



EM CASES SUMMARY

Episode 176 Orthopedic X-rays – Pitfall in Obtaining & Interpreting MSK X-rays

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Pitfalls in the use orthopedic x-ray clinical decision tools

Do not rely solely on decision tools like the Ottawa Ankle and Foot Rules to decide whether patients need x-rays, or as a guide for how to examine patients. Use the decision rules to support your decision not to image for patients in whom you have a very low clinical suspicion for fracture based on thorough history and physical exam. Anterior ankle injuries such as syndesmosis injuries can be missed by the Ottawa Ankle Rule. Examine the entire ankle, rather than only the areas indicated by the decision tools.

***Pitfall:** The Ottawa Foot Rule is not applicable to everyone who has a foot injury; it is applicable only to patients with an inversion-type ankle injury (i.e., rolled ankle) where the patient*

has foot pain; do not use this for a patient who has dropped something on their foot!

“Rule out fracture” is not enough: What more should we write on orthopedic X-ray requisitions and the concept of the central ray

Important pieces of information to communicate to radiologists that can help them with their orthopedic X-ray interpretation include:

- Was there an injury?
- Point of maximal pain/tenderness? (see below re: central ray)
- Your differential diagnosis (ie, infection, inflammatory etc)
- Acute or chronic

What is an X-ray central ray and why does it matter?

The central ray is the theoretical center of the X-ray beam that designates the direction of the X-ray photons as projected from the focal spot of the X-ray tube to the radiographic film. It delineates the area of interest and when directed appropriately maximizes the focus/clarity of the area in question. Hence communicating the point of maximal pain/tenderness improves the quality of orthopedic X-rays and allows ideal interpretation conditions. Examples of the central ray concept include:

- Suspect a fracture at the elbow and shoulder? Do not rely on a humerus x-ray, the joints are too far from the central ray to achieve an adequately focused view
- Suspect a fracture in upper L-spine/lower T-spine? A single lumbar spine x-ray series may not show the lower thoracic spine adequately; a dedicated thoracic spine x-ray series should be ordered and the spinal level of concern should be communicated
- Looking for free air under the diaphragm? CXR is better than Abdo X-Ray because the central ray is closer to the diaphragm

Pitfall: a common pitfall is relying on a “two for one” x-ray (e.g., a forearm view if you suspect an elbow and wrist injury); when this pitfall occurs, the central ray is far from the areas of concern leading to poor quality X-rays and increased chance of missed fractures

In anatomical ring-like structures, consider additional injuries – Maisonneuve, Galeazzi, Monteggia & Essex-Lopresti

Patients with extremity injuries in the ring structures such as the forearm (wrist – ulna/radius – elbow) and lower leg (ankle – tibia/fibula – knee) can sometimes sustain a second or third either proximally or distally within the ring because of the typical vector of force through these structures. Usually two or more separate series of X-rays are required. For a midshaft long bone fracture, ensure the x-ray image includes the joints above and

below, but if there is clinical concern for injuries at these joints, obtain dedicated x-ray series of the joints in question.

Maisonneuve fracture is a fracture of proximal fibula with an unstable ankle injury (usually a wide ankle mortise with fracture of the medial malleolus/medial ankle ligamentous injury) as a result of a pronation-external rotation mechanism.



Unstable ankle injury with wide medial ankle mortise as part of a Maisonneuve injury pattern



Maisonneuve fracture proximal fibula (Images: Case courtesy of The Radswiki, Radiopaedia.org, rID: 11592)

Galeazzi fracture-dislocation is a fracture of the distal third of the shaft of the radius with a disruption to the distal radio-ulnar joint (DRUJ).



Galeazzi fracture/dislocation. Fracture of the distal 1/3 of radius and disruption of DRUJ. Images: Case courtesy of The Radswiki, Radiopaedia.org, rID: 12221

Galeazzi fracture/dislocation showing fracture of radius and volar displacement of the ulnar styloid at the wrist

Monteggia fracture-dislocation is a dislocation of the radial head (proximal radioulnar joint) with fracture of the ulna.



Monteggia Fracture/dislocation: ulnar shaft fracture with dislocation of radial head

An easy way to remember the Galeazzi vs Monteggia is using the GRIMUS mnemonic

Galeazzi

Radius

Inferior

Monteggia

Ulnar

Superior

Essex-Lopresti injury (ELI) is a fracture of the radial head, disruption of the forearm interosseous membrane, and dislocation of the DRUJ and requires elbow, forearm and wrist views



Essex Lopresti injury – radial head fracture, DRUJ and violation of the interosseous membrane. Image: Case courtesy of Dr Liz Silverstone, Radiopaedia.org, rID: 92603

How many X-ray views is enough?

Long bones: 2 views (frontal and lateral views)

Joints: 3 views (except the hip, which is often 2 views)

Hand, wrist, foot: frontal, oblique and lateral

Ankle: frontal, lateral and mortise

Knee: frontal, lateral, sunrise view (for suspected patella fracture)
oblique views (to better characterize tibial plateau fractures or a fracture/injury of the femoral condyles)

Lumbar Spine: frontal and lateral is sufficient according to our expert, however if there is concern for an injury at the lumbosacral junction a “coned down” should be considered

Additional X-ray views to consider in the ED

Scaphoid view: for patients with a mechanism concerning for scaphoid fracture and 2/3 of snuffbox tenderness, axial thumb load tenderness or volar scaphoid tenderness

Clenched fist view/power grip view for suspected [scapholunate injury](#): subtle widening of the scapholunate junction can be accentuated (Terry Thomas sign is a complete tear of the scapholunate ligament, but partial tears may be more subtle); consider this view in patients with tenderness distal to the radius and Lister's tubercle on the dorsum of the wrist



Right scapholunate widening Image: Case courtesy of Andrew Murphy, Radiopaedia.org, rID: 47035

Carpal tunnel view/hook of hamate view: for suspected fractures of the hamate (consider this view in patients who sustain an injury with a racket or club in-hand with tenderness over the hypothenar eminence)



Carpel tunnel view



Carpel tunnel view showing hook of the hamate

Skyline/Sunrise View (patella): for patellar fracture/dislocation (can see osteochondral lesions after patellar dislocations), consider this in direct falls on the patella, concerning story for dislocation, lots of swelling over the patella or violation of the extensor mechanism of the knee



Patella skyline view showing vertical patella fracture. Image: Case courtesy of Dr Pir Abdul Ahad Aziz Qureshi, Radiopaedia.org, rID: 146705

Axillary/Modified Axillary View: for suspected [posterior shoulder dislocation](#) and for proximal humerus fractures to ensure the head of the humerus is in joint



Normal axillary view of the shoulder. Image: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 7505

Weight bearing views of the foot: often ordered for a suspected [Lisfranc injuries](#) and compared to the contralateral weight bearing foot X-ray. **Caution:** patients with Lisfranc injuries in the ED are usually unable to fully weight bear as they are limited by pain and so weight bearing views done in the acute setting can be misleading (check that they can fully weight bear on one leg before sending for these views)



Lisfranc fracture at base of 2nd metatarsal with widening between 1st and 2nd metatarsal seen on weight bearing view. Image: Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 88084

***Pitfall:** ordering weight bearing views for suspected Lisfranc injury for patients who are unable to fully weight bear can lead to false negatives; if a Lisfranc injury is suspected based on history and physical, immobilize and follow up, at which time weight bearing views may be obtainable.*

Other tips on improving X-ray interpretation skills

- **Always look at the lateral view first**, as this view often reveals a finding that is not present or very subtle on the frontal view, and we tend to gloss over the lateral view
- Review the X-rays of challenging cases with your radiology colleagues
- Have an approach to each X-ray series, and use the same approach every time
- Always examine your patients *before* looking at the X-ray so that you can focus your attention on the area of concern

Indications for CT scan for orthopedic injuries in the ED

Consider ordering a CT scan for an orthopedic injury when a diagnosis needs to be made in order to guide imminent treatment (ie: same day, same week). If unsure, do not hesitate to consult your radiologist or orthopedic surgeon to aid decision making.

Examples of common fractures that may require CT (note that many of these injuries can be assumed from history and physical and an outpatient CT may be appropriate depending on access, patient reliability, consultant preference etc)

- Lisfranc fracture/dislocation
- Calcaneus fracture
- Tibial plateau fractures
- Occult hip fracture
- Sternoclavicular malalignment

***Pitfall:** a clinical pitfall is assuming that a Lisfranc injury has been ruled out if weight-bearing foot X-rays and CT are negative. Imaging may be normal in patients who require operative management of Lisfranc injuries; if a Lisfranc injury is suspected based on history and physical, regardless of imaging findings, immobilize the extremity and arrange tight follow-up with orthopedics.*

Is there a role for ordering radiology department ultrasound for tendon injuries in the ED?

Radiology department ultrasound has a limited role in the ED patient with a suspected tendon injury according to our experts, as the accuracy for *partial* tendon injuries interpreted by general radiologists is heterogenous, and results may be misleading. Artifacts may disrupt anatomy and lead to misdiagnoses from an inexperienced ultrasound technician. While ultrasound is more accurate for the diagnosis of *full thickness* tendon tears such as quadriceps or achilles tendon ruptures, these are usually obvious clinically and generally do require ultrasound imaging to make a preliminary diagnosis in the ED.

Pitfall: a common pitfall is ruling out a partial tendon injury based on ultrasound; while ultrasound is quite accurate for full thickness tendon tears, there are often false positives and false negatives in partial tendon tears that may be misleading.

Take home points for Orthopedic X-rays Master Class – Pitfalls in Obtaining and Interpreting MSK X-rays

- Do not let a negative X-ray rule the day! Like almost all medical tests X-rays are far from perfect and should be interpreted only in the context of a thorough history and physical exam; if your post-test probability remains high for an orthopedic injury after a seemingly normal X-ray, consider immobilization and appropriate follow-up +/- orthopedic consultation.
- Orthopedic X-ray decision tools should only be applied in the appropriate clinical setting and not be used to guide the physical exam
- Using the *concept of the central ray*, order X-rays that will maximize the quality of the X-ray in the areas of concern and communicate these areas of concern with the radiologist to help improve their diagnostic accuracy
- Using the *ring structure concept* of the forearm and lower leg, consider Maisonneuve, Galeazzi, Monteggia and Essex-Lopresti injury patterns
- Order the adequate number of X-ray views depending on the location of injury and consider specific extra views such as the carpal tunnel view for hamate injuries and

axillary view of the shoulder for posterior shoulder dislocation

- Always look at the lateral view first which may reveal otherwise occult injuries
- CT and radiology department ultrasound are seldom required in the ED for the diagnosis of MSK injuries and may be misleading (exceptions include suspected hip fractures, sternoclavicular malalignment and tibial plateau fractures that are occult to X-ray); for highly suspected injuries that are not apparent on X-ray and may require urgent orthopedic intervention, immobilization and tight followup +/- discussion with orthopedics should be considered rather than additional imaging.

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