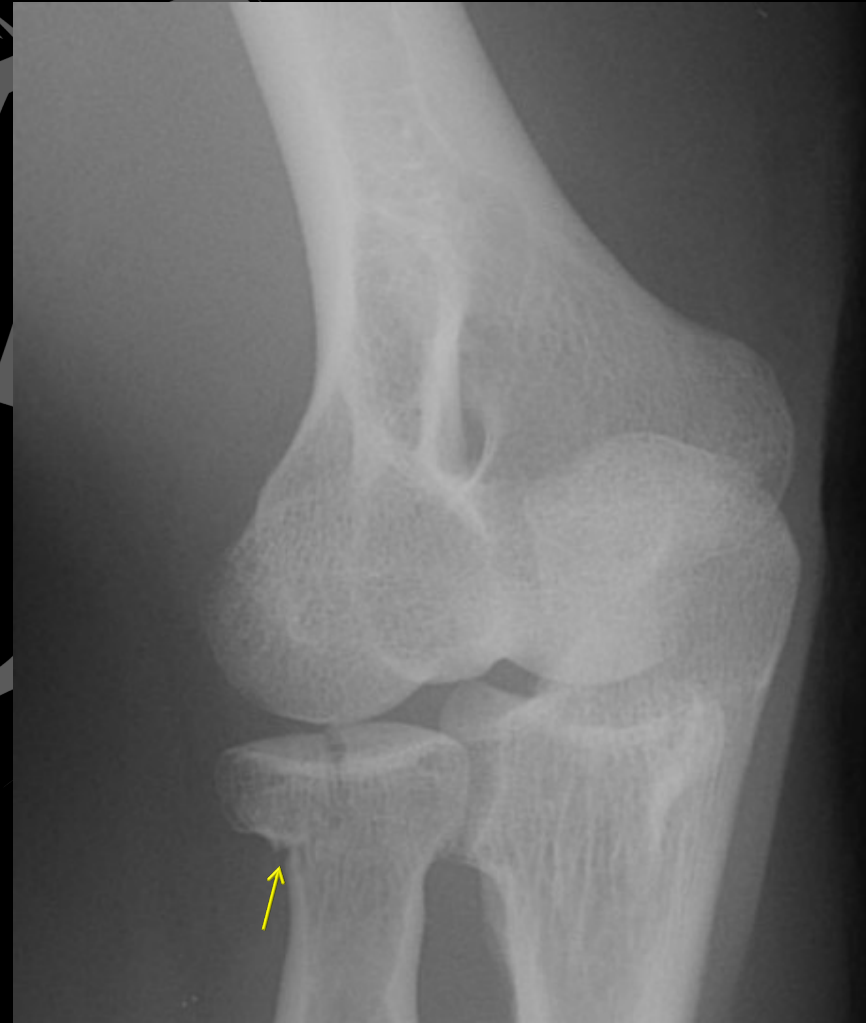
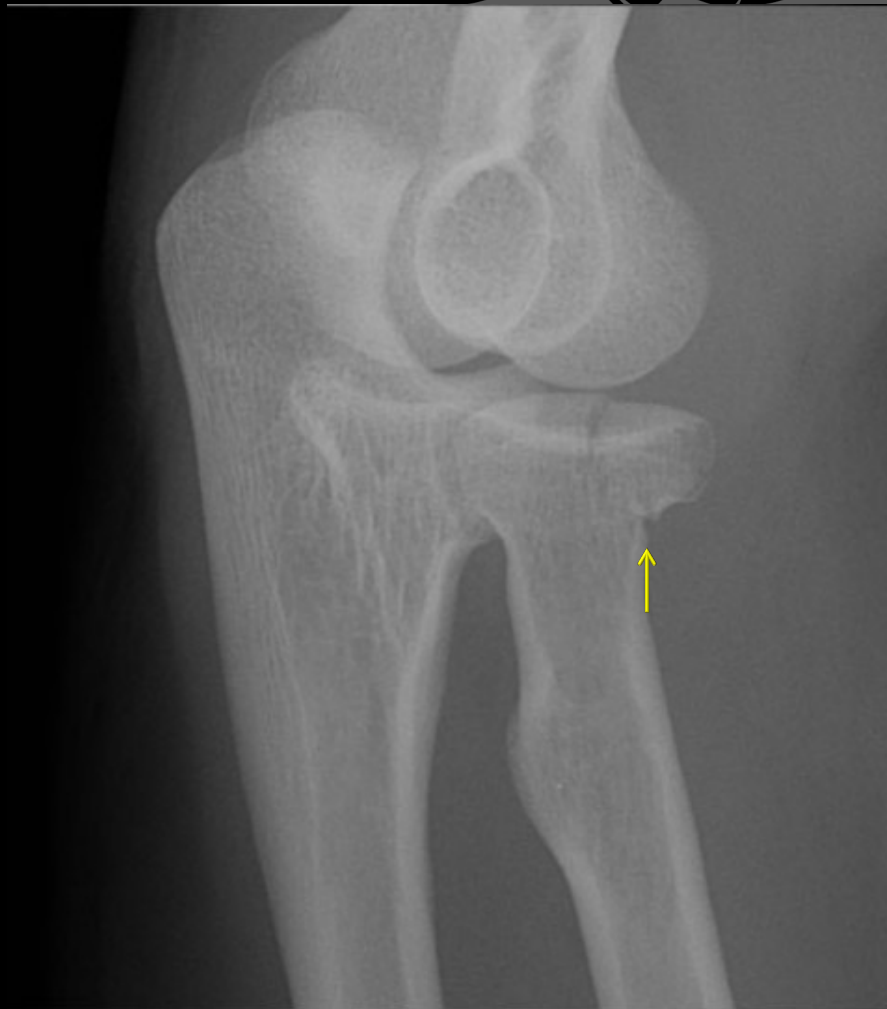
Fat Pad Sign



MASON TYPE I



MASON TYPE II



MASON TYPE III



OLECRANON FRACTURE

Avulsion Fx

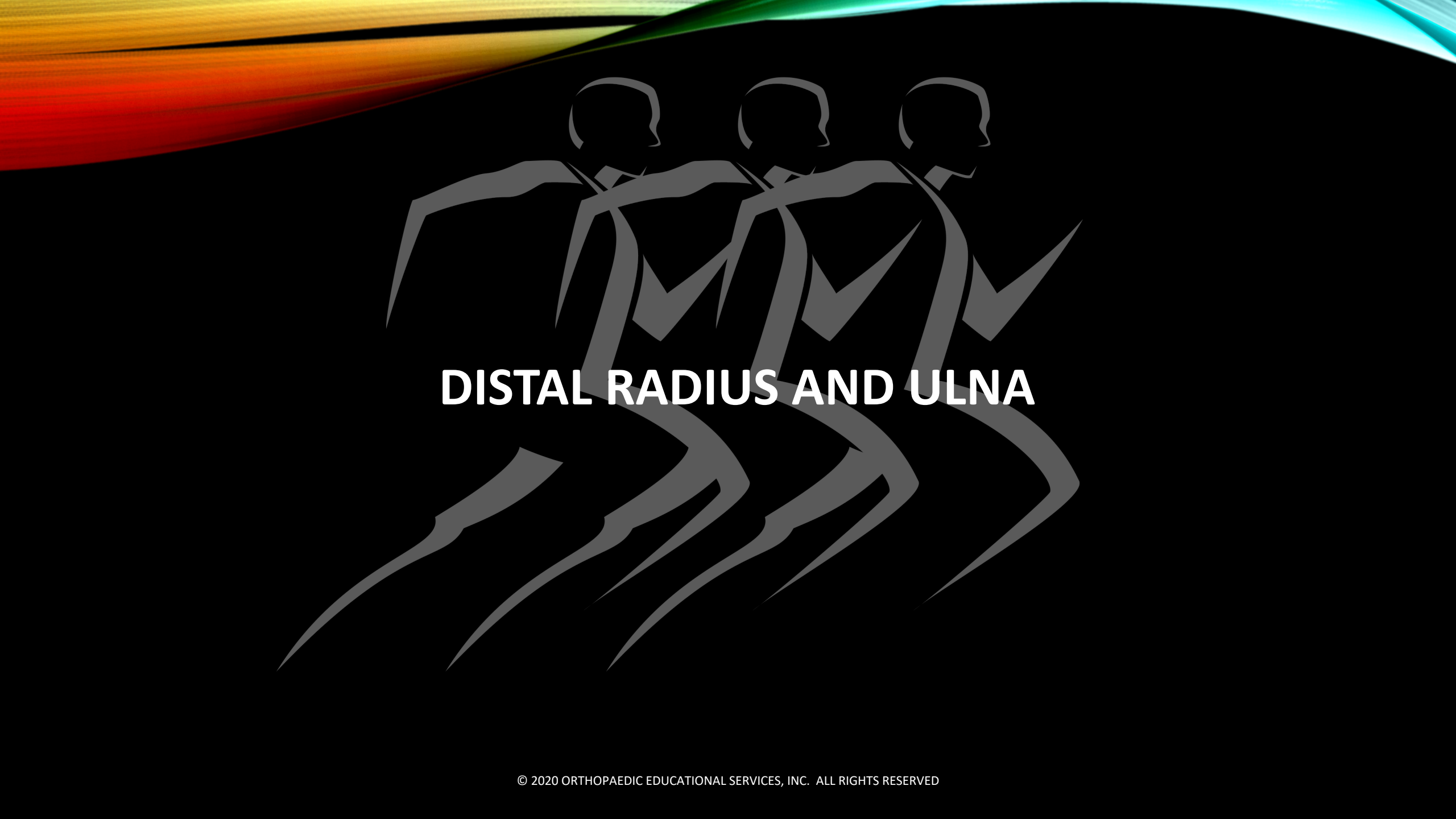


Pictures courtesy T Gocke, PA-C

Transverse fx



Pictures courtesy T Gocke, PA-C



DISTAL RADIUS AND ULNA



CARPAL BONES

Wrist (Carpal bones)

- X-rays
 - PA, Lateral, Oblique, Clenched fist view and Snuffbox view
 - Clenched Fist view:
 - Adds stress to Scapholunate ligament looking for instability
 - Snuffbox view:
 - Essential for identifying fx in carpal scaphoid

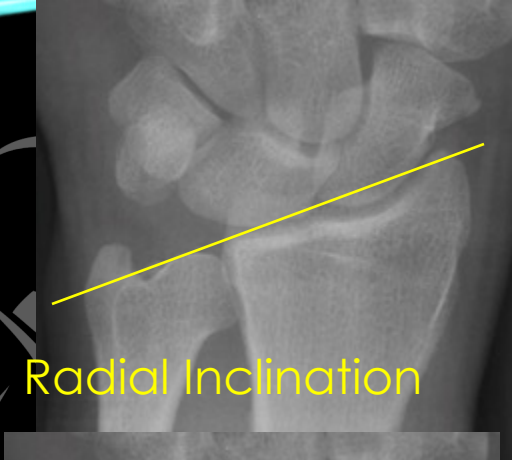


Picture courtesy T Gocke, PA-C

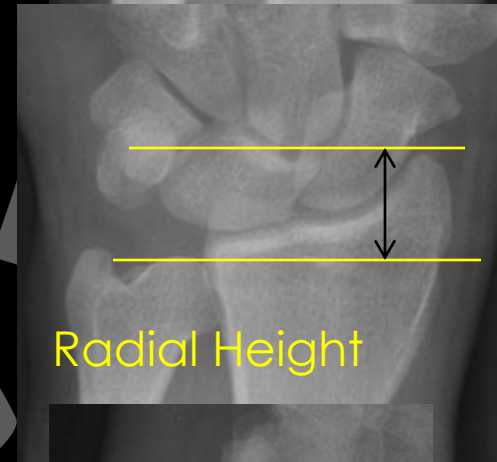
DISTAL RADIUS & ULNA

Radiographs

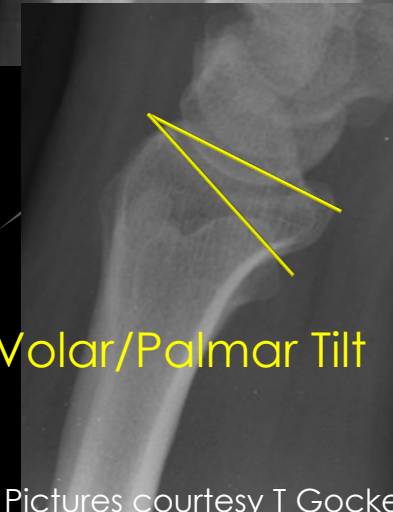
- Radial Inclination
 - Normal: 23 degrees (< 5 degrees)
- Radial Height
 - Normal 10-12 mm (ulnar negative)
 - Variant <5mm
 - **Fx: ulnar positive (loose radial height)**
- Radial articular surface
 - Normal :Congruent
 - Variant: <2mm step-off
- Palmar Tilt
 - Normal 10 degrees



Radial Inclination



Radial Height



Volar/Palmar Tilt

Pictures courtesy T Gocke, PA-C

RADIOLOGY REVIEW

Normal Carpal bone anatomy

Parallelism –

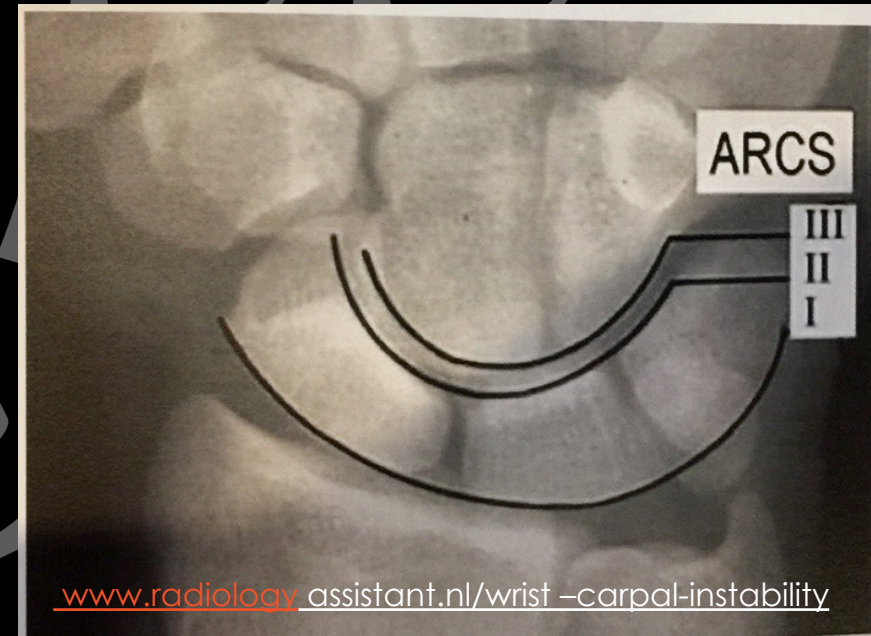
- 2mm width between carpal bones

Symmetric appearance

- Capitoulunate joint sets standard for Carpal joint symmetry

Carpal Arcs

- I: Convex curve
Scaphoid/Lunate/Triquetrum
- II: Concave curve
Scaphoid/Lunate/Triquetrum
 - Between proximal & Distal Carpal rows
- III: Convex curve Capitate/Hamate



Miler, MA, Thompson SR, Hart JA; Review of Orthopaedics, sixth edition, 2012, Elsevier, Phila, PA.; p340-341
Johnson TR, Steinbach LS: Essentials of Musculoskeletal Imaging, 2004, AAOS, Rosemont, IL; p 372-376
www.radiologyassistant.nl/en/p42a29ec06b9e8/wrist-carpal-instability.html

DISTAL RADIUS FRACTURES

General:

Distal Radius Fx names

- Colles' fx

Description

Dorsal displaced, extra-articular

- Chauffer's fx

Radial Styloid fx

- Smith's fx

Volar displaced extra-articular

- Die Punch Fx

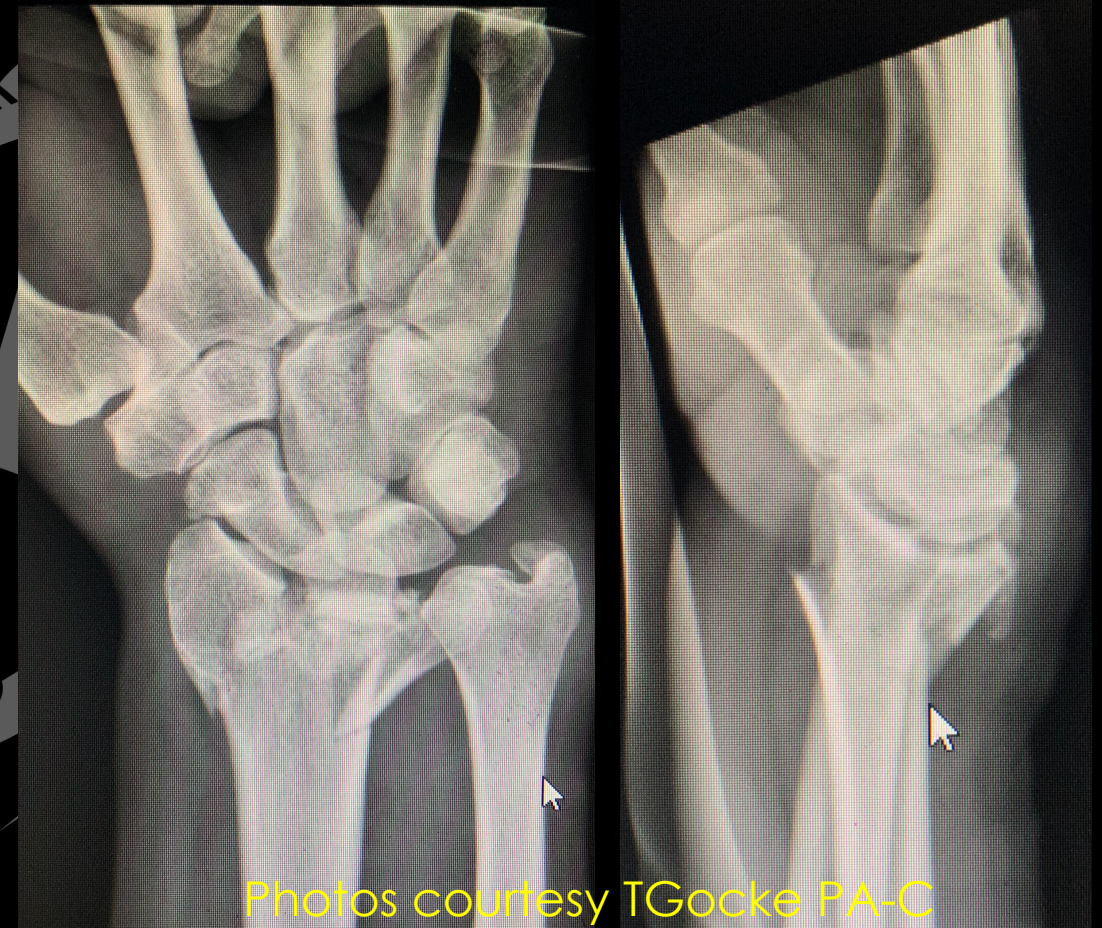
Depressed intra-articular distal radius fx into Lunate fossa

- Barton's fx

Intra-articular Radiocarpal fx-dislocation w/ volar or dorsal displacement

FRACTURE DESCRIPTION

- Fx location
- Open v. Closed:
 - Gustilio-Anderson classification
- Neurovascular status
- Angulation: direction fx apex
- Displacement vs. Non-displaced
- Comminution
- Impaction
- Rotation
- Articular extension



DISTAL 1/3 RADIUS FRACTURES

Colle's Fracture

- Extra-articular
- Dorsal fx line
- Dorsal displacement
- Dorsal comminution
 - Elderly
 - Osteoporosis
- Hand /wrist follows radius
- Radial deviation
- Prominent ulna
- Mechanism
 - Fall on flexed wrist



Picture Courtesy TGocke, PA-C



Picture Courtesy TGocke, PA-C

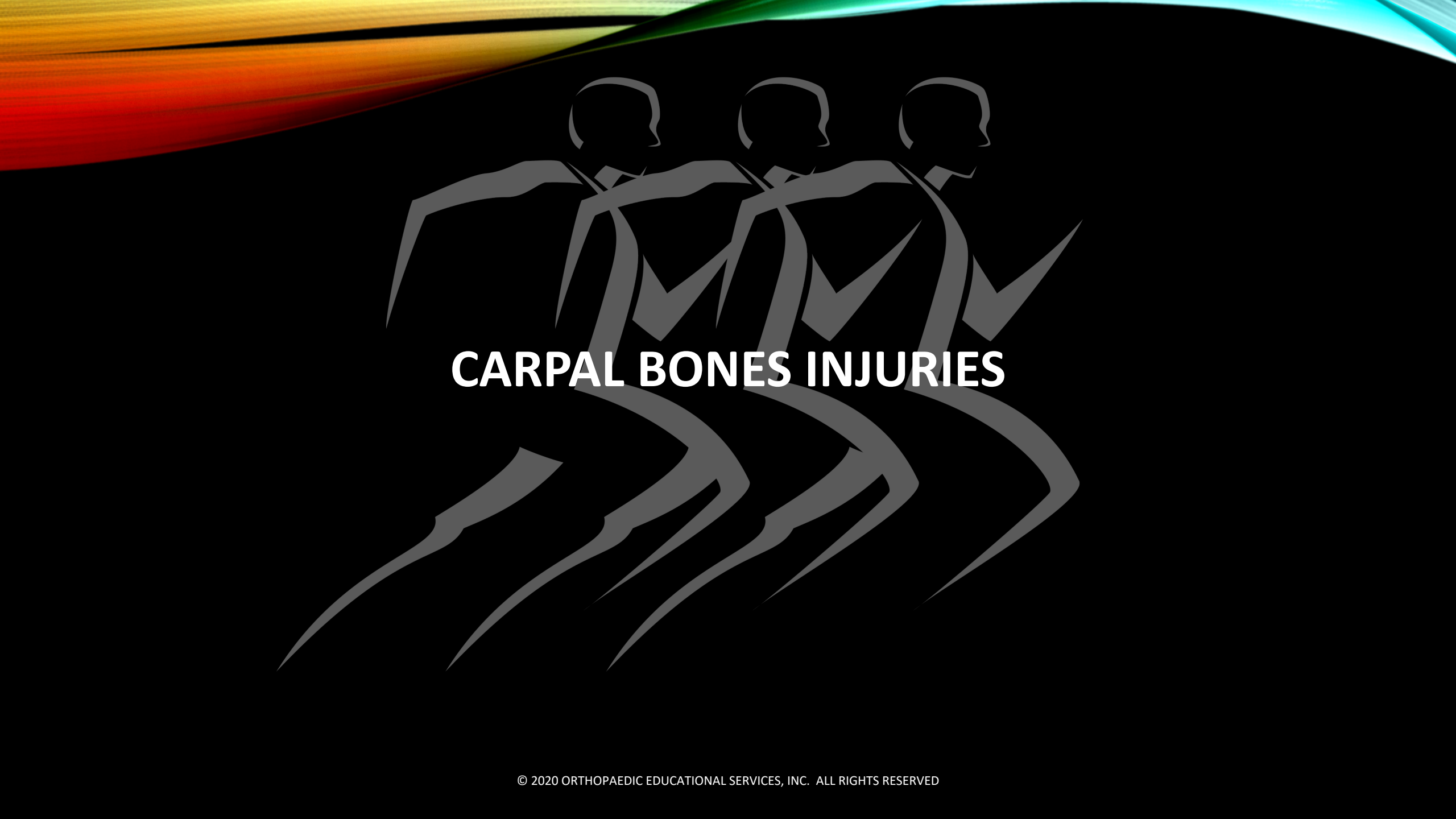
DISTAL RADIUS FRACTURES

Colles Fracture

- Lateral X-ray wrist
 - Loss volar/palmar tilt
 - Dorsal cortex comminution
 - Hand follows distal radius fx fragment



X-ray courtesy Tom Gocke, PA-C Library



CARPAL BONES INJURIES

CARPAL BONES

Wrist (Carpal bones)

- X-rays
 - AP, Lateral, Oblique, Clenched fist view and Snuffbox view
 - Clenched Fist view:
 - Adds stress to Scapholunate ligament looking for instability
 - Snuffbox view:
 - Essential for identifying fx in carpal scaphoid



Picture courtesy T Gocke, PA-C

CARPAL BONE INJURIES

Scaphoid Fx

Radiology:

- Snuffbox view
 - Suspect scaphoid fx, snuffbox pain, FOOSH
 - scaphoid view: 30 degree wrist extension, 20 degree ulnar deviation
 - negative x-ray & high suspicion for fx: repeat 14-21 days

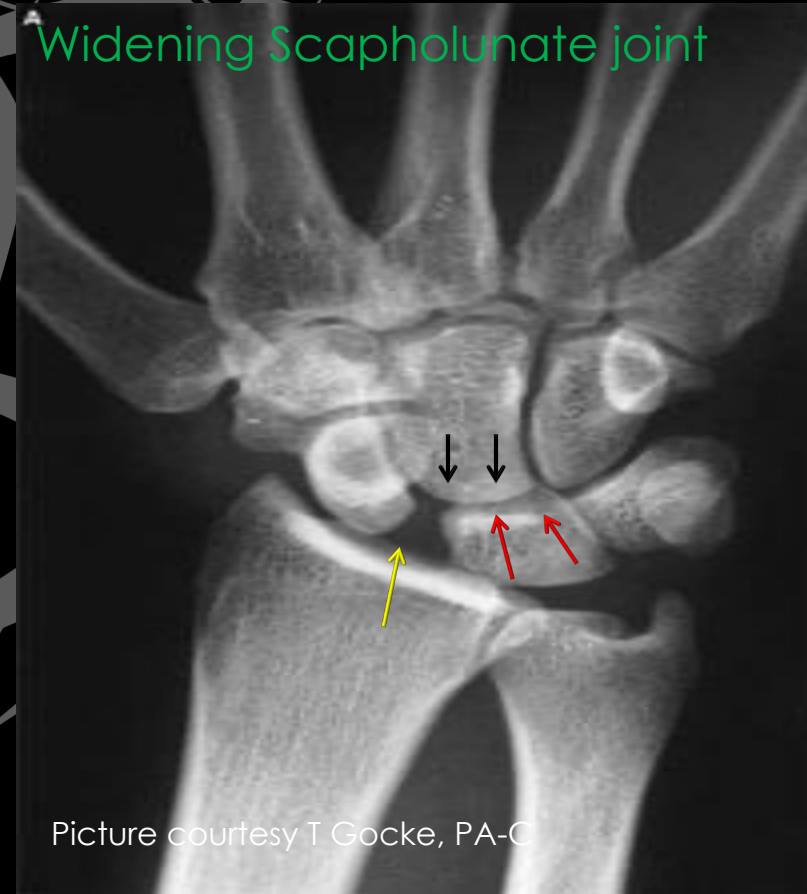


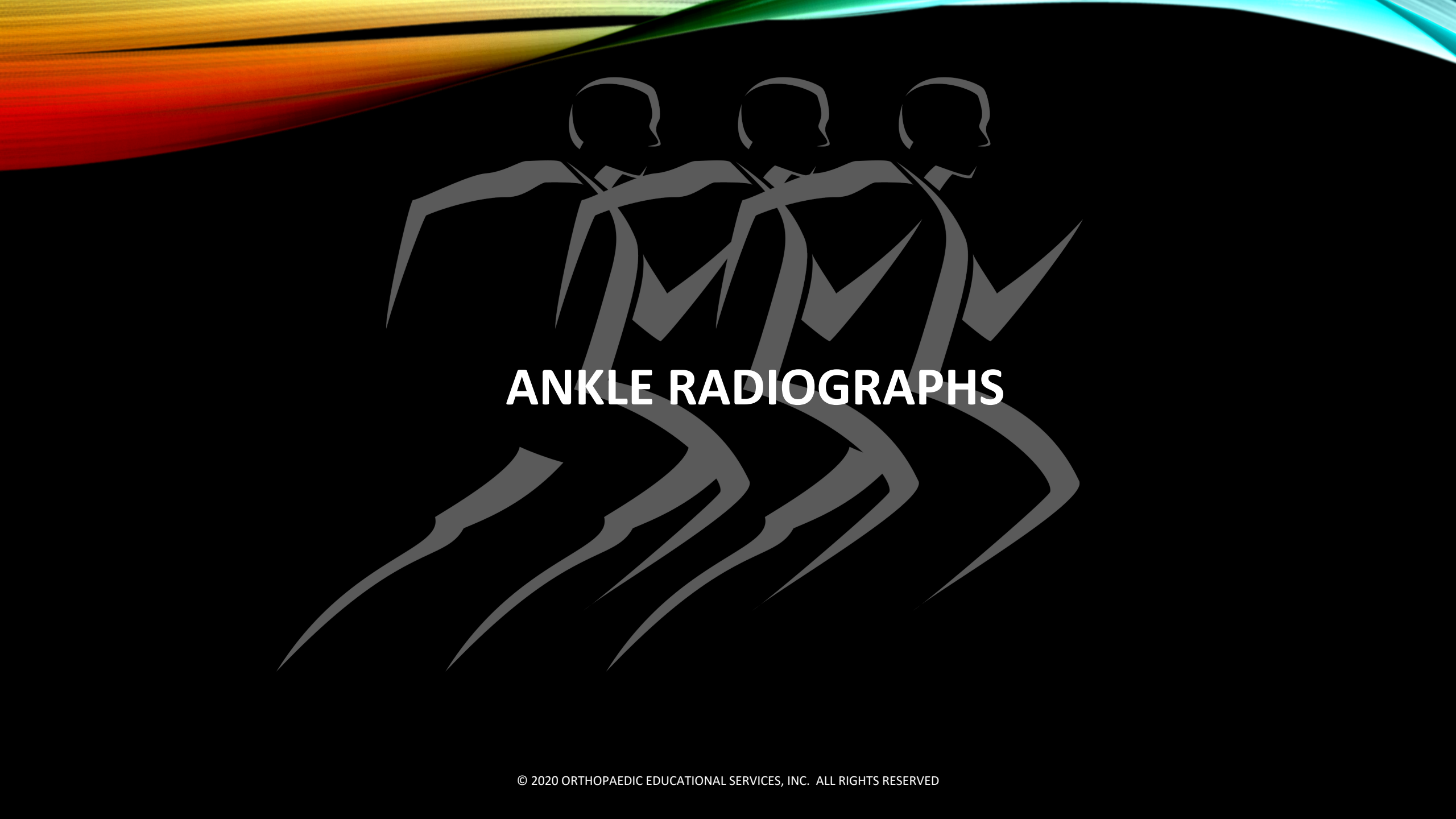
Photo courtesy T Gocke, PA-C

CARPAL BONE INJURIES

Scapholunate Ligament Injury

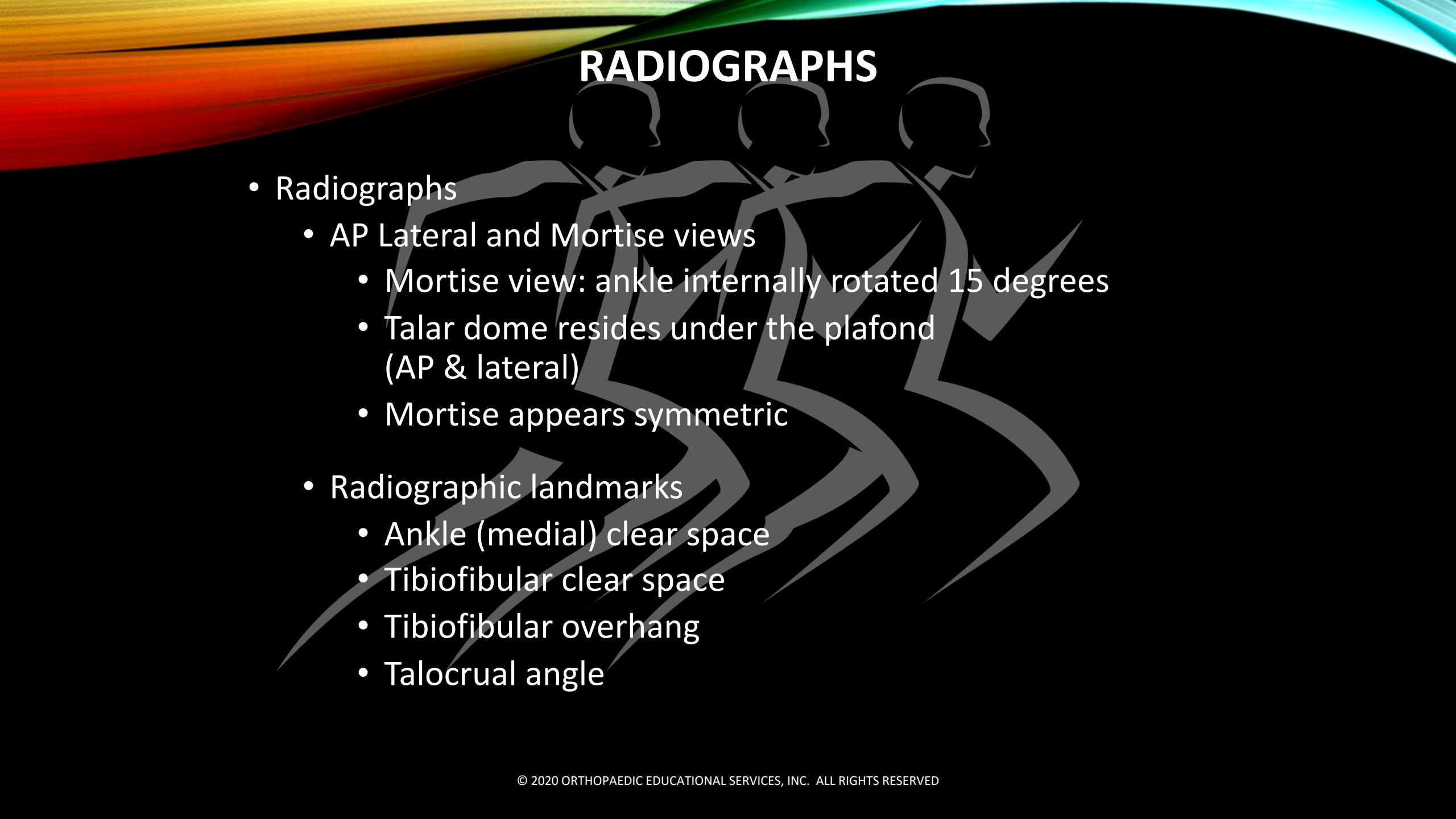
- Radiology
 - X-ray views: AP, Lateral, Oblique, Scaphoid, Clench-Fist
 - AP x-ray
 - **SL gap** > 4mm clenched fist view (Terry Thomas sign)
 - Dorsal & volar margins **distal Lunate** **proximal Capitate** are not superimposed (normal)





ANKLE RADIOGRAPHS

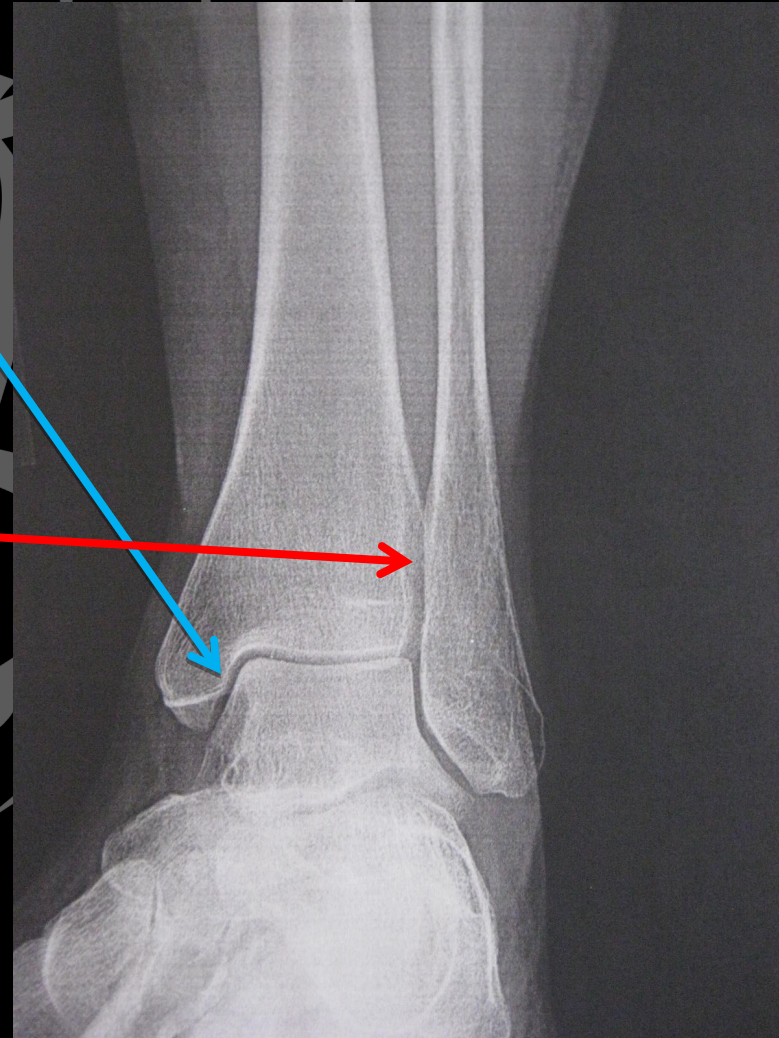
RADIOGRAPHS



- Radiographs
 - AP Lateral and Mortise views
 - Mortise view: ankle internally rotated 15 degrees
 - Talar dome resides under the plafond (AP & lateral)
 - Mortise appears symmetric
 - Radiographic landmarks
 - Ankle (medial) clear space
 - Tibiofibular clear space
 - Tibiofibular overhang
 - Talocrual angle

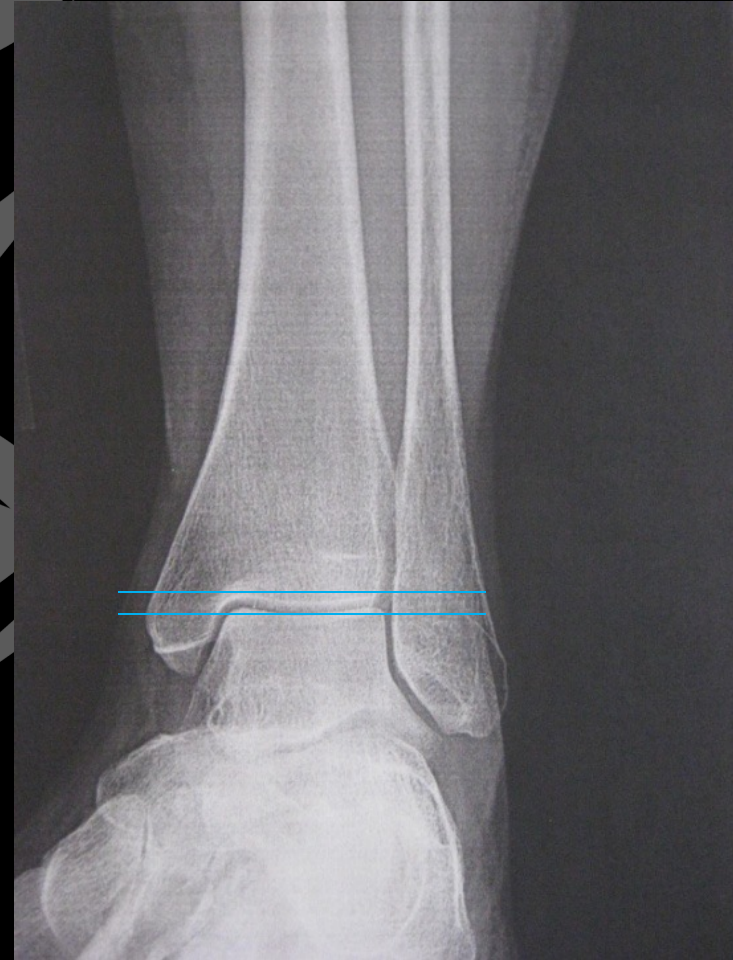
RADIOGRAPHS

- Ankle (medial) clear space
 - Normal range <4 mm between tibia
- Tibiofibular clear space
 - Normal range <5 mm between tibia & fibula



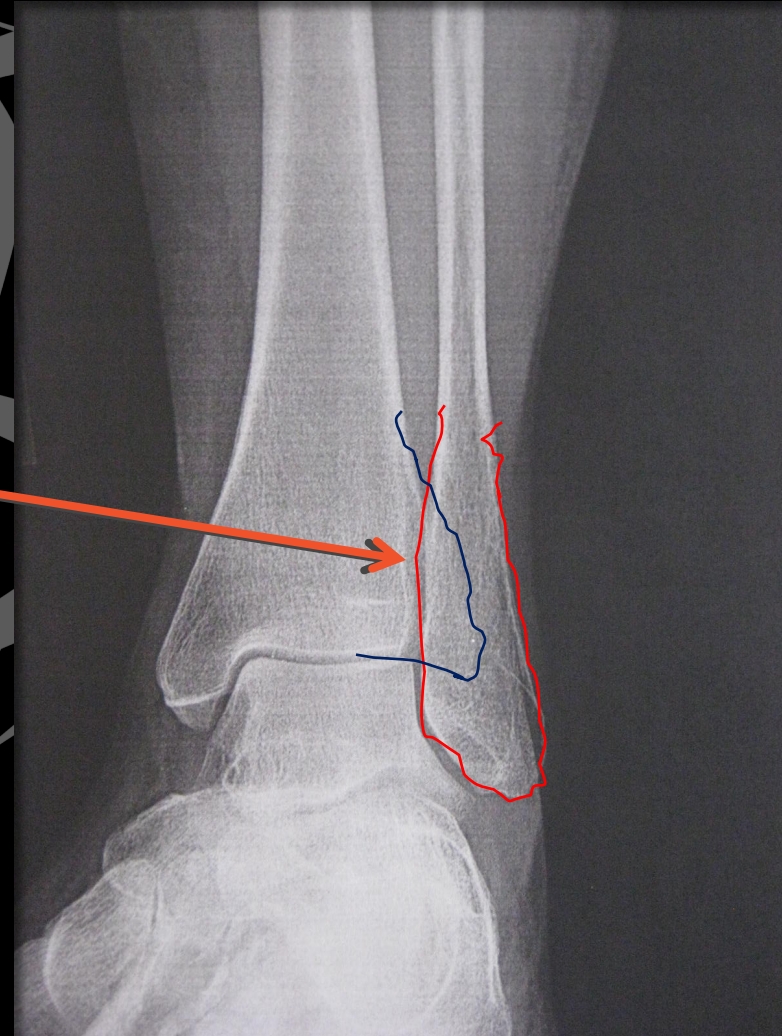
RADIOGRAPHS

- Talar Tilt
 - Parallel lines draw plafond and articular surface talus at ankle mortise
 - Normal < 10 degrees
 - Abnormal



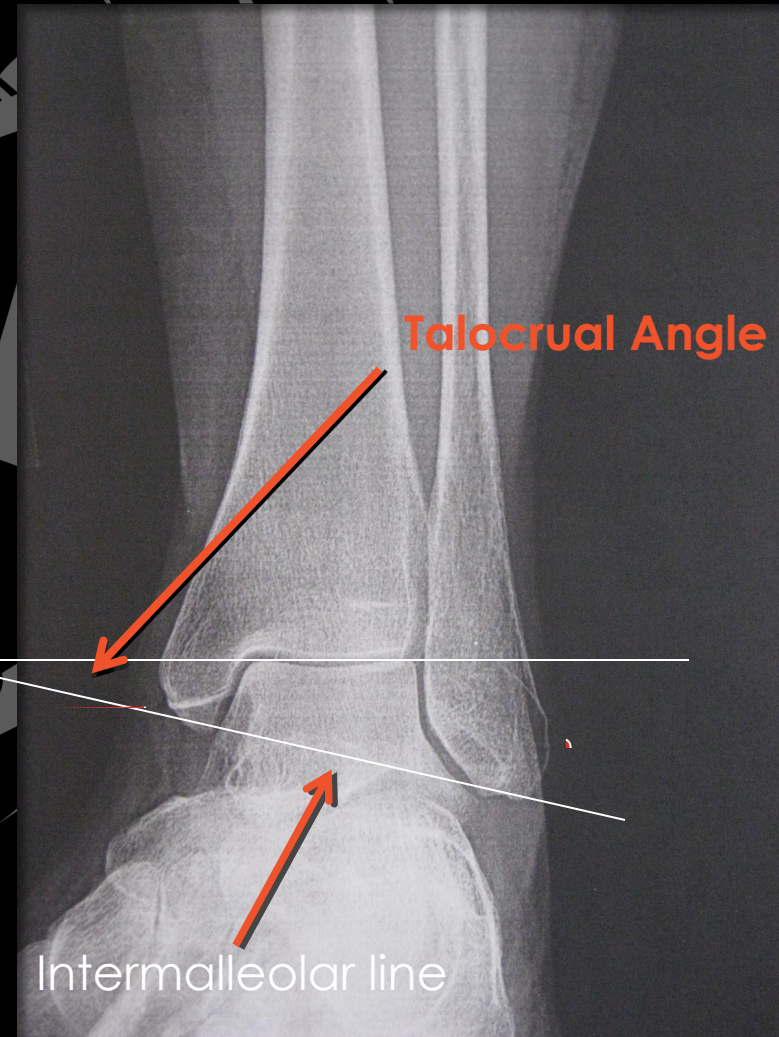
RADIOGRAPHS

- Tibiofibular overlap
 - Normal range >10 mm between tibia & fibula
 - Fibular notch



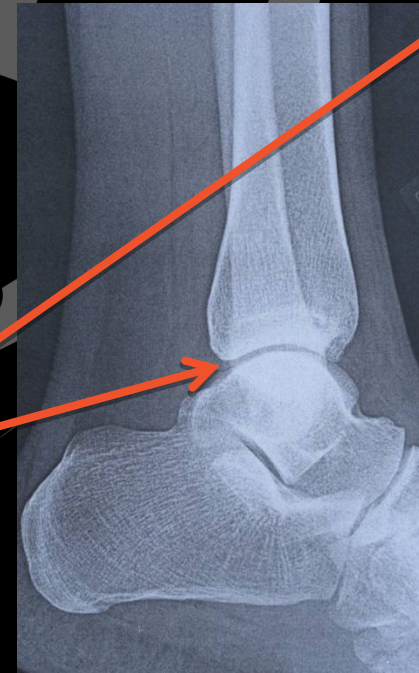
RADIOGRAPHS

- Talocrual Angle
 - Normal measurement 8-15 degrees
 - Strong indicator of syndesmosis disruption, because the fibula will be shortened and externally rotated
 - Talocrual Angle should be compared to the contralateral normal side



RADIOGRAPHS

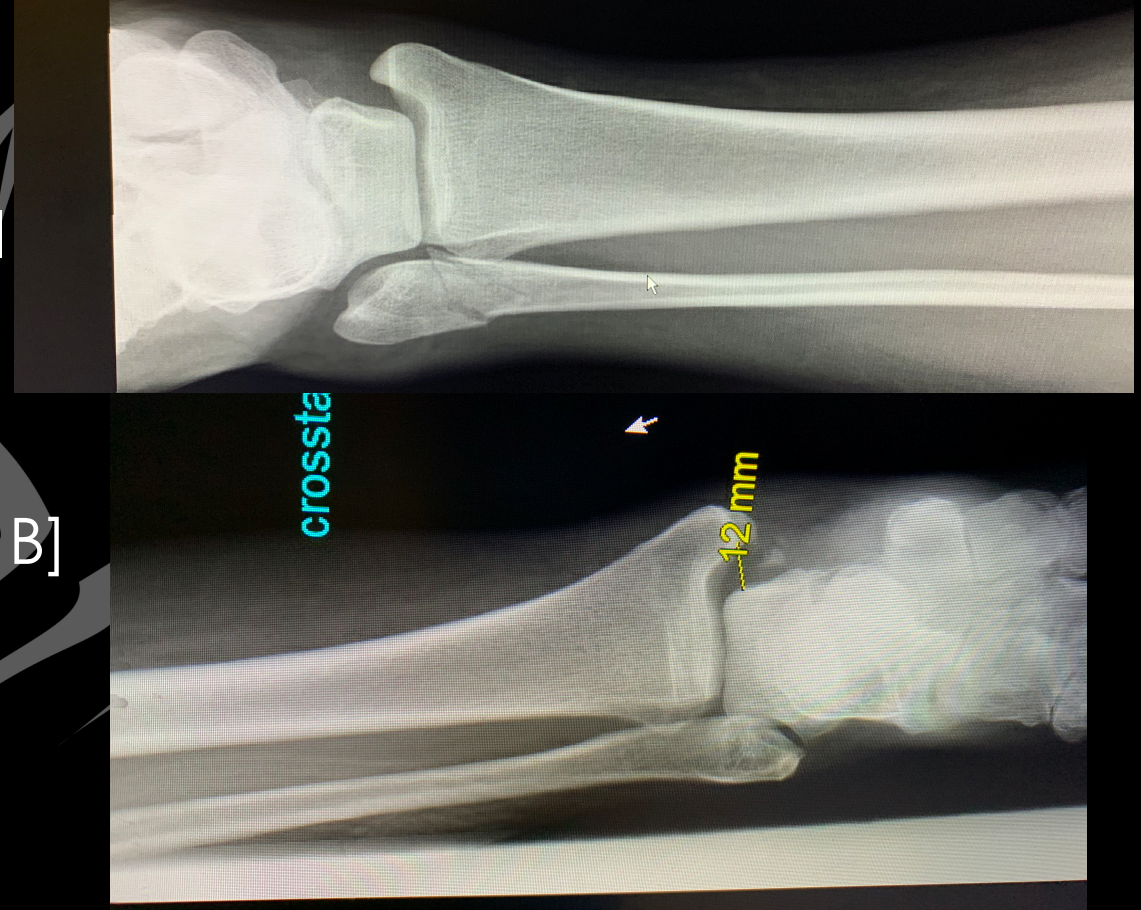
- Radiographs
 - AP Lateral and Mortise views
 - Mortise view: ankle internally rotated 15 degrees
 - Check medial Clear space
 - Normal mortise configuration
 - Talar dome fits under Plafond in ALL views

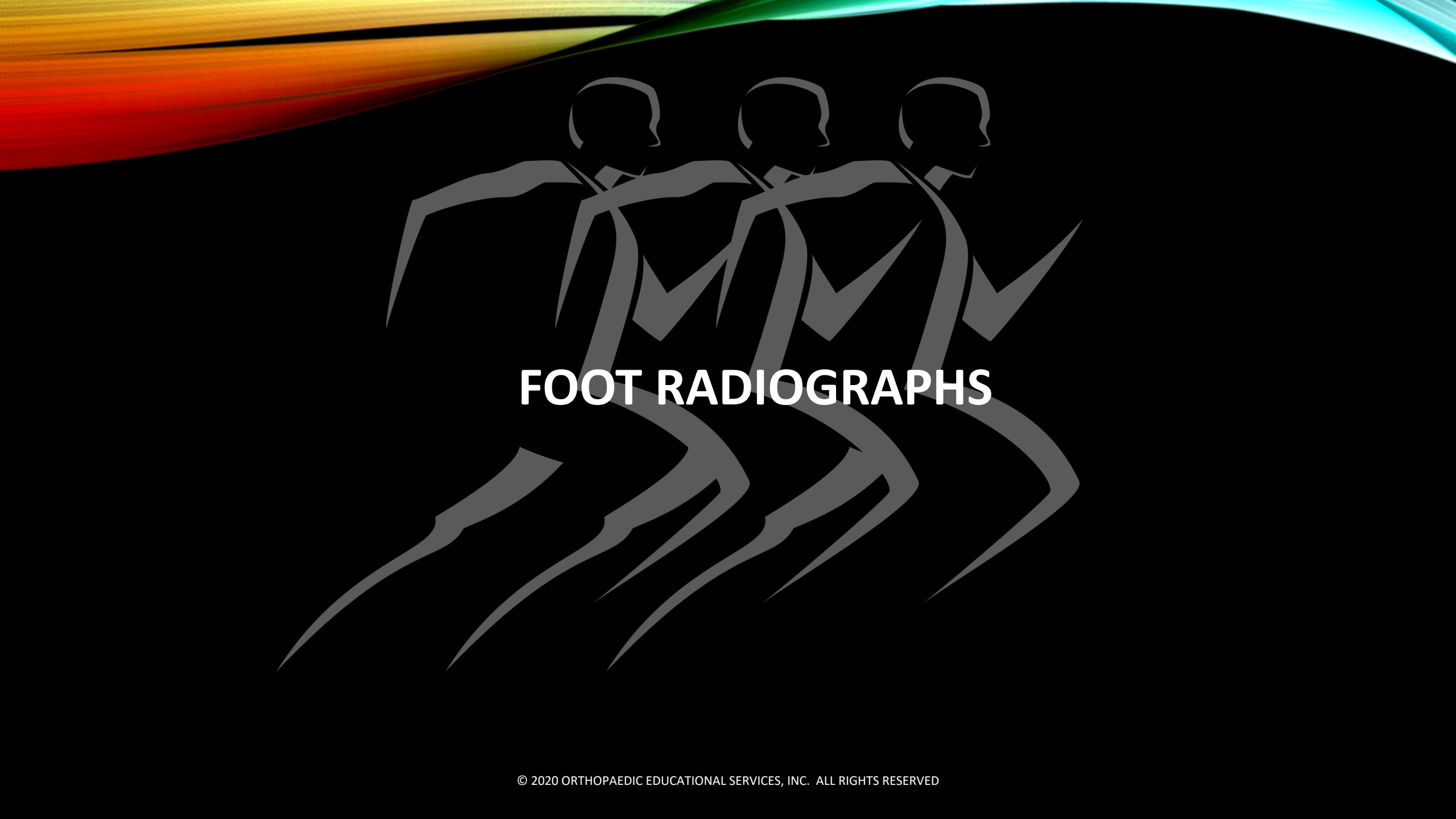


GRAVITY STRESS VIEW ANKLE

Gravity Stress View Ankle

- MCS >4mm on gravity stress view
- unstable ankle in supination-external rotation injury
- Deltoid ligament injury
- Positive findings related to need for surgical stabilization ankle fx [Weber B]

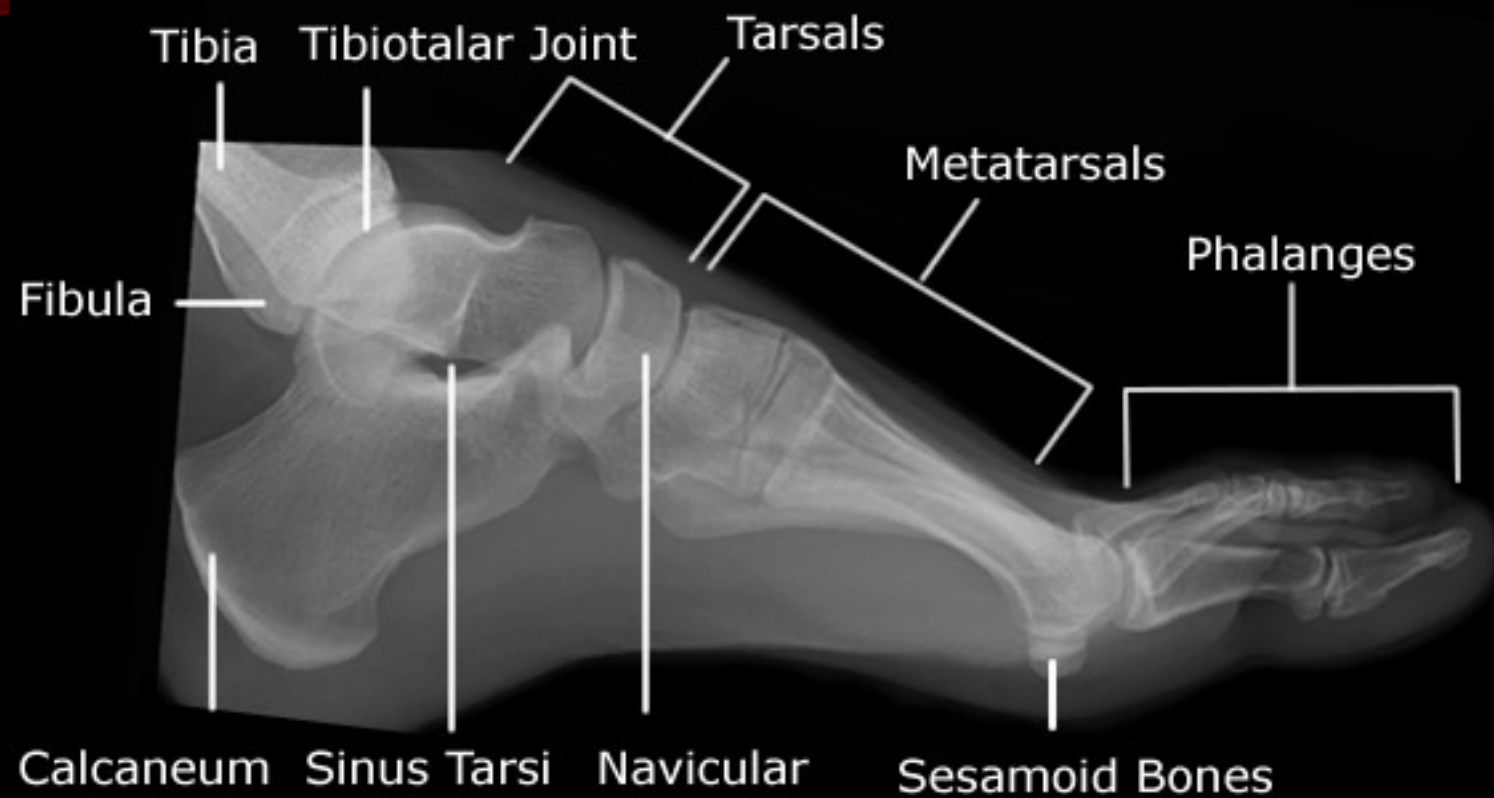




FOOT RADIOGRAPHS



Images courtesy Michael J. Fuller-WikiRadology



Images courtesy Michael J. Fuller-WikiRadology

RADIOGRAPHS

- Foot: AP, LATERAL & OBLIQUE
 - WT-BEARING –best to assess:
 - Hallux valgus angle (HVA)
 - Intermetatarsal angle (IMA)
 - CHARCOT foot
 - Lis-franc – pain/swelling allows
- **NORMAL ALIGNMENT**
 - 1ST MT -1ST CUNEIFORM
 - 2ND MT – 2ND CUNEIFORM
 - 3RD MT – 3RD CUNEIFORM
 - 4TH & 5TH MT – CUBOID



Photos courtesy TGoetze, PA-C

RADIOGRAPHS

- Lateral & Harris heel views
 - Calcaneal Fracture
 - Loss Bohler's angle and angle of Gissane
 - Harris/Beeth heel view – Calcaneal fx
 - CT scan w/ recon images best for calcaneous fx



RADIOGRAPHS

Harris/Beeth views

- Harris/Beeth heel view:
 - Best detect Calcaneal fx
- Normal: no varus or valgus angulation
- Abnormal:
 - Loss length Calcaneous
 - Varus/valgus deformity
 - Hind foot appears deformed
- CT scan w/ recon images best for calcaneous fx

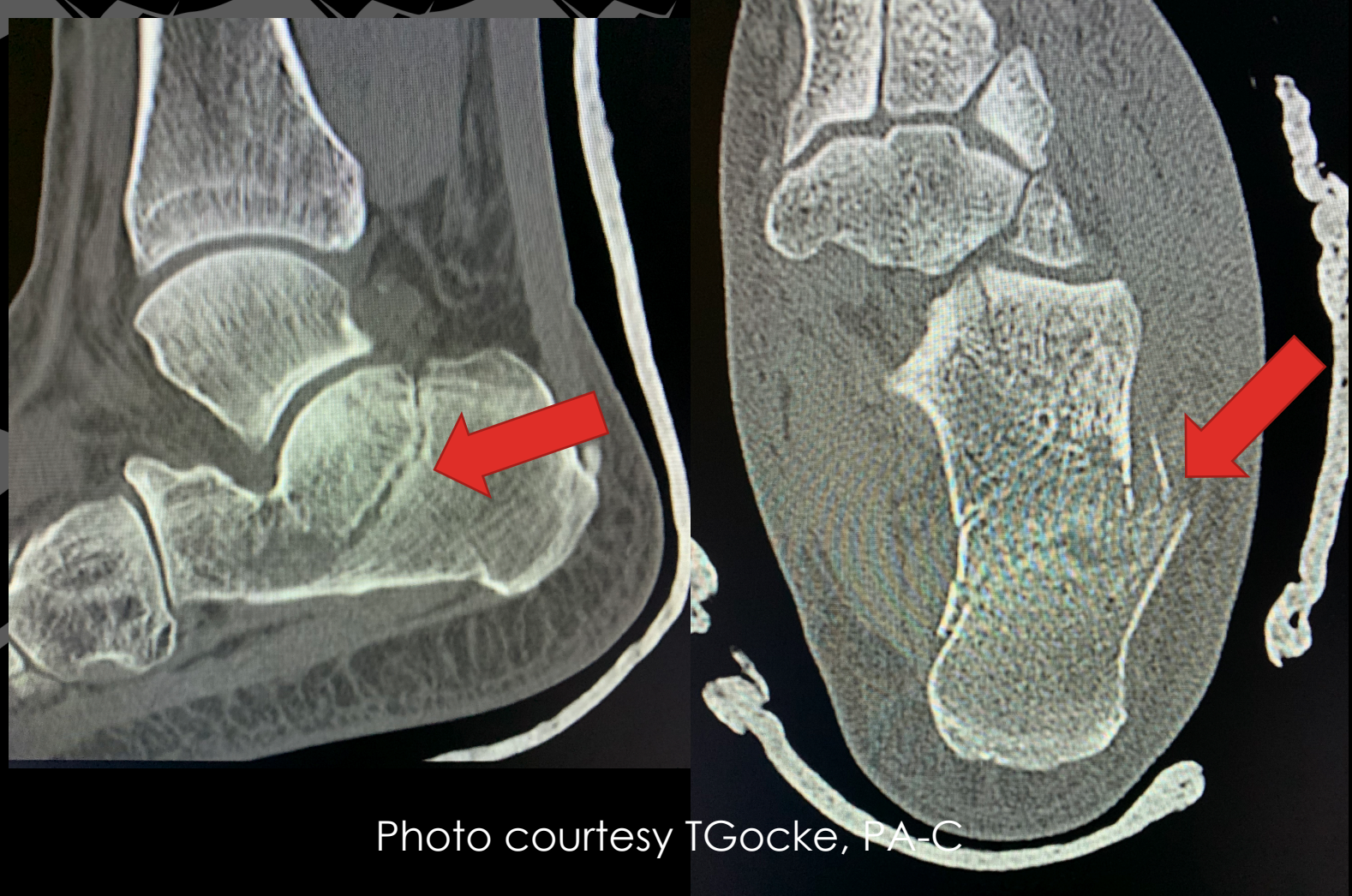


Photo courtesy TGocke, PA-C

TAKE HOME POINTS

- KNOW WHAT NORMAL LOOKS LIKE
- At least 2 views of every joint/bone you x-ray (PA & Lateral)
- Elbow- look for Radiocapitellar line, anterior Humeral line & Fat pad sign
- Wrist: Radius lines and Gilula's arch's, look for wide Scapholunate
- Ankle – look for Mortise widening
- Foot – Make sure the cuneiforms and the Metatarsals line up
- Spine – Lateral looking for disc space narrowing and loss of lordosis

REFERENCES

- Ehrlichman LK, Gonzalez TA, Macaulay AA, Ghorbanhoseini M, Kwon JY. Gravity Reduction View: A Radiographic Technique for the Evaluation and Management of Weber B Fibula Fractures. *Arch Bone Jt Surg*. 2017;5(2):89-95.
- Pitakveerakul A, Kungwan S, Arunakul P, Arunakul M. Radiographic parameters in gravity stress view of the ankle: Normative data. *Foot Ankle Surg*. 2019;25(6):819-825. doi:10.1016/j.fas.2018.10.011