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.
• Massachusetts Joint Underwriters Association: Missed fractures comprised 20% (during 1980-1987) 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 than 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
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
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

1. Femoral Neck Fracture
2. Intertrochanteric Fracture
3. Subtrochanteric Fracture
Hip Fractures

- Transcervical fracture
- Intertrochanteric fracture
- Subtrochanteric fracture
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
Lipoheemarthrosis
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
5\textsuperscript{th} MT-Avulsion, Jones, Stress Fracture
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

This fracture is not visible on this view. Multiple views are necessary.
Missed Fractures and Dislocations
Lower Extremity

• Foot
• Calcaneus and talus (hindfoot) fractures – Bohler’s angle on lateral view, axial calcaneus view
• Bohler’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

Boehler's angle

Normal: 25°–40°
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 injuries 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)
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 ligamentous 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

- 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.
Hyperextension Cervical Injuries
Hyperextension

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.