Talus Fractures

Bethany Gallagher, MD

Vanderbilt University
Outline:

Talar Neck Fractures
- Anatomy
- Incidence
- Imaging
- Classification
- Management
- Complications

Talar body, head and process fractures

Subtalar dislocations
- Classification
- Management
- Outcomes
Anatomy

• Surface 60% cartilage
  • Articulations with Tibial Plafond, Medial Malleolus, Lateral Malleolus, Calcaneus, Navicular

Anatomy

- Multiple Ligamentous Attachments
  - Anterior talofibular ligament
  - Posterior talofibular ligament
  - Talocalcaneal ligaments
  - Tarsal Sinus ligaments
    - cervical ligament
    - talocalcaneal interosseous ligament
  - Deltoid ligament
    - Anterior tibiotalar ligament
    - Superficial posterior tibiotalar ligament
    - Deep posterior tibiotalar ligament
  - Dorsal talonavicular ligament

Figure 64-4 and 64-5: Tornetta P, Ricci WM, eds. Rockwood and Green’s Fractures in Adults, 9e. Philadelphia, PA. Wolters Kluwer Health, Inc; 2019.
Complex Vascular Supply

- Posterior Tibial Artery (47%)
  - Artery of Tarsal Canal
    - Main Contributor Talar Body
  - Deltoid Branch
- Anterior Tibial Artery
- Artery Tarsal Sinus
  - Perforating Peroneal Arteries
Complex Vascular Supply

ANTERIOR
Anterior tibial artery

POSTERIOR
Posterior tibial artery
Perforating peroneal artery

LATERAL
Perforating peroneal artery

MEDIAL
Anterior tibial artery
Posterior tibial artery

Image used with permission AO Foundation
Talar Neck Fractures
Incidence

• 2 % of all fractures
• Associated complications
  • avascular necrosis
  • post-traumatic arthritis
  • malunion
Mechanism of Injury

- Hyperdorsiflexion of the foot on the leg
- Neck of talus impinges against anterior distal tibia, causing neck fracture
- If force continues:
  - Talar body dislocates posteromedial
  - Rotates around deltoid ligament
Injury Mechanism

• Previously called “aviator’s astragalus”

• Usually due to motor vehicle accident or falls from height

• Approximately 50% of patients have multiple traumatic injuries
Imaging

• Multiple plain film orientations:
  • 3 views ankle
    • Demonstrates joint congruity
Canale View

- Slight ankle plantarflexion with knee bent to rest foot on the table
- 15 degree pronation
- Xray Tube
  - 15 degree from vertical
- Outlines morphology talar neck
  - A True AP view talar neck

CT Scan

- Most useful assessment tool for surgical planning
- Confirms displacement
- Demonstrates subtalar joint reduction, comminution, osteochondral fractures/debris
Talar Neck Fracture Classification

• Hawkins Fracture Classification
• Predictive of AVN rates
  • Overall incidence 31%
  • Anastomotic sling formed between Artery Tarsal Canal and Artery Tarsal Sinus in the tarsal canal
    • Often injured in talar neck fractures
  • More recent studies have shown decrease AVN rates possibly due to improved surgical techniques
Hawkins 1

• Type I: undisplaced
• AVN rate 0 – 13 %

• Uncommon
  • CT often demonstrates malreduction and rotation
Hawkins 2

- Displaced fracture with subtalar subluxation / dislocation
  - AVN 20 – 50 %
- Most common type
- Subdivided:
  - 2A: Subluxation 0% AVN
  - 2B: Dislocation 25% AVN
Hawkins 3

- Subtalar and ankle joint dislocated
  - AVN 50 – 100 %
- Talar body extrudes, usually around deltoid ligament
- Closed reduction often unsuccessful
  - Urgent open reduction required
  - Clear interposed soft tissue
    - Flexor tendons/posterior tibial tendon incarcerated
    - Use joysticks and distractor for reduction
    - Carefully plan surgical incisions if planning for delayed ORIF

Image used with permission AO Foundation
Hawkins 4

- Incorporates talonavicular subluxation
  - AVN 100%
- Rare variant

Image used with permission AO Foundation
Hawkins Classification

- Predictor of outcomes
  - AVN
  - Malunion
    - Varus malunion 25-30%
  - Subtalar joint arthritis
    - 50% subtalar arthritis
Goals of Management

• Immediate reduction of dislocated joints
  • Skin tension
  • Vascular compromise
• Anatomic fracture reduction
• Stable fixation
• Facilitate union
• Avoid complications
Treatment Plan

• Initial Presentation
  • Nondisplaced fracture
    • CT scan
    • Splint immobilization
  • Displaced
    • Attempt closed reduction →
      • Be aware of the skin/skin compromise
      • Successful 30-60%
    • Adequate sedation
    • Flex knee to relax gastrocs
    • Traction on plantar flexed forefoot to realign head with body
    • Varus/valgus correction as necessary
    • Direct pressure on talar body
Treatment Plan

• Emergent OR
  • Irreducible
  • Open Fractures
    • 20-38%
  • Skin/Vascular Compromise

• Open reduction
  • Definitive ORIF vs Temporary External Fixation
  • Plan incisions for definitive management

Temporizing spanning external fixation with reduced talus fracture waiting until swelling decreases for definitive ORIF (no fixation in zone of surgical incisions)
Treatment Plan

• Place in temporary splint once talar neck fracture reduced

• Time to definitive fixation NOT related to increased risk of AVN
  • Wait for appropriate soft tissue envelope to reduce complications
    • Despite optimizing skin envelope risk of wound dehiscence, skin necrosis, and infection → 10%
Hawkins I Fracture

- Non Operative & Non-Weight-Bearing Cast

OR:

- Percutaneous screw fixation and early motion
  - AP screws acceptable treatment/union
    - Limited risk to surrounding structures
  - PA screws
    - Biomechanically superior
    - Perpendicular to fracture line
    - Increased risk to surrounding structures FHL/sural nerve
Hawkins II, III, and IV Fractures:

• Results dependent upon development of complications
  • Osteonecrosis
  • Malunion
  • Arthritis
Surgical Treatment

- Achieve anatomic reduction
- Utilize dual incisions
  - Maintain capsular soft-tissue insertions to protect blood flow
  - Allows for visualization and correction of medial talar neck comminution
- Utilize osteotomies as necessary
- Take x-ray of uninjured side for morphology comparison
1st Approach:

- Medial to Tib Ant
- Make incision more posterior for talar body fractures to facilitate medial malleolar osteotomy (if osteotomy planned)
1\textsuperscript{st} Approach:

• Provides view of neck alignment and medial comminution

• Extend incision distally to talonavicular joint – hardware is placed distal to proximal and needs to be well countersunk to avoid impingement
Medial Malleolar Osteotomy

• Predrill and pretap malleolus
• Osteotomy aims just off the medial corner of mortise to facilitate interdigitation
• Align exit point into the joint to allow for maximum visualization
• Chevron, straight, or stepcut techniques
• Osteotome to crack cartilage helps avoid mortise malalignment
• Care when retracting and dissecting to leave deltoid INTACT

2\textsuperscript{nd} Approach:

- Tip of Fibula Base of the 4\textsuperscript{th} metatarsal
- Mobilize EDB as sleeve
2nd Approach:

- Visualizes Anterolateral alignment and subtalar joint
- Allows for debridement of debris in subtalar joint
- Facilitates Placement of “Shoulder Screw” or lateral plate
2 incisions: Skin bridge

- Narrow skin bridge but generally well tolerated
- Be sure to not dissect the dorsal capsular structures to the distal neck/head
Fixation Options

• Stable Fixation to allow early motion is the goal
• Often a combination of mini-fragment plate fixation and screw fixation
  • Depends on fracture comminution and medial neck shortening
  • Consider fully-threaded screws medially to prevent medial neck shortening and varus
  • Lateral plating for buttress
Anterior Screw Fixation:

Screw fixation alone is acceptable for non-comminuted fractures, but consider adding a lateral plate if there is comminution.

- Easy to insert under direct visualization
- Countersink screw heads if encroaching on articular surfaces
- No difference in strength of countersinking vs headless screws
Plate Fixation:

- Very useful in comminuted fractures:
  - 2.0 or 2.4 mm plates
  - Easiest to apply to lateral cortex – impinge on medial side
  - Provides a length stable construct
  - Careful contouring of the lateral plate to prevent subfibular/lateral gutter impingement

Treatment

• Post operative rehabilitation:

• Sample protocol:
  • Initial immobilization, 2-6 weeks depending upon soft tissue injury and patient factors, to prevent contractures and facilitate healing
  • Non weight-bearing, Range of Motion therapy until 3 months or fracture union
Complications

• AVN
• Malunion
• Nonunion
• Arthritis
AVASCULAR NECROSIS

- Rates with Hawkins Class
- Functional outcomes significantly worse with AVN
- Early ORIF does not prevent development of AVN
- Can see revascularization without collapse in 34-47% patients with radiographic osteonecrosis
AVN: Diagnosis

- Hawkins’ Sign: Xray finding 6-8 weeks post injury
  - Presence of subchondral lucency implies revascularization
- Increased radiodensity c/w Osteonecrosis has been seen from 4wk-6month after injury
AVN: Imaging

- Plain radiographs: sclerosis common, decreases with revascularization
- MRI: very sensitive to decreased vascularity

AVN Treatment:

• Precollapse:
  • Modified WB
  • PTB cast
  • Compliance difficult
  • Efficacy unknown

• Postcollapse:
  • Observation
  • Hindfoot fusions are option if symptomatic
AVN Surgical Treatment

• 10-50% patients with AVN have collapse

• Surgical treatments
  • Patient age/comorbidities
  • Bone stock availability
  • Degree and location of arthrosis
Surgical Treatments

• Options
  • Total talus prosthesis
  • Total ankle arthroplasty
    • Dependent on talar bone stock health
  • Hindfoot fusions
Malunion: Incidence

• Common: up to 40%

• Most often Varus
  • Medial neck collapse and medial column shortening
Malunion: Diagnosis

• Varus hindfoot, midfoot supination on clinical exam

• Dorsal malunion on Xray
Clinical Effect of Malunion

- Malunion:
  - More pain
    - Lateral foot overload and ankle instability
  - Less satisfaction
  - Less ankle and subtalar motion
  - Worse functional outcome
Malunion Correction

• Intact motion with minimal OA
  • Talar neck osteotomy
  • Calcaneus osteotomy
  • Possible midfoot derotational osteotomy
  • Tendo Achilles Lengthening

• May require triple arthrodesis in fixed deformity with OA

Post-Traumatic Arthritis

• Incidence of post-traumatic arthritis
  • 30-90 %
  • Variations reported in outcomes are multifactorial
• Increases with subtalar dislocation
Post-Traumatic Arthritis

- Most commonly involves Subtalar joint

- Rx: Arthrodesis
Talar Body Fractures
Talar Body Fractures

• Treatment strategy and outcomes similar to talar neck fractures
• Fracture extends within or posterior to the lateral process
• Medial or Lateral Malleolar Osteotomy frequently required for visualization
Talar Body Fracture Classification

C1  C2  C3

Image used with permission AO Foundation
Talar Body Fracture Management

• **Shear**
  • Nondisplaced
    • Non-op treatment with immobilization/nonweightbearing
  • Displaced
    • ORIF
      • Countersink screws
      • Headless compression screws

• **Compression**
  • Highly comminuted
    • Acute fusion
      • Blair fusion
      • Strut from anterior tibia
    • Tibiocalcaneal fusion
Talar Body Fractures

• Be aware of threatened skin from fracture fragments
• Use both lateral and medial malleolar osteotomies/fractures for visualization

Lateral Skin tenting from lateral body fragment
Talar Body Fracture

• Similar fracture fixation principles as the talar neck fracture
  • Plate fixation in highly comminuted fractures with impaction and bone loss

• AVN rates and posttraumatic OA rates increase with fracture severity

• No significant difference in posttraumatic OA and rates of AVN when compared to talar neck fractures
Talar Body Fractures

- May consider percutaneous fixation in non-displaced
- Difficult Salvage
Osteochondral Injury
Osteochondral Injuries

• Frequently encountered with talus neck and body fractures
• Require small implants for fixation
• Excise if unstable and too small to fix
Osteochondral Injuries
Osteochondral Fragment Repair

Large fragment repaired, small fragment excised
Osteochondral Fragment Repair

• Counter-sink screw fixation
• Headless compression screws
Talar Head and Process Fractures
Talar Head and Process Fractures

• Treat according to injury
• Operate when associated with joint subluxation, incongruity, impingement or marked displacement
• Fragments often too small to fix and require excision
Talar Head Fracture

- Can be subtle
- CT demonstrates subtalar injury and subluxation

Treatment of Talar Head Fracture

- Requires 2 incisions to debride subtalar joint from lateral approach, and reduce / stabilize fracture from medial side
- Consider bridge plating across the fracture to maintain length and prevent collapse

Lateral Talar Process Fractures

• “Snowboarder’s fracture”
• Mechanism: may occur from inversion (avulsion injury) or eversion and axial loading (impaction fracture)
• Often misdiagnosed as “ankle sprain”
• Best results if treated early, either by immobilization, ORIF or fragment excision
• If diagnosed late consider fragment excision as attempts to achieve union often fail
Lateral Process Example

- Usually require CT scan
- Often excised due to size of fragments
- Difficult to achieve union
Lateral Process Fractures

• Can lead to subtalar OA and deformity through the subtalar joint
• Can also see cartilage damage of the posterior facet subtalar joint
Treatment Options

• Non-operatively for minimally displaced fractures
• Excision of fragment
• Isolated mini fragment screws
• Mini plate fixation
Mini Plate Procedure

1. Lateral approach
2. Subtalar chondral debris removed
3. Impaction elevated if present & filled with allograft if required
4. Preliminary 0.45 Kirschner wire (K-wire) fixation.
5. 2.0 mm “T” plate applied upside down
6. Lag screw fixation - avoiding overcompression with comminution
Posterior Talar Process Fracture

• 2 components: medial and lateral tubercle
• Groove for FHL tendon separates the two tubercles
• Differentiate fracture from os trigonum – well corticated, smooth oval or round structure
Posterior Talar Process Fractures

• Medial tubercle fracture: “Cedell’s fracture”
• Lateral tubercle: “Shepherd’s fracture”

• Treatment: immobilize or excise or ORIF
• Use low profile fixation to prevent posterior impingement or FHL tendon irritation
Treatment

• Usually associated with Talar Neck Fx
• Posteromedial Approach behind Neurovascular Bundle
• Medial Malleolar Osteotomy – usually not effective for exposure or fixation
• Significant displacement or nonunion can lead to varus hindfoot as the subtalar joint subsides into defect
Open Talar Body Extrusion

• Catastrophic Injury
• 60% Open injuries
• Infection Rates 25-50%
• Reinsert extruded bone after thorough washing
  • Maintain bone stock
  • Maintain height
Subtalar Dislocations

• Spectrum of injuries

Relatively Innocent

Very Disabling
Classification

• Usually based upon direction of dislocation:
  
  • Medial dislocation: 85 %, low energy
  
  • Lateral dislocation: 15 %, high energy
Other Important Considerations:

- Open vs Closed
- High or low energy mechanism
- Stable or unstable post reduction
- Reducible by closed means or requiring open reduction
- Associated impaction injuries
Important Distinction:

Pantalar dislocation vs Subtalar Dislocation

- Total talar dislocation, or pantalar dislocation
- Results from continuation of force causing subtalar dislocation
- High risk of AVN, usually open, poor prognosis

Open pantalar dislocation with skin loss showing Incongruent reduction: Result was AVN and pantalar fusion
Management of Subtalar Dislocation

• Urgent Closed reduction:
  • Adequate sedation
  • Knee flexion
  • Longitudinal foot traction
  • Accentuate, then reverse deformity

• Successful in up to 90% of patients
Anatomic Barriers for Unsuccessful Closed Reductions

Medial Dislocation
• Peroneal Tendons
• EDB
• Talonavicular joint capsule

Lateral Dislocation
• Posterior tibial tendon
• Flexor Hallucis Longus
• Flexor Digitorum Longus
Open Reduction:

- More likely after high energy injury
- More likely with lateral dislocation
- Cause:
  - soft tissue interposition (Tib post, FHL, extensor tendons, capsule)
  - bony impaction between the talus and navicular


Use a small posteromedial incision, retract interposed soft tissue to reduce dislocation

Be sure to plan for any necessary f/u surgical incisions!!
Associated Fractures

Medial dislocation
• Talar Head
• Posterior Process
• Navicular

Lateral Dislocation
• Cuboid
• Anterior process calcaneus
• Fibula
• Posterior process
Rehabilitation:

• Stable injuries:
  • 4 weeks immobilization
  • Physical Therapy for mobilization

• Unstable injuries:
  • Usually don’t require internal fixation once reduction achieved
  • If necessary – external fixation or transarticular wire fixation
Outcome of Subtalar Dislocations:

- Less benign than previously thought
- Subtalar arthritis:
  - Up to 89% radiographically
  - Symptomatic in up to 63%
- Ankle and midfoot arthritis less common
Summary:

Talar Neck Fractures
- Anatomy
- Incidence
- Imaging
- Classification
- Management
- Complications

Talar body, head and process fractures

Subtalar dislocations
- Classification
- Management
- Outcomes


*the two classics on talus fractures. Rates of AVN, classification, etc. Good descriptive papers.*

Additional Clinical papers:


Selected References


Selected References

