

Review of Lower Extremity: Foot and Ankle




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Overview



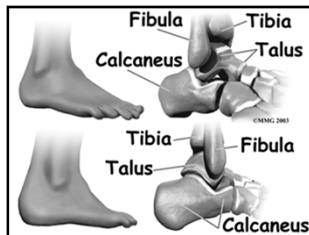
1. Ankle and foot functional anatomy and biomechanics
2. Anatomic based differential diagnosis
 - a. Epidemiology
 - b. Clinical presentation
 - c. Management strategies

 KEY CONCEPT

Ankle: Functional Anatomy and Biomechanics

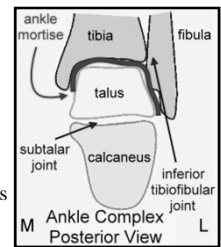
Three joints

1. Talocrural (tibiotalar)
2. Distal tibiofibular
3. Subtalar



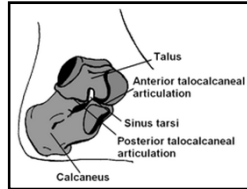
Talocrural Joint

- Dorsiflexion
 - Very stable due to bony articulations
- Plantarflexion
 - Trochlea (of the talus) moves anteriorly in the tibial mortise, lessening bony stability
 - Creates more reliance on ligamentous stability



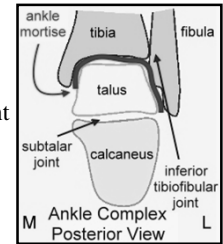
Talus

- Body
 - Three continuous facets for articulations
 - Superior: tibia
 - Lateral and medial: malleoli
 - Trochlea (superior surface)
- Posterior process:
 - Medial and lateral tubercles form a groove for the FHL tendon
 - Os trigonum: un-united lateral tubercle
- Lateral process:
 - Snowboarders fracture



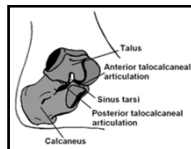
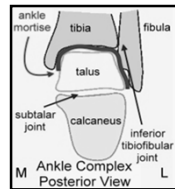
Distal Tib-Fib Joint

- Small amount of rotation
- Inferior tibio-fibular ligament
 - The syndesmosis
 - “high ankle sprain”



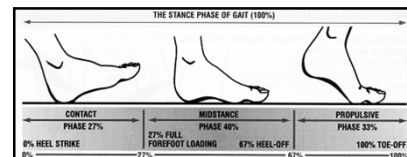
Subtalar Joint

- Between talus and calcaneus
- Anterior & posterior articulations separated by the sinus tarsi
- Inversion and eversion
- Excessive or delayed motion
 - Risk factor for running injuries
- Function:
 - Shock absorption
 - Allows foot to accommodate to uneven ground
 - Transmits forces efficiently



Pronation Supination

- | | |
|---|--|
| <ul style="list-style-type: none"> • Triplanar motion <ul style="list-style-type: none"> - Ankle dorsiflexion - Subtalar eversion - Forefoot abduction • Assists ankle and knee with impact shock absorption • Making the foot a relatively mobile, adaptive structure | <ul style="list-style-type: none"> • Triplanar motion <ul style="list-style-type: none"> - Ankle plantarflexion - Subtalar inversion - Forefoot adduction • Locks the hind and midfoot to act as a rigid lever <ul style="list-style-type: none"> - At heelstrike and push-off |
|---|--|



Pronation

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 - Ankle dorsiflexion
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Supination

- Triplanar motion
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Pronation in the Kinetic Chain

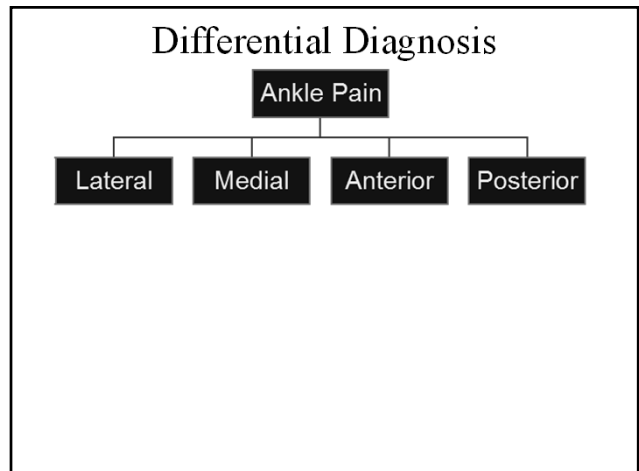
primarily eccentric muscle contractions to provide joint control and shock absorption

- Ankle dorsiflexion
- Tibial internal rotation
- Knee flexion & adduction (valgus)
- Femoral internal rotation
- Hip flexion & adduction
- Pelvis rotates anteriorly

Supination in the Kinetic Chain

primarily concentric muscle contractions (gluteals!) to provide acceleration and propulsion

- Ankle plantarflexion
- Tibial external rotation
- Knee extension & abduction (varus)
- Femoral external rotation
- Hip extension & abduction
- Pelvis rotates posteriorly



Differential Diagnosis

Ankle Pain

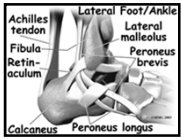
Lateral

Medial

Anterior

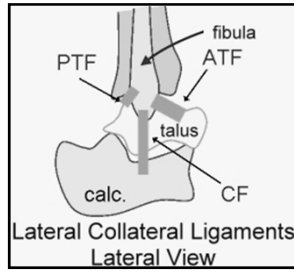
Posterior

1. Lateral Ankle Sprain
2. Peroneal tendon tendinopathy / subluxation
3. Lateral soft tissue impingement
4. Sinus tarsi syndrome (subtalar ligament sprain)
5. Osteochondral talus injury



Lateral Ligaments ★

- ATFL
 - Prevents:
 - Anterior talar translation in DF
 - Inversion when in PF
 - Weakest: most commonly torn
- CFL
 - Prevents inversion at talocrural
- PTFL
 - Prevents posterior talar translation
 - Strongest
 - Taut only in extreme dorsiflexion; sprained only in severe ankle sprains



**Lateral Collateral Ligaments
Lateral View**

Lateral Ankle Sprain


- Inversion, supination, & plantarflexion
- Grading
 - I - ligamentous stretching, no gross tear
 - II - partial ligamentous tearing
 - III - complete ligamentous rupture
 - ATFL solely - 65%
 - ATFL + CFL - 20%

Provocative maneuvers

Palpate for tenderness:

- Ligaments
- Malleoli
- Talus
- Fibula - distal and proximal
 - Maisonneuve fracture
- Base of the 5th metatarsal
- Peroneal tendons

Anterior drawer - ATFL
Talar tilt (inversion test) - CFL
Van Dijk 1996 JBJS Br
delay PxEx 5 days to improve sensitivity and specificity



Ottawa Ankle Rules

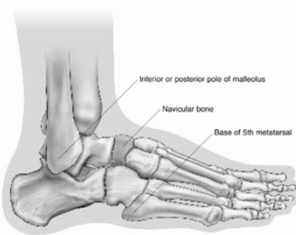
Indications for ankle radiographs

- Tenderness over the inferior or posterior pole of either malleolus, including the distal 6 cm
- Inability to bear weight (4 steps taken independently, even if limping) at the time of injury and at the time of evaluation.

Indications for midfoot radiographs

- Tenderness along the base of the 5th metatarsal or navicular bone
- Inability to bear weight (4 steps) at the time of injury and at the time of examination

A modification developed by physicians at the University of Buffalo focuses on tenderness along the midline crest instead of bony tenderness at the posterior and inferior malleolar edges. This modification (the Buffalo Rules) may obviate the need for radiographs in more than 50% of cases.



Ankle Sprain: treatment

1. Reduce pain and swelling: PRICE
 - a. Functional, removable brace (air splint) to control inversion/eversion generally recommended over rigid immobilization (walking boot), except for maybe grade III injuries
 - b. WBAT if no associated fractures
2. Rehabilitation
 - a. Restore ROM
 - b. Restore neuromuscular control - esp. peroneals
 - c. Strengthen
 - d. Proprioceptive training - for balance and postural control (wobble board)
3. Functional training
 - a. Once pain-free, full ROM, strength > 75%, adequate proprioception and balance
 - b. To increase power and neuromuscular control in multiple planes
 - c. Plyometrics, agility drills, closed chain single leg exercises
4. Return to sport
5. Surgical management: Rare (Modified Brostrom Procedure)
 - a. For grade III injuries after rehab has failed and other causes of pain have been ruled out

Ankle Sprain: treatment

KEY CONCEPT

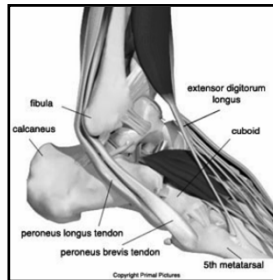
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 - a. Restore ROM
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 - c. Strengthen **ECCENTRIC ANKLE EVERTER STRENGTHENING**
 - d. Proprioceptive training - for balance and postural control (wobble board)
3. Functional training
 - a. Once pain-free, full ROM, strength > 75%, adequate proprioception and balance
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Chronic Pain and Functional Loss after Ankle Sprain

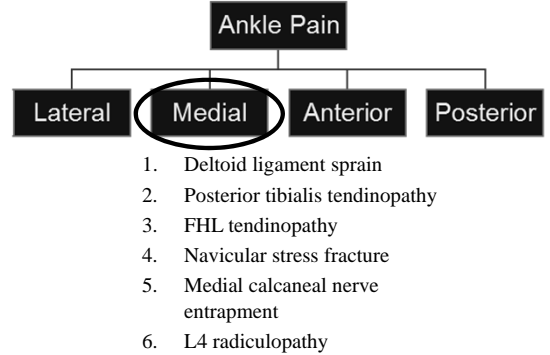
1. Inadequate rehabilitation
2. Other sources?
 - a. Talar dome injury
 - i. 7-22% of ankle sprains
 - ii. Commonly missed on initial evaluation
 - b. Other osteochondral injury
 - c. Peroneal tendon involvement
 - d. Lateral soft tissue impingement
 - i. Scarring or synovial hypertrophy from severe sprain or recurrent strains
3. Imaging: MRI

Peroneal tendinopathy

1. Excessive pronation and eversion
2. Pain with resisted eversion
3. Treatment
 - a. Rehabilitation
 - b. Foot orthoses to limit pronation
4. Subluxation
 - a. Can occur after acute dorsiflexion-eversion stress
 - b. Peroneal retinaculum tears or incompetence
 - c. Tendon subluxes anteriorly to lateral malleolus
 - d. Treatment
 - i. Injections
 - ii. Limit weightbearing
 - iii. Surgery

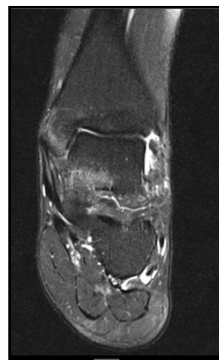


Differential Diagnosis



Medial Ligaments

- Deltoid
 - Tibionavicular
 - Anterior tibiotalar
 - Posterior tibiotalar
 - Tibiocalcaneal
- Attaches medial malleolus to the talus, navicular, and calcaneus



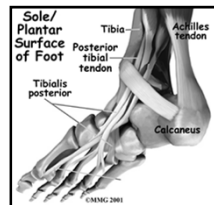
Deltoid Ligament Sprain

1. Less common injury
2. Eversion stress or forced ER on planted foot
3. Associated fractures common
4. Rehabilitation and return to play course is protracted



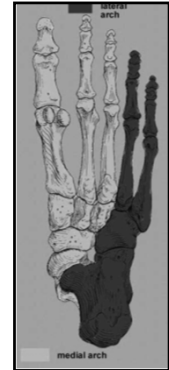
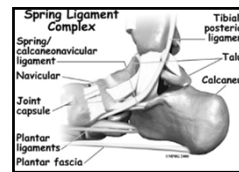
Posterior Tibialis Tendinopathy

1. Passes behind medial malleolus and inserts on navicular
2. Controls descent of the medial longitudinal arch
3. Worsened by excessive pronation from rapid increase in training intensity or poor footwear
4. Provocative maneuver: resisted inversion
5. Management
 - a. Rest, rehabilitation
 - b. Proper foot wear +/- orthosis that controls pronation
 - c. Surgical if complete tear due to the effect on the arch

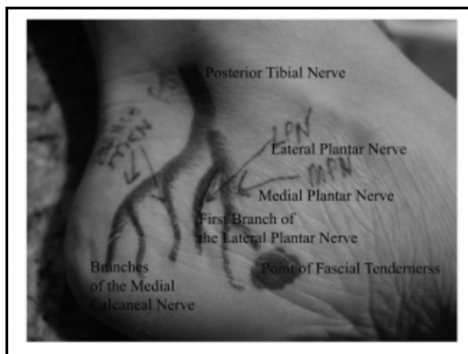


Medial Longitudinal Arch

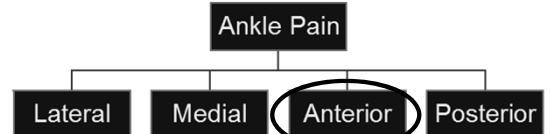
1. Posterior Tibialis
 - a) Dynamic stabilizer of MLA
2. Spring Ligament: plantar calcaneo-navicular ligament
 - a) Connects calcaneus to navicular along plantar surface
 - b) Supports the head of the talus
 - c) Static stabilizer of MLA



Medial calcaneal neuropathy & Tarsal tunnel syndrome



Differential Diagnosis



1. Anterior ankle impingement
2. High ankle (syndesmosis) sprain
3. EHL tendinopathy
4. Tibialis anterior tendinopathy
5. Osteochondral talar dome injury
6. L5 radiculopathy

Anterior Impingement

1. Soccer (kicking) and Ballet (plie/lunge)
2. Forced dorsiflexion
3. Bony lip develops on the anterior tibia or the anterior superior talus
4. Impinge on overlying soft tissue or each other
5. Provocative maneuver: extreme DF (lunge)
6. Management:
 - a. Rest, rehabilitation, talocrural mobilization
 - b. Surgical excision



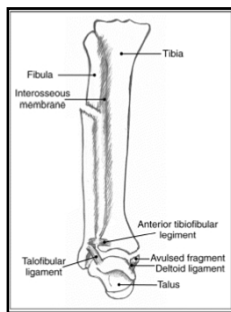
Syndesmosis Sprain

1. High ankle sprain
2. Associated with fractures
3. Provocative maneuver: External Rotational Stress Test & Squeeze test
4. Grade III tears
 - a. Tib-Fib widening on plain films
 - b. Associated fracture
5. Management
 - a. Grade I-II: rest, protracted rehabilitation
 - b. Grade III: cast immobilization or surgical



Maisonneuve Fracture

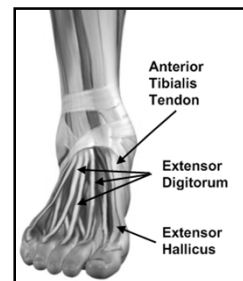
- Rupture of anterior tibiofibular ligament, interosseus membrane, and medial deltoid ligament
- May result in proximal fibular fracture



TA and EHL tendinopathy

Multiple causes:

- dorsiflexion overuse secondary to talocrural joint restriction
- running downhill
- tight shoelaces



SPLATT

Split Anterior Tibialis Tendon Transfer (spasticity management)

★ Surgically divide AT tendon to move the lateral half attachment to cuboid and 3rd cuneiform:

- to correct equino-varus deformity
- spastic gastroc/soleus and AT
- foot is plantarflexed, inverted, and supinated
- creates an eversion force
- in conjunction with achilles lengthening

Differential Diagnosis

Ankle Pain

Lateral

Medial

Anterior

Posterior

1. Achilles tendinopathy / rupture
2. Retrocalcaneal bursitis
3. Haglund's syndrome
4. Posterior ankle impingement
5. Sever's disease
6. S1 radiculopathy

Achilles tendinopathy

1. Common in runners, particularly older age group
2. Most tender area 2-6 cm above the calcaneal insertion
3. Biomechanical factors ★
 - a. Excessive pronation
 - b. Subtalar joint restriction
 - c. Limited ankle dorsiflexion
 - d. Weak gastroc-soleus
4. Clinical diagnosis; MRI and US can evaluate for tear/rupture
5. Thompson's test for rupture

Achilles Rupture: Thompson's Test

Management of Achilles tendinopathy

- Rest, immobilization, rehabilitation
- Correct contributing biomechanical faults
- Eccentric calf strengthening
- Percutaneous procedures

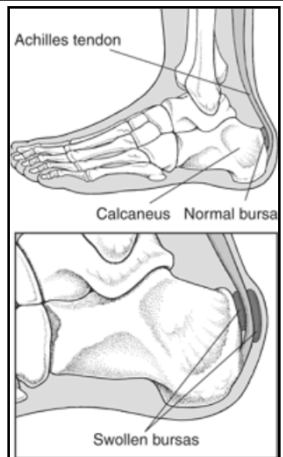
Management of Achilles tendinopathy



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Retrocalcaneal Bursitis

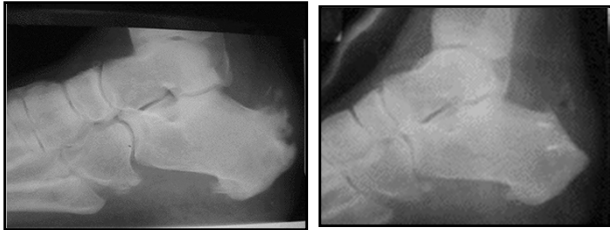


Haglund's syndrome

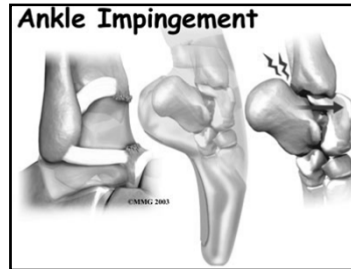
- Retrocalcaneal bursitis and achilles tendonitis in association with a retrocalcaneal exostosis or prominent posterior superior calcaneus (Haglund's deformity)



Haglund's Syndrome



Posterior Impingement



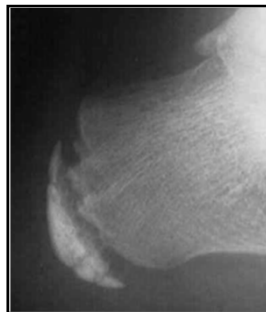
Os Trigonum

Sever's Disease

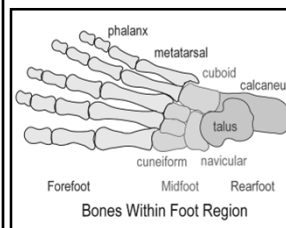
Calcaneal Apophysitis



Apophysis (growth plate)
Calcaneus (heel bone)



Foot: Functional Anatomy & Biomechanics



Rearfoot

- calcaneus, talus, soft tissues

Midfoot

- navicular, cuneiforms, cuboid, soft tissues

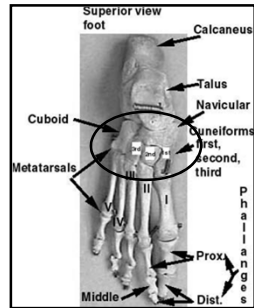
Forefoot

- metatarsals and phalanges

Lisfranc Chopart

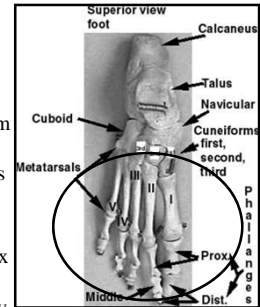
Midfoot

- Navicular, cuneiforms, cuboid
- Very little motion, in isolation
- Working together
 - Accomodation to the ground
- Common injuries
 - Stress fractures
 - Ligamentous injuries



Forefoot

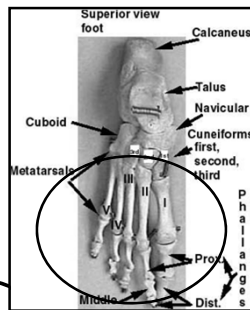
- Metatarsals & phalanges
- Tarsometatarsal joints = Lisfranc's joints
- Base of 2nd metatarsal
 - in a recessed position as it articulates with the 2nd cuneiform
 - Thus, inherently more rigid → ↑susceptibility to stress fractures
- 5th metatarsal
 - More mobile
 - Less common as a site of stress fx
 - When one does occur, healing may be protracted due to mobility



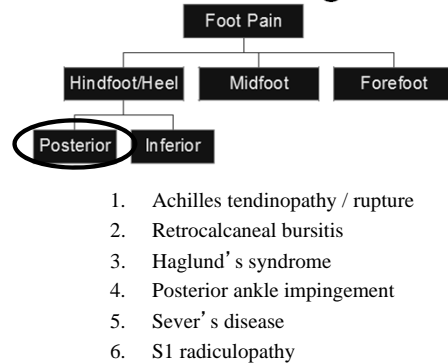
Forefoot

KEY CONCEPT

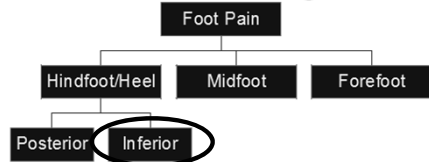
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Differential Diagnosis



Differential Diagnosis



1. Plantar fasciitis
2. Fat pad contusion
3. Calcaneal stress fracture
4. Tarsal tunnel syndrome
5. Medial calcaneal nerve entrapment
6. S1 radiculopathy

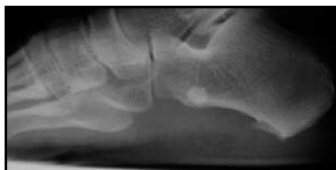
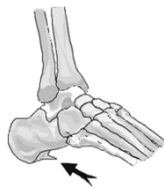
Plantar Fasciitis

- 11-15% of all adult foot symptoms seeking medical care
- 10% of all running injuries
- Bilateral in 15-30%
- Peak incidence: Bimodal
 - General population: 40-60 yo
 - Runners: much younger
- Pain at the anteromedial process of medial calcaneal tubercle
- Worse with first few steps in a.m. and later at end of day
- 80% of resolve within one year

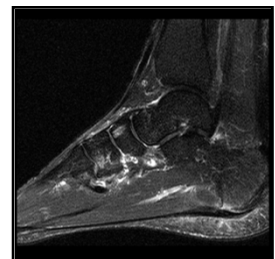


Plain films

- Rule out calcaneal stress fracture
- Spondyloarthropathy: “fluffy periostitis”
- Can visualize heel spurs
 - Robin 1963
 - of 125 pts with heel spurs, only 10% were symptomatic

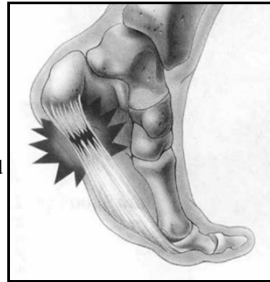


MRI



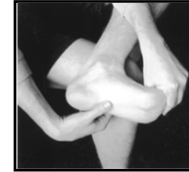
Risk Factors (JBJS 2003)

- Decreased ankle DF (tight calves)
 - < 0° DF has 23x risk of > 10° DF
- Obesity
 - BMI > 30 has 6x risk of < 25
- Occupations requiring prolonged standing
- Repetitive microtrauma
 - In runners

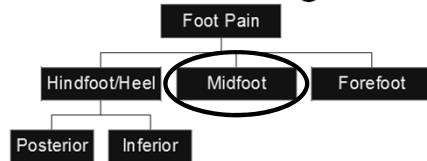


Treatment

- Rest- Limit offending activities
- Shoe modification- Heel cups, gel inserts, orthotics
- Night splints
- Taping
- Immobilization
- PF stretching
- Calf stretching
- Intrinsic foot strengthening
- Manual friction massage
- Corticosteroid injection/PRP



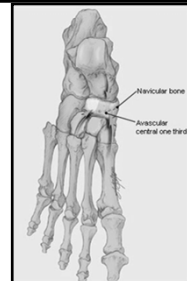
Differential Diagnosis



1. Posterior tibialis tendinopathy
2. Peroneal tendinopathy
3. Tarsal fracture (navicular)
4. Cuboid subluxation
5. Anterior tarsal tunnel syndrome

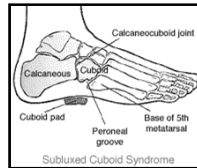
Navicular Stress Fracture

1. Common in runners
2. Vague midfoot pain
3. Tenderness over the proximal, dorsal surface of navicular
4. MRI or Bone Scan + CT
5. Management
 - a. NWB (cast) x 6 weeks
 - b. Post-immobilization rehab
 - c. Worry about non-union central third



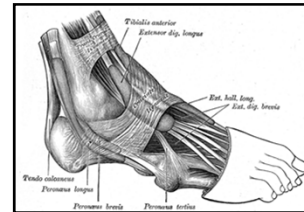
Cuboid Subluxation

1. Associated with peroneal tendinopathy
2. Caused by excessive traction of the peroneus longus
3. Commonly seen in overpronators
4. Cuboid is subluxed medially
5. Treatment
 - a. Manipulation of the cuboid in an upward and lateral direction
 - b. Treat peroneal tendon issue if present

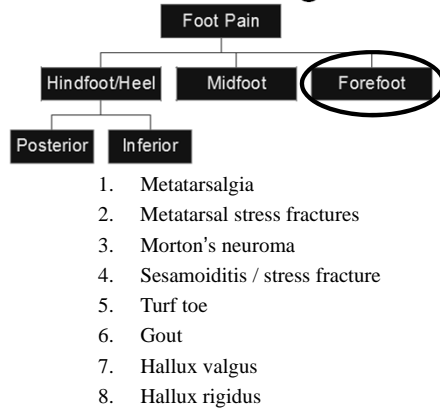


Anterior Tarsal Tunnel Syndrome

- Entrapment of the deep peroneal nerve under the extensor retinaculum
- Aching and numbness of the dorsal midfoot, extending to the first web space
- Cause: poor fitting shoes



Differential Diagnosis



Metatarsalgia

1. Diagnosis of exclusion
2. Potentially related to excessive pronation and further stress on the 1st and 2nd metatarsal heads
3. Management
 - a. Metatarsal pad
 - b. Orthosis with a cut-out for the painful metatarsal head



Metatarsal Stress Fractures

1. Common in runners & ballet, females > males
2. Second > third
3. 2nd metatarsal head is relatively immobile as it is tucked between the medial and lateral cuneiforms
4. Treatment
 - a. Relative rest until pain free
 - b. If walking is painful - NWB
 - c. Stiff soled shoe or walking boot
 - d. Average return to sport is 8 weeks (variable)



Metatarsal Stress Fracture



1 week after symptom onset



Week 6

5th Metatarsal Fractures

1. Jones fracture
 - a. Diaphyseal-metaphyseal jxn fracture
 - b. Inversion/plantarflexion injury vs. overuse
 - c. NWB cast x 6-8 weeks vs. screw fixation
2. Tuberosity at the base
 - a. Peroneus brevis avulsion injury after an acute ankle sprain
 - b. Immobilization for pain relief then protect mobilization and rehabilitation
3. Spiral fracture of the distal third
 - a. Non-displaced: weight-bearing rest
 - b. Displaced: 4-6 weeks of cast immobilization



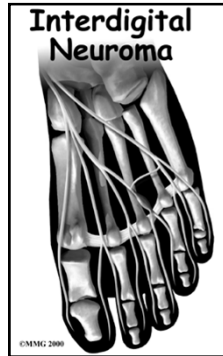
Stress Fractures Summary

High Risk	Low Risk
Medial malleolus	Distal fibula
Navicular	Metatarsal shaft
Proximal 5th metatarsal	
Sesamoids	

Harrast MA, Colonna D. *Stress Fractures in Runners* in Clinics in Sports Medicine 2010, 29(3): 399-416

Morton's Neuroma

1. Swelling of nerve and scar tissue around the interdigital nerves
2. Usually between 3rd-4th MT
3. Toe pain and paresthesias, worsened with weightbearing and narrow fitting shoes
4. Metatarsal hypermobility may contribute
5. Management
 - a. Metatarsal pad - to distribute forces more evenly
 - b. Intrinsic strengthening to improve transverse arch
 - c. Corticosteroid injection
 - d. If excessive pronation, orthosis
 - e. Surgical excision



Sesmoid injuries

1. Act as pulleys for the FHB tendons and stabilize the first MTP joint
2. Bipartite sesmoid prevalence: 30%
3. Potential injuries
 - a. Stress fracture
 - i. Difficult to see on plain films
 - ii. Prone to non-union
 - iii. NWB X 6 weeks
 - b. Sesmoiditis
 - i. Sprain of bipartite sesmoid
 - ii. Sprain of sesmoid-MT articulation



Turf Toe

1. First MTP joint sprain
2. Excessive forced dorsiflexion
3. Incidence increased with the use of non-slip artificial turf
4. Plain film appropriate to r/o fracture
5. Management
 - a. Relative rest, protected weightbearing
 - b. Taping and stiff-soled shoes

