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Medical Center



# Approach to acute ankle injury: Does this patient have a fracture?

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# Intro to Acute Ankle Injury

- Ankle radiographs are third most common radiograph ordered in the ED, exceeded only by chest and c-spine \*
- Acute ankle injury accounts for 25% of sports injuries and are the most common cause of time lost in athletics\*\*
- Population-level studies of acute ankle injuries presenting to the ED indicate that that less than 15% of these injuries have fractures \*\*\*

## DDX of acute ankle injury

- (1) Sprain
  - A clinical diagnosis
  - Up to 85 % of ankle sprains are caused by inversion forces during plantar flexion with damage to the lateral ligaments \*\*
- (2) Dislocation
- (3) Fracture
  - ~ 70 % unimalleolar
  - ~ 20 % bimalleolar
  - ~ 10 % trimalleolar
- (4) Other Injury: nerves or blood vessels

\* Dunlop, MG, et al. *BMJ* 1986 293 (6547): 603-605.

\*\* Dunfee, WR, et al. *Radiol Clin N Am* 40 (2002): 289– 312

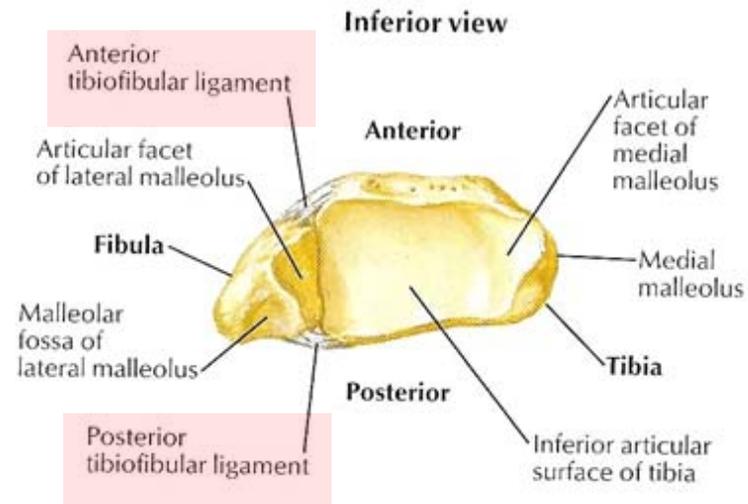
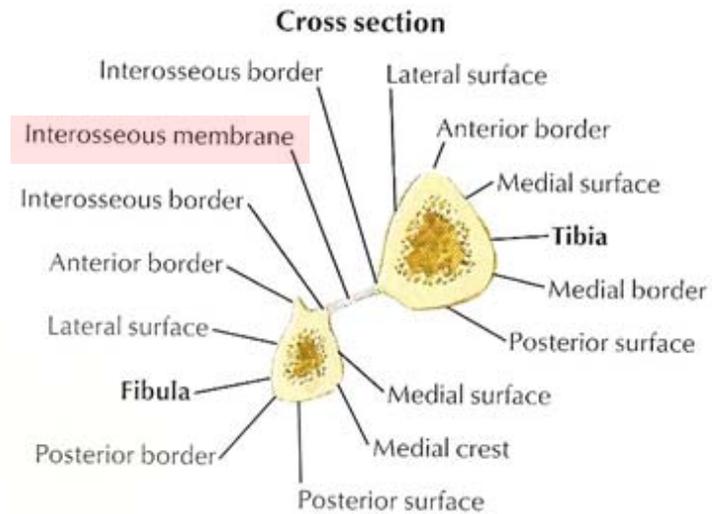
\*\*\* Bachman, LM, et al. *BMJ* 2003; 326: 417.

# Case I

The patient is a 64 year-old woman without previous history of fractures or ankle sprains who presents to the ED after falling on the ice and suffering an inversion injury to her right ankle. She had immediate pain and discomfort along the lateral aspect of her ankle. She has associated ankle swelling and pain, but denies paresthesias. She has pain with ambulating and no specific relieving factors other than rest.

Before you examine her, you review ankle anatomy and physical examination

# Anterior, cross sectional, and inferior views of tibia and fibula



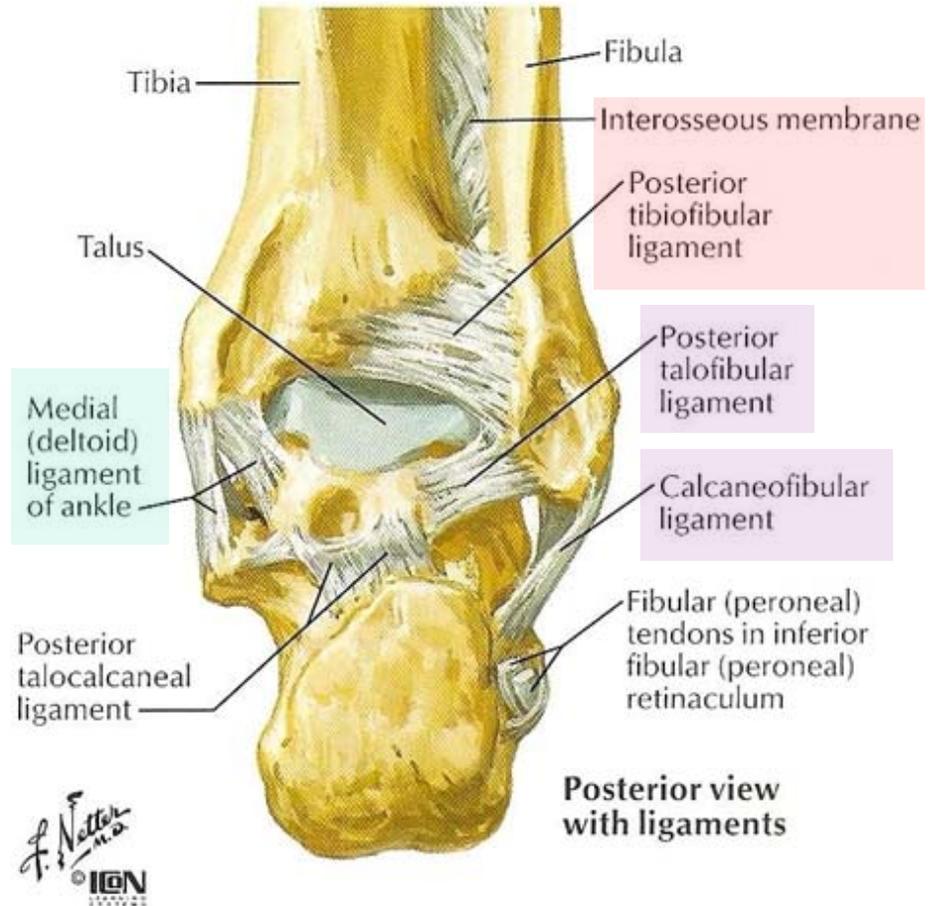
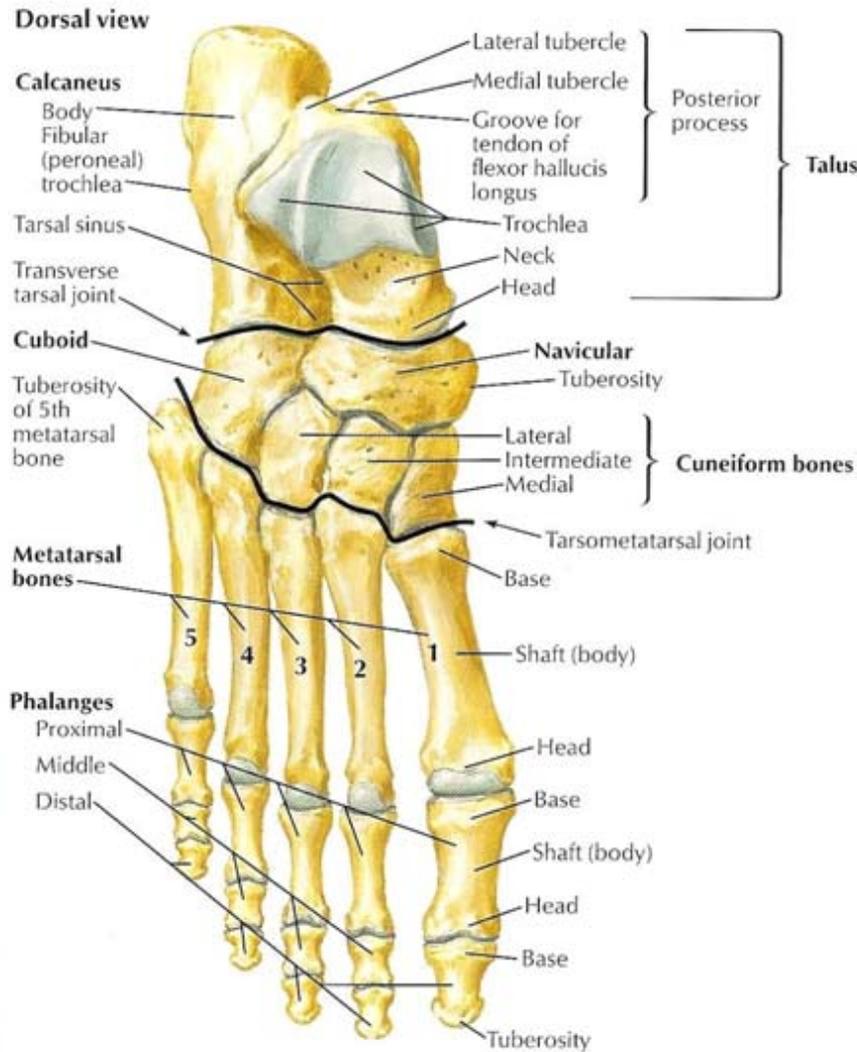
**Key**

- Syndesmosis
- Lateral Ligaments
- Medial (Deltoid) Ligament

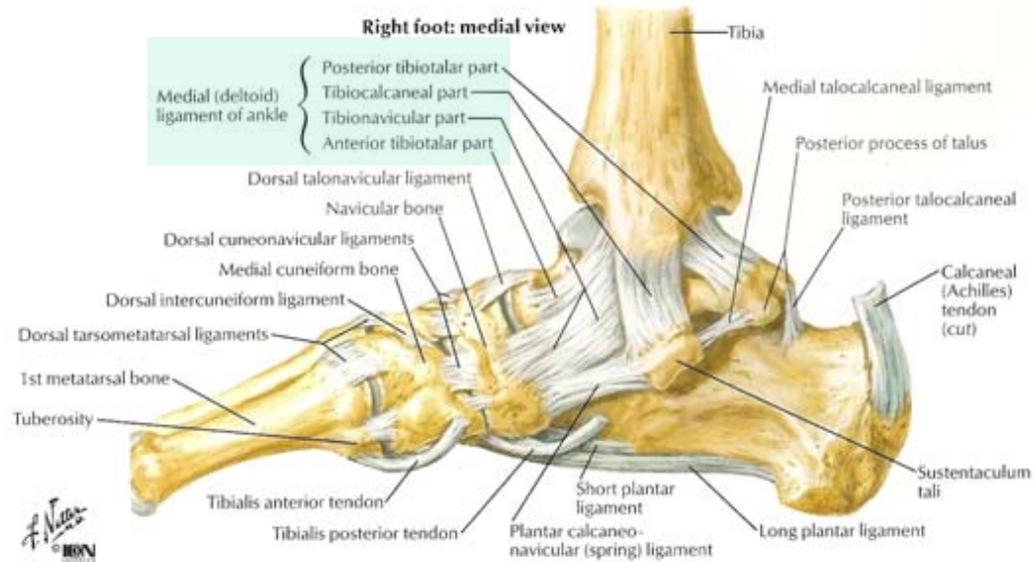
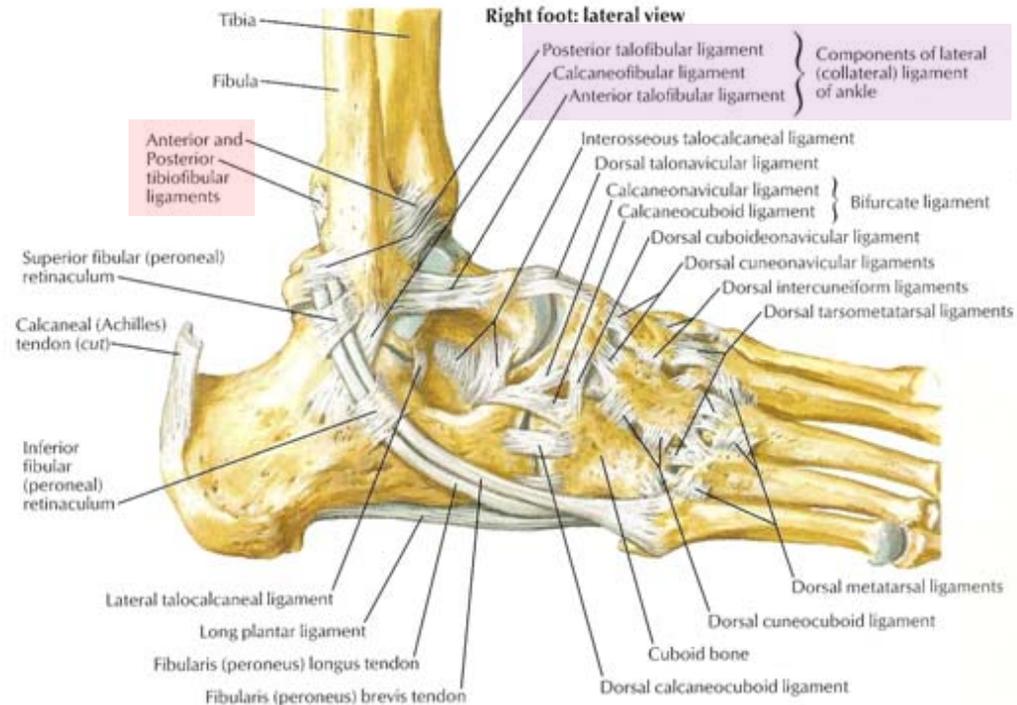
# Dorsal view of bones of foot, and Posterior view of ankle bones and ligaments

**Key**

- Syndesmosis
- Lateral Ligaments
- Medial (Deltoid) Ligament



# Medial and lateral views of ankle



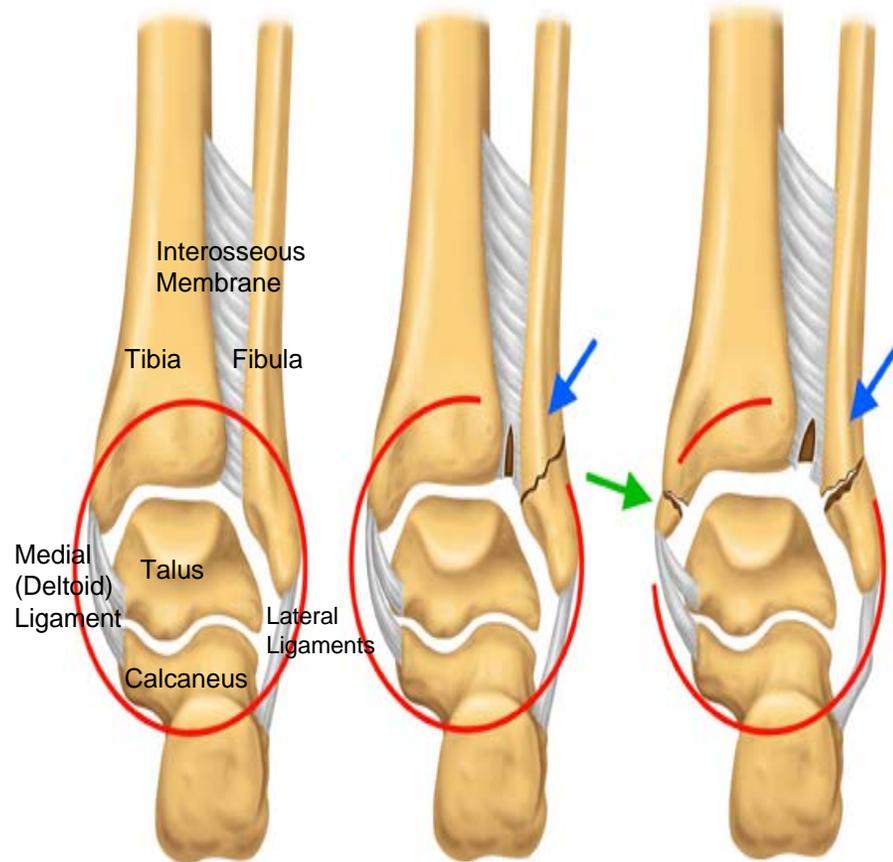
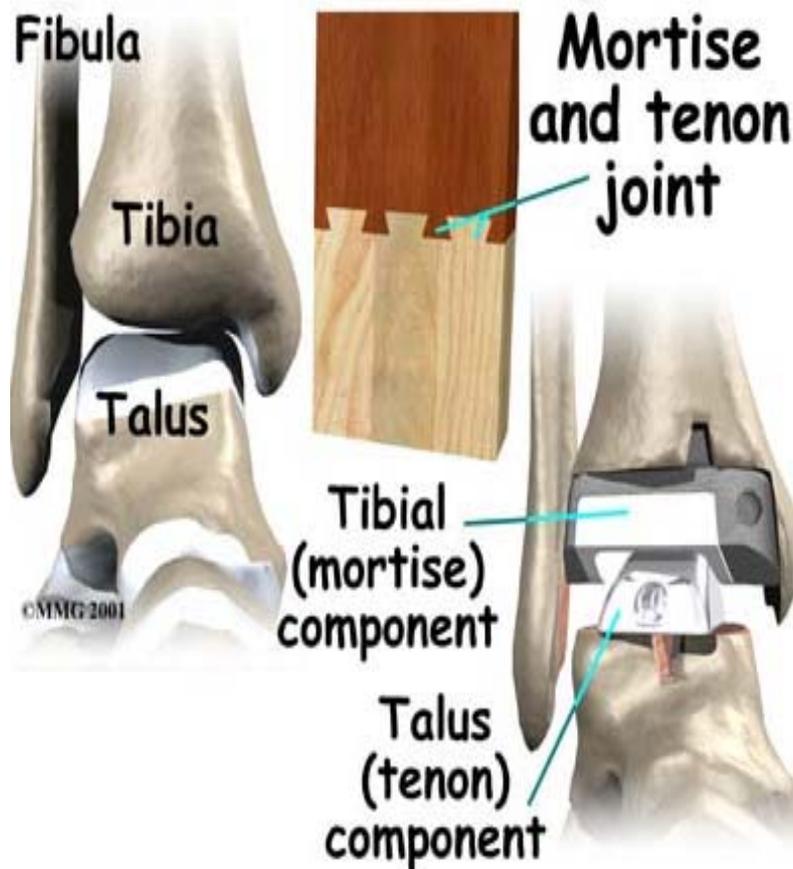
## Key

Syndesmosis

Lateral Ligaments

Medial (Deltoid) Ligament

# Ankle Anatomy: Nomenclature and the “Rule of Rings”



# Focused History and Physical Exam

## History

Blue terms indicate Ottawa Rules criteria

- Length of time from injury to presentation
- Mechanism of injury
- Site of the most significant pain, intensity of pain
- Other injured areas
- Ability to bear weight now and immediately after injury
- History of any previous injury or surgery
- Related comorbidities (especially diabetes)

## Exam

- Inspection*: swelling or deformity
- Palpation*:
  - Where maximally tender, other tender areas.
  - Along tibia and fibula, focusing on the medial and lateral malleoli
  - Proximal fibular neck, checking for associated fractures.
  - Proximal base of 5<sup>th</sup> metatarsal
  - Navicular bone
- Ligament laxity*: testing for this is often limited by pain in true ankle fractures.
- Pulses*
- Sensation*
- Ambulation*: can they take 4 steps?

Koehler, SM, et al. "Overview of Ankle Fractures". Up to Date 17.3.

Ivins, D. *Am Fam Physician*. 2006 Nov 15;74(10):1714-20.

# Case I: Physical Exam

- The patient appears generally well.
- She has restricted range of motion secondary to pain, but her ankle joint is stable.
- Her pain is most acute over her distal fibula. She also has pain on palpation over her lateral ankle ligament complex.
- She has no tenderness medially over the deltoid ligament, the medial malleolus, midfoot, or forefoot.
- Her skin is normal. Her foot appears to be well perfused. She has normal sensation to light touch in superficial and deep peroneal distribution as well as normal pulses in the dorsalis pedis and posterior tibial levels.

Your attending asks you if she needs imaging, what kind, and why

# Menu of Tests for suspected ankle fracture

## Common

### (1) X-ray:

- Indicated if the Ottawa Foot and Ankle rules are met.
- Malleolar fractures, distal fibula fractures, talar dome fractures, and syndesmosis separation may be diagnosed with plain X-ray.
- Three views are standard: Anterior-Posterior (aka Frontal), lateral, and mortise
- The mortise view is obtained with leg internally rotated 15-20 degrees, so the X-ray beam is perpendicular to the mortise. It allows unobstructed imaging of the mortise\*

## Uncommon

### (2) MRI:

- After X-rays obtained
- Indicated if suspicion of occult fracture, *to confirm a ligament injury making the ankle unstable* (like rupture of the tibia-fibula syndesmosis)
- Also indicated for subacute/chronic ankle pain caused by suspected tendon injury

### (3) CT:

- Indicated in high-energy poly-trauma, delineation of complex foot and ankle fractures, treatment planning of calcaneal fractures\*\*

\* Wheelless Online Textbook of Orthopedics. <[http://www.wheellessonline.com/ortho/radiographs\\_for\\_ankle\\_fractures](http://www.wheellessonline.com/ortho/radiographs_for_ankle_fractures)>

\*\* Dunfee, WR, et al. *Radiol Clin N Am* 40 (2002): 289– 312

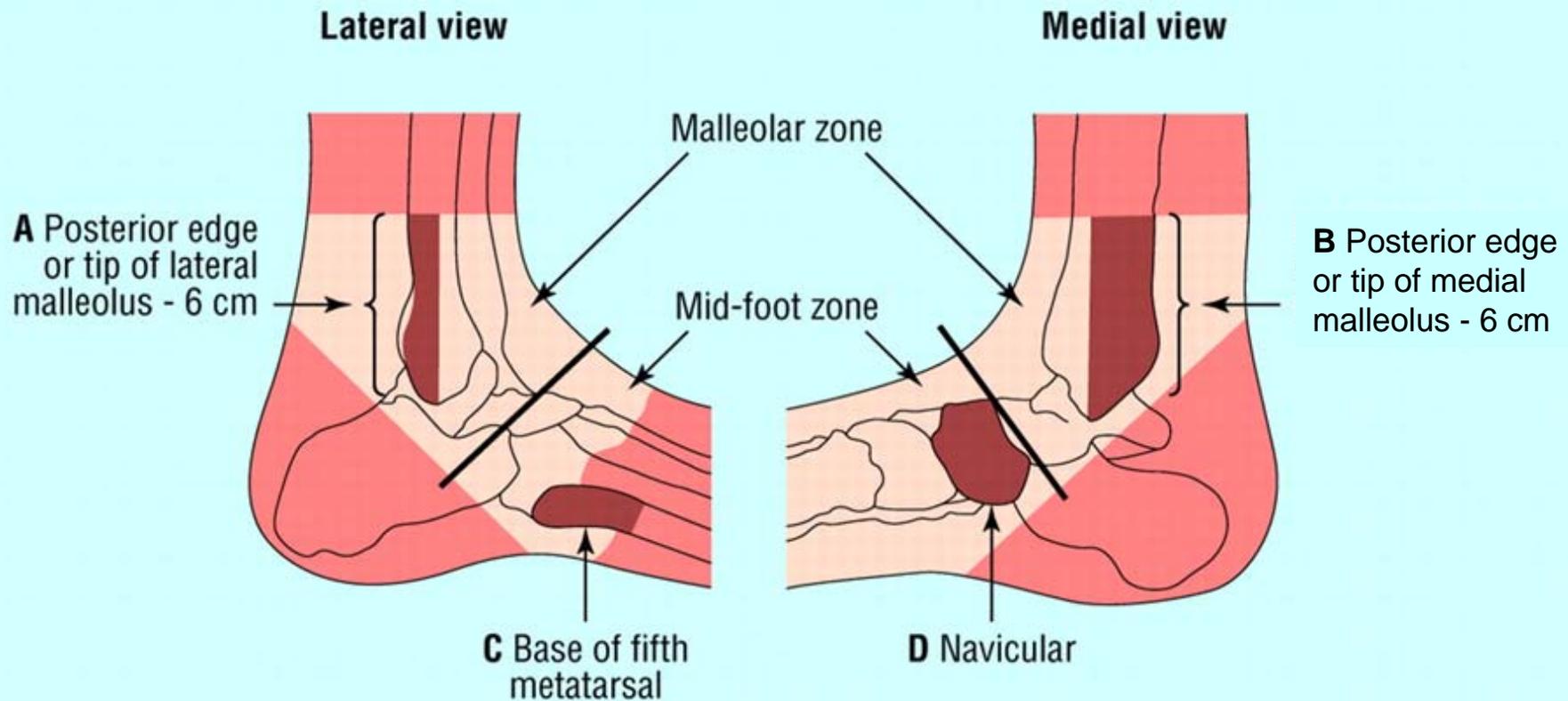
Bennett, DL, et al. "Suspected Ankle Fractures" American College of Radiology Appropriateness Criteria. 2008.

# Ottawa Ankle and Foot Rules

- A 2003 meta-analysis\* validated the usefulness of the rules in predicting the need for radiography in acute ankle injury.
- This meta-analysis included 32 studies: 12 studies assessing the ankle, eight assessing the foot, 10 assessing both, and 6 assessing the use of the rules in children.
- The rules missed fracture in only 47 out of 15,581 patients (0.3 %). Therefore, **the rules correctly ruled out fracture, without using radiography, in 299 out of 300 patients.**
- The rules have > 99% sensitivity, and therefore are excellent for ruling out fractures.
- The rules are not specific. The specificity varies from 10 to 79 %. The rules should not be used to rule in fractures.

\* Bachman, LM, et al. *BMJ* 2003; 326: 417.

# The Ottawa Foot and Ankle Rules



A series of ankle x ray films is required only if there is any pain in malleolar zone and any of these findings:

- Bone tenderness at **A**
- Bone tenderness at **B**
- Inability to bear weight both immediately and in emergency department

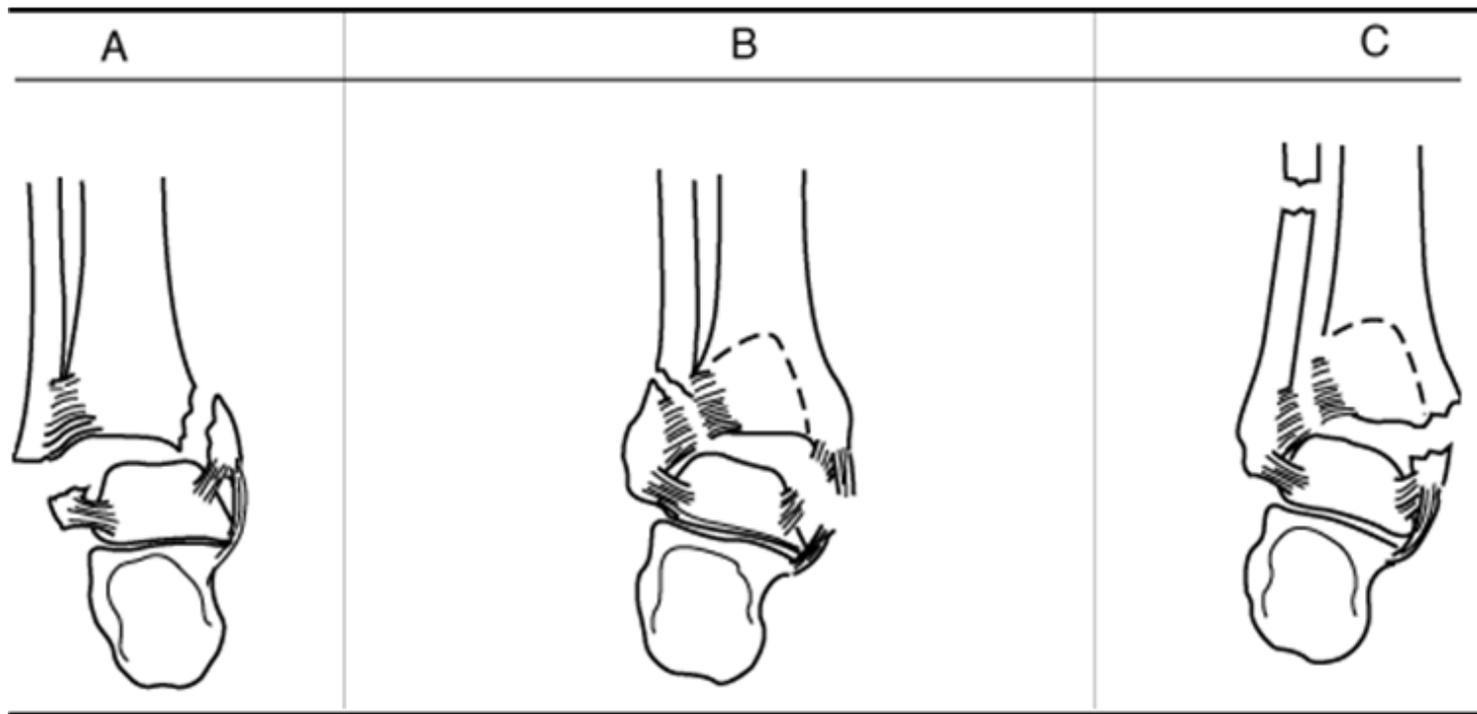
A series of ankle x ray films is required only if there is any pain in mid-foot zone and any of these findings:

- Bone tenderness at **C**
- Bone tenderness at **D**
- Inability to bear weight both immediately and in emergency department

# Classification of Ankle Fractures

- The **Weber** classification system of ankle fractures is more simple and more widely used than the **Lauge-Hansen** system.
- The Weber system is based on the level at which the fibular fracture occurs. The Lauge-Hansen system is based on the mechanism of injury.
- In addition to giving the Weber grade of a fracture, it is clinically important to note how many malleoli are involved: unimalleolar, bimalleolar, trimalleolar (fracture of distal posterior tibia)

# Weber Classification of Ankle Fractures



**Weber A:** Fibula avulsed distal to the joint line. Syndesmotic ligament is left intact. The medial malleolus may be normal, or fractured with preservation of the deltoid ligament.

**Weber B:** Common. Spiral fracture of the fibula beginning at the level of the joint line and extending proximally and posteriorly up the shaft of the fibula. Usually the syndesmotic ligament partially tears, but the interosseous membrane is intact and there is no widening of the mortise. Rarely the syndesmotic ligament completely tears causing the mortise to widen.

**Weber C:** Fracture of the fibula proximal to the syndesmotic ligament complex. There is disruption of the syndesmosis. Medial malleolar avulsion fracture or deltoid ligament rupture is also present.

# Case I: ED Images



AP (frontal)



Mortise

## Findings

- Minimally displaced oblique fracture through the distal fibula, Weber class B
- Narrowing of the lateral mortise and associated soft tissue edema.
- The medial mortise appears preserved without evidence of widening
- Congruent Tibiotalar joint

Before you talk to your attending, you review treatment of this type of ankle fracture

# Management of simple ankle fracture

- The stability of an ankle fracture determines whether surgery needed. Open Reduction and Internal Fixation (ORIF) stabilizes unstable fractures.
- A stable, unimalleolar, non-displaced fracture does not need orthopedic referral.
  - The patient should rest, elevate the involved ankle above the level of the heart, and apply ice.
  - If the injured leg is placed in a prefabricated splint able to withstand ambulation, the patient may bear weight as tolerated.\*
  - A short-leg walking cast is generally recommended for 6 weeks
- For unstable fractures not requiring ORIF, a long leg cast with the knee flexed to prevent weight bearing is recommended for 6 weeks.\*\*

\* Koehler, SM, et al. "Overview of Ankle Fractures". Up to Date 17.3.

\*\* Skinner HB: *Current Diagnosis & Treatment in Orthopedics, 4E.*

# Case I: ED course

- You diagnose her with a stable fracture of her right fibula at the level of the lateral malleolus (Weber B fracture), and discharge her home with crutches, a walking boot, and Vicodin. You instruct her to not bear weight on her right ankle, and to follow up within 2 weeks with an orthopedist to ensure that her ankle is healing well.
- Two weeks later the orthopedist confirms the ankle joint is congruent and places her right ankle in a non-weight bearing hard cast for 6 weeks. She was followed with serial ankle x-rays.

# Case I: 1 month after injury



AP



Mortise

## Findings

- Oblique fracture of the distal fibula extending into the mortise joint
- The fracture line remains visible. There is slight obscuration of the fracture line, consistent with faint callus formation.
- Tibiotalar joint remains congruent

## Case Conclusion:

She recovered uneventfully

# Case II

A 19 year old female presents to the ED after falling and spraining her right ankle. She was able to bear weight immediately after the injury and in the ED she is able to take four steps. On exam she appears well, but has pain on palpation at the base of her 5th metatarsal bone.

Recognizing she meets the Ottawa Rules, radiographs are taken in the ED

**Case II:** Radiographs reveal a nondisplaced comminuted fracture at the base of the right fifth metatarsal. The patient was discharged from the ED with NSAIDs, tylenol, crutches, a post-op shoe, and instructions to apply ice to her foot QID.



Lateral

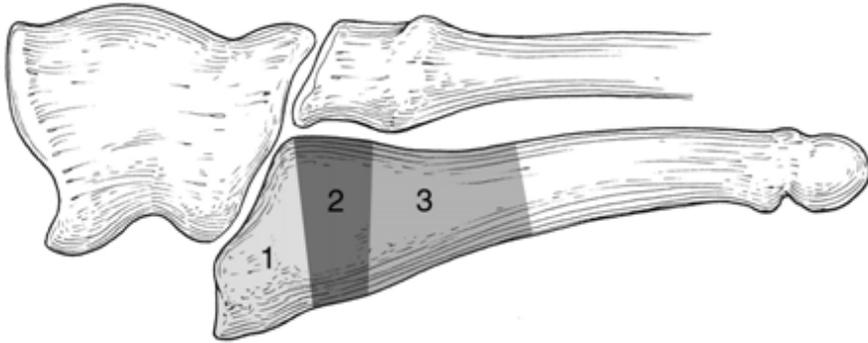


Mortise

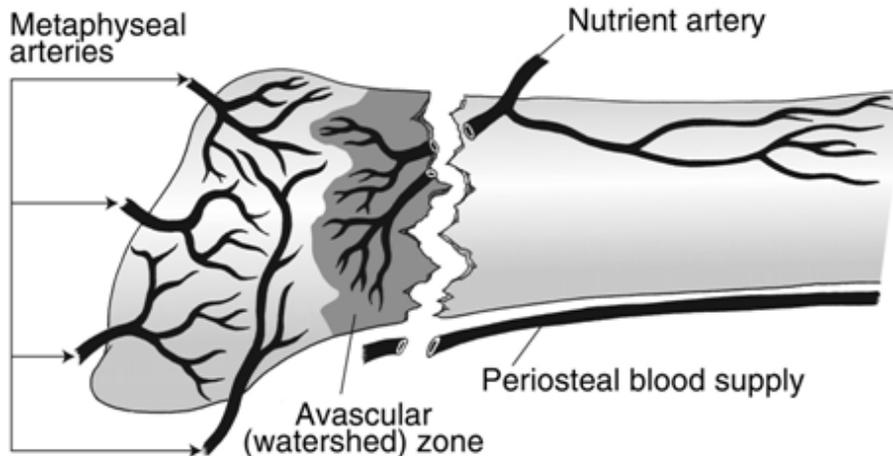


Oblique

# Jones Fractures



Lawrence SJ, Botte MJ. *Foot Ankle* 1993;14:358-365



Dameron TB Jr. *J Am Acad Orthop Surg* 1995;3:110-114.

-“Jones Fracture” if 1.5 cm distal to the tuberosity of the 5<sup>th</sup> metatarsal (zone 2). Jones Fracture is most common in 9-14 year olds, occurs along the metaphyseal-diaphyseal junction. They are typically caused by an inversion injury.

-Avulsion fractures (Zone 1) are more common than Jones Fractures. Stress Fracture is also on the DDx (zone 3).

-1/3 of Jones Fractures result in non-union

- Tenuous blood supply
- Insertion of Peroneus Brevis and Fibularis Tertius tendons

-Acute Jones fracture may be treated non-operatively with a non-wt-bearing cast for 6-8 wks. Surgical treatment for non-union is intramedullary screw fixation.

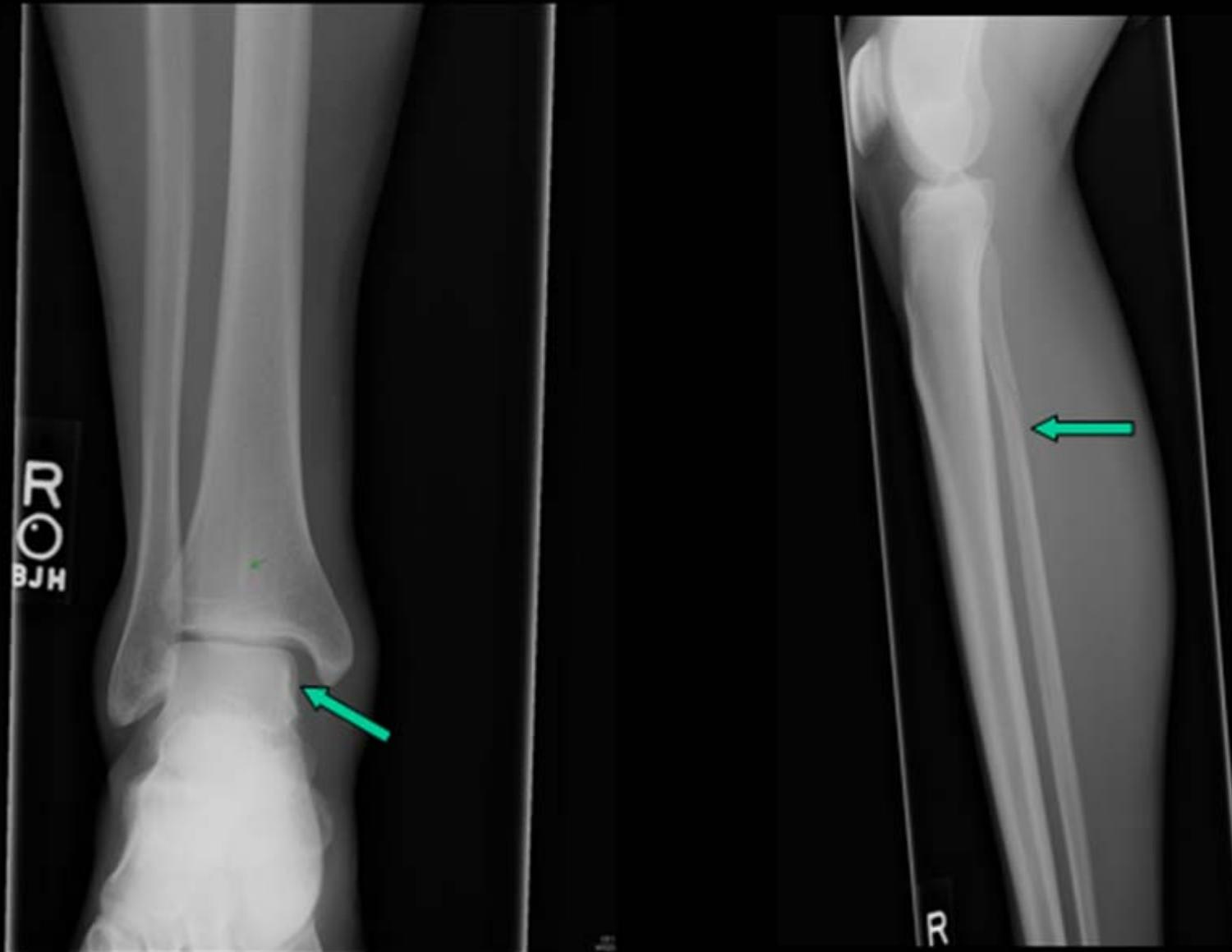
# Case III: The hockey player

A 24 year old man, who works as a mover and has a history of multiple past ankle sprains but no fractures, presents to the ED after suffering a rotational stress injury of his right ankle while playing hockey. He had immediate pain and disability in the ankle.

On exam he had pain on direct palpation over the deltoid ligament, the anterior tibia-fibula joint, and the *proximal and distal heads of the fibula*.

Ankle and lower extremity X-rays were obtained

# Case III, Continued



X rays showed widening of the medial mortise -- from  $< 4$  mm (the upper limit of normal) to 5.5 mm, suggestive of an injury to the deltoid ligament – and an oblique fracture of the proximal fibula. He was splinted and instructed to visit an orthopedist in the next 1-2 days for ORIF. His orthopedist ordered an urgent MRI to evaluate for possible injury to the tibia-fibula syndesmosis, as well as a full evaluation of his deltoid ligament injury.

# Maisonneuve Fracture

- Triad of Deltoid ligament tear, syndesmosis tear, and fracture of proximal head of fibula
- An uncommon fracture. It classically occurs after eversion injury or external rotational injury.
- In acute ankle injury: the initial force that tears the deltoid ligament travels through the syndesmosis and up the fibula, resulting in a fracture near the proximal fibular head.
- Acute knee injury may also cause this fracture pattern, with force traveling from the proximal head of the fibula distally to the deltoid ligament.
- First described by Maisonneuve in 1840
- On films that image only the ankle, the radiologist should be aware that widening of the medial mortise, implying a tear of the deltoid ligament or syndesmosis, may result in a proximal fibula fracture, and therefore lower extremity X-rays should be reflexively obtained.

# Case III, continued

Image from PACS, BIDMC



**Arrow:** Normal deltoid ligament from another patient, for comparison. This is Coronal Proton Density MRI through the right ankle.

# Case III, continued

## MRI Findings

- High grade tear of the deltoid ligament
- Completely torn interosseous ligament of the distal tibio-fibular syndesmosis (not shown)

## Clinical Course

- ORIF for his right ankle syndesmotic injury and deltoid ligament injury.
- At surgery there was evidence of a significant deltoid ligament injury with instability of the ankle mortise under stress testing, consistent with a deltoid ligament injury.
- 2 screws were used to stabilize the syndesmosis. He was placed in a non-weight bearing cast for 6 weeks.
- At 2 and 4 months after surgery, he had routine post-op ankle radiographs taken.



Our patient's MRI. This is a Coronal T2 weighted MRI through the right ankle. The deltoid ligament is poorly visible: it is macerated and disorganized.

# Case III: Complication



At 4 months s/p ORIF he was found to have broken through both of his screws, likely due to weight bearing.

The heads of his two screws were removed operatively, with the screw shafts being left in place.

Left film: at 2 months

Right film: at 4 months

# Ankle fracture and ORIF

- After ORIF, patients get a bulky sterile dressing and plastic splint for 1-2 weeks.
- In a reliable patient with stable joint:
  - Crutches, tell patient not to bear weight for 6 weeks.
- If the patient is unreliable or their joint is unstable after ORIF:
  - Short leg cast to immobilize joint for 6 weeks, with slow advancement of weight bearing

# Aknowledgements

- Dr. Jean-Marc Gauguet, my Big Sib.  
This presentation would not have been possible without his help.
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- Dr. Gillian Lieberman
- Ms. Maria Levantakis
- My medical student colleagues

# References

- Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. "Accuracy of Ottawa Ankle Rules to exclude fractures of the ankle and mid-foot: systematic review". *British Medical Journal*. 2003; 326: 417.
- Bennett, DL, et al, "Suspected Ankle Fractures". *American College of Radiology Appropriateness Criteria*. Updated 2008. <<http://acsearch.acr.org/procedureslist.aspx?tid=69011&vid=3072252>>. Accessed 2/18/2010.
- Dameron TB Jr. "Fractures of the proximal fifth metatarsal: Selecting the best treatment option". *Journal of the American Academy of Orthopedic Surgery*. 1995; 3: 110-114.
- Dunfee, WR, et al. "Imaging of athletic injuries to the ankle and foot". *Radiology Clinics of North America*. 40 (2002) 289–312.
- Dunlop, MG, et al. "Guidelines for selective radiological assessment of inversion ankle injuries". *British Medical Journal*. 1986; 293: 603-605.
- Ivins, D. "Acute ankle sprain: an update". *American Family Physician*. 2006;74 (10):1714-20.
- Judd DB, Kim DH. "Foot fractures frequently misdiagnosed as ankle sprains". *American Family Physician* 2002; 66: 785-94.
- Koehler, SM, Eiff, Patrice. "Overview of Ankle Fractures". *Up To Date*. Online version 17.3. Accessed 2/18/2010.
- Lawrence SJ, Botte MJ. "Jones' fractures and related fractures of the proximal fifth metatarsal". *Foot Ankle* 1993;14:358-365.
- Maughan, Karen. "Ankle Sprain". *Up to Date*. Online version 17.3. Accessed 2/18/2010.
- Netter, FH. *Atlas of Human Anatomy*, 3E, Icon Learning Systems, 2003.
- Nikken, JJ, Oei, EH, Ginai, AZ, et al. "Acute ankle trauma: value of a short dedicated extremity MR imaging examination in prediction of need for treatment". *Radiology* 2005; 234:134.
- Smith, WR, et al. "Ankle Fractures and dislocations". In *Current Diagnosis & Treatment in Orthopedics*, 4E, editor Harry B Skinner. Accessed via Access Medicine.
- Sujitkumar, P, Hadfield, JM, Yates, DW. "Sprain or fracture? An analysis of 2000 ankle injuries". *Archives of Emergency Medicine*. 1986; 3:101.