OITE Review:
Foot and Ankle

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LET’S GET STARTED . . . . . . . . . .
DEFORMITY

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Muscular Opposition

• Ankle inversion vs. eversion
  – PTT vs. PB

• Ankle dorsiflexion vs. plantarflexion
  – TA vs. Achilles

• 1st ray dorsiflexion vs. plantarflexion
  – TA vs. PL
Peripheral Nerves

• **Saphenous**

• **Common peroneal (CPN)**
  - SPN
    - 10-12cm proximal to the distal fibula
    - Medial, intermediate, lateral branches
  - DPN

• **Tibial**
  - Medial plantar
  - Lateral plantar
    • Baxter’s nerve

• **Sural**
  - Branches from CPN & tibial nerves
Nerve Roots

- **Motor**
  - TA tendon
    - L4
  - EHL
    - L5
  - Peroneals
    - S1
- **Sensation**
  - L5 – great toe
  - S1 – small toe
Muscles/Tendons of the Foot

- **1st layer**
  - Abductor hallucis
  - Flexor digitorum brevis
  - Abductor digiti minimi

- **2nd layer**
  - Quadratus plantae
  - Lumbricals
• 3rd layer
  – Flexor hallucis brevis
  – Adductor hallucis
  – Flexor digiti minimi brevis

• 4th layer
  – Plantar interossei
  – Dorsal interossei
Cavovarus Deformity

- Hereditary motor-sensory neuropathy
  - Previously known as Charcot Marie Tooth
  - Progressive distal muscle wasting & weakness

- Effect on
  - PB > PTT
  - TA > PL
  - Intrinsics

- Pathology
  - Sural nerve biopsy -> onion bulb formations
  - Segmental demyelination and remyelination
In a patient with Charcot-Marie-Tooth disease, which of the following anatomic abnormalities is responsible for the pathomechanics of the foot deformity seen in Figures 56a and 56b?

1- Intrinsic muscle atrophy
2- Talocalcaneal coalition
3- Achilles tendon contracture
4- First metatarsal plantar flexion
5- Lateral ankle ligament laxity
Answer: 4
Physical Examination

• Coleman block testing
  – Placed under the lateral calcaneus & column
  – Assesses:
    • Flexibility of Deformity
    • Is process forefoot driven?
  – Determines treatment
Surgical Treatment of the Cavovarus Foot

- **Heel varus**
  - Dwyer closing-wedge lateral calcaneal osteotomy
  - PL -> PB transfer

- **Lateral ankle instability**
  - Brostrom vs. non-anatomic reconstruction

- **Cavus**
  - Plantar fascial release
  - Dorsiflexion closing-wedge osteotomy of the 1st metatarsal
Surgical Treatment of the Cavovarus Foot

• Claw hallux
  – 1st IP joint fusion
  – Jones transfer of the EHL through the 1st metatarsal neck

• Lesser toe deformities
  – Flexible: flexor to extensor transfer
  – Rigid: PIP joint resection arthroplasty
  – Osteotomies of the metatarsals?
And Don’t Forget…

- Post-polio syndrome
  - Fatigue with overuse
  - Treatment = Physical therapy
• **Posterior tibial tendon (PTT)**
  - Stabilizes hindfoot & midfoot against valgus
  - Adducts transverse tarsal (TT) joints
  - Inverts subtalar (ST) joint

• **Affect on gastrocnemius-soleus**
  - Medializes direction of action
  - Maximal plantarflexion strength with TT joints locked
PTT Dysfunction

• Hindfoot valgus
  – Arch collapse
  – Forefoot abduction & compensatory supination
  – Risk of spring & deltoid ligament compromise

• Lateralization of Achilles tendon function
  – Worsens deformity
  – Contracture
Stage I PTT Dysfunction

- Tenosynovitis without deformity
- Inflammation vs. partial rupture
- Normal tendon continuity
- Mild weakness
  - Painful, but normal single leg heel rise
Treatment of Stage I

- **Initial nonsurgical trial of immobilization**
  - Short leg cast or CAM walker
  - Transition to semi rigid orthotic with arch support and medial posting

- **Physical therapy**

- **NSAIDs**
Surgical Treatment: RARE

- Synovectomy

- PTT repair?
  - Can be done if partially torn

- FDL tendon augmentation/tenodesis?
  - Harvested at the Knot of Henry
  - Fixed to the navicular
Stage II PTTD

- Pathologic tendon to the point of:
  - Attenuation
  - Atrophy
  - Rupture

- Flexible deformity

- Cannot perform single leg heel rise

- “Too many toes”
Treatment of Stage II

- **Initial nonsurgical**
  - Trial of immobilization

- **Orthotic manipulation**
  - Arch support, medial heel post
  - UCBL
  - ASO
  - Arizona Brace
Question!

The most appropriate orthosis for a patient with stage II posterior tibial tendon dysfunction and fixed forefoot varus would provide a

1. medial heel lift, longitudinal arch support, and medial forefoot posting.
2. medial heel lift, flattened arch, and no forefoot posting.
3. medial heel lift, longitudinal arch support, and a recess for the depressed first metatarsal.
4. lateral heel lift, longitudinal arch support, and lateral forefoot posting.
5. lateral heel lift, longitudinal arch support, and a recess for the depressed first metatarsal.
The most appropriate orthosis for a patient with stage II posterior tibial tendon dysfunction and fixed forefoot varus would provide a

1. medial heel lift, longitudinal arch support, and medial forefoot posting.
2. medial heel lift, flattened arch, and no forefoot posting.
3. medial heel lift, longitudinal arch support, and a recess for the depressed first metatarsal.
4. lateral heel lift, longitudinal arch support, and lateral forefoot posting.
5. lateral heel lift, longitudinal arch support, and a recess for the depressed first metatarsal.

Answer: 1
Surgical Treatment

• PTT reconstruction with soft tissue & bony procedures
  – FDL tendon transfer to the navicular
  – Medial calcaneal displacement osteotomy (MCO) and/or lateral column lengthening (LCL)
  – Spring ligament repair vs. reconstruction if needed
  – Achilles lengthening or gastroc recession if needed
  – Correction of forefoot varus if needed
    • Cotton osteotomy or first TMT fusion
Examination of a 49-year-old woman with a flexible adult-acquired flatfoot deformity in the non-weight-bearing position with the hindfoot held in the subtalar joint neutral position is seen in the Figure. Which of the following procedures will correct this deformity?

1. Triple arthrodesis
2. Medial displacement calcaneal osteotomy
3. Opening wedge first cuneiform (Cotton) osteotomy
4. Flexor digitorum longus tendon transfer to the navicular
5. Lateral column calcaneal lengthening osteotomy (Evans procedure)
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4. Flexor digitorum longus tendon transfer to the navicular
5. Lateral column calcaneal lengthening osteotomy (Evans procedure)

Answer: 3
Stage III PTTD

• Fixed deformity ± arthritis

• Treatment = Triple arthrodesis with Achilles lengthening
  – Subtalar (ST), Talonavicular (TN), & Calcaneocuboid (CC) Joints
  – Achilles tenotomy vs. gastroc recession

• Effects
  – Lose >90% of Hindfoot Inversion/Eversion
  – Adjacent joint arthritis
Stage IV PTTD

- Rigid flatfoot deformity with deltoid ligament dysfunction

Treatment:
- Pantalar fusion
  - Flatfoot + deltoid reconstruction
  - Flatfoot reconstruction with TAR or ankle fusion
Hallux Valgus - Evaluation

- Normal values
  - Hallux Valgus angle < 15°
  - IM angle < 9°
  - DMAA = 0°
Radiographic Evaluation

Distal metatarsal articular angle (DMAA) Radiographic Evaluation

Articular Surface
Hallux Valgus Algorithm

- **Hallux Valgus**
  - **Arthrodesis MTP**
    - Yes
  - **Arthritic MTP**
    - No
      - **Hypermobile TMT**
        - No
      - **Congruent ??**
        - Yes
          - **Lapidus 1st TMT arthrodesis**
Which of the following procedures is most likely to result in a recurrence when used to correct a hallux valgus deformity with a 14° intermetatarsal angle, a 35° hallux valgus angle, and a preoperative incongruent joint?

1. Proximal Chevron osteotomy
2. Proximal crescentic osteotomy
3. First tarsometatarsal fusion (Lapidus)
4. Isolated distal soft-tissue reconstruction (modified McBride)
5. Proximal oblique metatarsal osteotomy (Ludloff)
Question

Which of the following procedures is most likely to result in a recurrence when used to correct a hallux valgus deformity with a 14° intermetatarsal angle, a 35° hallux valgus angle, and a preoperative incongruent joint?

1. Proximal Chevron osteotomy
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4. Isolated distal soft-tissue reconstruction (modified McBride)
5. Proximal oblique metatarsal osteotomy (Ludloff)

Answer: 4
Hallux Valgus Algorithm

IMA ≤ 9°
HVA < 25°

IMA=10-14°
HVA=25-35°

IMA > 14°
HVA > 35°

Distal Soft Tissue Release?
Distal Chevron
Proximal osteotomy with DSTR
Distal Soft Tissue Release

- Adductor Hallucis
- IM ligament?
- Lateral capsule
- Plus medial capsular reefing
Figures 260a and 260b are the weight-bearing AP and lateral radiographs of a 61-year-old woman with progressively worsening pain at the first metatarsophalangeal joint and increasing angulation of the hallux over the last 3 years. Examination reveals significant pronation of the hallux. What is the most appropriate corrective surgical procedure?

1- Distal first metatarsal osteotomy

2- Distal first metatarsal osteotomy with lateral metatarsophalangeal joint soft-tissue release

3- Proximal first metatarsal osteotomy

4- Proximal first metatarsal osteotomy with lateral metatarsophalangeal joint soft-tissue release

5- First metatarsophalangeal arthrodesis
Answer: 4
Orthopaedic In-Training Examination Review: Foot and Ankle

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Thomas Jefferson University Hospital
October 16, 2012
Disclosure Statement

• Merz Pharmaceuticals
  – Research support
Etiology

- **Post-traumatic**
  - Most common
- **Osteoarthritis**
  - Degenerative
- **Inflammatory**
  - Rheumatoid
- **Infectious**
- **Neuromuscular**
  - HMSN
- **Metabolic**
- **Hematologic**
Ankle Arthritis

• **Traditional treatment = Arthrodesis**

• **Alternative treatment = Arthroplasty**
  – The OITE patient that gets this is –
    • Over 65
    • Low demand (RA?)
    • Under 200 lbs
    • Without deformity, infection, neuropathy, & osteonecrosis
Ankle Arthrodesis
Ankle Arthroplasty (Salto Talaris)
A 78-year-old man has long-standing ankle stiffness and pain that is aggravated by walking. Corticosteroid injection has not relieved his pain. He has a painful 10-degree arc of ankle motion. Radiographs reveal end-stage degenerative arthritis. Which of the following devices will be most effective?

1- Heel lift
2- Single rocker sole shoe modification
3- Double rocker sole shoe modification
4- Medial heel flare shoe modification
5- Lateral heel flare shoe modification
#1 heel lifts are used to absorb impact on heel strike for heel pain or to elevate the heel for achilles contractures or to relieve stress from achilles. Flares (#4 & 5) are used to correct hindfoot varus or valgus. #3 double rocker shoes are used to offload the midfoot such as in midfoot arthritis or deformity resulting from Charcot. #2 is the correct answer because single rocker shoes offload plantar pressures, and reduce the need for ankle motion and improve overall gait.

Recommended Reading(s):
A 48-year-old man has severe ankle and hindfoot pain after being treated nonsurgically for an intra-articular calcaneal fracture 1 year ago. Examination reveals a shortened, widened heel with absent-Subtalar motion. The ankle dorsiflexes to neutral with pain. A lateral radiograph is shown in Figure 38. Treatment should now consist of

1. in situ subtalar fusion.
2. Achilles tendon lengthening.
3. distraction bone block subtalar.
4. ankle fusion.
5. ankle and subtalar fusion.

Figure 68: Item 183
**Reason**

- This patient has symptomatic subtalar arthritis and loss of calcaneal height. He has anterior tibiotalar impingement as evidenced by the pain with dorsiflexion and seen on the xray. **Treatment of choice is a subtalar distraction bone block arthrodesis which will restore calcaneal height and correct the talar declination angle.** In situ fusion is indicated in patients without anterior impingement and loss of calcaneal height. In both cases lateral decompression is usually required to relieve calcaneofibular impingement.

**References**

Subtalar (ST) Arthritis

- Arthrodesis as treatment
  - In situ
  - Distraction
    - To addresses calcaneal fracture sequelae
    - Loss of calcaneal height
    - Anterior ankle impingement
Calcaneocuboid (CC) Arthritis

- Isolated CC arthrodesis?
  - Risk of nonunion

- Double Talonavicular (TN) - CC arthrodesis
Talonavicular (TN) Arthritis

- **Isolated TN arthrodesis?**
  - Risk of nonunion

- **TN-CC arthrodesis?**
  - Less risk of TN fusion nonunion

- **Modified double ST-TN arthrodesis?**
  - Less risk of TN fusion nonunion?

- **Triple arthrodesis?**
  - TN, CC, & ST fusion
    - Fusion of 2 normal joints!
Triple Arthrodesis

• Traditional treatment of ST, TN, & CC arthritis

• Expectations
  – Loss of >90% of hindfoot inversion/eversion
  – Increased stress/demands on the ankle
    • Risk of adjacent ankle arthritis
A morbidly obese 60-year-old woman has severe persistent foot pain and a pes planovalgus deformity after sustaining a plantar flexion injury 1 year ago. She was initially treated in a fracture boot but did not return for follow-up. Current radiographs are shown in Figures 33a and 33b. Treatment at this time should consist of realignment and

1. medial column tarsometatarsal arthrodesis.
2. lateral column tarsometatarsal arthrodesis.
3. medial and lateral column tarsometatarsal arthrodesis.
4. subtalar arthrodesis.
5. triple arthrodesis.
Answer

• 1 - medial column tarsometatarsal arthrodesis.

• This patient had a ligamentous Lisfranc injury that resulted in a flatfoot with medial midfoot arthritis. The treatment for this is rigid deformity correction with medial column fusion.

• Komenda et al.
  • Lateral column arthrodesis unnecessary for good result.

• References
  • Komenda GA, Myerson MS, Biddinger KR: Results of arthrodesis of the tarsometatarsal joints after traumatic injuries JBJS 1996;78:1665-1676.
Midfoot Arthritis
Treatment of Midfoot Arthritis

• Navicular-cuneiform fusion

• Metatarsal-cuneiform fusion
  – 1\textsuperscript{st}, 2\textsuperscript{nd}, and 3\textsuperscript{rd} TMT Joints

• Metatarsal-cuboid interposition arthroplasty
  – 4\textsuperscript{th} and 5\textsuperscript{th} TMT joints
  – Peroneus Tertius vs. Extensor Digitorum Brevis tendons
  – Preserves motion
The Figures show the radiographs of an athletically active 47-year-old man who reports 6 weeks of progressively worsening pain over the dorsal hallux. Examination reveals minimal limitation of motion, a negative ‘grind’ test, and pain at maximum dorsiflexion. What is the most appropriate treatment?

1- Cheilectomy
2- Implant arthroplasty
3- Rigid Morton’s extension foot orthosis
4- Dorsiflexion osteotomy of the proximal phalanx
5- Arthrodesis of the first metatarsophalangeal joint
3- Rigid Morton’s extension foot orthosis

A morton’s extension is a rigid extension often made of carbon fiber that extends within the orthosis under the great toe. The idea is that this protects the great toe from experiencing loads at dorsiflexion during toe-off. You need to note that he has only had pain for 6 weeks without mention of any conservative treatment. Also, he does not have evidence on his lateral radiograph of a big osteophyte that would move you in the direction of chielectomy for hallux rigidus.
Figure shows the AP radiograph of a 33-year-old man who reports a 3-year history of progressively worsening pain in the first metatarsophalangeal joint. Passive range of motion is painful throughout the entire arc from $30^\circ$ of dorsiflexion to $0^\circ$ of plantar flexion. Nonsurgical management has not provided any relief. What is the most appropriate surgical treatment?

1. Cheilectomy
2. Moberg osteotomy
3. Mayo resection arthroplasty
4. Resurfacing implant hemiarthroplasty
5. First metatarsophalangeal arthrodesis
• **5-First metatarsophalangeal arthrodesis**

• First things first. This is a case of hallux rigidus. So acceptable treatments would be a chilectomy for mild disease, moberg if the joint is maintained and a fusion for advanced disease.

• Arthrodesis of the first metatarsophalangeal joint is an accepted surgical option for advanced-stage hallux rigidus, particularly in younger and more active patients. It eliminates painful motion and maintains stability of the first ray.

• Numerous studies (Level II evidence) have compared arthrodesis with a Keller arthroplasty and hemiarthroplasty of the hallux MTP joint. In all studies, arthrodesis demonstrated equivalent or superior results with fewer complications.

• The consistently favorable results reported in many Level II and IV studies constitute fair evidence (Grade B recommendation) to support the use of arthrodesis for the treatment of advanced-stage hallux rigidus.

• Gibson JN, Thomson CE. Arthrodesis or total replacement arthroplasty for hallux rigidus: a randomized controlled trial. Foot Ankle Int. 2005 Sep;26(9):680-90. PubMed PMID: 16174497.
Hallux Rigidus - Staging & Treatment

• **I** – Dorsal, medial, & lateral osteophytes
  - NSAIDs
  - Rigid shank with Morton’s extension
  - Joint debridement/cheilectomy

• **II** – Moderate joint space narrowing with osteophytes
  - Cheilectomy vs. arthrodesis

• **III** – Severe joint space narrowing
  - Arthrodesis
Wrong Answers!

• Keller resection arthroplasty
  – Destabilizes the 1st ray
  – Possible option for very elderly, debilitated patients

• Hemi- or total joint arthroplasty
  – Remains controversial
Charcot Neuro-Arthropathy

- Joint destruction with -
  - Fractures
  - Bony collapse

- Etiology
  - Trauma
    - Minor vs. major
    - Acute vs. chronic
  - Sensory neuropathy
    - Recognized vs. unrecognized
Acute Symptoms

- Redness
- Warmth
- Swelling
- Improve with elevation
Chronic Symptoms

• Edema

• Deformity
  – Rocker-bottom
  – Increased width
  – Bony prominences
# Eichenholtz Staging

<table>
<thead>
<tr>
<th>St.</th>
<th>Symptoms</th>
<th>Radiographs</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Warm, red, swollen</td>
<td>Bony fragmentation</td>
</tr>
<tr>
<td>II</td>
<td>Less warm, red, swollen</td>
<td>Bony coalescence</td>
</tr>
<tr>
<td>III</td>
<td>No warmth, redness or swelling</td>
<td>Bony consolidation/remodeling</td>
</tr>
</tbody>
</table>
## Brodsky Classification

<table>
<thead>
<tr>
<th>St.</th>
<th>Location</th>
<th>Sequelae</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Midfoot</td>
<td>Rocker-bottom, midfoot valgus, prominences.</td>
</tr>
<tr>
<td>2</td>
<td>Hindfoot</td>
<td>Instability. Slow healing.</td>
</tr>
<tr>
<td>3A</td>
<td>Ankle</td>
<td>Instability. Slow healing.</td>
</tr>
<tr>
<td>3B</td>
<td>Calcaneus</td>
<td>Wide heel. Flatfoot.</td>
</tr>
</tbody>
</table>
Brodsky Classification cont
Goals for Treating the Charcot Foot

• Achieve bony healing

• Treat & minimize soft-tissue ulcers

• Keep patients as ambulatory as possible
Initial Treatment

- Rest
- Elevation
- Total contact cast
Subsequent Treatment

• Custom-made Charcot Restraining Orthotic Walker (CROW)
  – Lined with polyethylene foam

• Transition to wide shoes with proper insoles

• Expect long duration
Complications

- Nonhealing ulcerations
- Infection
  - From superficial to deep
- Unbraceable deformity
Surgical Treatment of the Charcot Foot

- To treat complications
- Best results when performed in Stage II
- Does not improve healing
  - Risk of delaying healing
  - Risk of creating new fractures or instability
- Cannot restore normalcy
- Prolonged postoperative immobilization
Surgical Treatments

• Exostectomy

• Arthrodesis
  – With bone graft
  – Internal vs. external fixation

• Amputation?
Midfoot Arthrodesis

• Screws

• Plate & screw
  – Increased stability with plantar/medial plating

• Bone graft
Ankle/Hindfoot Arthrodesis

- Screws
- Intramedullary nails
- Blade plates
- Locking plates
Arthrodesis via External Fixation

- Best for simultaneous management of –
  - Deformity correction
  - Ulcer healing
  - Infection resolution
End of Section

Thank You
Foot & Ankle Trauma and Sports OITE Review

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Assistant Attending Orthopedic Surgeon
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Outline

• Trauma
  – Ankle Fractures
  – Talus Fractures
  – Lisfranc Injuries
  – 5th Metatarsal Fractures
  – Calcaneus Fractures

• Sports
  – Achilles Injuries
  – Ankle Sprains
  – Talar OCD
Radiographic Determination of Ankle Fracture Instability

- Fracture displacement
  - More than 2 mm

- Medial clear space
  - More than 4 mm

- Tibiofibular overlap
  - Less than 10 mm on the AP

- Tibiofibular clear space
  - More than 5 mm on the AP

- Talocrural angle & Talar Tilt
Ankle Fractures - Lauge-Hansen Classification

- Supination-external rotation (SE)
  - I: Avulsion fracture of the ATFL
  - II: + distal fibula fracture
  - III: + posterior malleolus fracture or PTFL disruption
  - IV: + medial malleolus fracture or deltoid disruption
What is the most accurate way to distinguish a SER-2 from a SER-4 ankle fracture?

1. Proximal fibular tenderness
2. Lateral ankle tenderness
3. Medial ankle tenderness
4. Medial ankle ecchymosis and swelling
5. Stress radiographs
Explanation

Physical examination has been proven in the literature to be an unreliable way to predict disruption of the deltoid ligament in SER-type ankle fractures. A study by Tornetta (2004) demonstrated that degree of medial tenderness, swelling, and ecchymosis did not correlate with stress-positive or SER-IV equivalent fracture patterns.

A subsequent paper (Schutt 2007) has demonstrated that a **gravity stress test** (JAAOS, 2003, pictured) is equivalent to a manual stress test in predicting deltoid ligament disruption.
Explanation

The stress radiograph (pictured) is taken with the leg stabilized in 10° of internal rotation, neutral dorsiflexion, and 10lb of external rotation is applied. A positive finding on the stress radiograph was defined as a medial clear space of >4 mm that was also >1 mm greater than the superior joint space, or any identifiable amount of lateral talar subluxation.
Ankle Fractures - Lauge-Hansen Classification

• **Supination-adduction (SA)**
  - I: Fibula fracture
  - II: + vertical shear medial malleolous fracture

• **Pronation-Abduction (PA)**
  - I: transverse fracture of the medial malleolus or deltoid rupture
  - II: + syndesmotic instability or Chaput avulsion fracture
  - III: + horizontal fibula fracture above the joint
Lauge-Hansen Classification cont.

- **Pronation-External Rotation**
  - I: medial malleolus fracture or deltoid disruption
  - II: + syndesmotic instability
  - III: + high fibula fracture
  - IV: + posterior malleolus fracture

- **Maisonneuve variant**
Maisonneuve
Malleolar Fixation

- **Lateral**
  - Lateral plate & screw
  - Peroneal irritation with posterior anti-glide plate & screw

- **Medial**
  - Screws perpendicular to the fracture
  - Medial buttress plate for vertical fractures with comminution

- **Posterior**
  - Screw fixation when –
    - Unstable
    - >30% of articular surface
Syndesmotic Fixation

- Cotton test performed intraoperatively to confirm syndesmotic instability
- Screw fixation from fibula to tibia
  - At sigmoid notch
    - 2 cm proximal to tibial plafond
  - Parallel to plafond
  - 30 degrees from horizontal
  - Tibiofibular joint compressed with ankle dorsiflexed
A 59-year-old man sustained a trimalleolar equivalent ankle fracture and underwent open reduction and internal fixation. Radiographs obtained at 2 weeks follow-up are shown in Figures 60a and 60b.
A 59-year-old man sustained a trimalleolar equivalent ankle fracture and underwent open reduction and internal fixation. Radiographs obtained at 2 weeks follow-up are shown in Figures 60a and 60b. Management should now consist of

1. immobilization followed by progressive weight bearing and physical therapy.
2. Deltoid ligament repair.
3. lateral collateral ligament ankle reconstruction.
4. reduction and internal fixation of the syndesmosis.
5. ankle arthrodesis.
Pilon Fracture - Treatment

1st stage = Immediate

- **Fibula**
  - Plate fixation

- **Tibia**
  - Spanning external fixation
2nd Stage of Surgery

2nd stage = Delayed

• With optimal resolution of soft tissue injuries
  – 10 - 20 days

• Complications when surgery is performed before soft tissue is “ready”
  – Wound dehiscence
Distal Tibial Reconstruction

• **Restoration of articular surface**
  – Screws outside or through a plate
  – Constants are medial malleolus, Chaput’s, & Volkmann’s fragments

• **Reduction of metaphysis to the plafond**
  – Plate fixation
  – Definitive external fixation?
Talar Neck Fractures - Hawkins Classification

- I – Nondisplaced
- II – Displaced with subtalar dislocation
- III – Displaced with subtalar & tibiotalar dislocation
- IV – III with talonavicular dislocation

Prognosis Based on Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Osteonecrosis</th>
<th>Arthritis</th>
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<tbody>
<tr>
<td>I</td>
<td>0-13%</td>
<td>0-30%</td>
</tr>
<tr>
<td>II</td>
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</tr>
<tr>
<td>III</td>
<td>75-100%</td>
<td>70-100%</td>
</tr>
<tr>
<td>IV</td>
<td>100%</td>
<td>100%</td>
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</tbody>
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Treatment of Displaced Fractures

- Surgical open reduction and internal fixation (ORIF)
  - Anatomic reduction
  - Adequate fixation and immobilization
    - Screws vs. plate & screws
  - Preserving talar blood supply
Talar Blood Supply

- **Dorsalis Pedis Artery:**
  - most blood supplied to the head and neck of the talus arises from the anastomosis within sinus tarsi & tarsal canal form major blood supply to the talar head

- **Artery of the Sinus Tarsi:**
  - the sinus tarsi and tarsal canal anastomosis lies beneath the talar neck

- **Peroneal Artery:**
  - from peroneal artery comes branches to posterior process & branch to form artery of sinus tarsi

- **Artery of Tarsal Canal:**
  - branch of posterior tibial forms anastomosis with branches entering talar neck
  - main artery supplying blood to the body of the talus

- **Deltoid Branches:**
  - usually arise from the artery of the tarsal canal and supplies the medial third of the body
Surgical Approaches

• **Anteromedial + lateral**
  - Between TA and EHL
  - + lateral malleolar osteotomy?

• **Anterolateral + medial**
  - Between peroneus tertius and extensor digitorum longus (EDL) muscles
  - + medial malleolar osteotomy?
Lisfranc Injury

- AP view – 15° cephalad tilt (Stein RE. Foot Ankle, 1983)
- Middle Column
  - Medial border 2\textsuperscript{nd} metatarsal
  - Medial border middle cuneiform
  - IM space between 1\textsuperscript{st} and 2\textsuperscript{nd} metatarsals is equal to space between the medial and middle cuneiforms
Lateral Talar Process Fractures

• 24% of all talar fractures

• Mechanism of injury
  – Ankle dorsiflexion while hindfoot is inverted

• Classification
  – I: Large fracture involving talofibular joint
  – II: Comminuted fracture
  – III: Small “chip” fracture NOT involving talofibular joint
Treatment of Lateral Process Fractures

• **Nondisplaced**
  – Initial nonweightbearing in fracture boot x 6 weeks
  – Followed by weightbearing in fracture boot x 6 weeks

• **Displaced**
  – Open reduction and internal fixation
    • Headless steel vs. bioabsorbable fixation
  – Excision if comminuted
Subtalar Dislocation - Classification

- **Medial - 80%**
  - Due to inversion while foot is plantarflexed

- **Lateral - 17%**
  - Due to eversion while foot is plantarflexed

- **Posterior - 2.5%**
  - Due to SEVERE plantarflexion?

- **Anterior - 1%**
  - Due to SEVERE anterior traction?
Open Reduction

**Indications**
- Failure to reduce closed
- Intra-articular fractures or loose bodies

**Impediments to medial dislocations**
- Extensor digitorum brevis
- Extensor retinaculum
- Talonavicular capsule
- Deep peroneal neurovasculature

**Impediments to lateral dislocations**
- Post. tibialis tendon
- Flexor digitorum longus
Fractures

- “Nutcracker fracture”
  - Cuboid fracture
    - More frequent in dancers

- Jones fracture
  - Solid screw fixation
  - Surgery in athletes, high demand
Proximal 5th Metatarsal Fracture - Treatment

• **Nondisplaced**
  – Nonoperative
    • Nonweightbearing x 6 weeks
    • Progressive weightbearing in fracture boot x 6 weeks

• **Nondisplaced in athlete & displaced in all**
  – ORIF
    • Intramedullary screw vs. tension band wiring vs. plate & screws
    • Nonweightbearing x 6 weeks
    • Progressive weightbearing in fracture boot x 6 weeks
Intraarticular Calcaneal Fractures - Pattern

- **Anterior main**
  - Includes anterior process

- **Anterolateral**
  - Includes anterolateral wall

- **Constant superomedial sustentacular**

- **Superolateral**

- **Tongue**
  - Includes posterior tuberosity

- **Posterior main**
Sanders Classification

- **Type I**
- **Type II**
  - A, B, C
- **Type III**
  - AB, AC, BC
- **Type IV**

Based on CT - Relates to prognosis
Nonoperative Management

- Type I fractures

- Patient factors
  - Medical disease
    - Peripheral vascular disease
    - Diabetes
  - Lifestyle
    - Smoking
    - Substance abuse
Operative Management

• **Indications**
  – Type II, III, and IV fractures

• **Goals**
  – Restore articular surface
  – Restore height & width

• **Timing**
  – Within 3 weeks
  – With adequate resolution of swelling
Percutaneous Fixation

• **Indications**
  – Minimally displaced Type II or III joint depression fractures
  – Simple tongue type (IIC) fractures

• **Essex-Lopresti reduction maneuver**
  – Guide pins placed into posterior tuberosity
  – Pins AND foot levered plantarward

• **Implants**
  – Screws through posterior tuberosity & body
Intraarticular - ORIF

- **Indications**
  - Displaced fracture & articular surface not amenable to closed reduction

- **Surgical technique**
  - Extensile lateral approach

- **Implants**
  - Plate & screws
A displaced calcaneal fracture is treated with open reduction and internal fixation. Postoperative radiographs reveal that one of the medially directed screws beneath the posterior facet is 5 mm too long. What structure is most at risk?

1. Posterior tibial tendon
2. Posterior tibial neurovascular bundle
3. Abductor hallucis muscle
4. Flexor digitorum longus tendon
5. Flexor hallucis longus tendon
Answer!

- The answer to this question is the FHL tendon. This is a straightforward anatomy question that requires one to remember that the sustentaculum tali is an overhanging horizontal eminence on the anteromedial surface of the calcaneus. It supports the middle articular surface above it and has an inferior groove for the FHL tendon.

Subtalar Fusion

• **Indications**
  – Type III or IV fractures where joint surface cannot be salvaged
  – Type IV fractures in manual laborers

• **Surgical technique**
  – Identical to ORIF of calcaneus, but with less screws fixing fracture
  – Screws crossing joint
Extraarticular Calcaneal Tuberosity Fractures

• 30% of calcaneal fractures

• Mechanism of injury
  – High vs. low energy
  – Violent pull of gastrocnemius-soleus with forced ankle dorsiflexion
  – Varying involvement of Achilles insertion
  – May have intraarticular extension
  – Distinct from tongue-type fractures!
Extraarticular Tuberosity

• Assessment
  – Skin condition is critical
  – Tenting necessitates early treatment
Treatment

• **Nondisplaced**
  - Nonweightbearing in short leg cast or Achilles boot in resting equinus x 6 weeks
  - Gradual weightbearing and resolution of equinus thereafter

• **Displaced**
  - ORIF
    • Lateral paratendinous approach
    • 4.0 mm screws vs. 6.5 mm screws vs. tension band wiring
A 33-year-old man involved in a motor vehicle accident sustained the injuries shown in Figures 56a and 56b. His foot and ankle are swollen, and skin wrinkles are not present. A 1 cm area of skin over the Achilles tendon insertion is tented and blanched. What is the next most appropriate step in management?
Question #4

A 33-year-old man involved in a motor vehicle accident sustained the injuries shown in Figures 56a and 56b. His foot and ankle are swollen, and skin wrinkles are not present. A 1 cm area of skin over the Achilles tendon insertion is tented and blanched. What is the next most appropriate step in management?

1. Immediate reduction and internal fixation of the calcaneal fracture
2. Delayed open reduction until skin wrinkles appear
3. A short leg plantar flexed cast
4. A splint until comfortable, followed by early range of motion
5. Closed treatment and definitive management in an external fixator
Answer

• **Reason:** The x-ray in question depicts an ankle fracture with a calcaneal fracture. Post tuberosity fx usually occurs during a strong contraction of the gastroc-soleus complex w/ axial loading of the foot. The boney frag. Displaces superiorly w. the attached achilles tendon. The majority of these fragments have significant displacement w/ the post aspect of the fragment tenting the post. Skin. In these cases the fx must be treated urgently as the skin will slough if there is no relief of underlying boney tension. The skin is frequently blanched upon initial presentation.

• **References:** OKU foot and ankle 2 pgs 218-219
Achilles Tendon

- Longest and strongest of body
- Insertion site approx 2cm x 3cm
- Watershed area 2-6 cm proximal to insertion site
- Insertional
  - > 50% debridement → need FHL augmentation
  - > 30% detached → need to reattach
- Ruptures
  - Open, percutaneous, mini-open
  - Good data to support functional bracing or functional rehab
Acute Achilles Injuries
Trauma vs. Tendinosis

- **Tendinosis: Chronic degeneration without inflammation**
  - Microtears lead to increased tenocyte proliferation & deposition of a disorganized extracellular matrix
  - Weak tissue can lead to eventual rupture.
Treatment

• No universally accepted protocol

• Very surgeon dependent

• Generally, operative repair is recommended for younger, physically active individuals

• Role of percutaneous and minimally invasive techniques is unclear
What can we all agree on?

In the absence of reliable evidence, it is the opinion of the work group that although operative treatment is an option, it should be approached more cautiously in patients with diabetes, neuropathy, immunocompromised states, age above 65, tobacco use, sedentary lifestyle, obesity (BMI >30), peripheral vascular disease or local/systemic dermatologic disorders.

Strength of Recommendation: Consensus

We suggest early (≤ 2 weeks) post-operative protected weight bearing for patients with acute Achilles tendon rupture who have been treated operatively.

Strength of Recommendation: Moderate

We suggest the use of a protective device that allows mobilization by 2-4 weeks post operatively.

Strength of Recommendation: Moderate
Ankle Sprains

- **85-90% lateral injuries**
  - Inversion and internal rotation of foot with external rotation of leg
  - Vast majority of ankle sprains occur in PF/ADD/INVERSION

- **Injury pattern**
  - ATFL
  - CFL
  - PTFL
Brostrom (1964-66)

- Isolated ATFL - 65%
- ATFL + CFL - 20%
- AITFL - 10%
- Deltoid - 3%

ATFL & CFL failure
- ATFL is the weakest
- Typically failure is by:
  - Midsubstance rupture
    - Most common
  - Talar avulsion
- Ruth & colleagues
  - Open primary repairs
    - Ligament ends were never approximated
      » Manipulation had no effect
Lateral Ankle Sprain

- Baumhauer AJSM 1995
  - Prospective study of
    - Laxity
    - Alignment
    - Ligament stability
    - Isokinetic strength

- Associated Risk Factors
  - Inappropriate shoewear
  - Irregular playing surface
  - Cutting activities
  - Cavus Foot
  - *Previous ankle sprain*
Instability Criteria

• **AP Ankle**
  – Greater than 10 degrees of varus
  – 5 degrees greater than opp side

• **Lateral Ankle**
  – ant translation 1 cm or greater
  – 5 mm greater than opp side
ANKLE PORTALS

- **Anteromedial**
  - Medial to AT
  - Beware saph

- **Anterolateral**
  - Lateral to PT
  - Beware SPN
OCD of the Talus

- 2nd-4th decade
- Slight male predominance
- Bilateral in 4-10%
- Most commonly anterolateral (acute) and posteromedial (chronic) talar dome
Treatment Options

- **Nonoperative**
  - Activity modification
  - Injections

- **Debridement**

- **Microfracture/Drilling**

- **ACI**

- **OATS**

- **Osteochondral allograft**
Thank You
Please wait for link to Evaluation

Next Webinar: Lesser MTP & Hammertoes

November 6, 2012

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