Identify risk factors and symptoms associated with certain foot and ankle conditions.

Discuss available treatment options for certain foot and ankle pathologies.

Describe complications that can occur with delay in treatment with certain foot and ankle pathologies.

Recognize degrees of conditions requiring a referral to a foot and ankle specialist.
Adult Acquired Flatfoot Deformity
Key Anatomical Structures

Alt: posterior tibialis tendon dysfunction

Risk Factors
- BMI >25
- Age >45
- Female (4:1 compared to males)
- General or metabolic condition that predisposes toward tendon degeneration (i.e. diabetes, obesity, and rheumatic diseases)

Symptoms
- “pain on inside part of ankle”
- Swelling
- Pain with weight bearing, worse with stair climbing/descending
- Somewhat improves with rest
- Later stages may include “pain at outside part of ankle”

Findings
- Varying degrees of loss in arch height with hindfoot valgus and forefoot abduction
- Mostly unilateral (occasionally bilateral)
Single Heel Rise Test
<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendon condition</td>
<td>Peritendonitis and/or tendonosis</td>
<td>Tendon elongation</td>
<td>Elongated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nonfunctional, loss of deltoid ligament causes ankle valgus</td>
</tr>
<tr>
<td>Complaint</td>
<td>Focal pain and edema medially; mild to moderate</td>
<td>Medial; along PT tendon course; moderate pain</td>
<td>Medial, possibly lateral; moderate pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>General hindfoot pain, moderate to severe</td>
</tr>
<tr>
<td>Examination</td>
<td>Able to perform heel rise, no major deformity, flexible</td>
<td>Week heel rise, valgus heel, medial collapse, flexible</td>
<td>No heel rise, valgus heel, medial collapse, rigid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ne heel rise, valgus heel, valgus talus in ankle mortise, rigid hindfoot</td>
</tr>
</tbody>
</table>
Pathophysiology

- Static supporting structures of the medial hindfoot stretched/attenuated

- PT tendon forced to work harder to resupinate an already unstable foot during gait

- Painful acquired adult flatfoot deformity results from failure of PT tendon function
Supportive Evidence


- Division of Orthopaedic Surgery, Kingsbrook Jewish Medical Center, 585 Schenectady Avenue, Brooklyn, NY 11203, USA.

- Aim – clarify the etiology of adult-acquired flatfoot deformity
- Histologic analysis
- N = 28 specimens from patients diagnosed with PTTD stage 2 and 3
- Hematoxylin and eosin and Masson trichrome-stained sections of formalin-fixed tissue viewed in plain and polarized light
- Qualitative analysis for abnormalities in collagen orientation, degree of vascularization, tenocyte cellularity, mucinous change, and chondroid metaplasia
- Findings
  - 50% of specimens had neovascular infiltration disrupting collagen fibril
  - 28-35% of specimens had increased mucin content and chondroid metaplasia
  - 28% of specimens had hyperplasia of tenosynovial lining cell layer
  - 79% of specimens had thickening of the subtenosynovial lining cell layer
  - Little evidence to support an inflammatory etiology

- Conclusion
  - Postulate that overuse, tension, or stretching may activate the tenosynovial lining cells and incite angiogenesis.
  - Supports chronic insufficiency of the tendon as a result of attenuated medial arch ligamentous support as opposed to failure of the PT tendon as a primary event.

- Swedish Medical Center, Northwest Podiatric Surgical Residency Program, Seattle, WA.

Aim - to determine the effect that sectioning the spring ligament complex (SLC) has on foot stability, and whether engagement of the posterior tibial tendon would be able to compensate for the loss of the spring ligament complex

- Cadaveric study
- N = 5 fresh-frozen left feet
- Simulated weight bearing to 350 N
- PTT was loaded at 0%, 50%, 100%, and 150% of its calculated strength before and after sectioning the SLC to determine if the increased pull of the tendon affected foot position and arch stability.
- Positions and rotations of the talus, navicular, and calcaneus were measured and recorded using 3-dimensional (3-D) kinematic sensors

Findings
- Posterior tibial tendon was unable to compensate once SLC was sectioned
- Sectioning the spring ligament complex produced significant changes in talar, navicular, and calcaneal rotations

Conclusion
- SLC is a major stabilizer of the arch during midstance
- Posterior tibial tendon is incapable of fully accommodating for its insufficiency,
- Suggests that the SLC should be evaluated and, if indicated, repaired in flatfoot reconstruction.
Management of AAPE

**Stage 1**
- NSAIDS, rest
- Avoid corticosteroid injections
- Supportive shoes
- Physical therapy
- Refer for custom functional orthoses/brace

**Stage 2 & 3**
- Physical therapy
- Refer for custom functional orthoses/braces
- If conservative treatment fails: surgery to reconstruct tendon and calcaneal osteotomy

**Stage 4**
- Trail of accommodative orthoses or shoe modifications
- If surgical candidate: triple arthrodesis (pan talar arthrodesis if ankle involved)

Division of Foot and Ankle Surgery, The Western Pennsylvania Hospital, Pittsburgh, PA and Penn Presbyterian Medical Center, Philadelphia, PA

**Aim**
- outcomes of nonoperative care for AAFD


**N = 64 consecutive patients**

**Inclusion** – all patients treated for unilateral acute symptoms AAFD

**Tx = NSAIDs, initial immobilization, physical therapy, and bracing**

**Findings**
- 84% success incident over 27 months observation
- 78.12% of patients had BMI ≥ 30
- 62.5% of those with BMI ≥ 30 failed nonoperative care but logistical regression analysis did not show statistic significance of association with tx outcome
- OR 19.8621 (95% CI 1.8774-210.134) - bracing
- OR 0.016 (95% CI 0.0011-0.2347) – longitudinal tear along tendon

**Conclusions**
- Systematic nonsurgical treatment approach to AAFD can be successful in most cases

- Department of Orthopaedic Surgery, The Union Memorial Hospital, Baltimore, MD

Aim - To assess the efficacy of surgical correction of stage II tibial tendon deficiency with medial translational calcaneus osteotomy and flexor digitorum longus tendon transfer to the navicular

- Retrospective cohort study from 1990-1997
- N = 129 patient who have had surgical correction for stage II
- Physical exam, radiographs, isokinetic evaluation performed at a mean of 5.2 yrs postoperatively
- American Orthopaedic Foot and Ankle Society (AOFAS) Hindfoot Scale and Short Form Health Surgery (SF-36) used to evaluate patients postoperatively

Findings
- AOFAS 79 (out of possible 100)
- 94% improvement of function
- 95% pain relief
- 84% improved in arch of foot
- 84% increased comfort wearing shoes without modifications
- Complications in six patients.

Conclusions
- Minimal complications and a high patient satisfaction rate
Ankle Sprain
One of the most common injuries

- 85% of ankle sprains involve lateral ankle
- 1 per day in population of 10,000
  - 12% of all musculoskeletal injuries seen in the ER
- Up to 50% result from sports injury
  - 1/5 of all sports injuries
  - Up to 45% of basketball injuries
  - 20-25% of all time-loss sport injuries
- 10-30% go on to have chronic instability

Mechanism of Injury

Mechanism
- Ankle plantar flexion and inversion

Afferent proprioceptive fibers:
- Direct appropriate position for joint function
- Stimulates muscular reflex arc for stabilization

Anatomy/geometry provide stability for ankle and subtalar joints—guards against pathologic extremes
Tenderness to the lateral ankle ligaments
  - ATFL - finger width anterior to fibula
  - CFL - finger width below lateral malleoli

(+ ) anterior drawer sign
(+ ) talar tilt sign

Tenderness along course of peroneal tendons may indicate tear or rupture

Tenderness at distal syndemosis may indicated high ankle sprain

Rule out tenderness along medial and lateral malleoli, fibula, navicular, fifth metatarsal – indicating fracture
- Limb length discrepancy
- Tibial Varum
- Ankle Varus
- Previous ankle injury
- Uncompensated equinus
- Hindfoot varus
- FF Valgus
- Rigid PF 1st Ray
- Muscular insufficiency (peroneals)
- Neurological disease /deficit
Reliability of anterior drawer/talar tilt tests:
- Exam within 48 hours:
  - Specificity 33% and Sensitivity 71%
- Delayed exam 4-7 days:
  - Specificity 84% and Sensitivity 96%
  - Van Dijk et al. JBJS. 1996
Differential Diagnosis

- High ankle sprain
- Ankle fracture
- Osteochondral injury
- Ankle sprain
- Sinus tarsi injury
- Subluxing and/or torn peroneal tendons
15% to 30% of ankle injuries have fractures

Order ankle radiographs if:
- Pain in malleolar region
- Bone tenderness at tip or posterior edge of either malleolus
- Age 55 or greater
- Unable to bear weight
Ottawa Ankle Rules

Ottawa ankle rules

- Sensitivity – approx. 95% for predicting fractures
- May not apply if:
  - Impaired lower extremity sensation
    - Diabetes neuropathy
    - Nerve damage
  - Impaired inflammation
    - Steroids
    - Immunosepressed
  - Under 18 years
Ottawa Ankle Rules

A) Posterior edge or tip of lateral malleolus
B) Posterior edge or tip of medial malleolus
C) Base of 5th Metatarsal
D) Navicular

Appreciate soft tissue edema

Rule out:
- Gross ankle fx/ dislocation
- Anterior process fx
- 5th met fx
- Osteochondral/avulsion fx

Stress Radiographs:
- Talar tilt
  - > 5 degrees
- Anterior Drawer
  - > 4-5mm
MRI

- Extent and chronicity
- Chronic—Fibroplasia, attenuated poorly defined ligaments
- Acute—Inflammation, noticeable defect

Arthrography

- Can be used if cannot use MRI
- High false-negative > 1 wk due to adhesions/hematoma
## Table 1
Classification of Ankle Sprains

<table>
<thead>
<tr>
<th>Severity</th>
<th>Physical Examination Findings</th>
<th>Impairment</th>
<th>Pathophysiology</th>
<th>Typical Treatment*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Minimal tenderness and swelling</td>
<td>Minimal</td>
<td>Microscopic tearing of collagen fibers</td>
<td>Weight bearing as tolerated&lt;br&gt;No splinting/casting&lt;br&gt;Isometric exercises&lt;br&gt;Full range-of-motion and stretching/strengthening exercises as tolerated</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Moderate tenderness and swelling&lt;br&gt;Decreased range of motion&lt;br&gt;Possible instability</td>
<td>Moderate</td>
<td>Complete tears of some but not all collagen fibers in the ligament</td>
<td>Immobilization with air splint&lt;br&gt;Physical therapy with range-of-motion and stretching/strengthening exercises</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Significant swelling and tenderness&lt;br&gt;Instability</td>
<td>Severe</td>
<td>Complete tear/rupture of ligament</td>
<td>Immobilization&lt;br&gt;Physical therapy similar to that for grade 2 sprains but over a longer period&lt;br&gt;Possible surgical reconstruction</td>
</tr>
</tbody>
</table>

*Patients must receive treatment that is tailored to their individual needs. This table outlines common treatment protocols.

Reprinted with permission from Bernstein J (ed): Musculoskeletal Medicine, Rosemont, IL; American Academy of Orthopaedic Surgeons, 2003, p.242
Basic principles

- Early mobilization
- Protection from further injury
  - Taping—looses 40% strength in 10 minutes
  - Ankle bracing: air cast, gel supports, lace-up
  - Orthoses
  - Shoe gear modification
Initial Treatment

- **RICE protocol**
  - Rest joint
  - Ice – applied for 20 minutes every couple hours
  - Compression – elastic wrap
  - Elevate limb above heart

- **Pain control**
  - NSAIDs
Functional rehabilitation program aims to optimize the healing by aligning treatment goals with biological phases.

4 healing phases of acute lateral ankle ligament tear:

- Phase 1 – Inflammation
  - RICE immediately after injury to minimize hemorrhage, swelling, inflammation, and pain for best possible conditions for healing

- Phase 2 - proliferation
  - 1-3 weeks following injury
  - Ligaments must be protected to allow healing; brace or taping
  - During this time the fibroblasts invade the injured area and proliferate to form collagen fibers
Phase 3 – maturation
- 3 weeks after the injury
- collagen fibers mature and become scar tissue
- controlled stretching of muscles and movement of the joint
- encourage the orientation of the collagen fibers along the stress lines
- prevent deleterious effects of immobilization on joint cartilage, bone, muscle, and tendons

Phase 4 – remodeling
- 6 to 8 weeks after injury
- new collagen fibers can withstand almost normal stress
- full return to activity is the goal
- The entire maturation and remodeling of the injured ligaments lasts from 6 to 12 months.
- Ankle mobilization
  - The early phases of treatment begin with lower resistance sports such as stationary cycling or swimming, with weight bearing as tolerated as soon as possible
  - Muscle strengthening is begun when normal weight bearing and pain-free range of motion are achieved
  - Assisted eversion exercises should be performed in dorsiflexion to strengthen the peroneus brevis tendon and in plantarflexion to strengthen the peroneus longus tendon
Proprioception

- Proprioception training begins by using a tilt board or Biomechanical Ankle Platform System (BAPS) once muscle strength has improved enough to support balance.
- The goal of proprioceptive training is to improve not only balance but neuromuscular control.
Additional forms of treatment

- Only cryotherapy has been proven to be effective in reduction of swelling
- NSAIDs were found to be more effective than placebo in treating ankle tenderness and swelling during the first 2 weeks after the injury
  - Differences were small and seemed to disappear during an extended follow-up
Grade 1 sprains

- Ambulate, usually, in ankle stirrup or small brace
- Complete ligament healing in 4 – 6 weeks
Grade 2 sprains

- Crutches until comfortable, brace
- Ankle motion and exercises as swelling subsides
- Complete healing within 8 - 12 weeks
- Consider referral to foot & ankle specialist
Grade 3 sprains

- Refer to foot & ankle specialist due to high risk of complications
- Casting to control pain and swelling (controversial)
- Ankle motion and exercises as swelling subsides
- Complete healing 8 – 12 weeks
Complications of Ankle Sprain

- Chronic pain
- Chronic ankle stiffness – inability to plantarflex, feeling like there’s a catching sensation
- Partial tear of the peroneal tendons
- Chronic ankle joint instability
- Osteochondral defect of the talar dome
- Early onset of arthritis
Multiple studies and meta-analyses demonstrate no significant differences between conservative-functional vs. operative treatment

- One study did show operative repair improved “giving way” but no difference was found with respect to pain (outcome variables were restricted to these 2 subjective criteria)

50% of chronic sprains respond well to PT and proprioceptive training

- Leads to ankle arthritis, synovitis, cartilage injury
- Recurrent/Recalcitrant pain, giving-way, reduced ROM
Outcomes - Surgical

- No major difference has been found in the outcome of patients treated with primary repair of the torn lateral ligaments compared to functional rehabilitation treatment.
- At this time, acute repair of the lateral ligaments are only indicated in high performance athletes.
- Most authors agree that in acute lateral ligament ankle injury, the preferred treatment is functional treatment.
  - According to the Cochrane review, meta-analysis of surgical versus non-surgical management of acute ankle injuries were performed and results were inconclusive, as most trials were methodologically flawed.
  - A randomized trial demonstrated statistically significant difference in favor of surgical intervention with regard to pain, giving way, and recurrent sprains at follow up.33
Heel Pain
Definition

- Inflammation (fasciitis) or degenerative changes (fasciosis) occurring at the plantar fascia and the surrounding fibrous tissue
- Repetitive tensile overload of plantar fascia origin
- Leads to degeneration and attenuation

- "Heel spur syndrome" = misnomer

- Most commonly due to chronic overload
Consists of
- Medial band
- Central band
- Lateral band

Inelastic

Dorsal to the plantar fascia
- Flexor digitorum brevis (FDB) muscle
- Branch of lateral plantar nerve divides from the tibial nerve medially runs between the fascia of FDB and quadratus plantae (QP) muscles
Function of the Plantar Fascia

- Provides protection to underlying structures
- Maintains foot arch
- Keeps foot in relative supination through push-off phase of ambulation
  - Windlass mechanism
    - Described by Hicks in 1954, during toe-off phase of gait, the metatarsophalangeal joints are dorsiflexed, resulting in high tensile forces concentrated at the calcaneal origin of the fascia
10-16% prevalence in population
Women >> men
40-60 year of age
Long periods of standing or walking on hard surfaces
Poor foot wear
Obesity, pregnancy
Decreased ankle motion
Etiology

- Unknown
- Risk factors:
  - Lack of dorsiflexors
  - Running athletes
  - Occupation that involve prolonged standing
  - Limited ankle dorsiflexion
  - Increased BMI
  - Pes planus/ Pes cavus
Clinical Presentation

- Diagnosis based on patient’s history and clinical exam
  - Non-radiating pain, located to plantar medial tubercle region
  - Bilateral 30%
  - Gradual onset of inferior heel pain
    - Worse with first step in the morning or after a period of prolong standing or sitting
    - Lessen with activity
    - Worsens by the end of the day
Clinical Findings

▫ Tenderness
  o Medial tubercle of calcaneus (origin of PF)
    ▪ Point specific and reproducible
  o Not diffuse central heel or mid arch tenderness

▫ May have equinus contracture

▫ Compare plantar fascia of both feet
  o Place plantar fascia on stretch
    ▪ Maximal toe and ankle dorsiflexion recreates windlass mechanism
Radiographs
- Not needed first visit
- Only if fail to improve
  - Occult calcaneus stress fracture?

WB foot radiographs

Role of heel spur
- Spur located origin of FDB
  - 75% with heel spur
  - 63% with no heel spur
Technetium bone scan

- Limited indications
- Only if diagnosis is in doubt
  - Suspect stress fracture
  - Non specific
MRI

- Imaging characteristics
  - Fusiform thickening of plantar fascia at the origin
  - Fusiform thickening of plantar fascia at the origin
  - Increased signal within the fascia on both T1 and T2
  - Edema in the adjacent soft tissues
  - Bony edema within the calcaneus

Getting to the heel of the problem: plantar fascia lesions.
Jeswania T, Morleseb J, McNallyc, EG. Clinical Radiology (2009) 64, 931-939
Ultrasound

- Characteristics
  - Increased thickening of plantar fascia over 4mm
  - Loss of reflectivity of ligament with central bundle most specifically affected
  - Enthesial new bone formation, including spur formation

Long axis ultrasound image showing a thickened, hypoechoic, plantar fascia representing plantar fasciitis.

Figure A. thickened plantar fascia. Figure B. Normal plantar fascia.
Nonoperative Treatment

- Mainstay of management
- High success rate
- Resolution of symptoms can be slow
- Recurrence is common
Nonoperative Treatment

- **Primary modalities**
  - Stretching exercises
    - Calf stretching with knee straight
    - Plantar fascia specific stretch
  - Inserts/Strapping
    - OTC vs. Custom
    - Low-dye strap
  - NSAIDS
  - Cryotherapy
  - Activity modification
    - Avoid repetitive weight bearing exercise
Nonoperative Treatment

- Secondary modalities
  - Night splints
  - Walking cast or fracture boot
  - Steroid injection
    - Use rarely
    - Risk of plantar fascia rupture
    - Risk of causing fat pad atrophy
  - Physical therapy
Rarely indicated

- 90% resolve within 9 months time

Indications

- At least 6 months to 1 year of symptoms
- Exhausted non-operative treatment regimens
- Presence of associated nerve compression
  - First branch of lateral plantar nerve (to abductor digiti minimi)
Operative Treatment

- Open plantar fasciotomy
- Endoscopic plantar fasciotomy (EPF)
- Extracorporeal shock wave therapy (ESWT)
- Bipolar radiofrequency
- Ancillary procedure
  - Gastroc recession
Operative Treatment

EPF
- Minimally invasive
- 2 or 1 portal approach
- Release of medial band

Technically easy to perform

Medial incision site

Lateral incision site