Commonly Missed Orthopedic Injuries

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Missed Orthopedic Injuries

- Overlooking orthopedic injuries is a leading cause of medical malpractice claims out of the ED.
- Am J Emergency Med 1996. 14(4):341-5. Karcz et al, 1996.
- Massachusetts Joint Underwriters Association: Missed fractures comprised 20% (during1980-1987) and 10% (1988-1990) of malpractice claims.
- Fractures are 2nd in claim amount and number of cases established against ED physicians.

Radiographics Commonly Missed

- Wei (Taipei, Acta Radiol 2006) identified specific regions of misinterpretation:

- Foot 7.6% 18/238
- Knee 6.3% 14/224
- Elbow 6.0% 14/234
- Hand 5.4% 10/185
- Wrist 4.1% 25/606
- Hip 3.9% 20/512
- Ankle 2.8% 8/282
- Shoulder 1.9% 5/266
- Tibia/fibula 0.4% 1/226
- Total 3.7% 115/3081

Pitfalls of ER X-Rays

- Incorrect interpretation (interpretation errors)
- Inadequate (suboptimal) images
- Over-reliance on radiography
- Inadequate clinical examination

Fractures are a Clinical Diagnosis

- 1) Mechanism of injury
- 2) Findings on physical examination
- 3) Age of the patient.
- Radiography confirms the diagnosis and provides anatomical detail.
- Fractures can be present without radiographic abnormality.

Fractures are a Clinical Diagnosis

- If a fracture is clinically suspected
- but not radiographically apparent, treat the patient as though a fracture were present with
- adequate immobilization and follow-up (e.g., scaphoid fracture, femoral neck fracture).

Fractures are a Clinical Diagnosis

- Soft tissue injuries may be more significant that the skeletal injury (ligaments, articular cartilage, neurovascular injuries).
- Diagnosis by physical exam or imaging studies: MRI, angiography, arthroscopy, stress views.

Pitfalls in Orthopedic Radiology

- **Misinterpretation of radiographs**
- Failure to recognize subtle signs of injury
- Misinterpreting radiographic variants as acute injuries
- Missed second injury (“satisfaction of search” error)

Pitfalls in Orthopedic Radiology

- **Inadequate radiographs**
- Inadequate views (technically suboptimal)
- Incomplete radiographic series (missing views)
- Failure to order supplementary views or other studies (MDCT, MRI)

Pitfalls in Orthopedic Radiology

- **Clinical examination inadequate**
- Radiography of the incorrect region (hand/wrist, foot/ankle)
- Missed soft tissue injury (neurovascular, compartment syndrome, ligamentous)
- Missed second injury
- Failure to obtain radiographs

Pitfalls in Orthopedic Radiology

- **Inadequate treatment**
- Failure to consider and treat potential occult fractures (scaphoid, femoral neck)
- Poor discharge and follow-up instructions
- **Breakdown in radiology follow-up (re-call) systems**

Missed Fractures and Dislocations

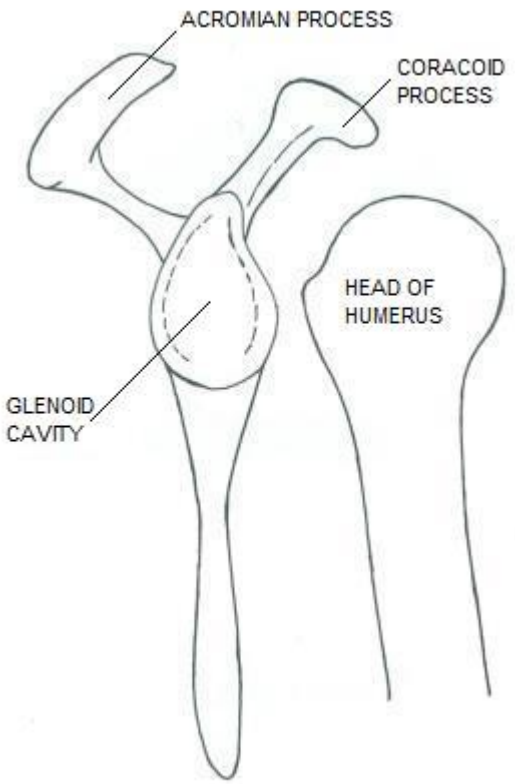
- Common injuries that present with subtle clinical and radiographic findings.
- The fractures are usually nondisplaced or minimally displaced.
- Associated clinical signs must be sought when examining the patient.
- Additional radiographic views are sometimes needed to visualize these injuries.
- Many of these injuries have substantial morbidity if missed.

Missed Upper Extremity Injuries

Shoulder Dislocation

Y scapular x-ray

--Needed to determine dislocation and direction of dislocation

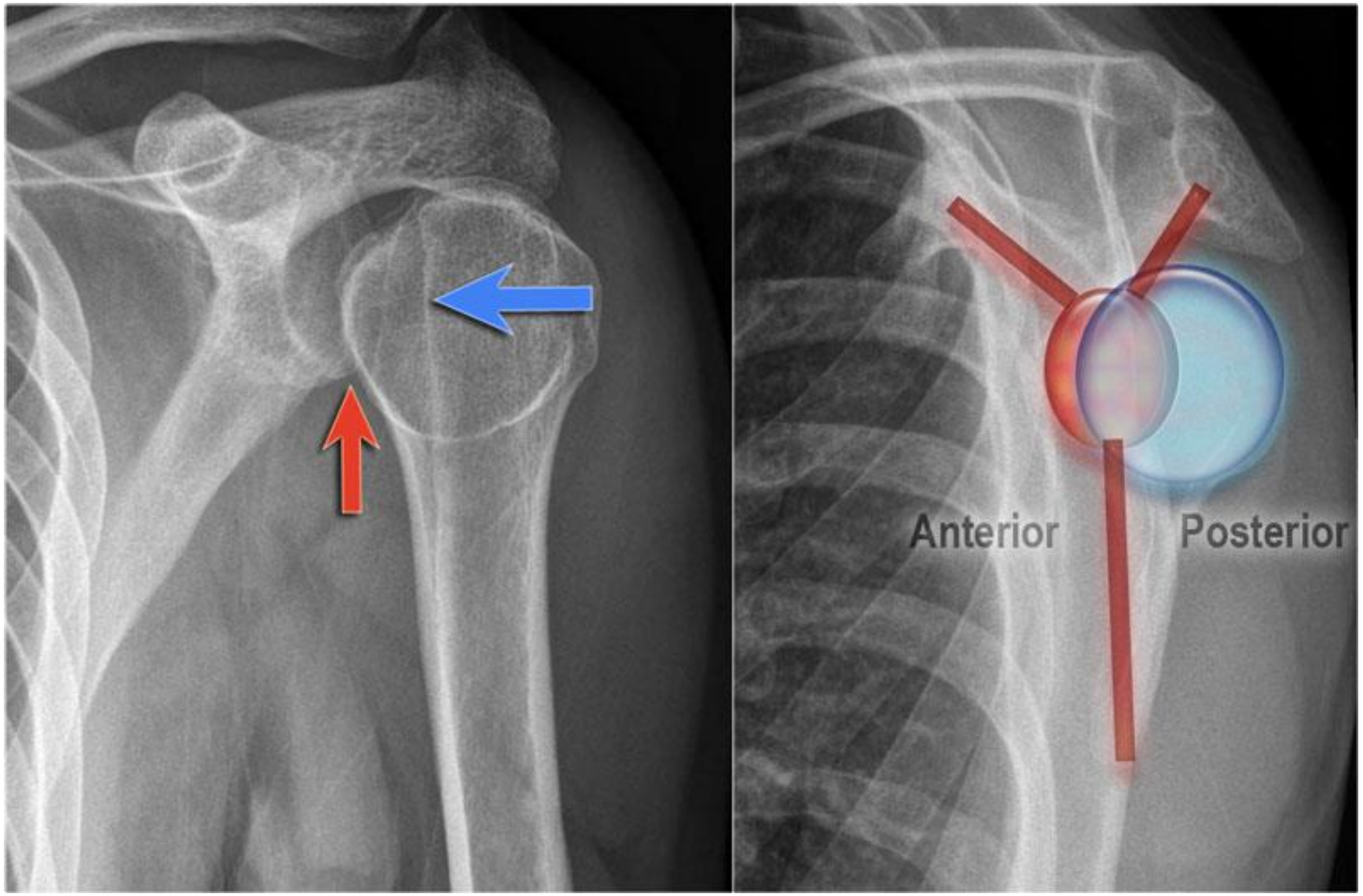


ANTERIOR SHOULDER DISLOCATION

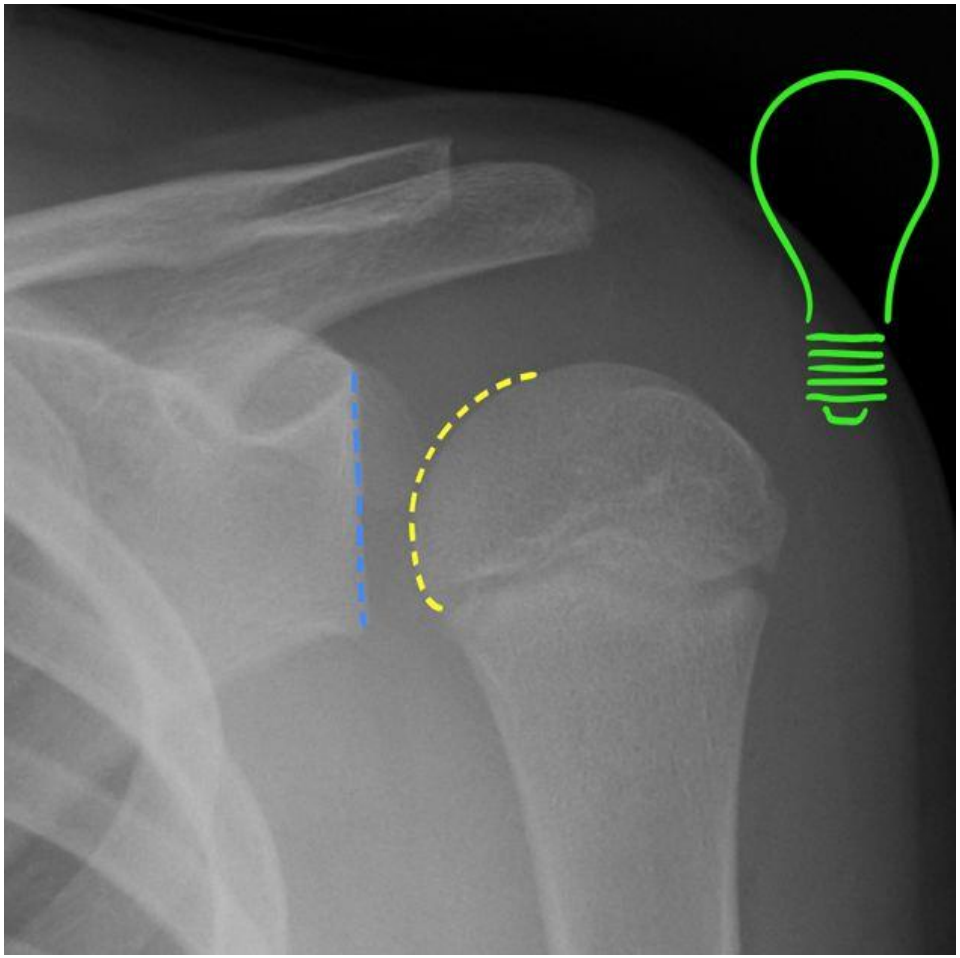
Missed Fractures and Dislocations Upper Extremity

- Shoulder
- **Posterior dislocation** – AP view: “light bulb on a stick” humerus fixed in internal rotation plus wide space between humeral head and glenoid fossa; axillary view to confirm.
- Beware of proximal humerus fracture with subtle associated posterior dislocation.

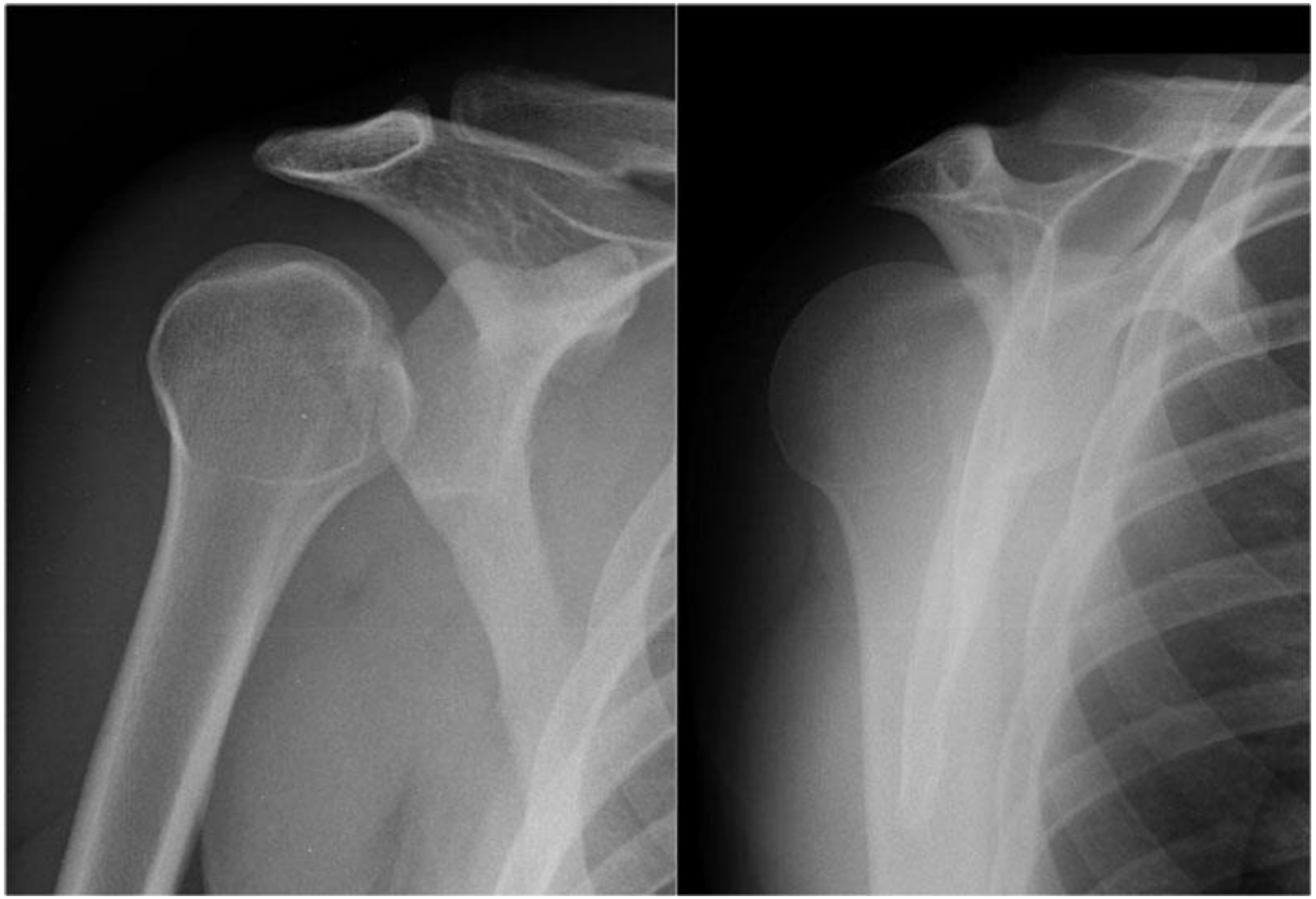
Posterior Dislocation



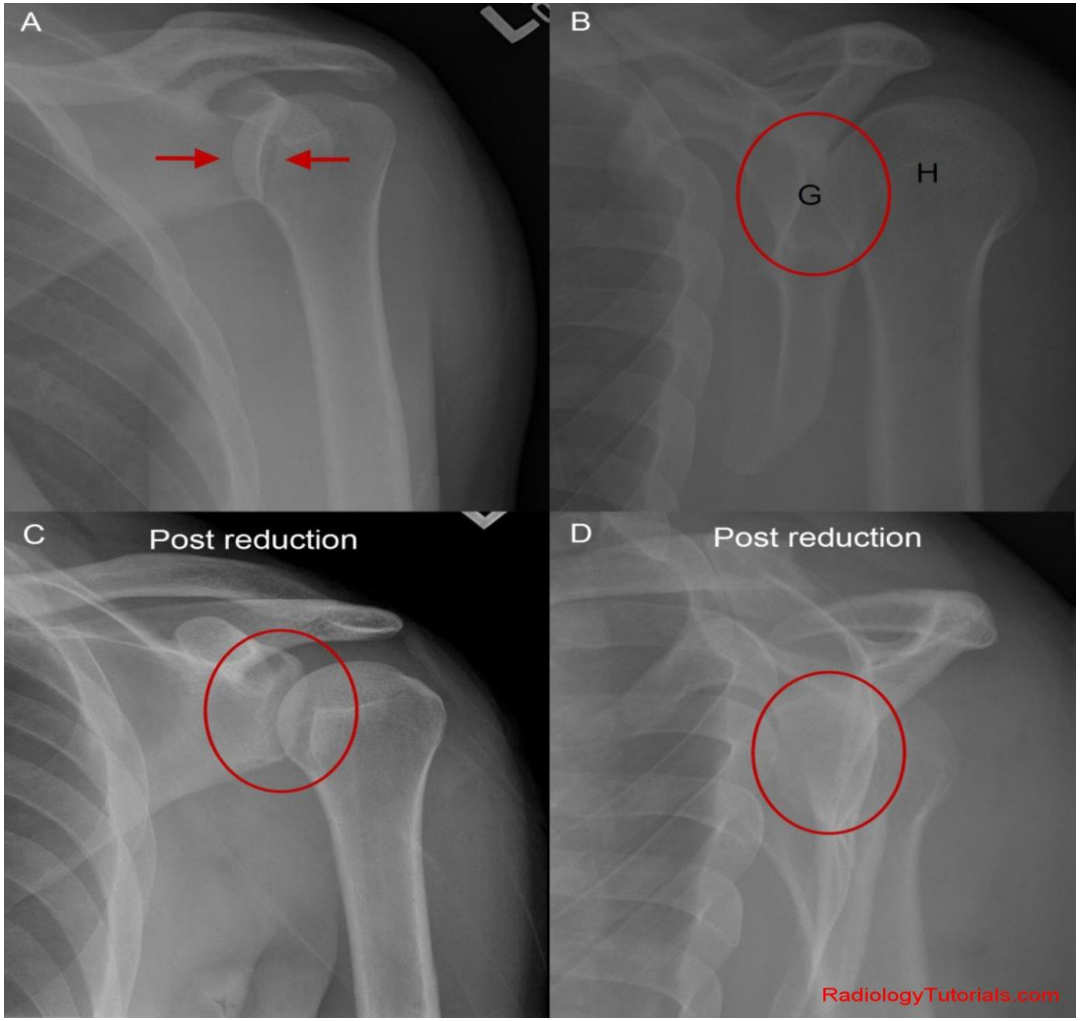
Posterior Dislocation



Posterior Dislocation



Posterior Dislocation



Missed Fractures and Dislocations Upper Extremity

- Shoulder
- Anterior dislocation with humeral neck fracture – unstable for closed reduction

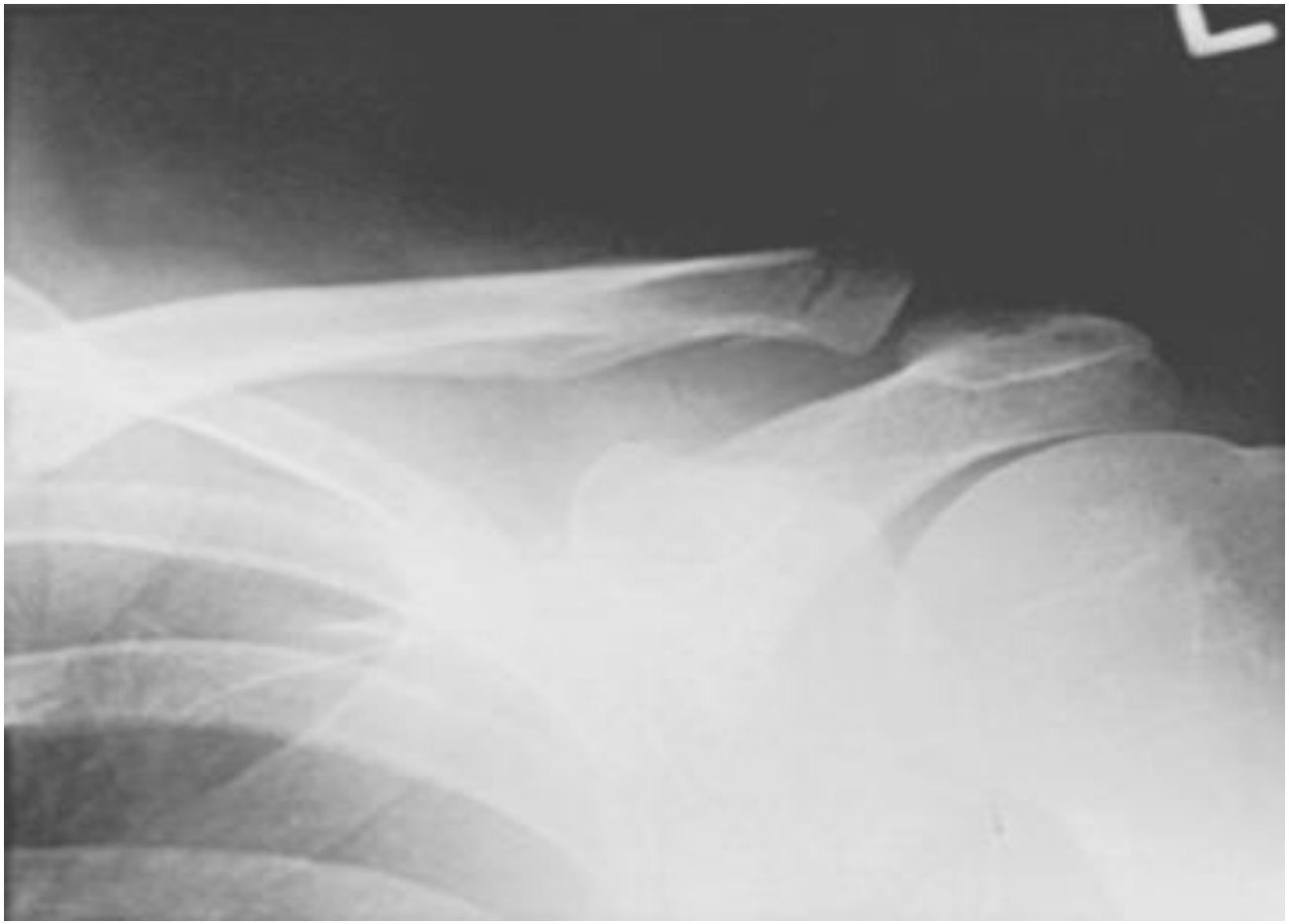
Anterior Dislocation

Dislocation with Fracture

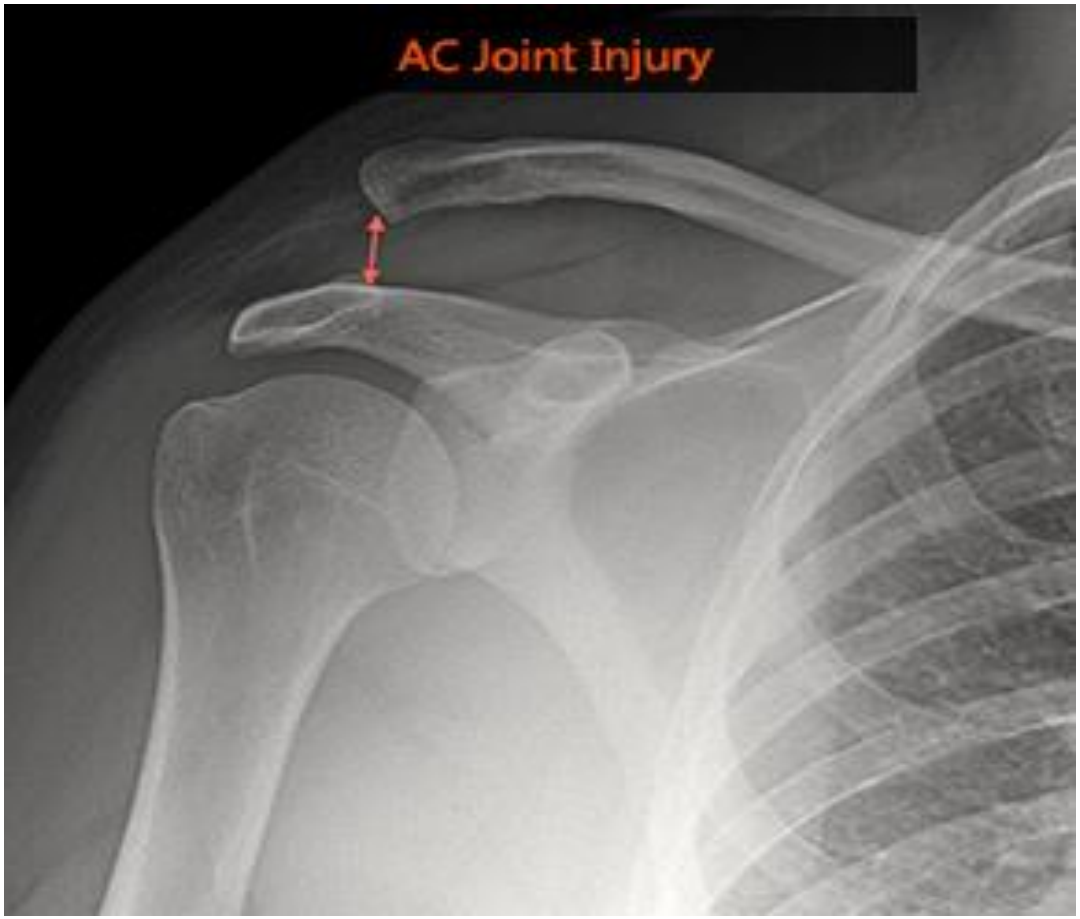
Missed Fractures and Dislocations Upper Extremity

- Shoulder
- Distal clavicle fracture (elderly) or A-C separation (young adults)

Distal Clavicle fracture



AC Joint Dislocation

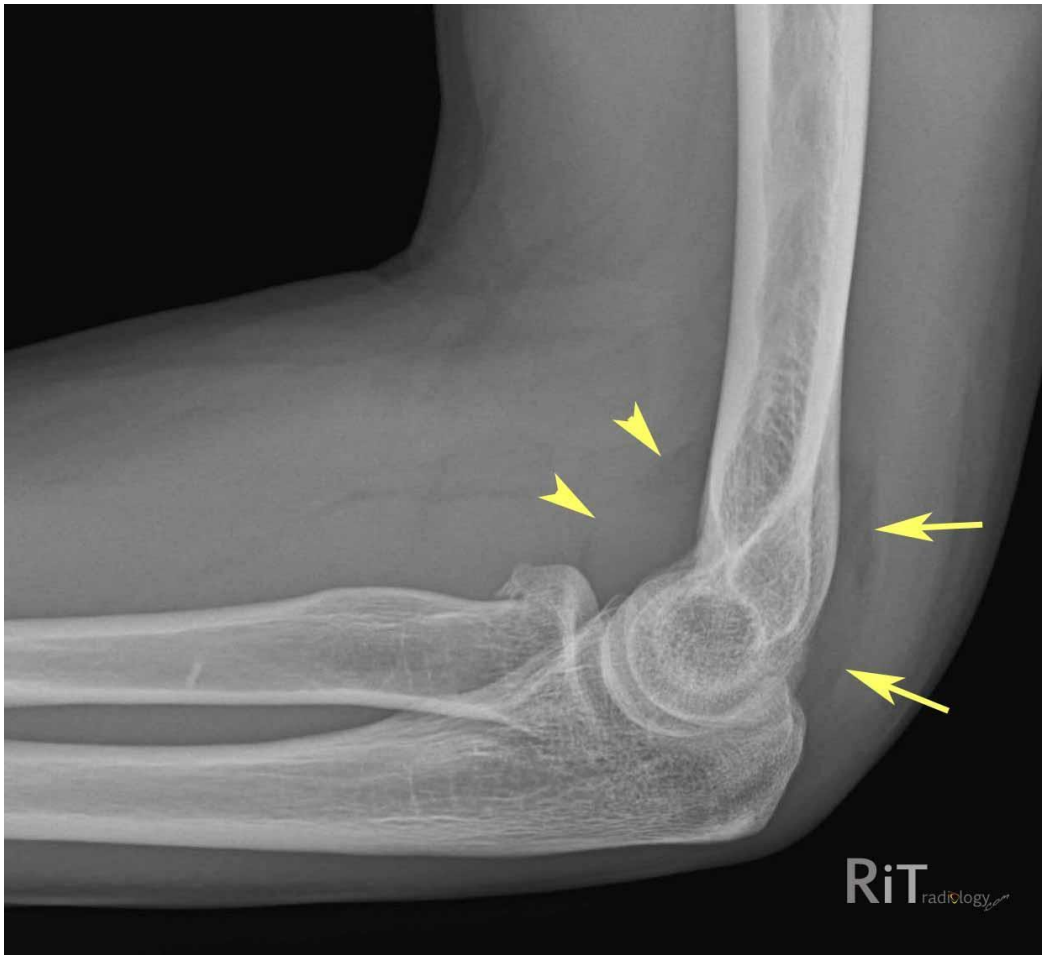


Missed Fractures and Dislocations Upper Extremity

- Elbow Fat-pad sign
- Adult - Radial head fracture or other intra-articular fracture

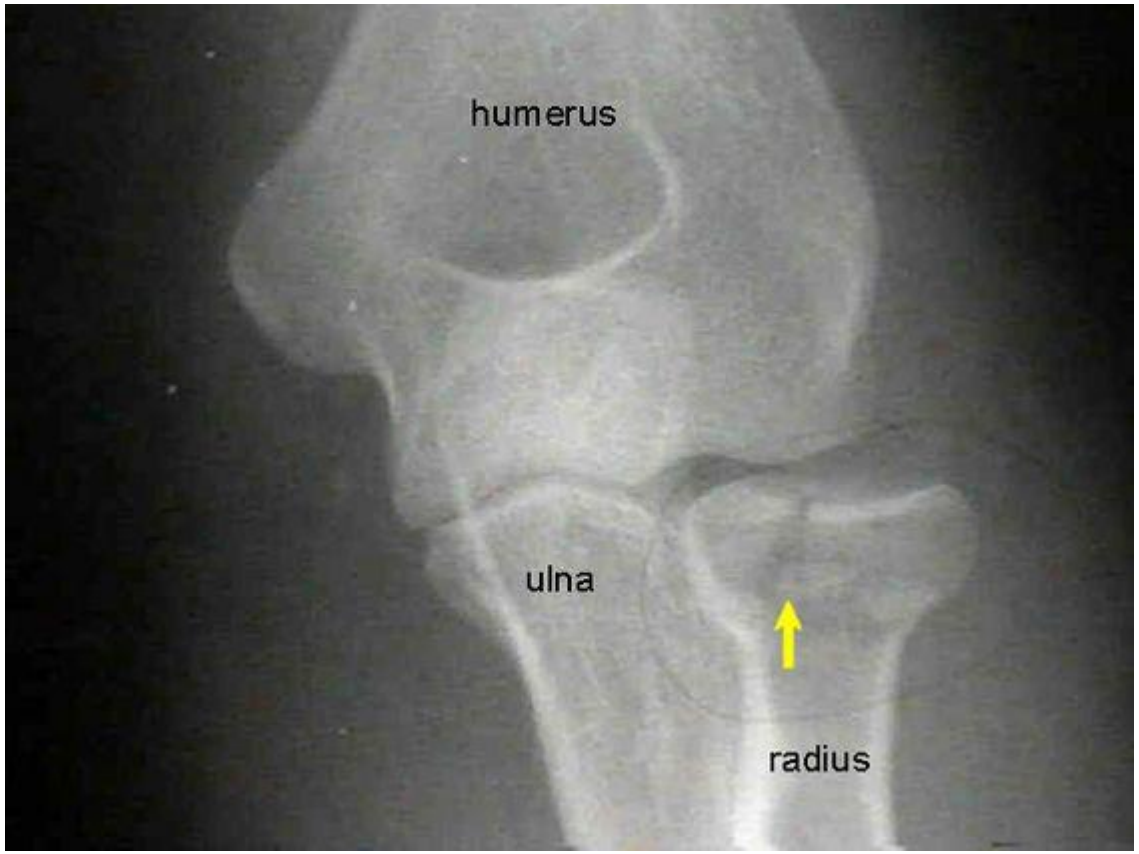
Elbow Fat Pad Sign

Elbow Fat Pad



Elbow Fat Pad

Radial Head Fracture



Radial Head Fracture

Missed Fractures and Dislocations Upper Extremity

- Elbow Fat-pad sign
- Child - Supracondylar or lateral condylar fractures; medial epicondyle avulsion fracture maybe displaced into joint space and be mistaken as an ossification center; radial head or neck fracture

Missed Fractures and Dislocations Upper Extremity

- Forearm
- Monteggia and Galeazzi fracture-dislocations – examine joint above and below a forearm fracture
- *Monteggia fracture*-dislocations comprise of a *fracture* of the ulna shaft and dislocation of the radial head. The ulna *fracture* is usually very obvious whereas the radial head dislocation can be overlooked, with potentially serious functional and medico-legal ramifications.

Monteggia Fracture

Missed Fractures and Dislocations Upper Extremity

- *Galeazzi fracture*-dislocations consist of *fracture* of the distal part of the radius with dislocation of distal radioulnar joint and an intact ulna.

Galeazzi Fracture

Galeazzi Fracture

Missed Fractures and Dislocations Upper Extremity

- Wrist
- Distal radius fracture (non-displaced) – on lateral view see displaced pronator fat stripe and disruption of cortex

Nondisplaced Wrist fracture

Missed Fractures and Dislocations Upper Extremity

- Carpal fractures:
- Scaphoid – 60% (“snuff box” tenderness) hyperextension injury of wrist or fall on outstretched hand,
- Triquetrum (dorsal chip) – 20%, Triquetrum fractures typically occur from a fall onto an outstretched arm with the wrist in extension and ulnar deviation, or in extreme flexion. It is the second most common wrist fracture after scaphoid fracture
- Carpal dislocations/instability – 20%: perilunate, lunate, scapholunate dissociation

Scaphoid Fracture

Triquetrum Fracture

Carpal Dissociation

Missed Fractures and Dislocations Upper Extremity

- Metacarpal base fractures (thumb: Bennett & Rolando fractures are unstable)

Rolando Fracture

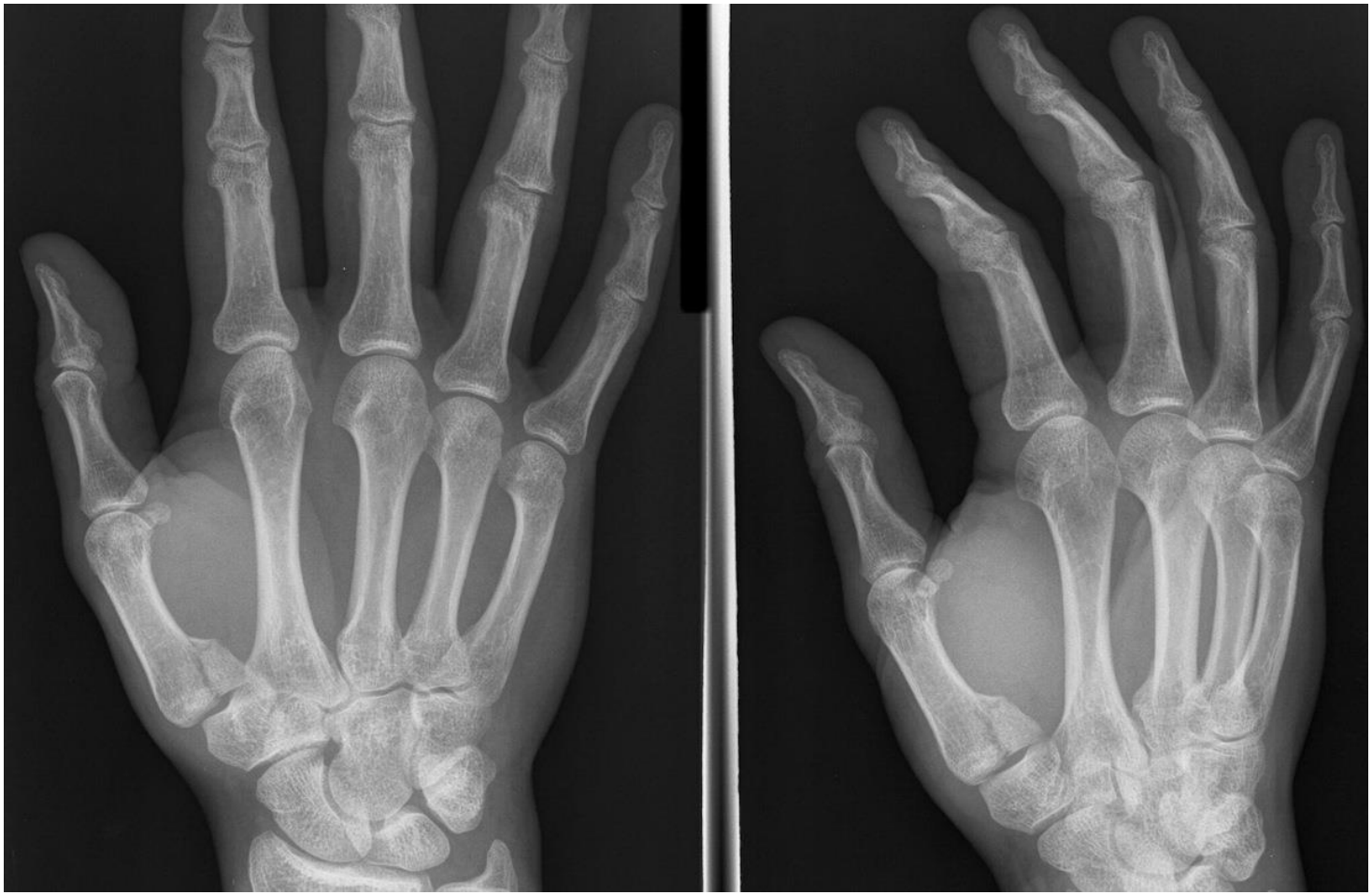
- *Rolando fracture* is a three part or comminuted intra-articular *fracture*-dislocation of the base of thumb (proximal first metacarpal). It can be thought of as a comminuted Bennett *fracture*. The mechanism is usually an axial blow to a partially flexed metacarpal, such as a fistfight.

Rolando Fracture

Bennett Fracture

- **Bennett fracture** is a **fracture** of the base of the first metacarpal bone which extends into the carpometacarpal (CMC) joint. This intra-articular **fracture** is the most common type of **fracture** of the thumb, and is nearly always accompanied by some degree of subluxation or frank dislocation of the carpometacarpal joint.

Bennett Fracture



Missed Fractures and Dislocations Upper Extremity

- Hand
- Tendon & ligament injuries: mallet finger, boutonniere deformity, gamekeeper's thumb
- Phalangeal avulsion (volar plate) fractures

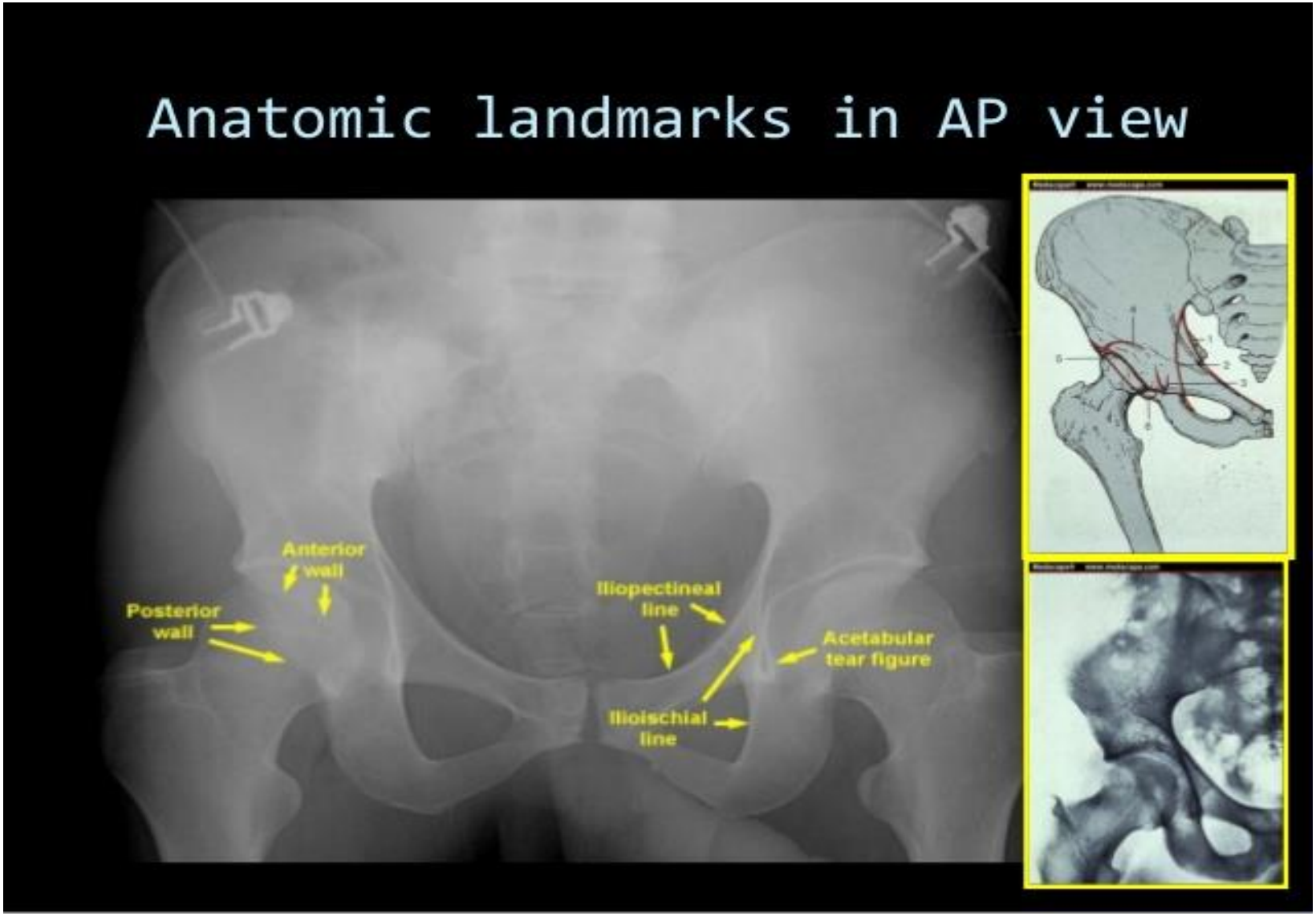
Volar Plate Fracture

Volar Plate Fracture

Volar Plate Fracture

Missed Lower Extremity Injuries

Pelvis


Anatomic landmarks in AP view
Anterior wall
Posterior wall
Iliopectineal line
Acetabular tear figure
Ilioischial line

Missed Fractures and Dislocations Lower Extremity

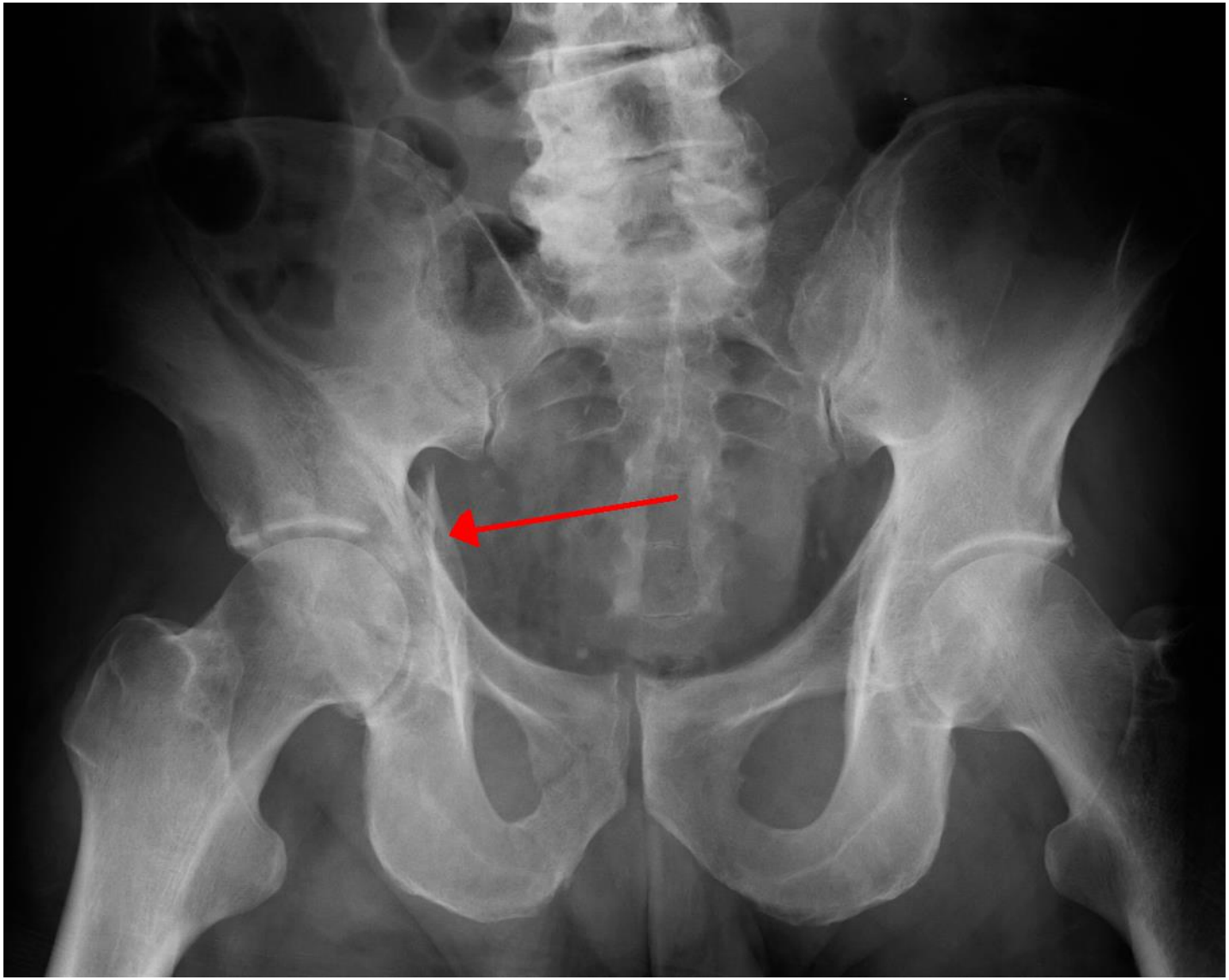
- Pelvis
- Pubic ramus fractures, iliac wing fracture, avulsions (ischial tuberosity, anterior iliac spine)

Pubic Ramus Fracture

Missed Fractures and Dislocations Lower Extremity

- Pelvis
- Pelvic ring fractures – Posterior (sacral wing) fractures – disrupted sacral neuroforaminal lines

Pelvic Fracture

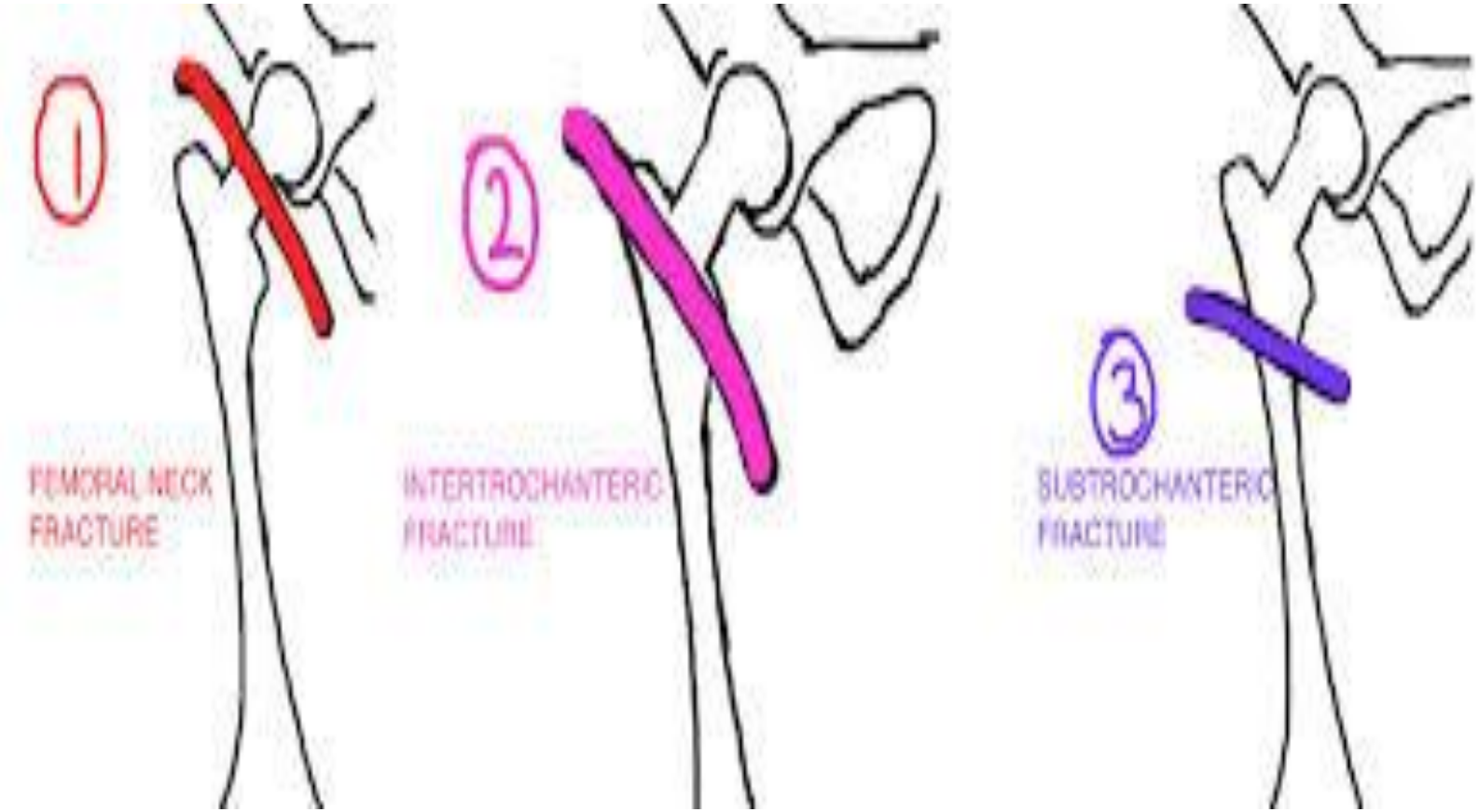


Missed Fractures and Dislocations Lower Extremity

- Pelvis
- Acetabular fractures – disrupted “radiographic tear drop.” Judet (oblique) views, MDCT

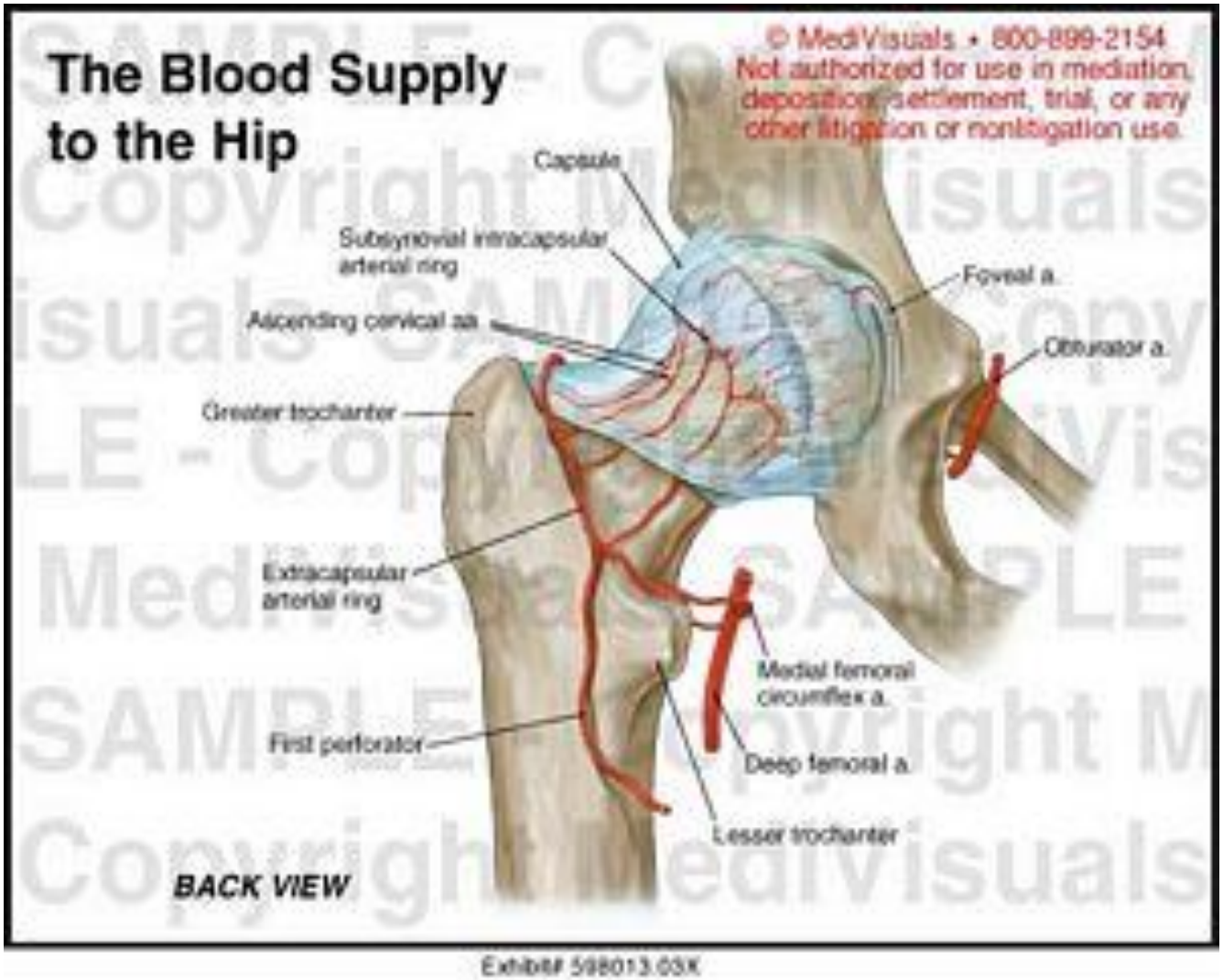
Hip Fractures

Hip Fractures

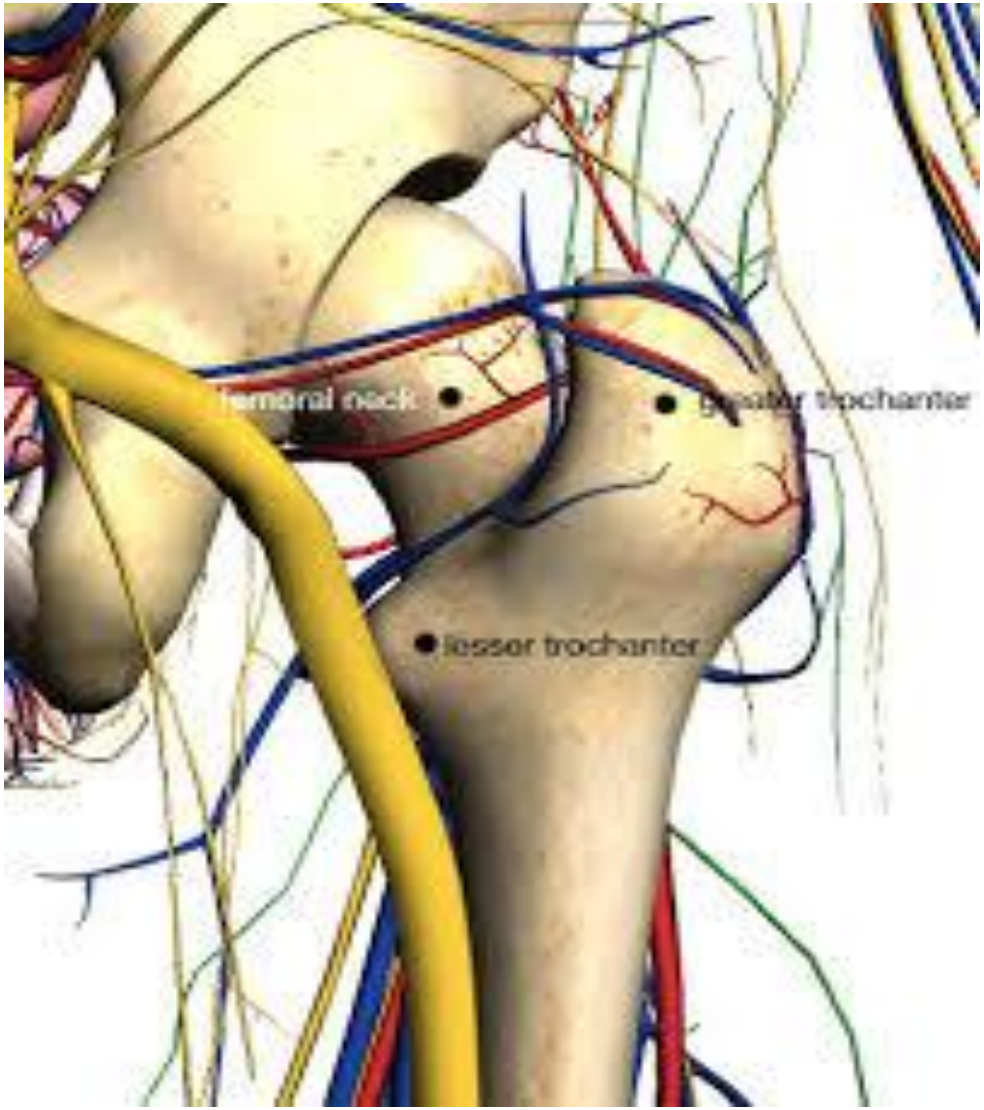


Hip Fractures

Hip Blood Supply



Hip Fractures

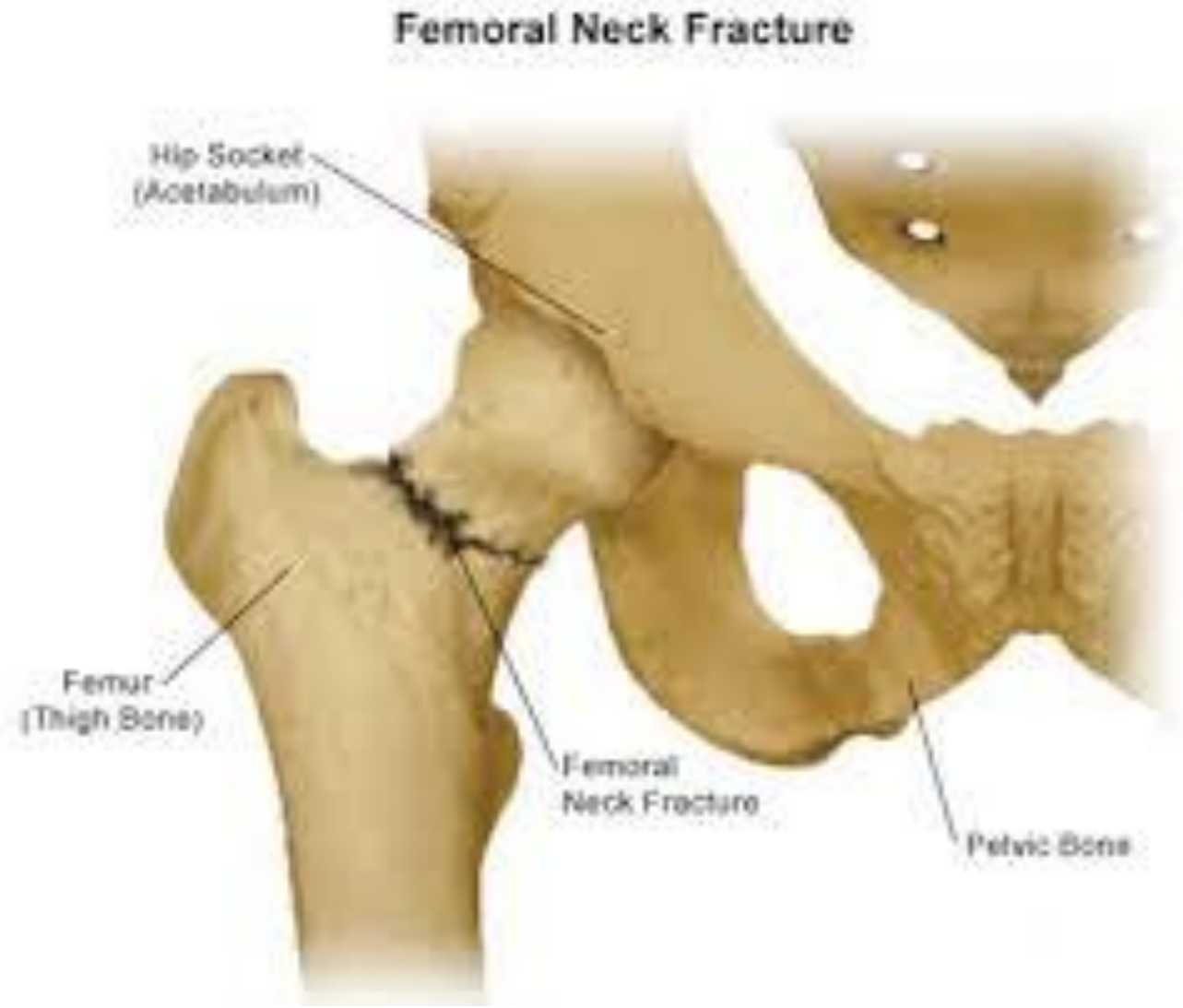


Femoral Neck Fractures

Missed Fractures and Dislocations Lower Extremity

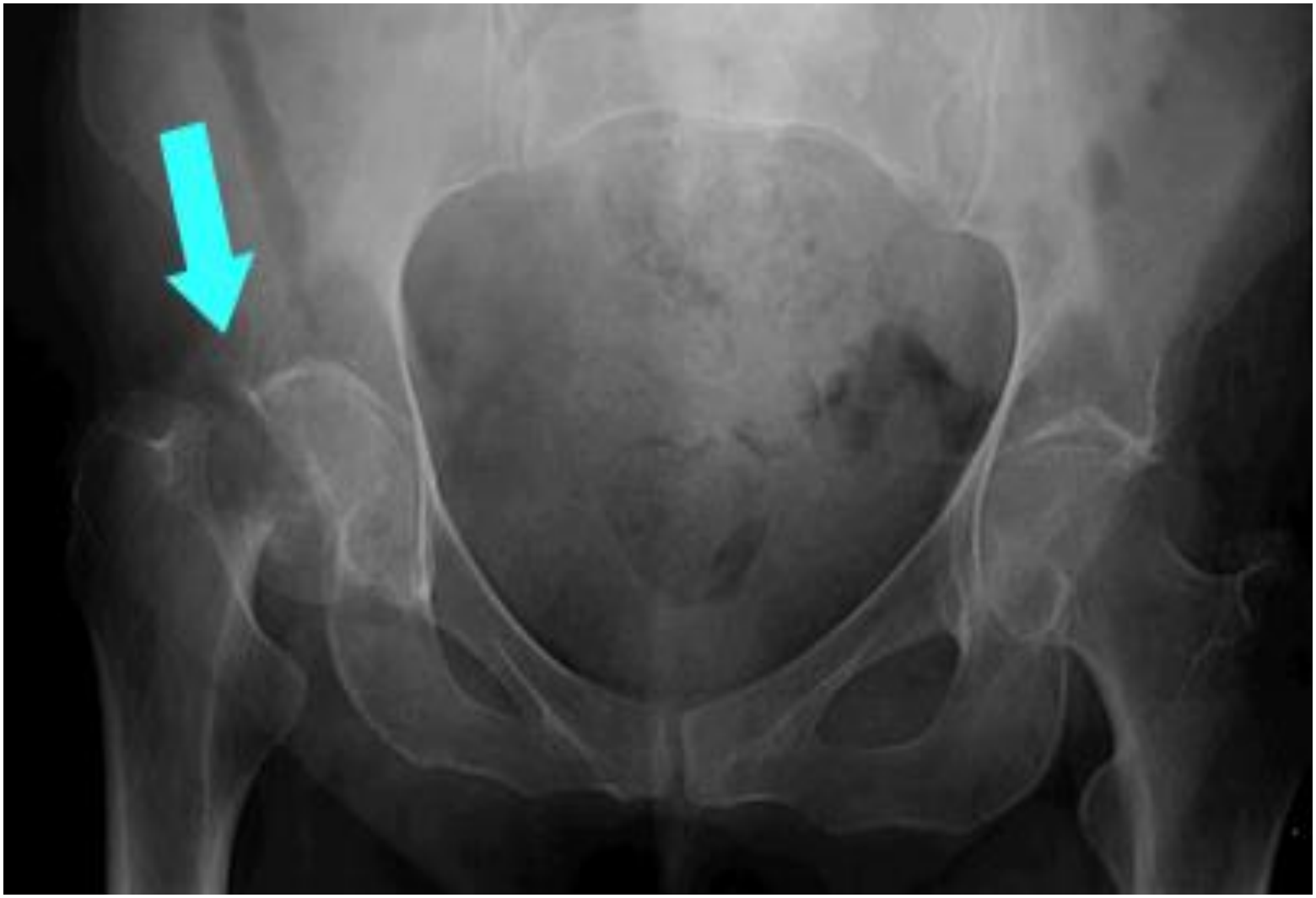
- Hip
- Femoral neck fracture: Subtle radiographic signs
- 1. Discontinuity of the normal smooth contour of cortical bone
- 2. Discontinuity or disruption of the normal trabecular
- architecture
- 3. Transverse band of increased bone density (sclerosis) where
- the fracture fragments are impacted. Diminished bone density
- where the fracture fragments are distracted
- 4. Foreshortening of the femoral neck (not due to poor
- positioning – external rotation of hip)
- 5. Abnormal angle between the femoral neck and the femoral
- head

Femoral Neck Fracture



Femoral Neck Fracture

Femoral Neck Fracture



Intertrochanteric Hip Fracture

Missed Fractures and Dislocations Lower Extremity

- Hip
- Intertrochanteric fracture – may only be seen on frog-leg or lateral view

Intertrochanteric Fracture

Intertrochanteric Fractures

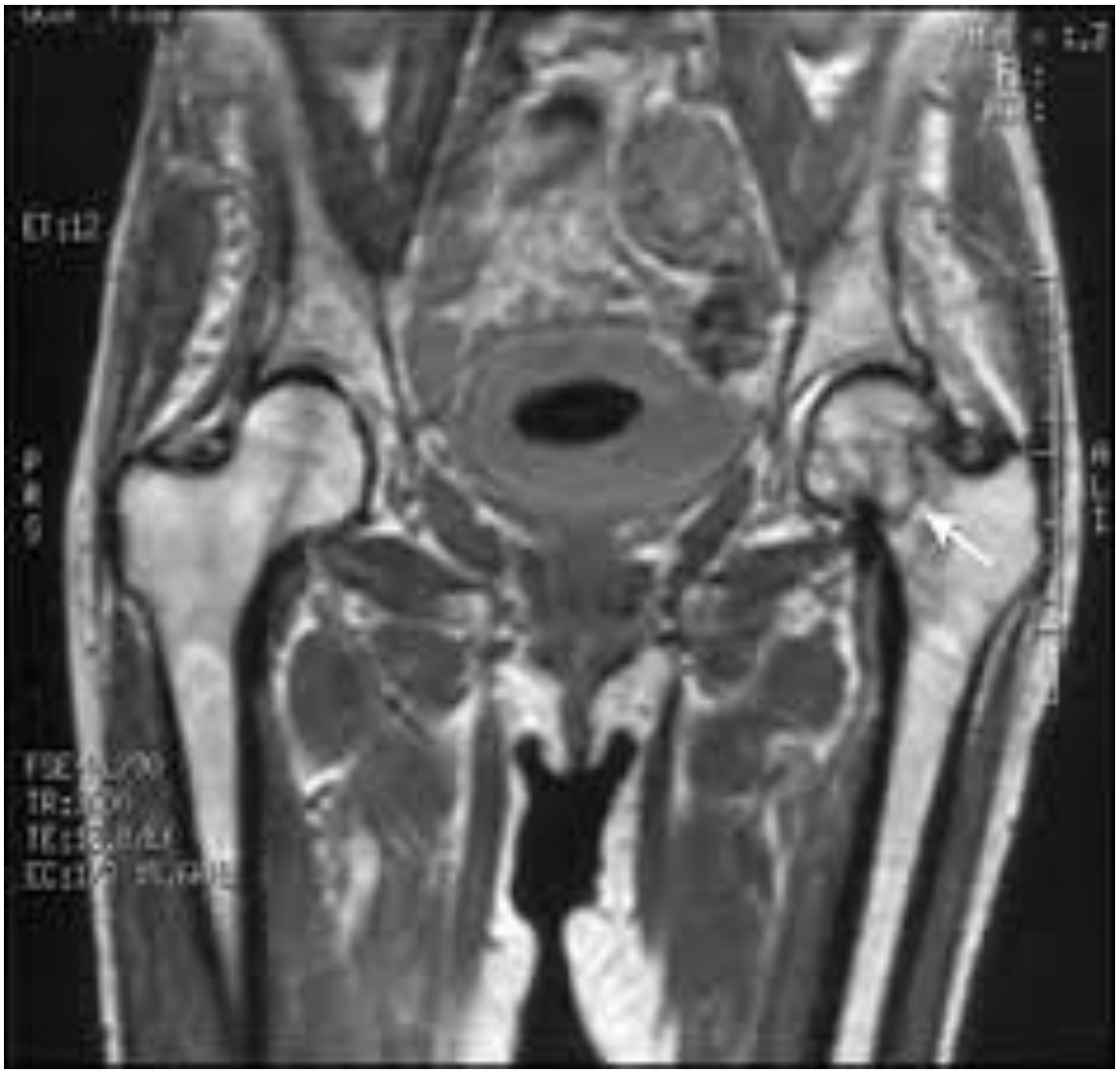
Intertrochanteric Femur Fracture

Intertrochanteric Fracture

Missed Fractures and Dislocations Lower Extremity

- Hip
- Occult proximal femoral fractures – MRI (MDCT not quite as sensitive as MRI)

Femoral Neck Occult



Missed Fractures and Dislocations Lower Extremity

- Hip
- Pubic ramus fracture or other pelvis fracture – obtain AP pelvis view rather than AP hip

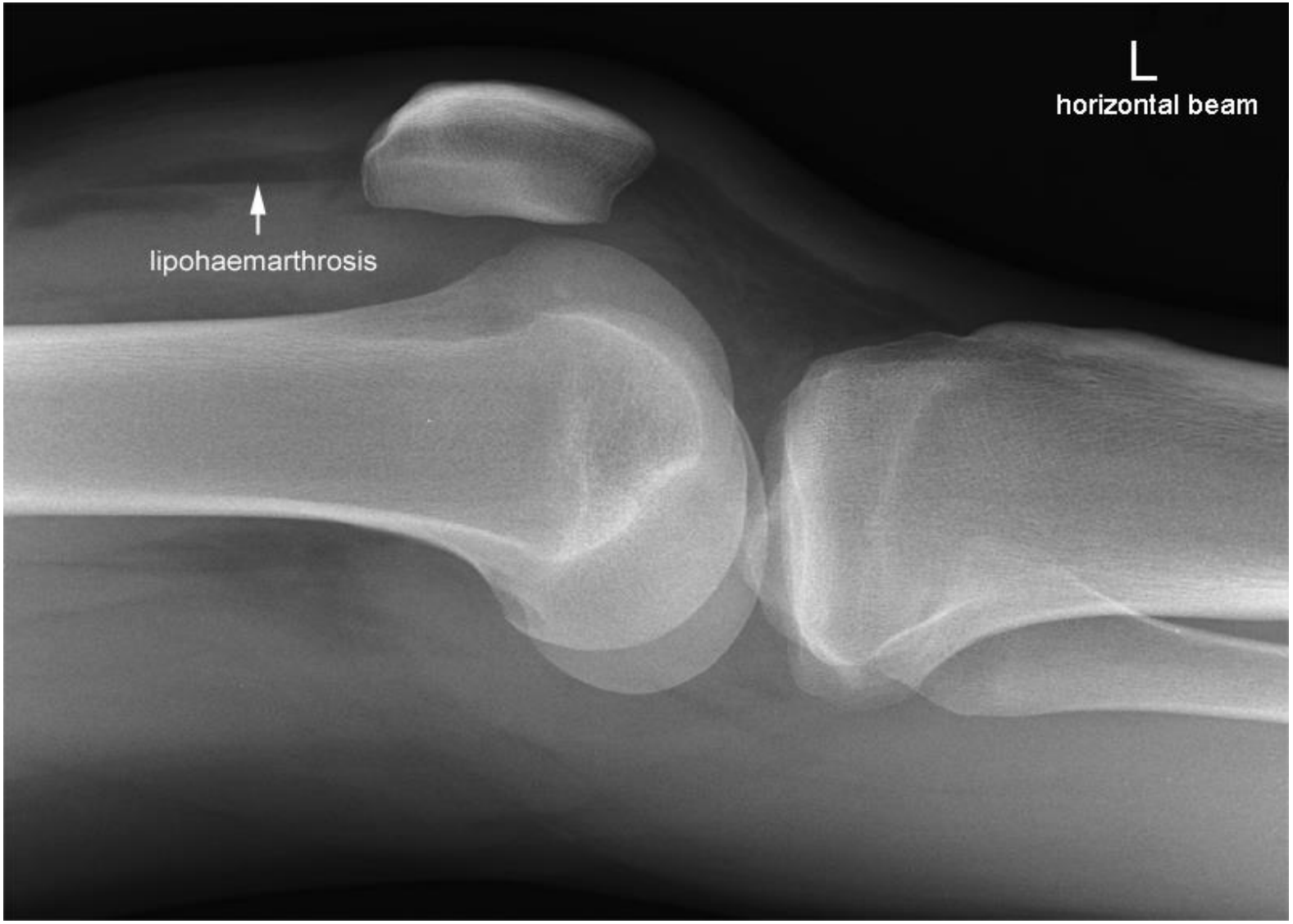
Pubic Ramus Fracture

Missed Fractures and Dislocations Lower Extremity

- Knee
- Tibial plateau fracture (lateral plateau in 85%) – cortical irregularity, trabecular impaction, obtain oblique view or MDCT (coronal reformatted images)
- Cross-table lateral view can show a lipohemarthrosis – a sign of intra-articular fracture

Tibial Plateau Fracture

Lipohemarthrosis



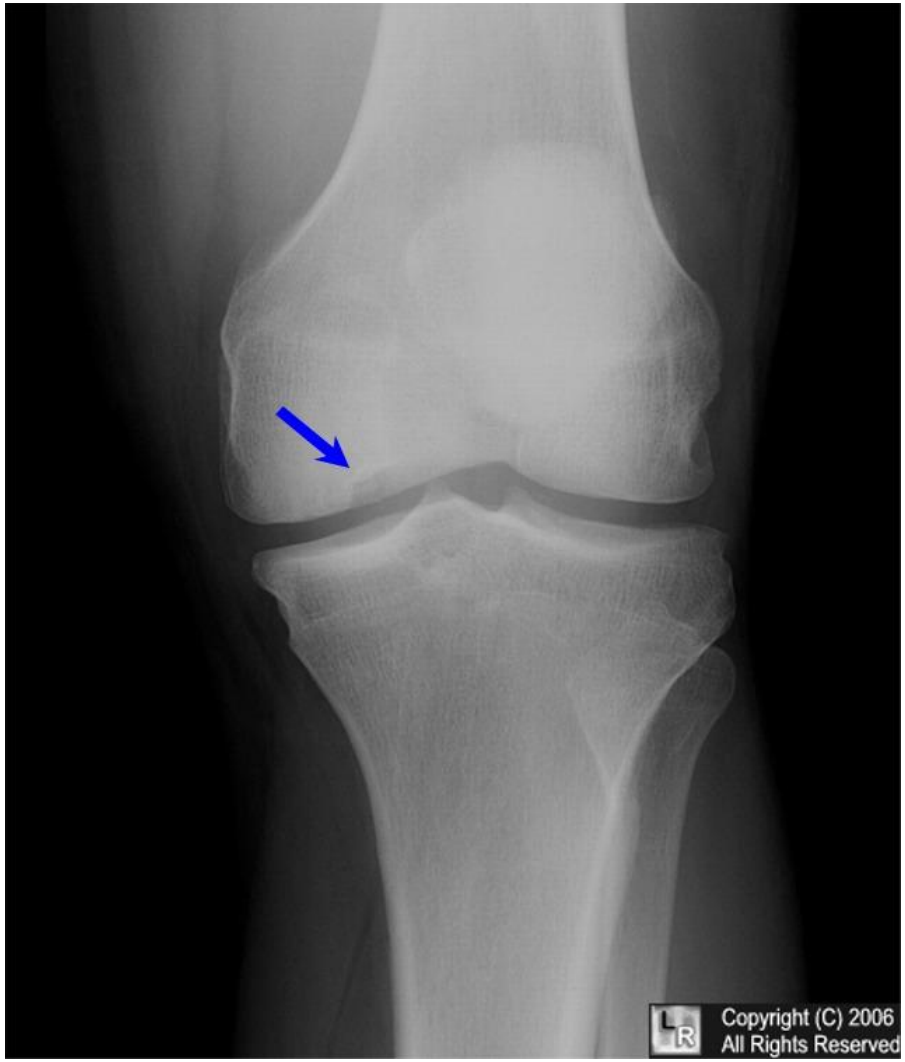
Missed Fractures and Dislocations Lower Extremity

- Knee
- Patella fractures (vertical or oblique orientation) – order “sunrise” patella view or oblique views

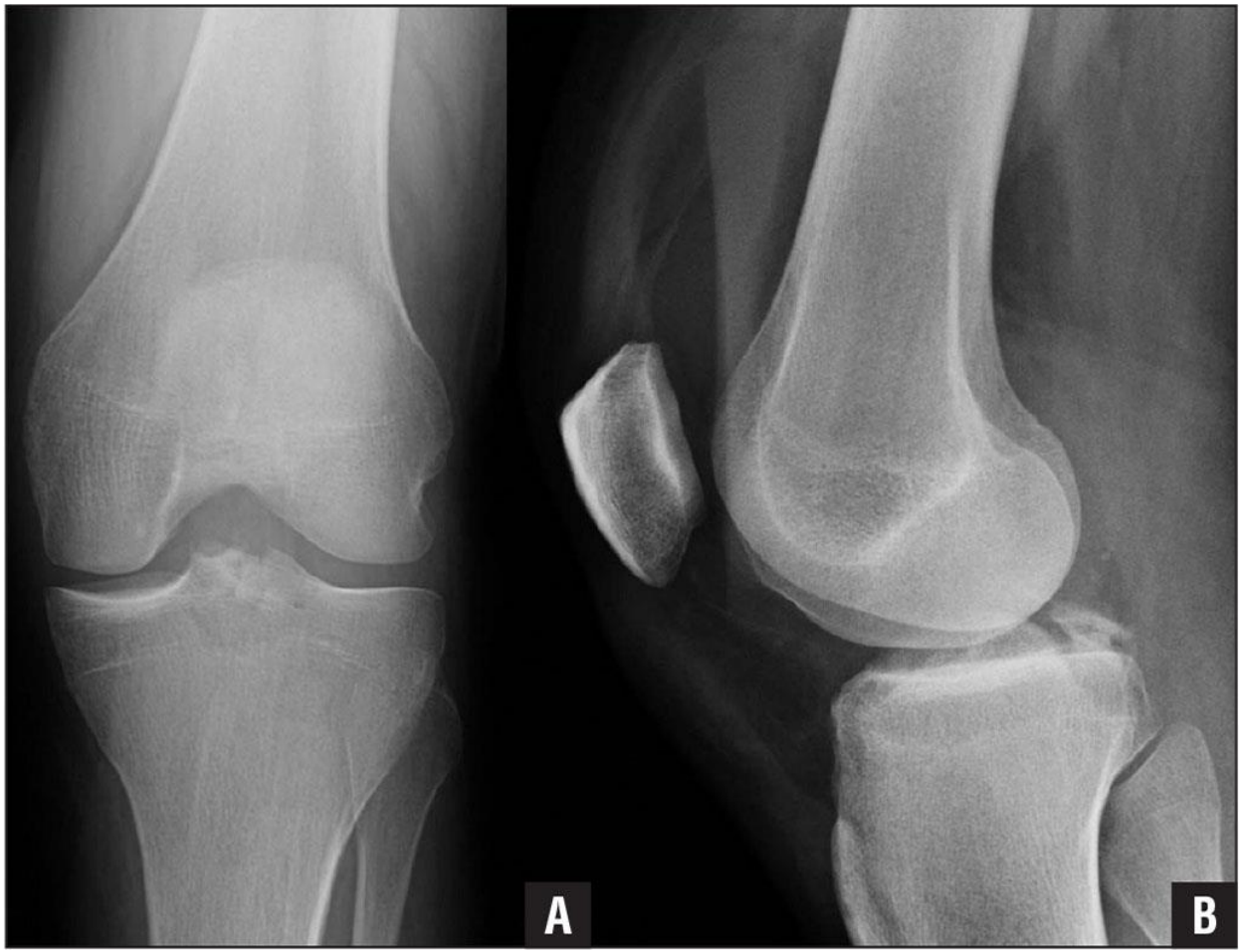
Missed Fractures and Dislocations Lower Extremity

- Knee
- Osteochondral fractures or cruciate ligament avulsions – bone fragment in joint space

Osteochondral Fracture Knee



Cruciate Avulsion Injury



Missed Fractures and Dislocations Lower Extremity

- Ankle
- Lateral malleolar fractures – tip avulsions, nondisplaced spiral fractures (lateral view)

Lateral Malleolus Fracture

Lateral Malleolus Spiral Fracture

Missed Fractures and Dislocations Lower Extremity

- Ankle
- Ligament tears and instability – examine joint space on mortise view; may need stress views

Ankle Mortis

AP mortise view

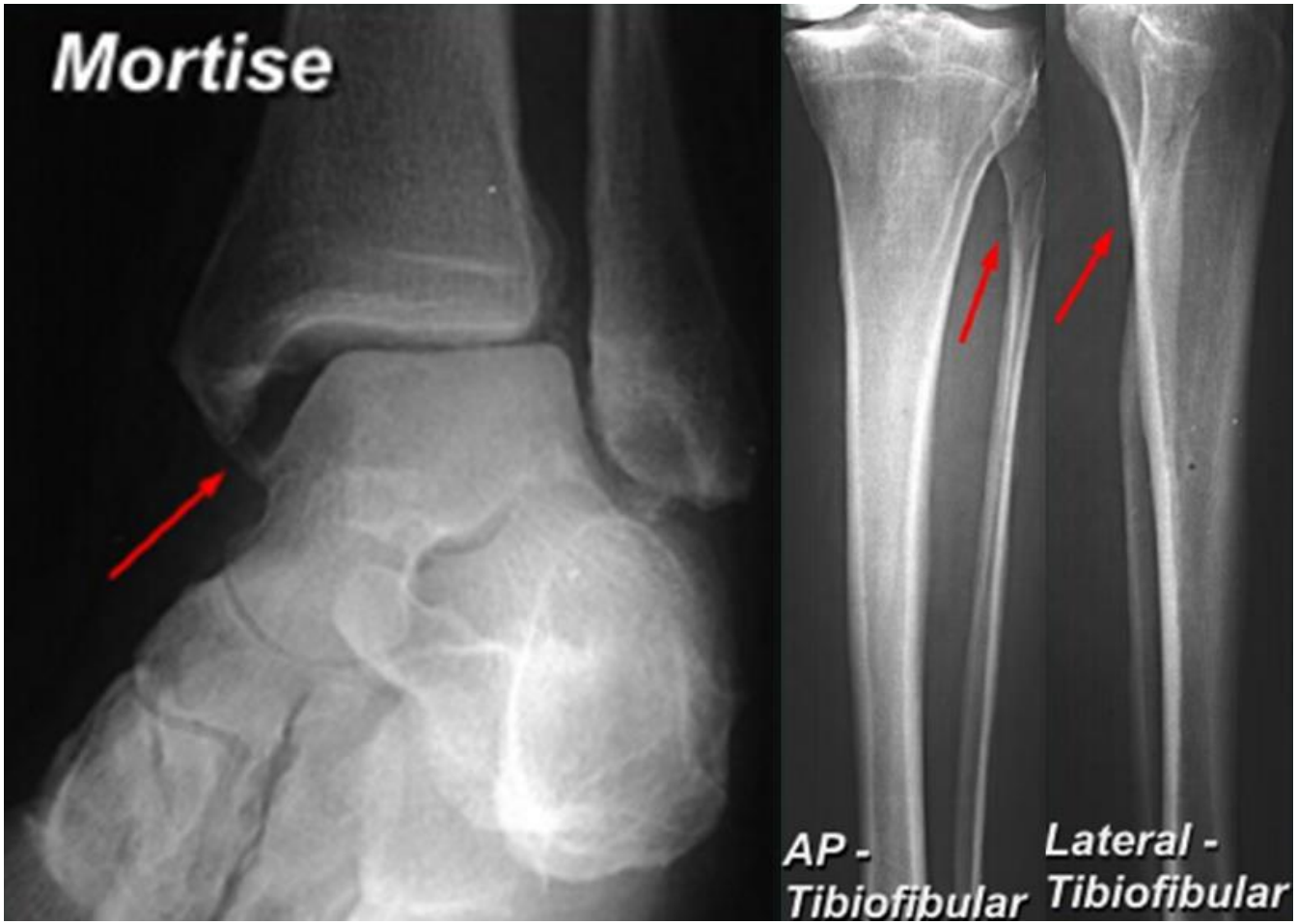
Clear space

Ankle Mortis View Instability

Missed Fractures and Dislocations Lower Extremity

- Ankle
- Tibiofibular syndesmosis tear – Maisonneuve fracture – tender proximal fibula, obtain tib-fib radiographs

Maisonneuve Fracture



Missed Fractures and Dislocations Lower Extremity

- Ankle
- Fifth metatarsal base fracture and tuberosity avulsion (Jones and “pseudo-Jones” fracture)
- (obtain foot views)

Jones Fracture

5th MT-Avulsion, Jones, Stress Fractue

Missed Fractures and Dislocations Lower Extremity

- Ankle
- Midfoot fractures occur with “ankle sprains” – navicular, talar neck (risk of AVN), talar dome (osteochondral), calcaneus (anterior process) – MDCT if pain persists

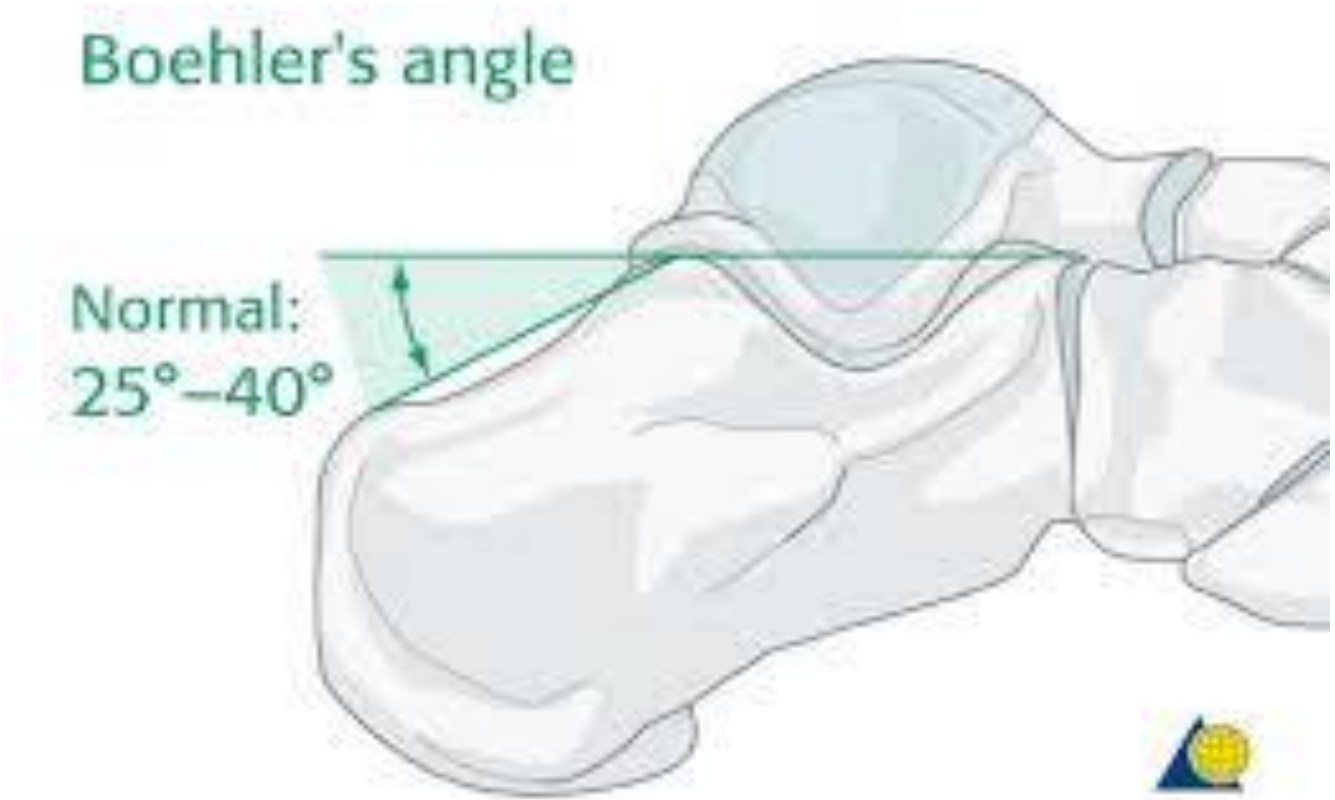
Talar Dome Fracture

Talar Dome Fracture

Missed Fractures and Dislocations Lower Extremity

- Foot
- Calcaneus and talus (hindfoot) fractures – Boehler's angle on lateral view, axial calcaneus view
- Boehler's Angle: These lines are drawn tangent to the anterior and posterior aspects of the superior calcaneus. The normal value for this angle is **between 20 to 40 degrees**. A value less than **20 degrees** can be seen in calcaneal fracture. However, a normal Böhler angle does not exclude a calcaneal fracture.

Boehler’s Angle

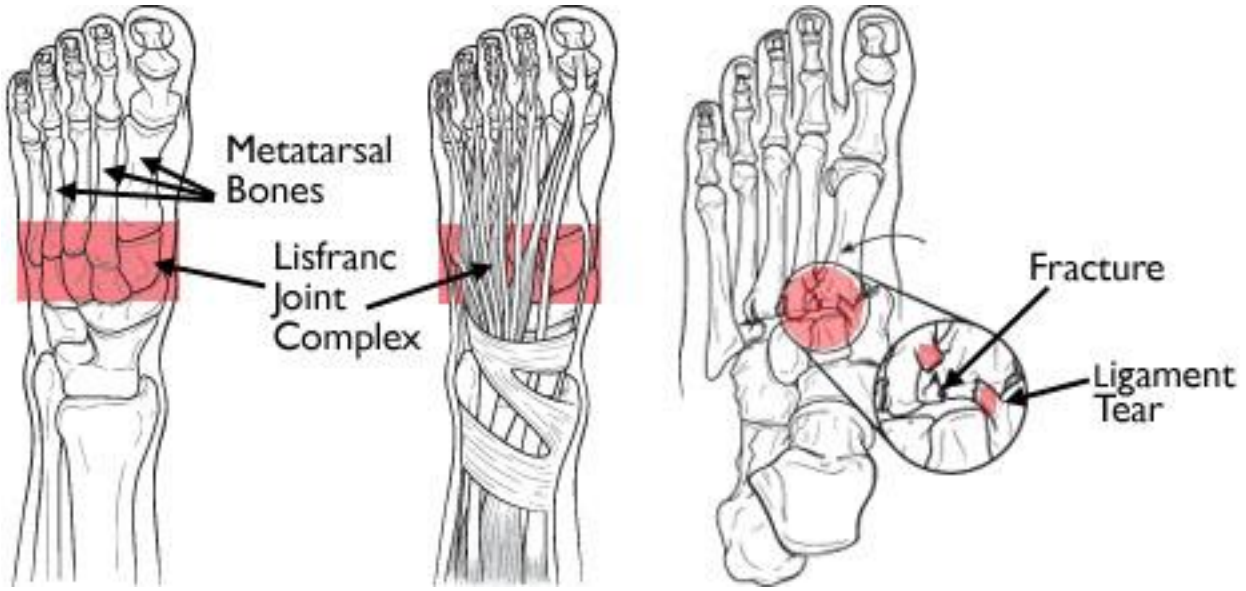


Calcaneus Fracture

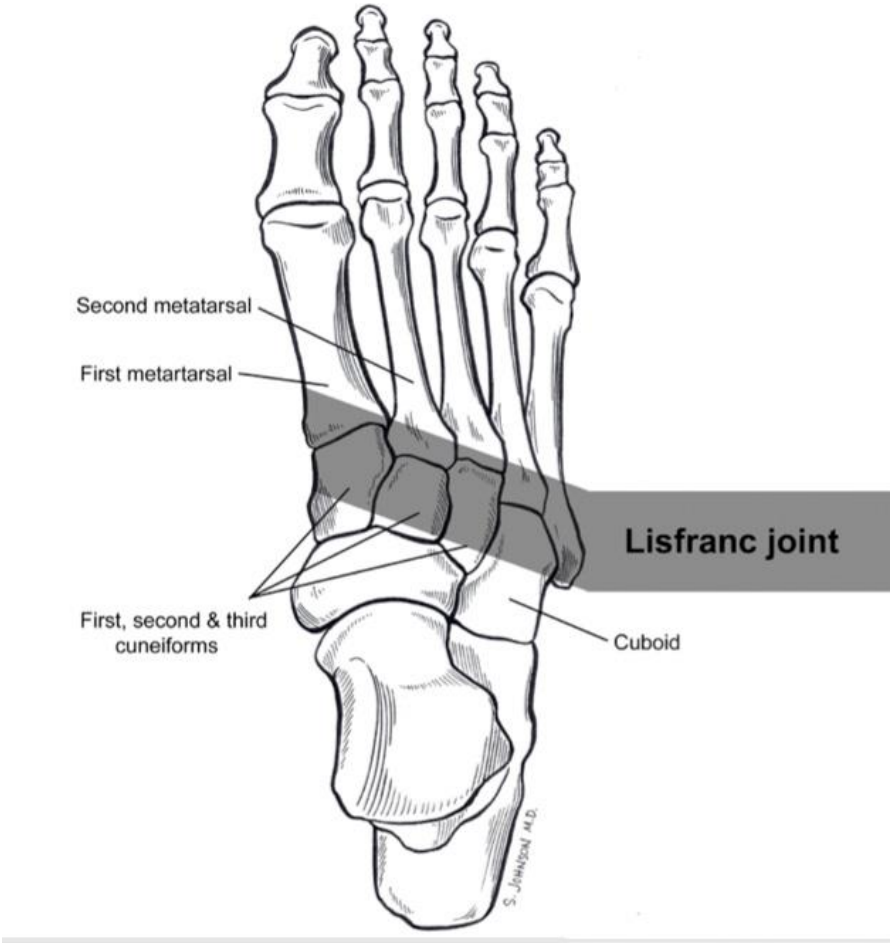
Missed Fractures and Dislocations Lower Extremity

- Foot
- Tarso-metatarsal fracture-dislocation (Lisfranc)
- See small fracture of 2nd metatarsal base; malalignment of metatarsal bases and cuneiforms; standing or stress view can unmask instability

Lisfranc Fracture



Lisfranc Fracture



Lisfranc Fracture

Missed Fractures and Dislocations Cervical Spine

Missed Fractures and Dislocations Cervical Spine

- Missed cervical spine injuries, although less common than extremity injuries, have high morbidity and are responsible for a large proportion of litigation costs.

Missed Fractures and Dislocations Cervical Spine

- Cervical spine radiography has been supplanted by CT in high-risk patients, so the problem of missed injuries should be reduced. CT sensitivity is very high, (99%), and the problem of inadequate radiographs in major trauma victims is virtually eliminated by CT.

Missed Fractures and Dislocations Cervical Spine

- Radiography is currently reserved for low-risk patients, so the frequency of injures is extremely low, < 1%. However, cervical spine injury can occur in patients who appear well enough to be managed in the ED and potentially discharged.

Missed Fractures and Dislocations Cervical Spine

- Historically, up to 10% of spine cord injury occurred after the patient was under medical care. This has been reduced to a very rare occurrence thanks to the heightened alertness to potential cervical spine injury in trauma patients. occult injuries.
- Awareness of unstable injuries that can potently be missed by radiography and even
- CT must be maintained, i.e., hyperflexion sprain.

Missed Fractures and Dislocations Cervical Spine

- **MDCT** – **High-risk** (> 5% injuries); patients having other CT (e.g. head CT); elderly with degenerative spondylosis (increased risk of injury and radiographs difficult to interpret)
- **Non-high-risk** – **C-spine radiography** – injuries rare (<1%); sensitivity 90-95%
- **Minimal risk** – **Clinically clear** without radiography (NEXUS or Canadian rules)
- **Obtunded** – cannot "clear" c-spine despite negative MDCT. Maintain immobilization and obtain MRI within 48 hours to detect occult spinal cord or ligamentous injury.
- **Neuro deficit or excessive pain** – MRI detects spinal cord injury, cervical disk herniation, ligamentous injury, or vascular injury (vertebral or carotid artery).

Missed Fractures and Dislocations Cervical Spine

- **Patients at risk for clinically occult c-spine injury:**
- 1) Severe mechanism of injury and patient appears well
- 2) Difficult to evaluate clinically (intoxication, uncooperative)
- 3) Excessive pain despite normal radiographs
- 4) Pre-existing vertebral abnormalities (degenerative spondylosis (elderly), malignancy, ankylosing spondylitis)

Missed Fractures and Dislocations Cervical Spine

- **Pitfalls in the diagnosis of cervical spine injury**
- Inadequate clinical evaluation
- Inadequate radiographs (C7-T1)
- Missed subtle radiographic abnormalities (6% of c-spine injuries) (Mower 2001)
- Normal radiographs (4% of CSI) (Mower 2001)
- Normal MDCT (<1%) (Ptak 2001, Hansen 2000, Bollinger 2004, Benetti 2000)

Missed Fractures and Dislocations Cervical Spine

- **Easily missed cervical spine injuries:**
- Cervicocranium – complex anatomy, difficult to visualize some injuries
- Cervicothoracic junction C6-T1 – not seen on suboptimal radiographs due to overlying shoulders; clearly seen using MDCT.
- Occult ligmentous injury with normal or equivocal radiographs – may need dynamic imaging (MRI, flexion-extension views)

Missed Fractures and Dislocations Cervical Spine

- **Cervicocranial injuries**
- C1 ring fractures (Jefferson burst) – poorly seen on radiographs, well seen on axial CT
- Dens fractures – Type II at base of dens radiographically subtle and can be missed on axial CT.
- Occasionally missed on MDCT; common in the elderly.
- C2 neural arch fractures (Hangman fractures) – radiographically subtle if non-displaced; well seen on axial CT.

Missed Fractures and Dislocations Cervical Spine

- **Hyperflexion sprain (Anterior subluxation)** – an unstable occult lower cervical spine injury
- Isolated posterior ligamentous tear – distractive-flexion mechanism of injury
- May have no associated fractures
- Grossly unstable – high risk of spine cord injury

Missed Fractures and Dislocations Cervical Spine

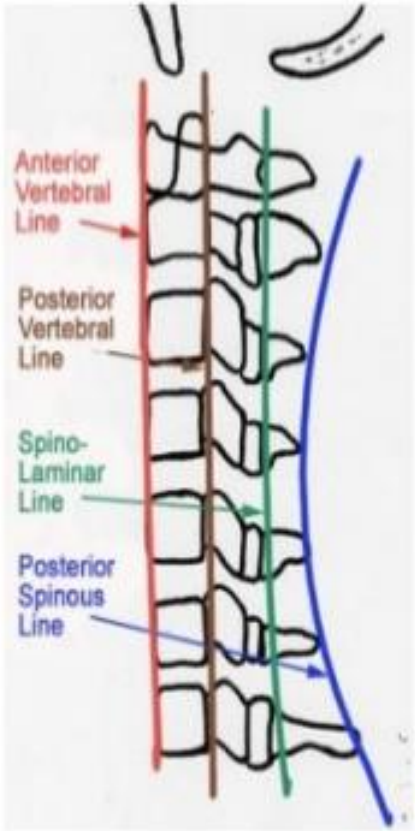
- Flexion/extension radiography traditionally used to detect this injury. Perform in ED(controversial) or in clinic follow-up after 1 week immobilization in hard plastic collar.
- MRI has largely supplanted flexion/extension views in admitted trauma patients. It is more reliable, less risky, provides more information (spinal cord injury, disk herniation).
- A negative MRI excludes ligamentous injury.

Radiographic signs of hyperflexion sprain

- 1) Fanning of the spinous processes
- 2) Subluxation of the facet joints (*arrowheads*), and
- 3) anterior slippage and angulation of the vertebral body (*arrow*).
- **MDCT** sagittal sections show similar findings. Subtle widening of the facet joint may be the only finding.
- **To avoid missing this injury**, re-examine patients with normal radiographs or CT testing neck flexion and rotation before finally clearing the patient.

Cervical Alignment

Alignment



- The anterior vertebral line, posterior vertebral line, and spinolaminar line should have a smooth curve with no steps or discontinuities

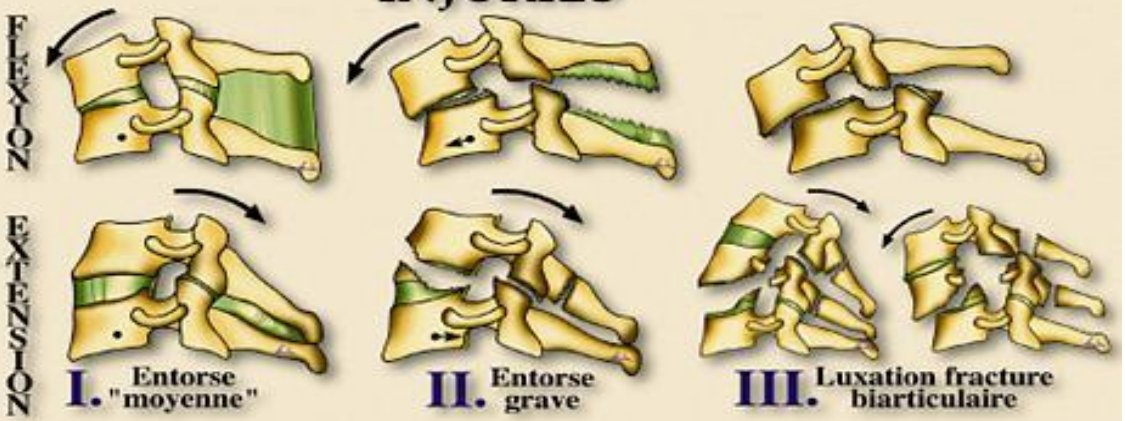
- Malalignment of the posterior vertebral bodies is more significant than that anteriorly, which may be due to rotation

- **A step-off of >3.5mm is significant anywhere**

CLASSIFICATION OF LOWER CERVICAL SPINE INJURIES

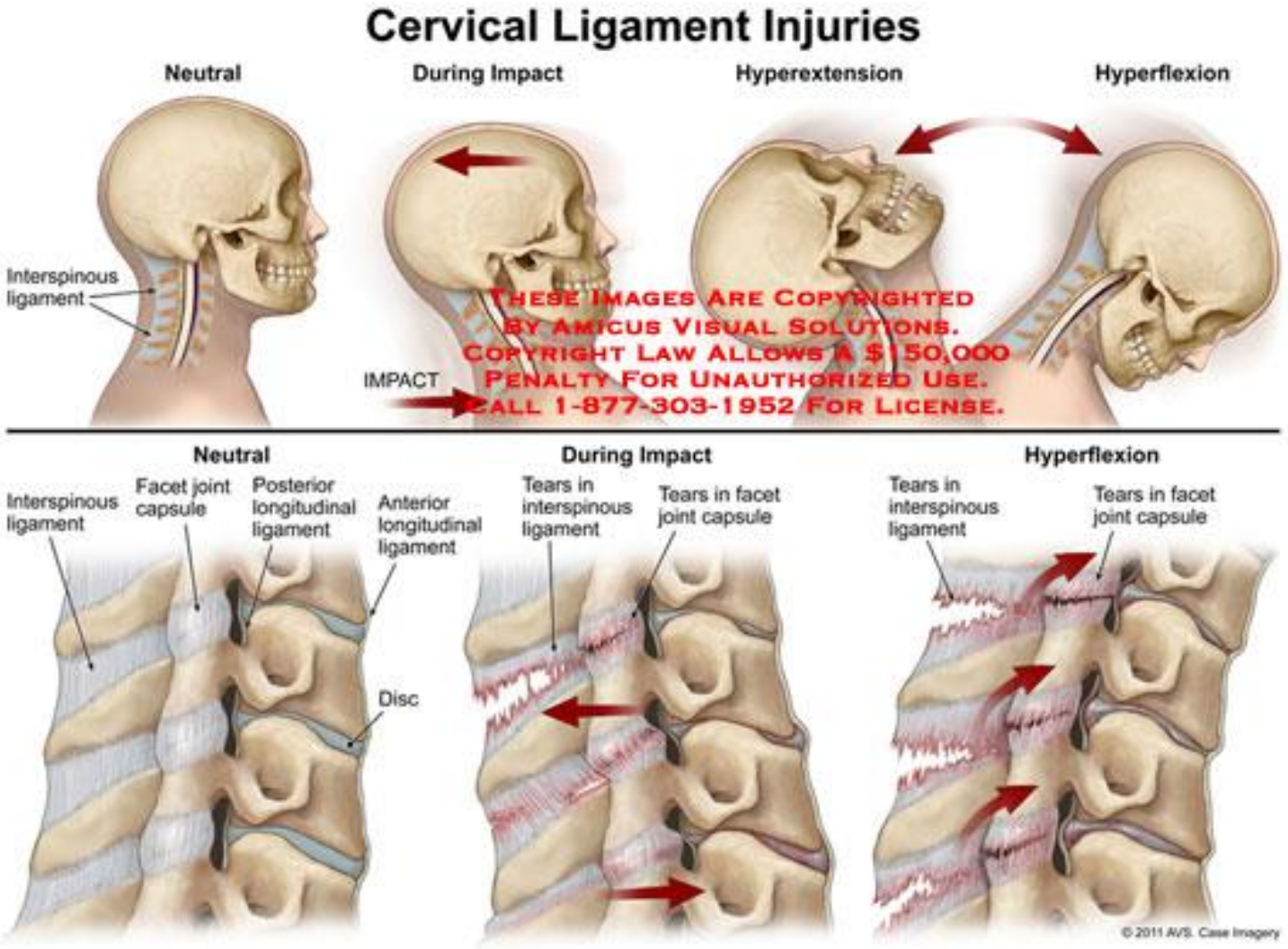
A COMPRESSION INJURIES

B FLEXION-EXTENSION-DISTRACTION INJURIES

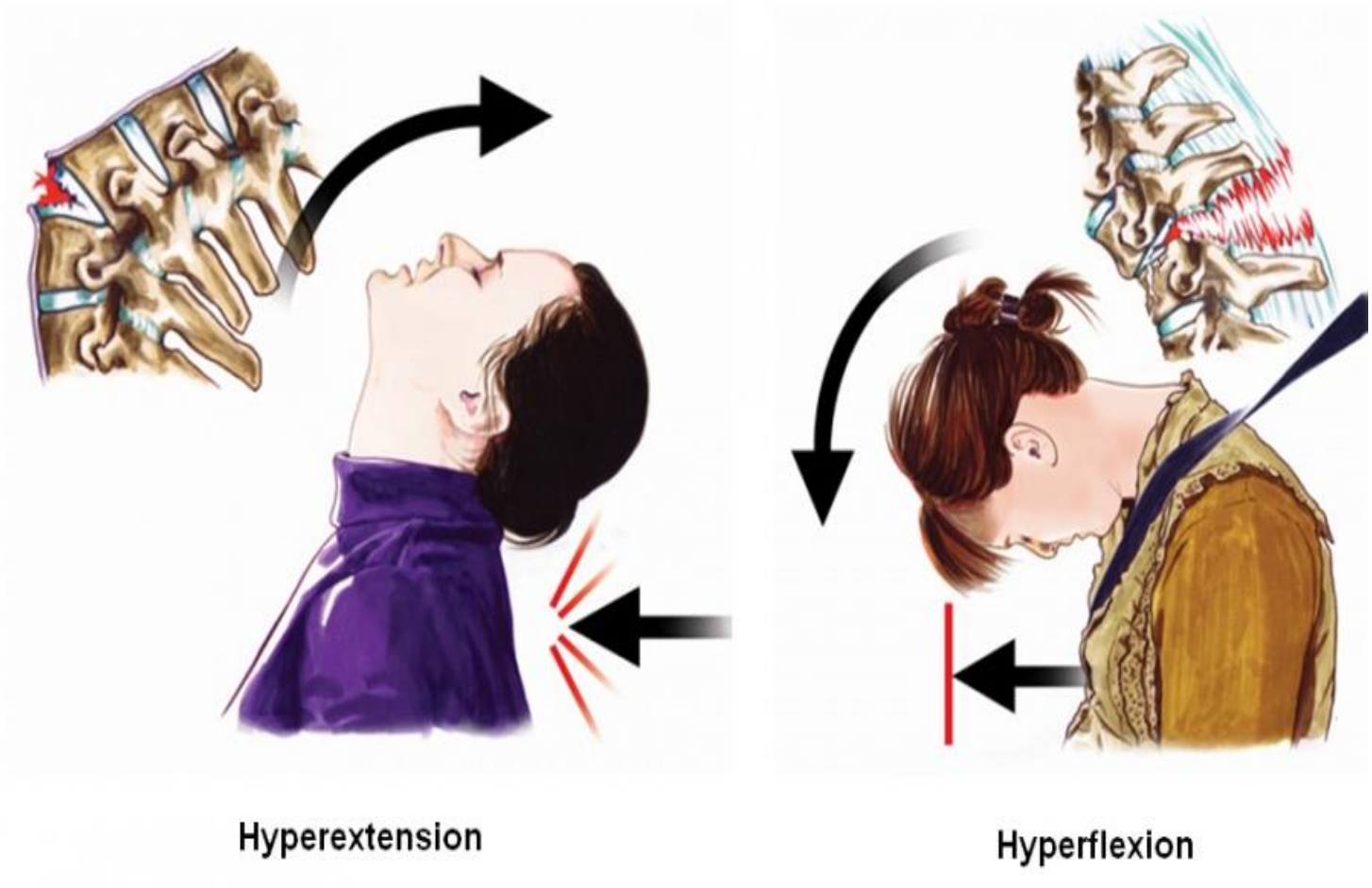


C ROTATION INJURIES

Hyperextension Cervical Injuries



Hyperflexion



Cervical Injury

Missed Fractures and Dislocations Cervical Spine

- Papadatos A: Missed cervical spine injury yields huge award ($31million). Emerg Med
- News Jan. 2005, pp. 10-12. A 41-year-old truck driver was involved in a vehicular rollover. In the ED, he had a scalp hematoma, but was neurologically intact. Cervical spine and other radiographs were performed and interpreted as normal, although the C7-T1 region was not seen. The patient was cleared, got up and walked ten feet before collapsing due to anterior subluxation and a cervical spinal cord injury.

Missed Fractures and Dislocations Cervical Spine

- Unstable hyperflexion sprain with normal MDCT (Sciubba 2007). A 49-year-old man fell down stairs and complained of neck pain. MDCT was normal. Because of significant pain at the base of his neck with attempted flexion, the patient was to be discharged wearing a rigid cervical collar and follow up in neurosurgery clinic in 1-2 weeks. His neck pain was too severe for him to stand up. Flexion/extension views revealed complete instability at C5-C6. The patient underwent posterior surgical fixation.
- Sciubba DM, McLoughlin GS, Gokaslan ZL, et al: Are computed tomography scans adequate in assessing cervical spine pain following blunt trauma? Emerg Med J 2007;24: 803-804.