Mass General Brigham
Spaulding Rehabilitation

Evaluation of Foot and Ankle Conditions in Athletes

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Disclosure Statement

Speaker:

Dr. Adam Tenforde

- Disclosed the following financial relationships:
  - StateFarm
    - ➢ Consultant
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    - ➢ Grant/Research Support Recipient
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    - ➢ Grant/Research Support Recipient
  - Strava
    - ➢ Consultant

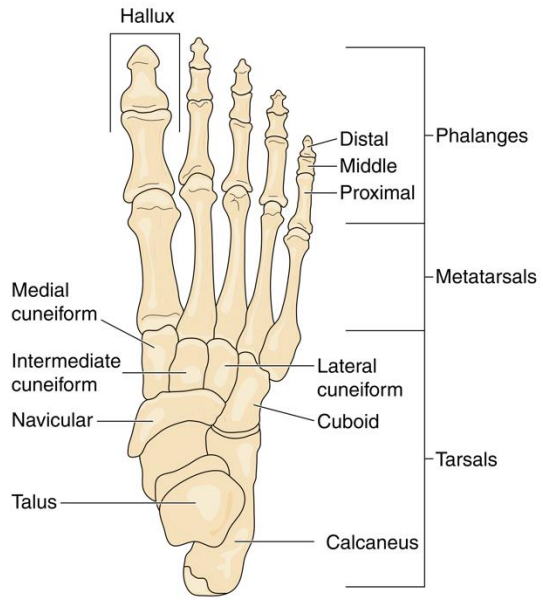
Objectives

- To provide an overview on evaluation of foot and ankle
- To review evaluation and management of common injuries

Overview of the foot and ankle

- **Foot consists of 26 bones, 33 joints, 4 layers of muscle in combination with fascia and ligaments**

- **Concept of "foot core" important to consider when evaluating for impairments and restoring function**



McKeon, et al. Foot Core Paradigm. Br J Sports Med, 2014

Overview of the foot and ankle

- **Ankle comprised of 3 joints: tibiotalar (talocrural), inferior tibiofibular, and subtalar joints**

- **Lateral ligaments, medial ligaments and high ankle structures contribute to joint stability**

Physical Exam

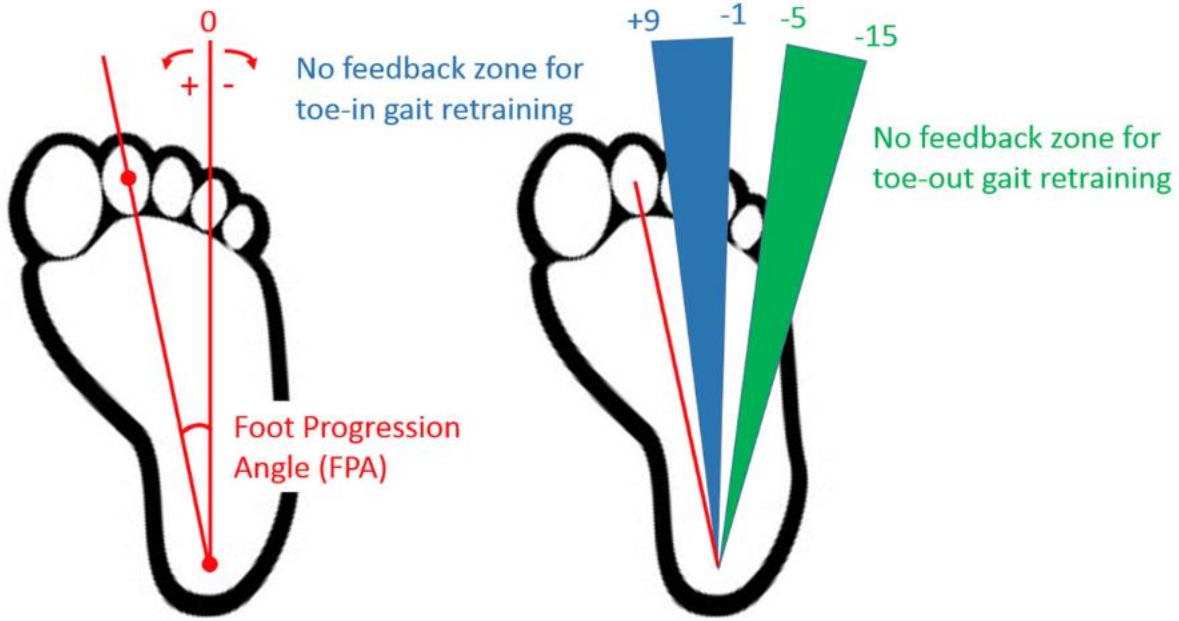
- **Weight bearing examination:**
  - **Inspection**
  - **Gait**
  - **Single limb squat**
  - **Calf raise**
  - **Balance**
- **Seated examination**
  - **Palpation**
  - **Range of motion**
  - **Special tests of forefoot, midfoot and hindfoot**

Standing inspection

- Weight bearing exam: more appropriate for athletes!
- Forefoot: presence of hallux valgus, digitus quintus varus
- Midfoot: enlargement over dorsum of foot
- Hindfoot
  - presence of effusion, tenosynovitis
  - alignment: hindfoot valgus, too-many-toe-sign

Gait

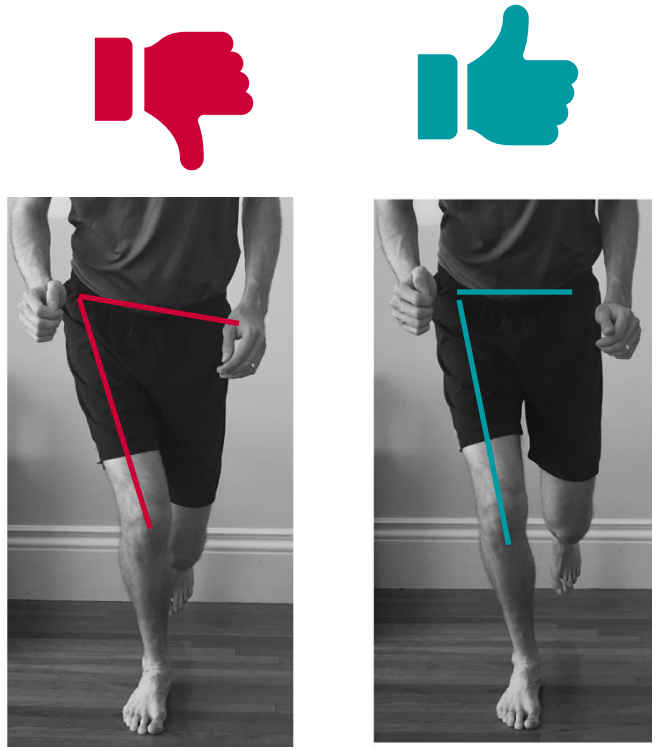
- **Presence of antalgic gait**
- **Foot progression angle**
- **Presence of pronation or supination**



Xu, et al. Configurable, wearable sensors and vibrotactile feedback system for real-time postural balance and gait training: Proof-of-concept. J NeuroEng and Rehab, 2017.

Single Leg squat

- Perform repetitively and evaluate
  - Trunk: evaluate for stability
  - Pelvis and Knee: presence of femoral adduction/abduction
  - Foot and Ankle
    - deformation of longitudinal/transverse arch
    - Position of the foot (maintain contact with ground?)
    - Degree of ankle dorsiflexion (ankle impingement?) or forefoot/toes leaving ground (sign of tight heel cord)



Calf raise

- Functional test of plantar flexion, evaluate for:
  - Ability to perform heel rise test
    - Inability to perform may indicate advanced Achilles tendinopathy or tibialis posterior tendon dysfunction
  - Contact of forefoot
    - Tendency to roll to outside of foot may indicate poor mechanics during HEP or pain/guarding to offload hallux sesamoid complex

Balance

- Single leg stance
  - Both eyes closed and no talking
- Tandem gait in select cases

Seated examination

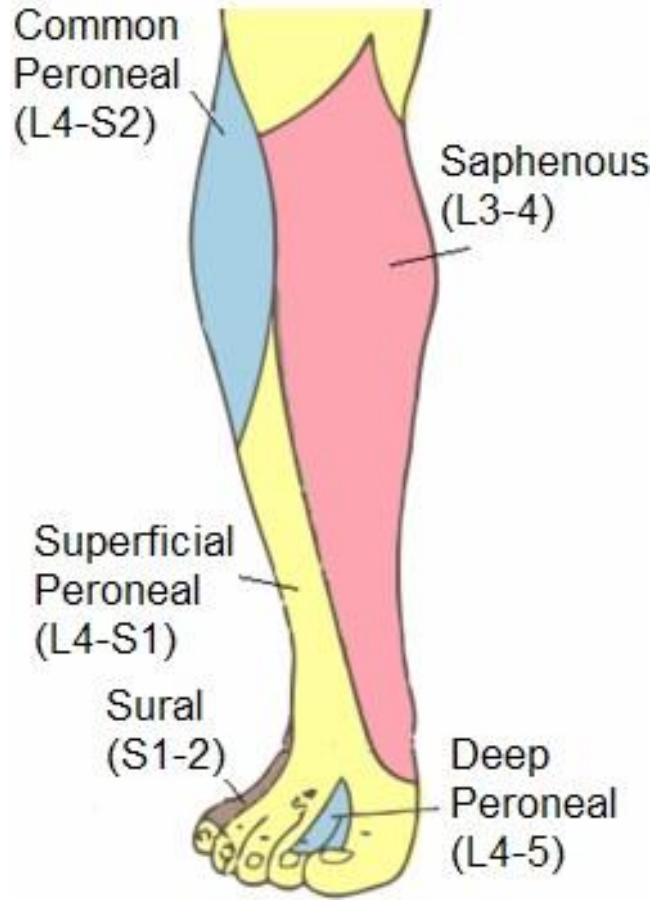
- Palpation over bones, tendons, ligaments, webspace and fascia of foot
- Swelling over the dorsum of the foot:
  - Evaluate lis franc injury
  - Focal bony pain to suggest bone stress injury
- Plantar foot pain:
  - location of symptoms
- Skin examination for calluses or breakdown
  - May indicate asymmetric wear patterns (check the shoes too!)
  - Plantar warts
  - fibromas

Range of motion

- **Forefoot**
  - **Special consideration for first MTP joint flexion through extension**
- **Midfoot**
  - **Tarsal-metatarsal joints, intermetatarsal mobility, rotatory defects**
- **Hindfoot**
  - **Dorsiflexion with knee bent and in extension**
  - **Hinfoot inversion through eversion**

Sensory testing

- **Light touch over sural, superficial peroneal, and tibial nerves**
- **In select cases:**
  - **Proprioception of great toe**
  - **Filament testing for peripheral neuropathy**



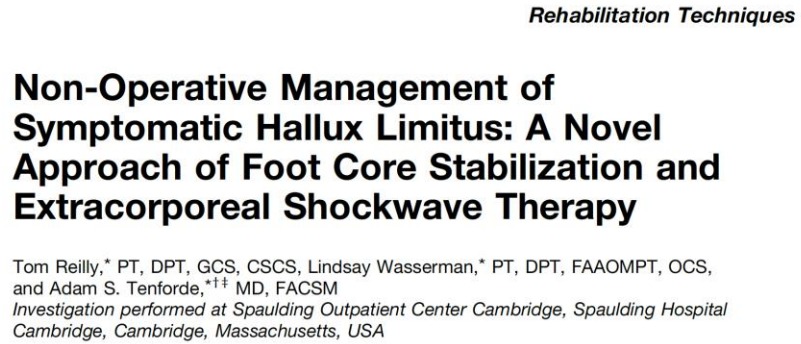
Forefoot condition: Hallux limitus

- Loss of first MTP passive range of motion
- Presence of crepitus/synovitis
- Often associated with hallux valgus
- Evaluate full hallux complex
  - Pain over hallux sesamoid bones
  - Activation FHL/EHL
- Standing X-ray: evaluate for osteoarthritis, degree of hallux valgus

Management of Hallux limitus/rigidus

- Common treatment of foot orthosis/Morton extension, steroid injections, surgical correction

- Alternative approach
  - Foot core strengthening program
  - Use of wide toe box shoes, toe spaces
  - Manual therapy to optimize first MTP range of motion
  - Shockwave and non-steroid injections to address pain



Rehabilitation Techniques

Non-Operative Management of Symptomatic Hallux Limitus: A Novel Approach of Foot Core Stabilization and Extracorporeal Shockwave Therapy

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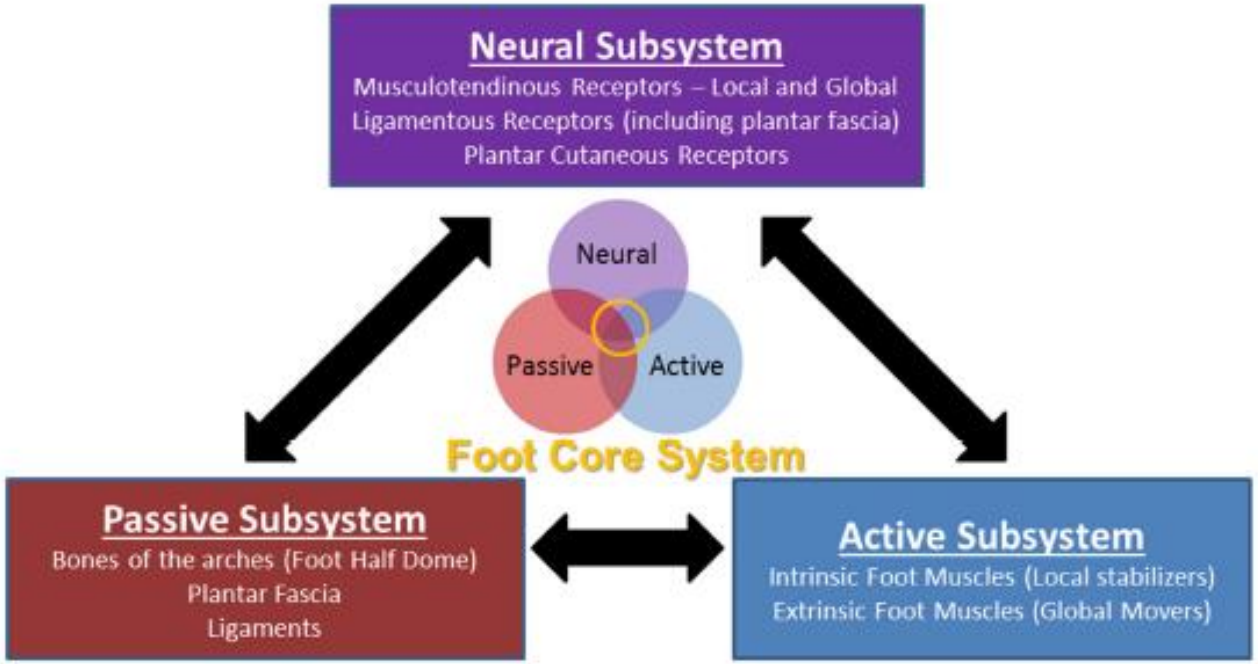
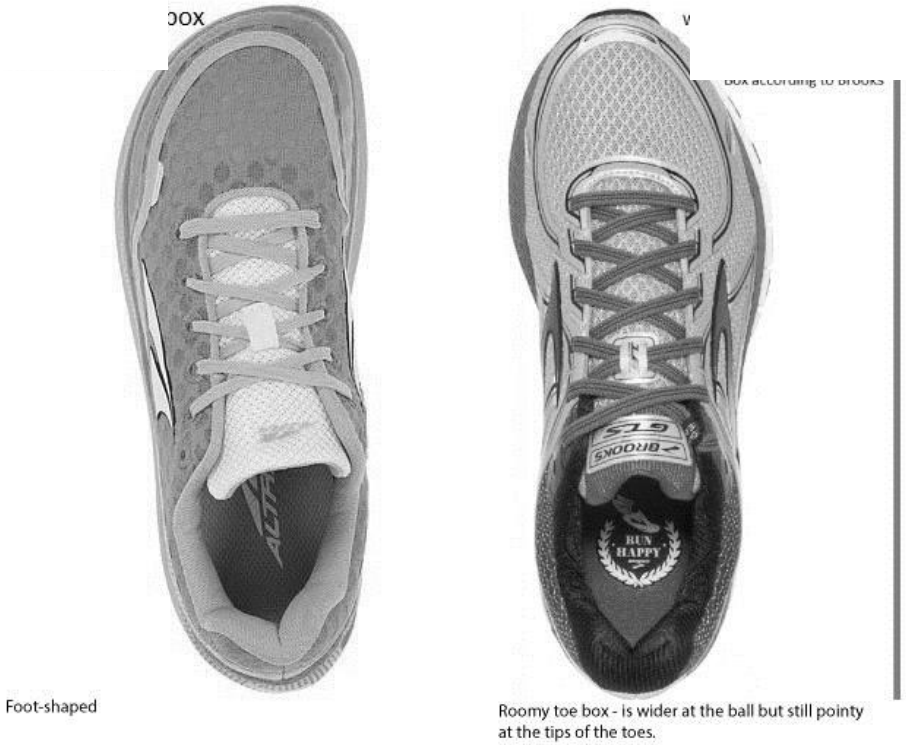
Investigation performed at Spaulding Outpatient Center Cambridge, Spaulding Hospital Cambridge, Cambridge, Massachusetts, USA

Foot Core Exercises



McKeon, et al. Foot Core Paradigm. Br J Sports Med, 2014

Considerations – Match footwear to foot shape!



Credit: Golden Harper

Considerations – Use toe separators

Correct Toes – Toe Spacers

Forefoot condition: Hallux sesamoiditis/bone stress injury

- **Pain directly over hallux sesamoids, may have swelling**
- **Imaging**
  - **X-ray with sesamoid view: evaluate for fracture, distinguish from bipartite hallux sesamoids (often bilateral!)**
  - **MRI: presence of bone marrow edema, stress fracture**
  - **CT: limited cases to evaluate for AVN**
- **Management to offload (dancer's pad), temporary orthosis, foot core including address hallux valgus, address shoe toe box?**

Forefoot condition: plantar plate injury, metatarsalgia

- **Pain over the plantar foot metatarsal heads**
- **X-ray is often negative, MRI may detect plantar plate injury**
- **Treatment: immobilization for plantar plate injury, progressive foot core exercises, orthobiologics and surgery in limited acute cases**

Forefoot condition: neuroma and bursitis

- Pain localized to intermetatarsal webspace
- Distinguishing neuroma:
  - Quality of pain
  - Morton compression testing
  - Mulder's click
- Imaging: MRI may distinguish neuroma from bursitis
- Treatment: similar to Hallux limitus/rigidus, corticosteroid injection of neuroma, shockwave/other injections?

Forefoot Pain: metatarsal bone stress injury

- Swelling over dorsum of foot confused for “tendinitis”
- Focal bone pain seen with metatarsal bone stress injury
- Imaging: x-ray often non-diagnostic, MRI is imaging of choice
- Treatment
  - tall walking boot and crutches for base second metatarsal or fifth metatarsal metaphyseal/diaphyseal junction, more advanced injuries
  - Vitamin D supplementation, calcium intake, screening/treatment REDs
  - Foot core exercises and restore mobility after immobilization!

Midfoot pain: Arthritis

- Enlargement over dorsum of foot
- Pain over joint with associated pain on PROM
- X-ray to evaluate for joint space narrowing, MRI in select cases to distinguish for AVN
- Treatment: foot core, wide toe box shoes, shockwave and non-steroid injections

Midfoot pain: Lis franc sprain

- Mechanism of injury: direct trauma or torsion to joint
- Swelling over dorsum of foot, bruising over plantar foot
- Imaging
  - bilateral standing AP x-ray to evaluate for widening
  - MRI: request protocol thin slices lis franc interval
  - CT: in limited cases with concern for instability
- Treatment:
  - Walking boot and crutches 4-6 weeks, followed by foot core
  - Advanced injuries: surgical treatment with ORIF

Ross, et al. Plantar ecchymosis sign: a clinical aid to diagnosis of occult Lisfranc tarsometatarsal injuries. J Orthop Trauma, 1996
Eleftheriou, et al. Lisfranc injuries: An update. Knee Surg Sports Traumatol Arthrosc, 2013.

Midfoot pain: Navicular bone stress injury

- **Often presents as vague midfoot/hindfoot pain**
- **Pain over navicular tubercle and body of navicular bone**
- **X-ray often negative, MRI and CT if clinical concern**
- **Management: tall walking boot (limit plantar flexion!), crutches for 6 weeks**
- **Optimize nutrition including vitamin D, consider shockwave therapy**

Midfoot pain: Navicular bone stress injury

- **The CT grading scale by Saxena helpful to guide management**

- **Question whether footwear may contribute to injury**

Table 1
Navicular stress fracture classification

Type	Description
0.5	Stress reaction; signal change on MRI noted, but stress fracture not imaged on CT
I	Dorsal cortical fracture on coronal image
2	Fracture extends into navicular body on coronal image
3	Complete propagation of fracture to second cortex (medial, lateral or plantar) on coronal image

Saxena and Fullem. Navicular Stress Fractures in Athletes. FAI, 2006
Tenforde, et al. Bone Stress Injuries in Runners Using Carbon Fiber Footwear. Sports Med, 2023.

Hindfoot pain: lateral ligament sprain

- Common following ankle inversion injury
- Anterior drawer and talar tilt tests for stability
- X-ray by Ottowa Ankle Rules, limited role for MRI unless concern of OCD, occult fracture, or high ankle sprain
- Treatment with (P)RICE – limit immobilization, foot core program, taping and ankle brace on return to sport
- Refractory cases: consider PRP/prolotherapy, shockwave, surgery in advanced cases

Hindfoot pain: deltoid ligament sprain

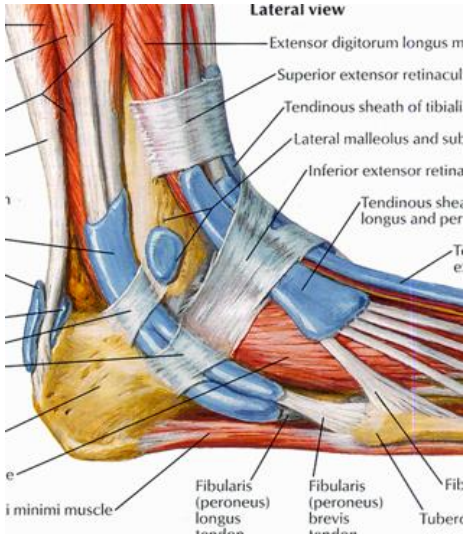
- Less common, mechanism of ankle sprain in plantarflexion
- Pain over medial ankle deltoid ligament complex, anterior drawer testing
- X-ray and MRI in select cases
- Initial treatment in tall walking boot
- Progressive foot core program, restore ankle mobility with manual therapy

Hindfoot pain: high ankle sprain

- Exam with pain above ankle mortise
- Full exam of syndesmosis and fibula for pain
- Dial test and squeeze test
- Standing x-ray with ankle mortise view
- Dynamic/stress imaging considered in select cases
- Management: severe injury to surgery, otherwise tall walking boot and crutches for 4-6 weeks, progressive strengthening/foot core program

Hindfoot pain: Peroneal tendon disorders

- Palpation over common peroneal tendons, to fifth metatarsal head (-brevis) and through transverse arch (-longus)
- Strength testing of eversion and plantar flexion
- Tenosynovitis: consider rheumatological disease or split tear
- Imaging:
  - X-ray for os peroneum or avulsion injury
  - MRI to quantify tenosynovitis or split tear
  - Diagnostic ultrasound may detect unstable peroneal tendons
- Split tear: tall walking boot with heel wedge
- Foot core and generalized strengthening program, consider PRP and/or shockwave



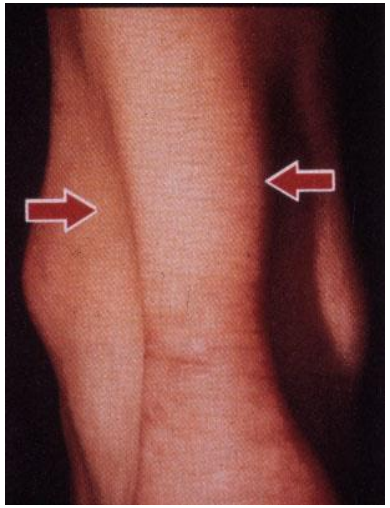
Hindfoot pain: Tibialis Posterior Tendinopathy/Dysfunction

- **Pain over tibialis posterior, inversion with plantar flexion**
- **More advanced cases: inability to perform heel rise test, too many toe sign and presence of tenosynovitis**
- **Standing x-ray: tibiotalar/subtalar osteoarthritis, alignment**
- **MRI: may detect condition of tendon**
- **Management: acute/more advanced tendinopathy with trial of tall walking boot with crutches, progressive foot core progression, shockwave/PRP**

Rhim, et al. Characteristics and Future Direction of Tibialis Posterior Tendinopathy Research: A Scoping Review. Medicina, 2022.

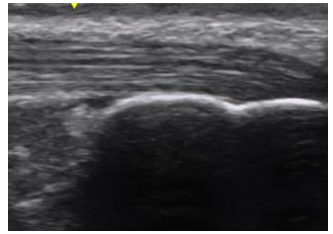
Hindfoot pain: Achilles tendinopathy

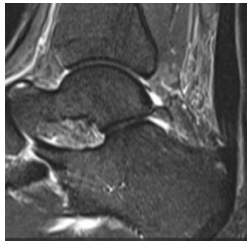
- **Evaluation includes inspection, palpation, range of motion and assessing strength and tendon integrity**
- **Achilles tendinosis**
  - Thickened, nodular tendon
- **Paratenonitis**
  - Crepitus
- **Single leg calf raise for strength, Thompson test**



Hindfoot pain: Achilles tendinopathy

- **Point of care ultrasound:** low cost, may detect tear
- **X-ray:** presence of calcifications, Haglund's deformity
- **MRI:** selective cases with concern for high grade injury/full tear or distinguishing for calcaneal bone stress injury

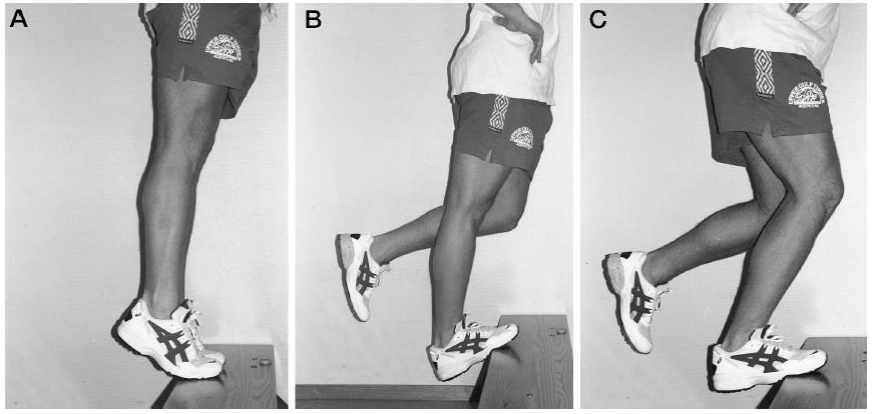




Hindfoot pain: Achilles tendinopathy

- **Management: acute tear requires boot with heel wedge**
- **all injuries require progressive exercise program and load management strategies**

1. The pain is allowed to reach 5 on the NPRS during the activity.
2. The pain after completion of the activity is allowed to reach 5 on the NPRS.
3. The pain the morning after the activity should not exceed a 5 on the NPRS.
4. Pain and stiffness are not allowed to increase from week to week.



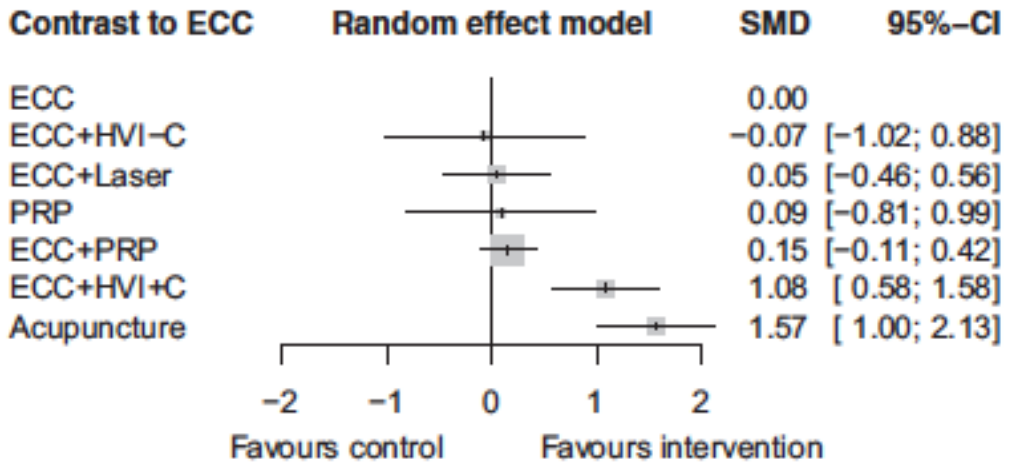
Alfredson, et al. Heavy-Load Eccentric Calf Training Achilles Tendinosis. AJSM, 1998

Jonsson, et al. New regimen for eccentric calf muscle training in patients with chronicinsertional Achilles tendinopathy. BJSM, 2008

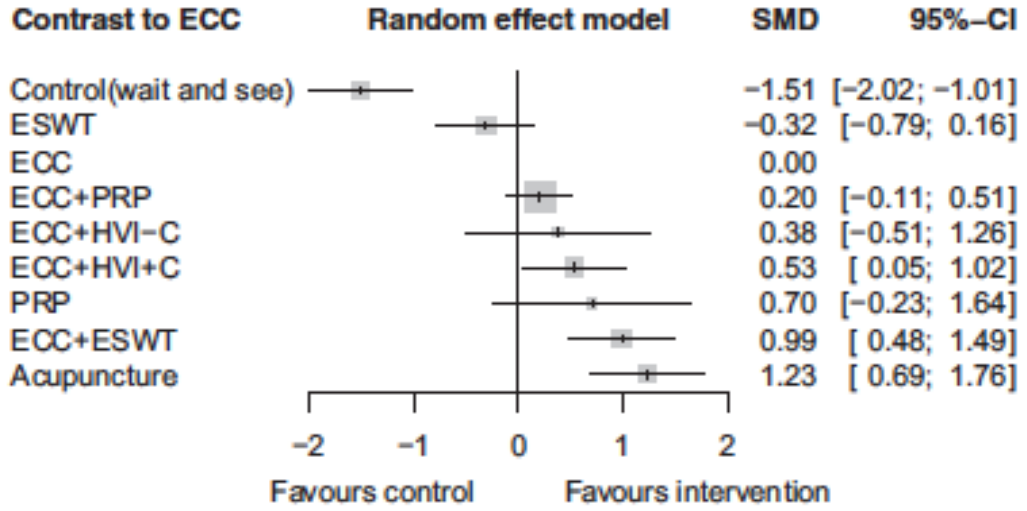
Silbernagel and Crossley, A Proposed return to sport for Achilles tendinopathy. JOSPT, 2015

Achilles tendinopathy: Eccentric Loading combined with shockwave therapy

Short Term < 12 weeks



Longer Term > 12 weeks



Rhim, et al. Comparative Efficacy and Tolerability of Nonsurgical Therapies for Treatment of Midportion Achilles Tendinopathy. OJSM, 2020

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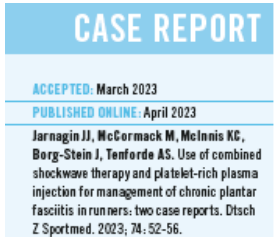
Hindfoot pain: Plantar fasciopathy

- common cause of plantar foot pain
- pain localized to heel, associated morning stiffness
- medial calcaneal tubercle common region for pain may also have symptoms along medial longitudinal arch and with windlass test
- Management: night splint, temporary orthosis and low dye taping, foot core progression
- For athletes: shockwave therapy +/- PRP


CASE REPORT

ACCEPTED: March 2023

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Jarnagin JJ, McCormack M, McInnis KC, Borg-Stein J, Tenforde AS. Use of combined shockwave therapy and platelet-rich plasma injection for management of chronic plantar fasciitis in runners: two case reports. Dtsch Z Sportmed. 2023; 74: 52-56.

Jarnagin JJ[1], McCormack M[1], McInnis KC[1], Borg-Stein J[1], Tenforde AS[1]

Use of Combined Shockwave Therapy and Platelet-Rich Plasma Injection for Management of Chronic Plantar Fasciitis in Runners: Two Case Reports

De Garceau, et al. Association of Plantar Fasciitis and windlass test, FAI, 2003

Hindfoot pain: Arthritis

- **Synovitis, limited range of motion, ankle impingement and often secondary tendinopathy**
- **Standing x-ray gold standard, MRI in early cases to evaluate for OCD or alternative etiology**
- **Management: foot core progression, low profile brace/taping, and consider shockwave +/- orthobiologics**

Summary

- **Develop a systematic approach for evaluation of foot and ankle**
- **Mainstay of treatment is non-surgical**
- **Targeted interventions can be considered based on injury**


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