The Not So Simple Ankle Fracture

Objectives
- Appreciate importance of bony and ligamentous anatomy
- Emphasize critical appraisal of adequate ankle imaging
- Understand spectrum of injury
  - Recognize problematic ankle fracture patterns
- Review operative strategies for addressing these patterns

Functional Anatomy – Tibiotalar Joint

Mortise = a recess cut into a part, designed to receive a corresponding projection on another part as to join or lock the parts together
Incisura = a deep indentation or notch in a surface

Anterior tubercle projects more laterally thereby deepening concavity anteriorly

Evaluation

Adequate imaging paramount

- AP
- Mortise
- Lateral
  + ?external rotation lateral
- Stress Radiographs
- +/- CT scan
- +/- MRI

AP Radiograph

Tib-fib clear space > 5mm
Tib-fib overlap < 10mm
No association with deltoid/syndesmosis injury (Helfet 2005 CORR)

Talar Tilt
Mortise Radiograph

- 10 – 20 deg internal rotation view
- True AP of the transmalleolar axis

Mortise Radiograph

- Medial clear space
- Talocrural angle
- Tib-fib overlap

Pathological Mortise?

Normal ankles evaluated (Kadakia FAJ 2012)

- Green (MCS oblique):
  - Male: 33% > 4 mm
  - Female: 3% > 4 mm
- Yellow (MCS perpendicular):
  - Male: 17% > 4 mm
  - Female: 1% > 4 mm
- Use perpendicular line
- Compare contralateral side
**Lateral Radiograph**
- Posterior malleolus
- A-P talar subluxation
- Distal fibular relationship
- Associated injuries calcaneus / talus

**Stress Radiographs**
- Manual ER
- Gravity Stress
  - Both Effective

**Difficult Fracture Characteristics**
- Fibular comminution / shortening
- Shear mechanisms
- Articular plafond involvement
- Posterior malleolar variants
- Syndesmotic disruption

*All possibly compounded by osteopenia / osteoporosis
Treatment Goals

- Obtaining and maintaining a stable ankle mortise without talar shift through union

Ramsey JBJS 1976, Lloyd FAI 2006
- 1mm lateral shift of talus increased contact stress by 42%
- 3 mm lateral shift decreases contact area by > 60%

Harford CORR 1995
- Posterior malleolar fractures associated with decreased tibiotalar contact area, particularly when >33% in size

Fibular Shortening (Mortise Radiograph)

Contralateral Views Helpful
Fibular comminution / shortening

- Push-Pull Screw
- Restore Dime Sign
5 months post op

Shear mechanisms
Use pathomechanics to your advantage
  => buttress

Articular plafond involvement
Supination Adduction (SAD)

Associated injury?
Medial tibial plafond impaction 42% (McConnell 2001 JOT)
Posterior Malleolus Evaluation

- Lateral radiograph
- External rotation lateral
- CT scan
Posterior Malleolar Fractures

Difficult to assess on standard lateral radiograph
External rotation lateral view
CT scan

[Decoster FAI 2000]
[Haraguchi JBJS 2006]

Posterior Malleolar Variants – "Posterior Pilon"

Retrospective review (n=270)
(Switaj et al. FAI 2014)

- 50% posterior mal fx
- 20% posterior pilon variant
- Posteromedial extension
- Articular impaction
- 2 fragments
  - Posterolateral
  - Posteromedial
- Posteromedial subluxation

*Images: McMinn textbook on Foot and Ankle Anatomy
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Gardner et al. CORR 2006
- posterior malleolus fixation provides greater syndesmotic stability than transsyndesmotic stabilization (70% vs 40%)

... New Case
Syndesmosis

Function: resists external rotation, axial & lateral displacement of talus

Pathological disruption: often difficult to diagnose & techniques to do so are variable /frequently unreliable

Bottom Line: instability should be assessed after osseous injuries have been stabilized
Syndesmotic Reduction

Closed (radiographic) versus Open (visualization / palpation + radiographic)

- Compare contralateral (Summers 2013 JOT)

52% malreduction CT (Gardner 2006 FAI)

Worse function at 2 yrs (Sagi 2012 JOT)

Clamp/screws malreduce in cadavers (Miller 2013 JOT)
Syndesmotic Reduction

Open Reduction and direction palpation / visualization best
Syndesmotic Fixation?

- 1 or 2 screws (Hoiness 2004)
- 3 or 4 cortices (Moore 2006)
- 3.5mm vs 4.5mm (Thompson 2000)
- Position of foot (Tornetta 2001)
- 2-5 cm proximal to joint line (Kukreti 2005)

  - *No clinical differences able to be delineated*

?dynamic syndesmotic fixation* (Westermann et al. JBJS 2014 - allows "natural" correction of malreduction in cadaveric model)

Bonus Case
Future Directions

- Reliable intra-operative syndesmotic reduction assessments
- Novel syndesmotic fixation techniques (?dynamic fixation)
- Value of adjunctive arthroscopy
- Role for primary ligamentous / Deltoid repair

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Take Home Points:

Be Cognizant of Difficult Fracture Characteristics

- Fibular comminution / shortening
- Shear mechanisms
- Articular plafond involvement
- Posterior malleolar variants
- Syndesmotic disruption

.... and have a surgical tactic to combat these challenging fractures!
Thank You