Metatarsalgia

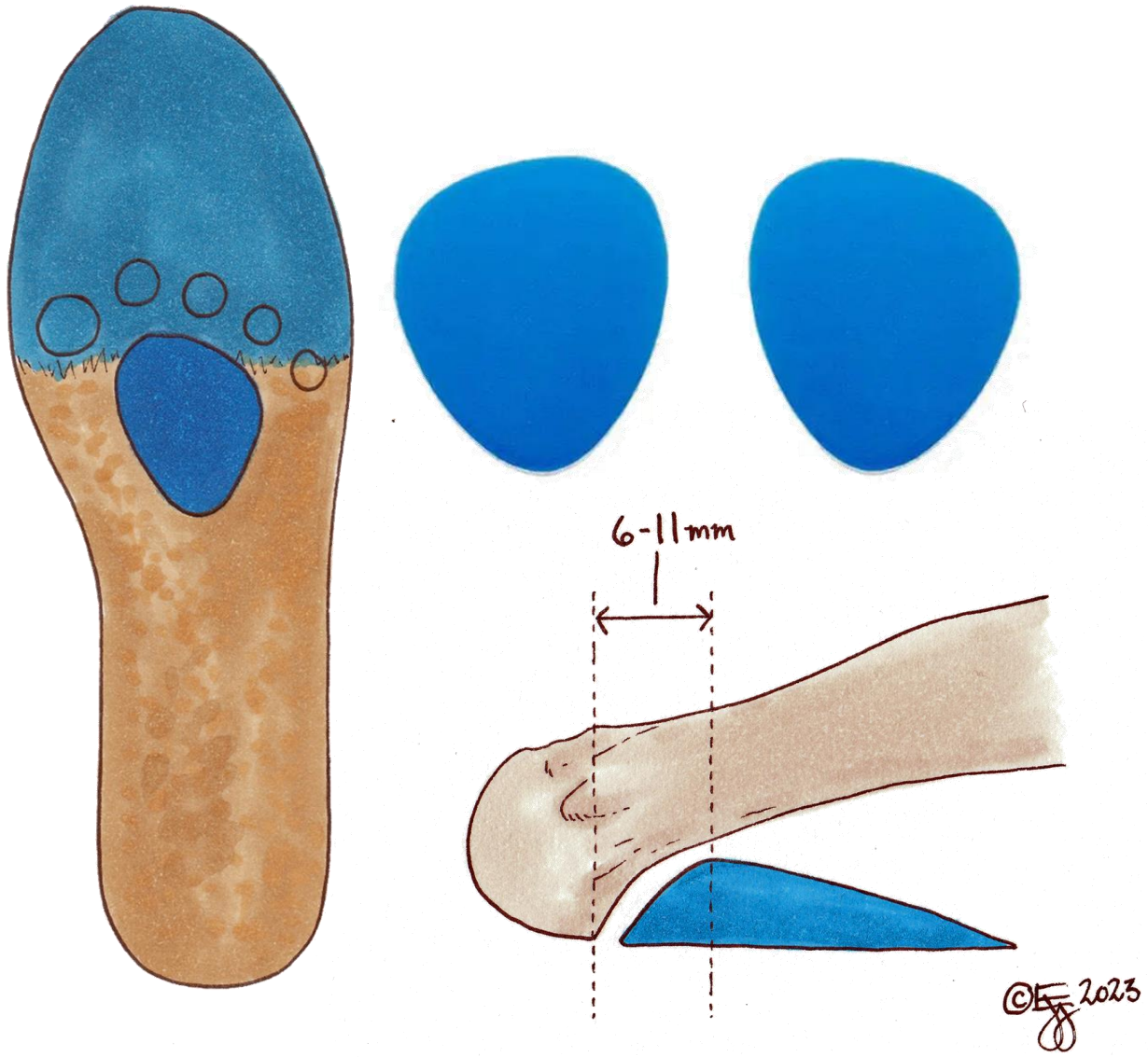
Metatarsalgia

(Not a helpful “diagnosis”)

- Cleveland Clinic: *Metatarsalgia, or pain in the ball of your foot, may be caused by a variety of factors*.
- Mayo Clinic: *Metatarsalgia (met-uh-tahr-SAL-juh) is a condition in which the ball of your foot becomes painful and inflamed*.
- WebMD: *Metatarsalgia is a common overuse injury. The term describes pain and inflammation in the ball of your foot. It’s often thought of as a symptom of other conditions, rather than as a specific disease.*

Metatarsalgia

- Pedorthic Treatment
  - Generally speaking…
  - Reduce pressure under painful MTHs
  - Offload Vs. Cushion
  - Foot orthoses
    - Custom Vs. Prefab
    - Met pad, met bar, etc. will be used in some fashion by the pedorthist to treat most etiological causes of metatarsalgia



- Metatarsal pads…
  - Available in a wide variety of shapes, thickness, densities and materials
  - Self-adhesive
    - Easy to use
    - Don’t stay in place for long

Metatarsal Pad Placement

Hastings MK, Mueller MJ, Pilgram TK, Lott DJ, Commean PK, Johnson JE. **Effect of metatarsal pad placement on plantar pressure in people with diabetes mellitus and peripheral neuropathy.** Foot Ankle Int. 2007 Jan;28(1):84-8. doi: 10.3113/FAI.2007.0015. PMID: 17257544.

METHODS: Twenty subjects with diabetes mellitus, peripheral neuropathy, and a history of forefoot plantar ulcers were studied (12 men and eight women, mean age=57+/-9 years). CT determined the position of the metatarsal pad relative to metatarsal head and peak plantar pressures were measured on subjects in three footwear conditions: extra-depth shoes and a 1) total contact insert, 2) total contact insert and a proximal metatarsal pad, and 3) total contact insert and a distal metatarsal pad. The change in peak plantar pressure between shoe conditions was plotted and compared to metatarsal pad position relative to the second metatarsal head.

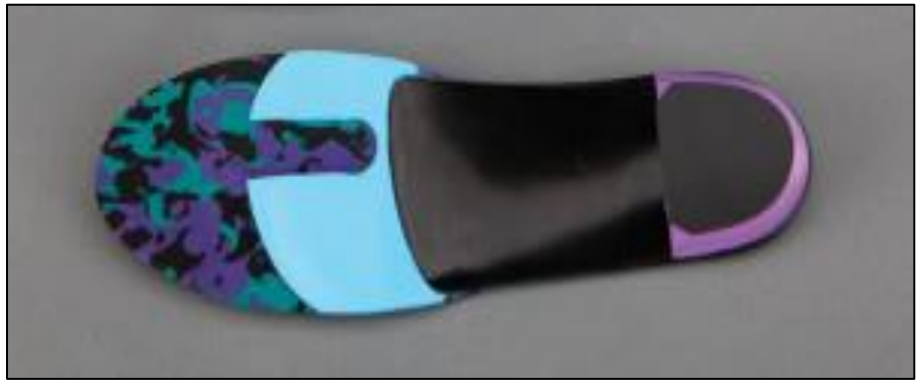
RESULTS: Compared to the total contact insert, all metatarsal pad placements between 6.1 mm to 10.6 mm proximal to the metatarsal head line resulted in a pressure reduction (average reduction=32+/-16%). Metatarsal pad placements between 1.8 mm distal and 6.1 mm proximal and between 10.6 mm proximal and 16.8 mm proximal to the metatarsal head line resulted in variable peak plantar pressure reduction (average reduction=16+/-21%). Peak plantar pressure increased when the metatarsal pad was located more than 1.8 mm distal to the metatarsal head line.

CONCLUSION: Consistent peak plantar pressure reduction occurred when the metatarsal pad in this study was located between 6 to 11 mm proximal to the metatarsal head line. Pressure reduction lessened as the metatarsal pad moved outside of this range and actually increased if the pad was located too distal of this range.

MTH Offloading

- Intrinsic = Built into either the positive model and/or the device itself. Typically refers to wedges, met pads and areas of relief.
- Not easily adjustable.
- Precise placement can be a challenge.

- Extrinsic = Added to the finished orthotic device. External wedges, met pads,offloads, etc.
- Simpler to adjust/correct.

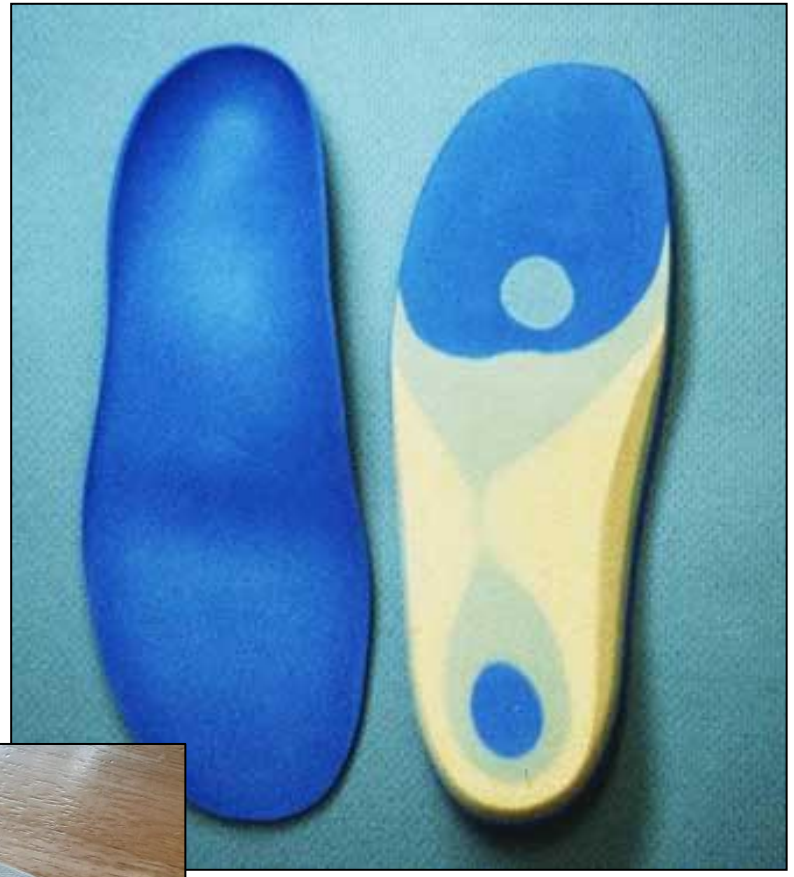


MTH Offloading

- Intrinsic offload, depression
  - Requires a thicker foot orthosis
  - Exact placement can be tricky
  - Consider “edge effect”

Metatarsalgia

- “Sweet spot” for additional cushioning
- Provides padding, but not much (if any) pressure reduction via offloading.



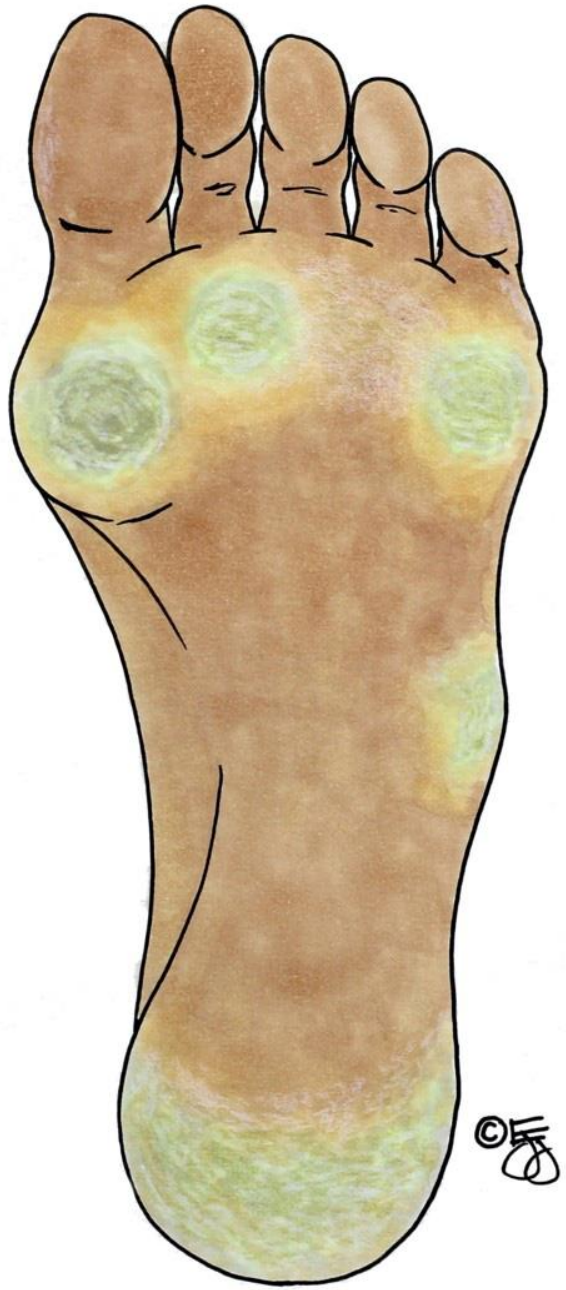
Etiology of Metatarsalgia

Corns and Calluses

- Skin becomes thickened and hardened under areas of excess pressure
  - Increased keratin production increases thickness of the stratum corneum (the outermost layer of the skin)
- The repeated friction and pressure of the skin overlying the bony prominences leads to a hyperkeratotic thickness resulting in corn and callus formation.
- Corn (clavus, heloma, focal intractable plantar hyperkeratosis) has a well-delineated focal area of hyperkeratosis.
  - Smaller and deeper than calluses and have a hard center surrounded by swollen skin. They can be painful when pressed.
    - Hard corns (heloma durum) often form on the top of the toes or the outer edge of the small toe.
    - Soft corns (heloma mole) tend to form between the toes. This location often leads to maceration of the corn, which is conducive to the development of a bacterial or fungal infection, or ulceration.
- Callus is a more diffuse type of callosity
  - They may vary in size and shape and are not necessarily painful.
- Differential diagnosis: Plantar warts
  - Plantar warts do not necessarily occur under areas of pressure, are small and have a well-defined center core

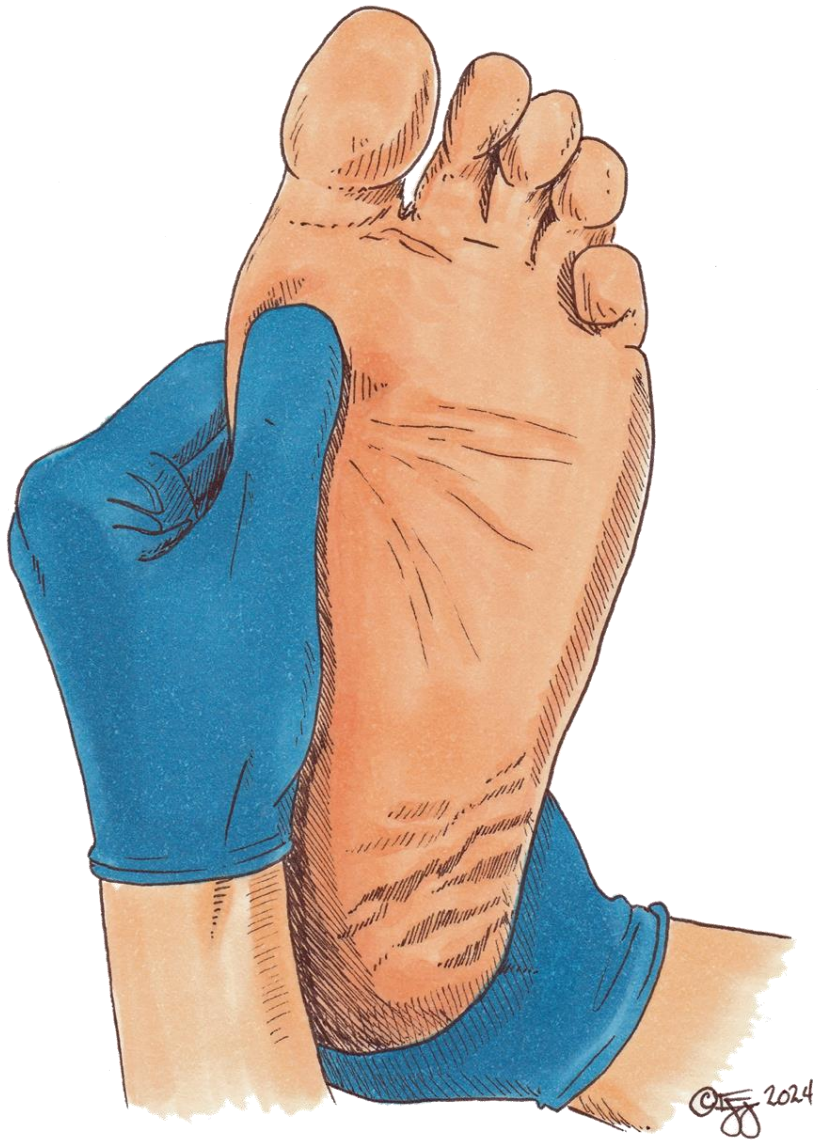
Corns and Calluses

- Pedorthic treatment
  - Footwear
    - Well-fitted, depth shoes to accommodate foot orthoses. Wide, oblique toe box shape for soft corns between toes.
    - Appropriate shear- and friction-reducing socks
  - Foot Orthoses
    - Custom Vs. prefab with relief/offloading for callused areas
  - Shoe Modifications
    - Rocker soles for chronic, recurring painful calluses
- Even if calluses are sanded down, they will return if underlying causative pressure is not sufficiently resolved.



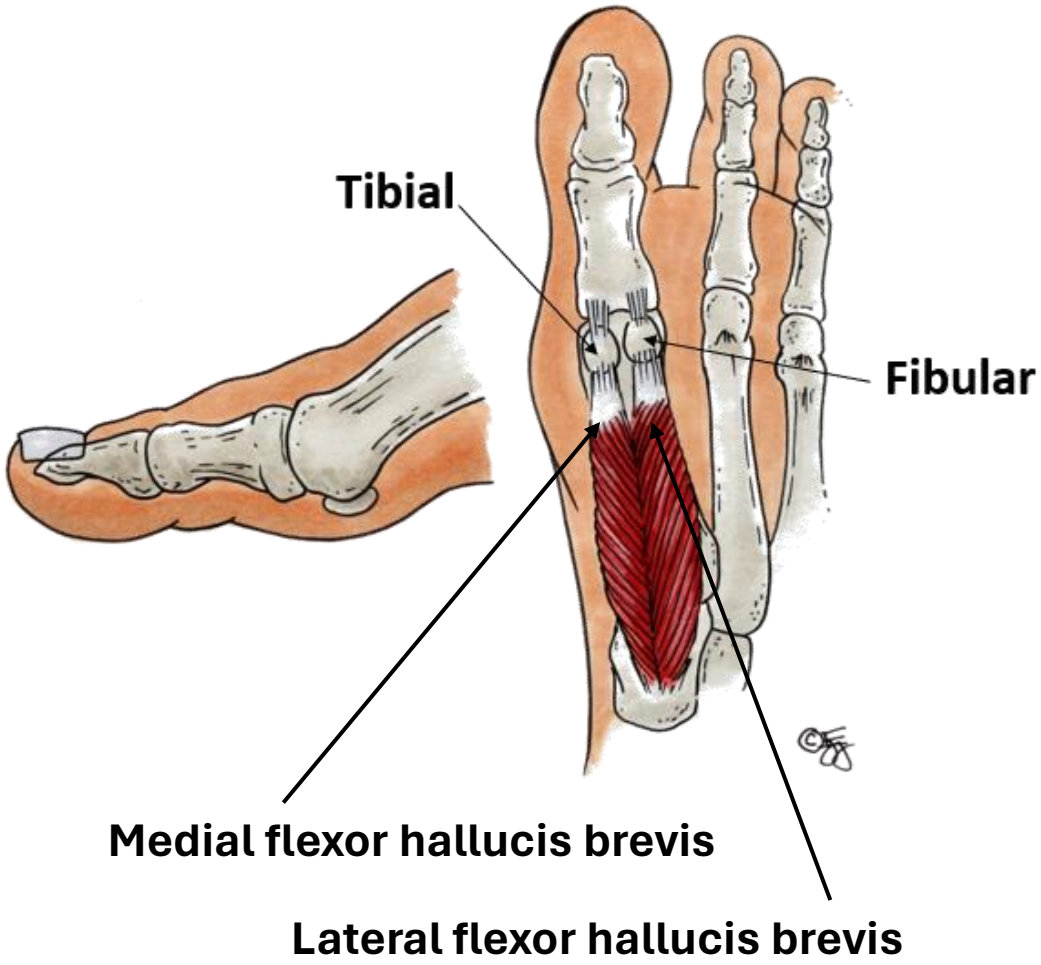
Sesamoiditis

- Inflammation in one or both sesamoids
- Overuse injury – tendinitis of flexor hallucis brevis
- Pain with DF, weightbearing, or both
- Sesamoid fracture (Acute Vs. Hx of)



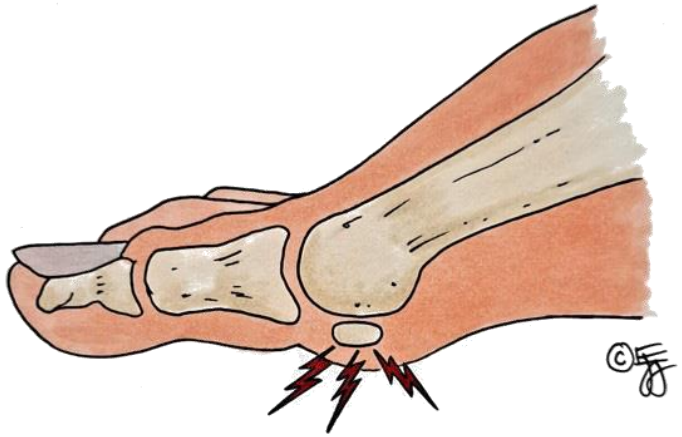
Sesamoiditis

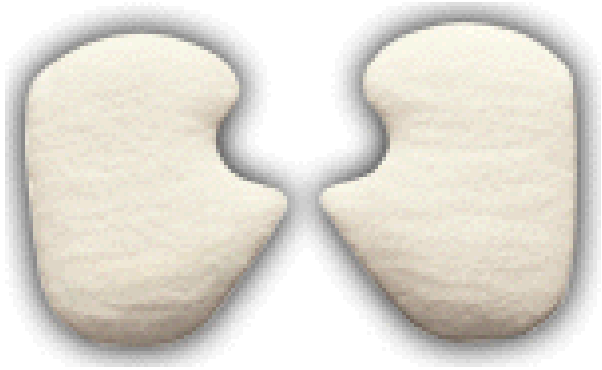
- Sometimes the painful sesamoid is removed surgically and frequently (as should be to no one's surprise) the remaining sesamoid becomes painful.
- Sesamoids are integral to normal function of 1st MTPJ.



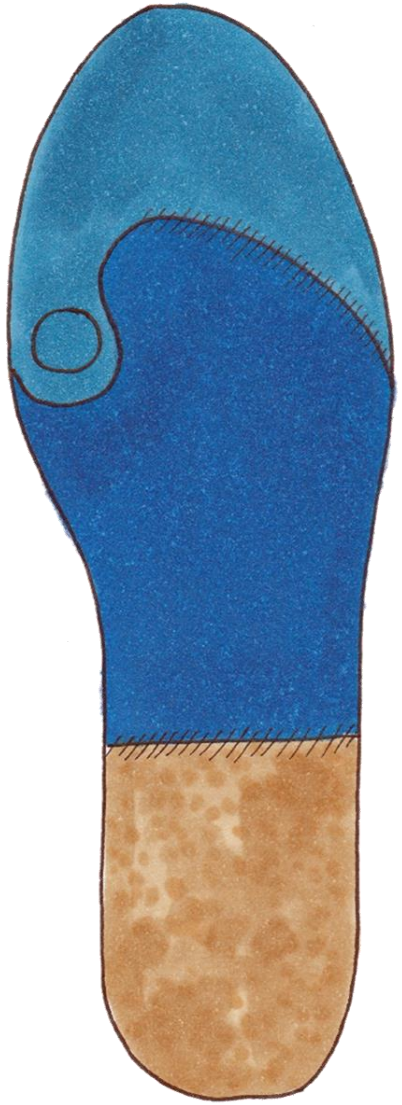
Sesamoiditis

- Pedorthic Treatment
  - Custom Vs. prefab FO designed to offload 1st MTH
  - Rigid footplate or extended shank in shoe to prevent painful dorsiflexion
  - Rocker soled shoes to further offload painful sesamoid(s)
  - Activity appropriate in-depth footwear



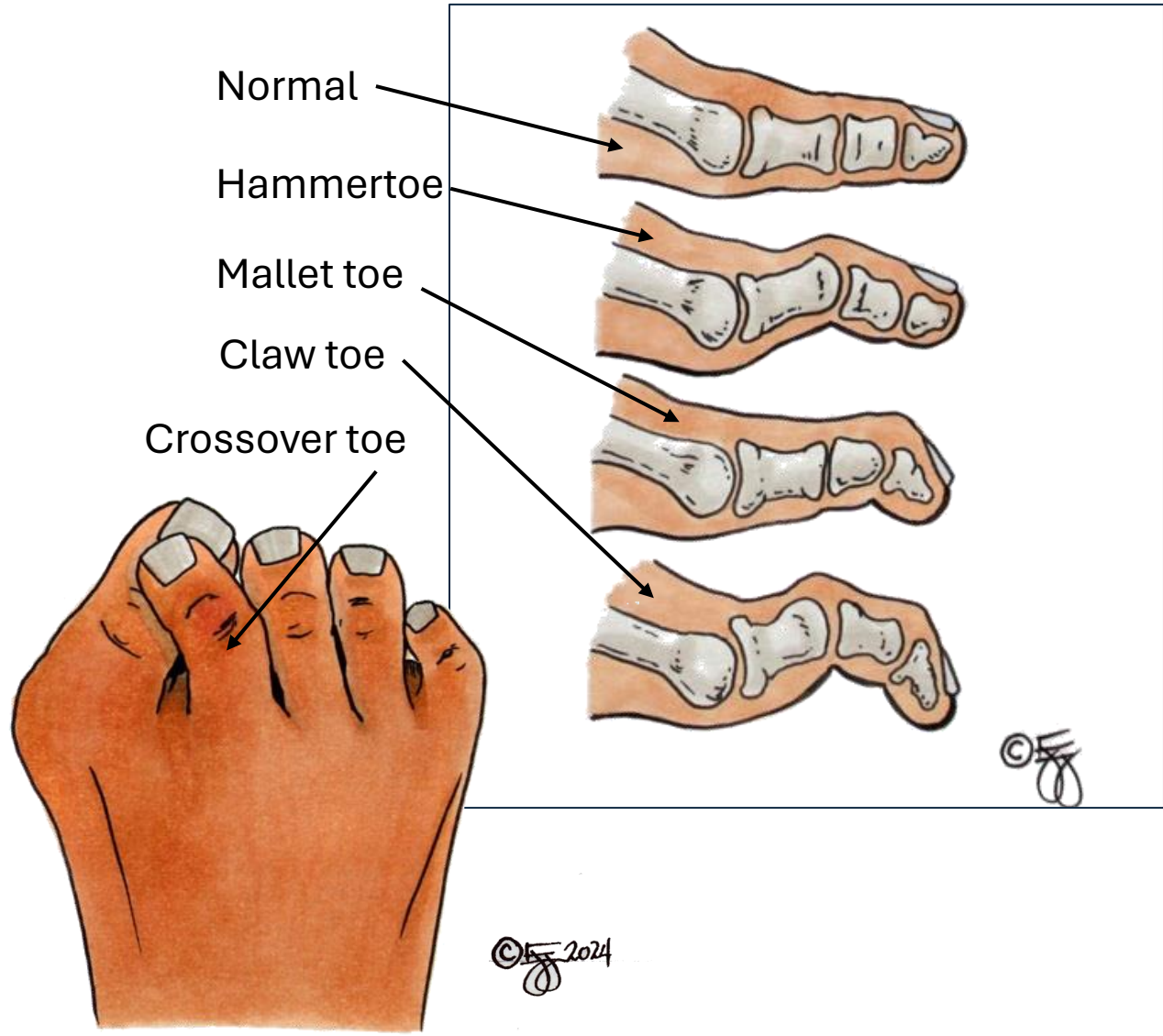


Felt dancer's pads



Hammertoes and Crossover Toes

- Due to the underlying muscle imbalances that contribute to the formation of these deformities, hammertoes, claw toes and crossover toes can all cause the associated metatarsal heads to become more prominent, and therefore painful.
- The distal tip of the hammertoe may develop pain, as well, from “digging” into the insole with every step.

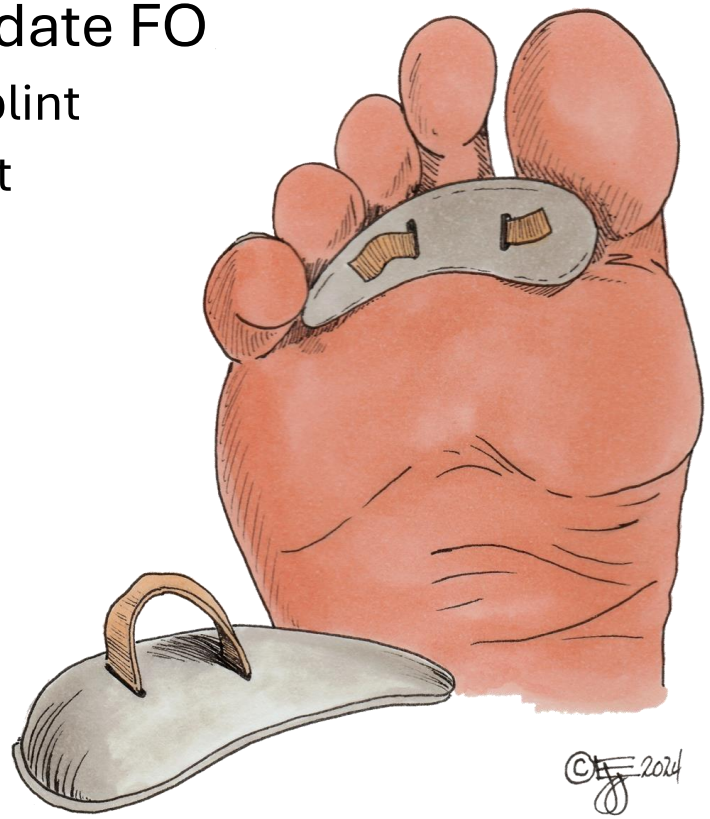


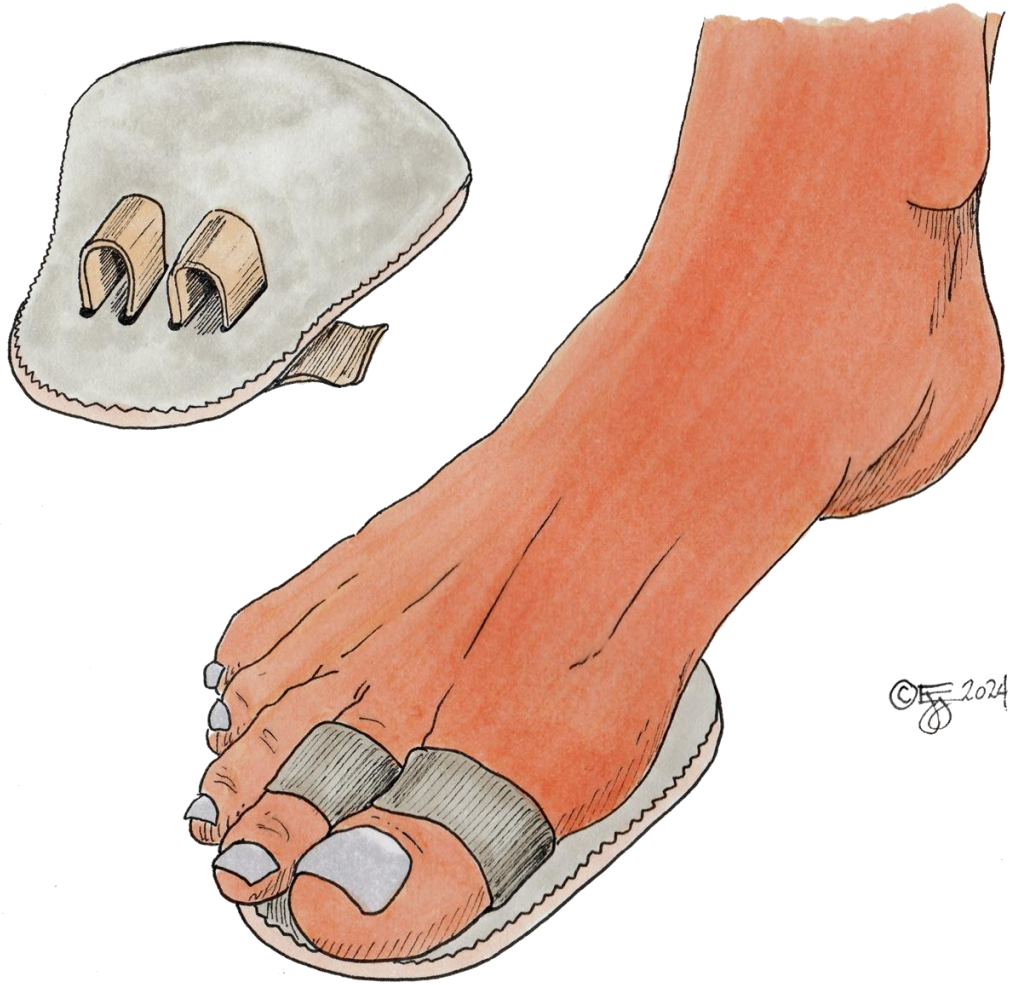
Hammertoes and Crossover Toes

- Pedorthic Treatment
  - Footwear
    - Well-fitted, in-depth shoes to accommodate deformity
    - Consider Lycra® upper
  - Foot Orthoses
    - Total contact to more evenly distribute plantar pressures
    - Cutout under affected MTH(s)
    - Met pad; global MTH relief; unload affected MTH(s) and load unaffected ones
  - Shoe Modifications
    - Rigid rocker sole to unload ball of foot
    - Internal cushioned excavation to insole of shoe

Hammertoes and Crossover Toes

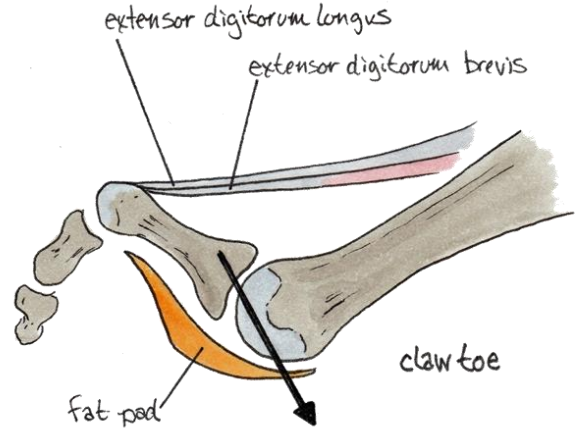
- Pedorthic Treatment
  - Options when shoe won't accommodate FO
    - Budin splint
    - Toe crest

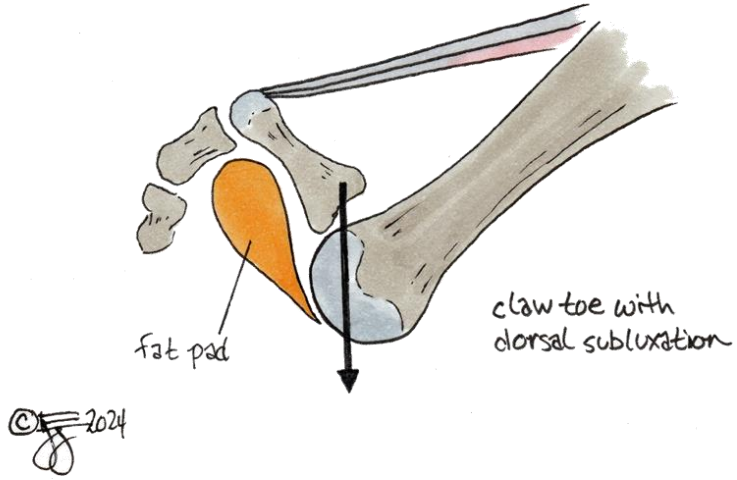




Claw Toes with Distal Fat Pad Migration

- Dorsal subluxation (dislocation)
  - Claw toe develops and worsens over time
  - Fat pad migrates distally unveiling MTH
  - Toe extensors overpower weakened and/or displaced flexors forcing MTH into ground
  - Painful, prominent and “uncushioned” MTH(s)



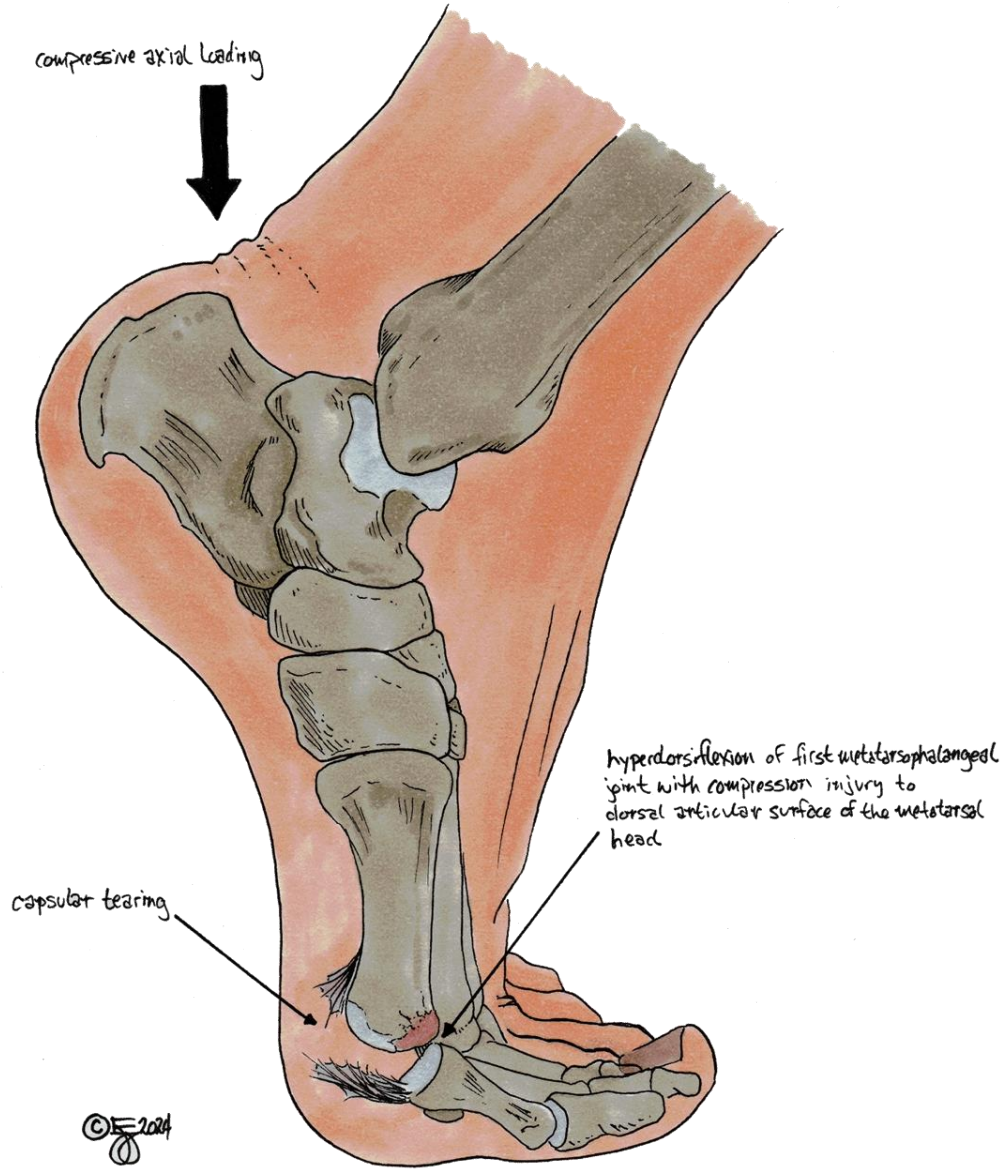


Claw Toes with Distal Fat Pad Migration

- Pedorthic Treatment
  - Deformity is typically not passively correctable
  - Goal of treatment is accommodation and pain relief
  - Footwear
    - Well-fitted, in-depth shoes (double-depth to accommodate claw toe?)
    - Consider Lycra® upper
  - Foot Orthoses
    - Total contact to more evenly distribute plantar pressures
    - Cutout under affected MTH
    - Viscoelastic polymer or polyurethane foam under MTHs to replace displaced fat pad
    - Met pad; global MTH relief; unload affected MTH(s) and load unaffected ones
  - Shoe Modifications
    - Bubble patch over claw toe
    - Rigid rocker sole to unload ball of foot

Turf Toe

- The term “turf toe” was initially coined by Bowers in 1976 to describe a sprain of the plantar capsule–ligament of the first MTP joint.
- It occurs secondary to a forceful hyperextension of the first MTP joint. Injury to the plantar plate of the great toe leads to pain with push-off and reduced agility.
- It can be a devastating injury in the elite athlete but also a nuisance in the general population.

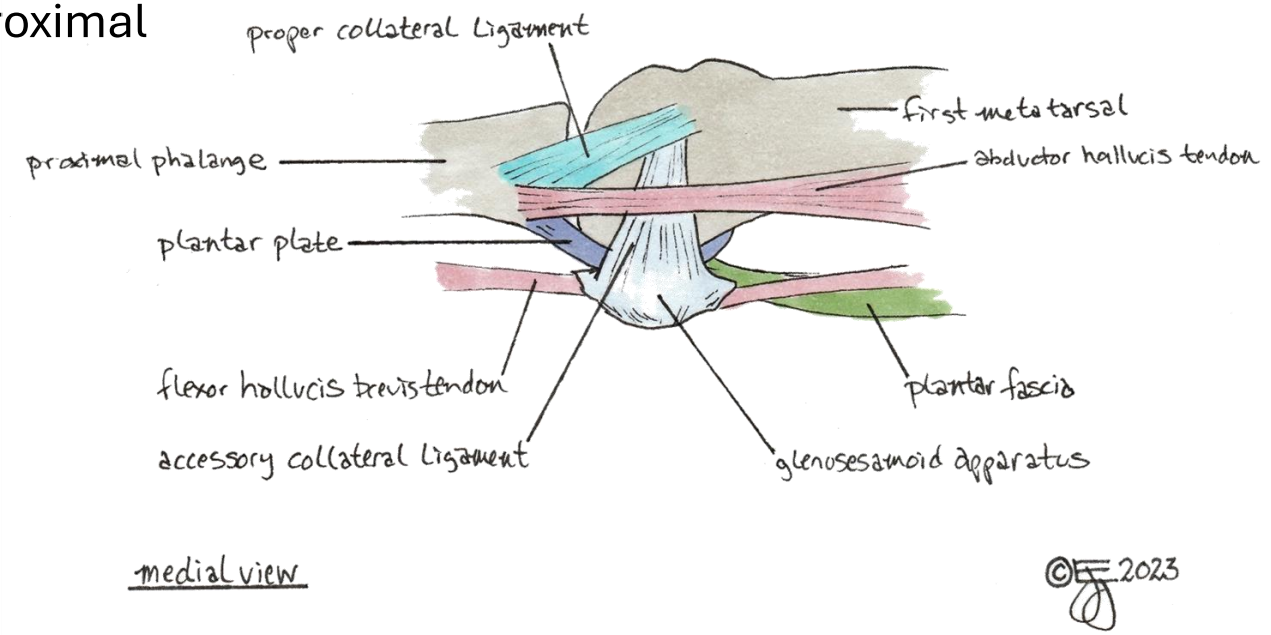


Turf Toe

- The 1st MTP functions as a hinge and a sliding joint. The shallow articulation between the convex metatarsal head and the concave base of the proximal phalanx articular surface results in little bony stability.
- As a result, the 1st MTP relies heavily on the complex attachments of the capsule, ligaments, and musculotendinous structures surrounding the joint.
- The plantar plate is the strongest stabilizer of the first MTP joint and is composed of a thickening of the joint capsule. It attaches to the transverse head of the adductor hallucis, the flexor tendon sheath, and the deep, transverse intermetatarsal ligament.

Turf Toe

- The classification system is composed of the degree of injury to the plantar plate:
  - Grade I – Stretch injury or minor tearing of capsuloligamentous complex of 1st MTP (plantar plate)
  - Grade II – Partial tear of plantar plate without involvement of the articular joint surface
  - Grade III – Complete tear of the plantar plate; tearing it from its attachment on the metatarsal head/neck with dorsal impaction of the proximal phalanx into the metatarsal head
- Complications
  - Sesamoid Fx
  - Separation of bipartite sesamoid
  - Proximal migrations of sesamoids
  - Instability w/pain or synovitis
  - Hallux rigidus
  - Loose body in joint

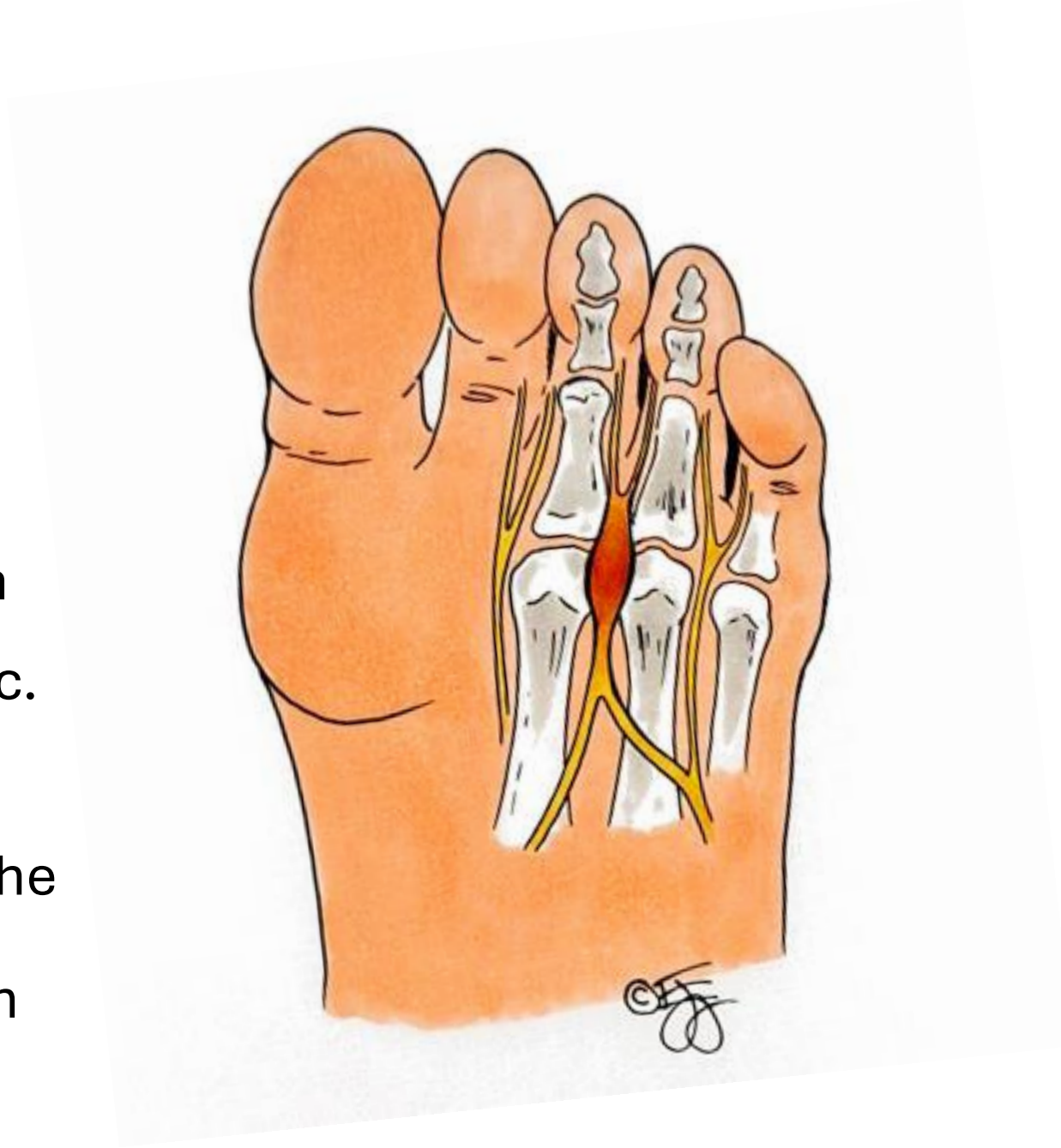


Turf Toe

- Pedorthic Treatment
  - Footwear
    - Shoe with enough depth to accommodate foot orthosis
    - Consider spike placement when selecting cleats
  - Foot orthosis
    - Offload for 1st MTH
    - Rigid footplate to restrict 1st MTP dorsiflexion
      - Spring steel Vs. carbon composite (consider length:rigidity ratio)
      - Flat Vs. Contoured
      - Full Vs. Forefoot Vs. Morton's Extension
      - (Yes…No…Just okay…)
  - Shoe Modifications
    - Spike positioning
    - Rigid rocker sole in "street" shoes to relieve plantar pressure and restrict dorsiflexion

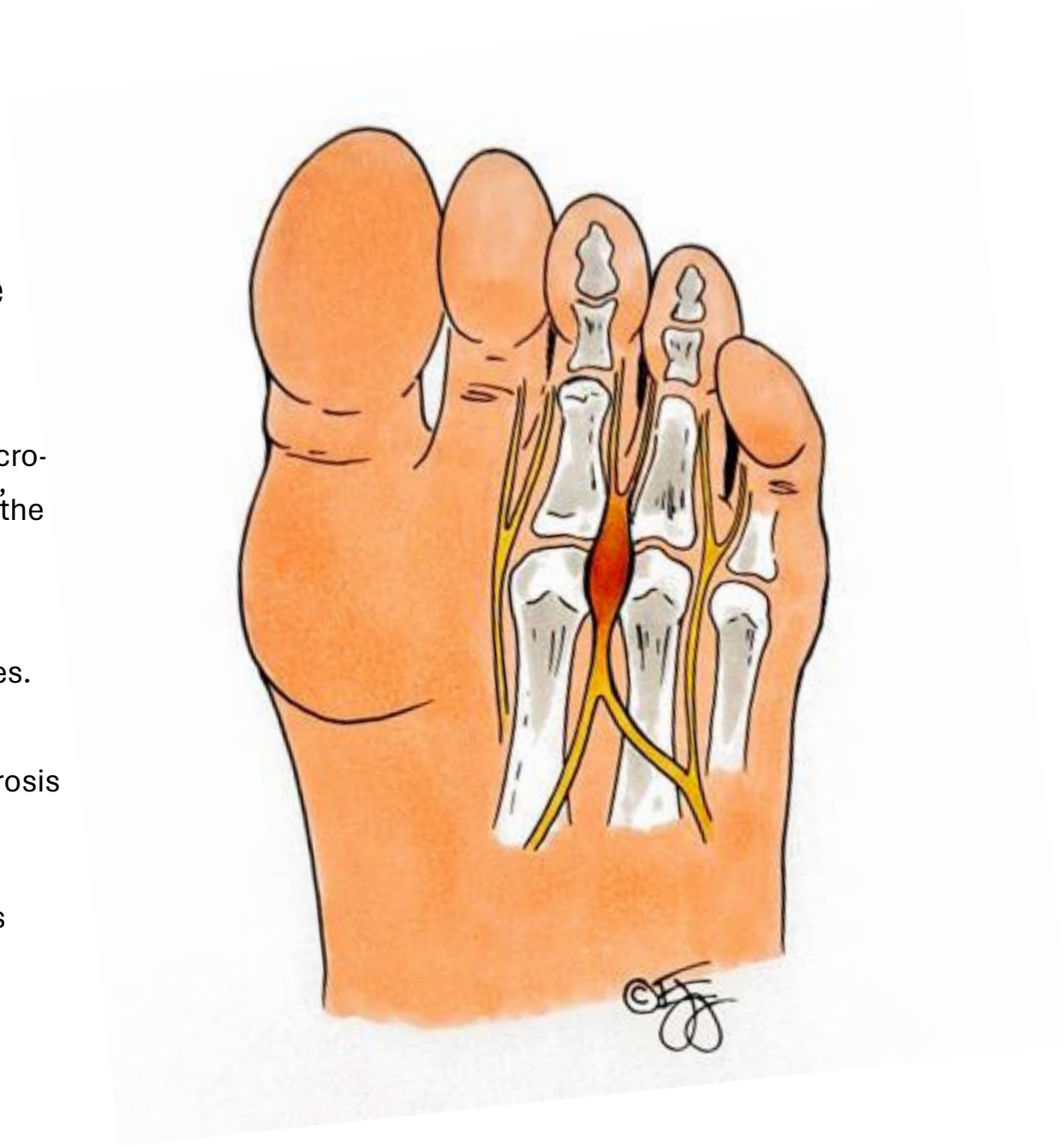
Interdigital Neuroma

- Compressive neuropathy of the forefoot interdigital nerve. Neuropathy is mainly due to compression and irritation at the plantar aspect of the transverse intermetatarsal ligament. It is not a true neuroma as the condition is degenerative rather than neoplastic.
- A.K.A. Morton's neuroma
- Occurs most commonly in the 3rd webspace. (As it is narrower than the other three to begin with.)
- Can be very painful, especially with side-to-side compression.



Interdigital Neuroma

- Exact cause is not fully understood, but there are four hypotheses as to why the condition happens.
  - Chronic trauma theory (most widely accepted)
    - The mechanical effects of walking cause chronic micro-traumas to the intermetatarsal plantar digital nerves, which become compressed between two MTHs and the MTPJs.
  - Entrapment theory (earliest proposed theory)
    - Occurs due to compression of the interdigital nerve against the anterior end of the deep transverse metatarsal ligament and plantar soft tissue structures.
  - Intermetatarsal bursa theory
    - Bursitis in the intermetatarsal region causes compression and inflammation with subsequent fibrosis of the affected common plantar digital nerve
  - Ischemic theory
    - Based on histopathological findings of the common plantar digital artery exhibiting degenerative changes prior to the fibrous thickening of the nerve.



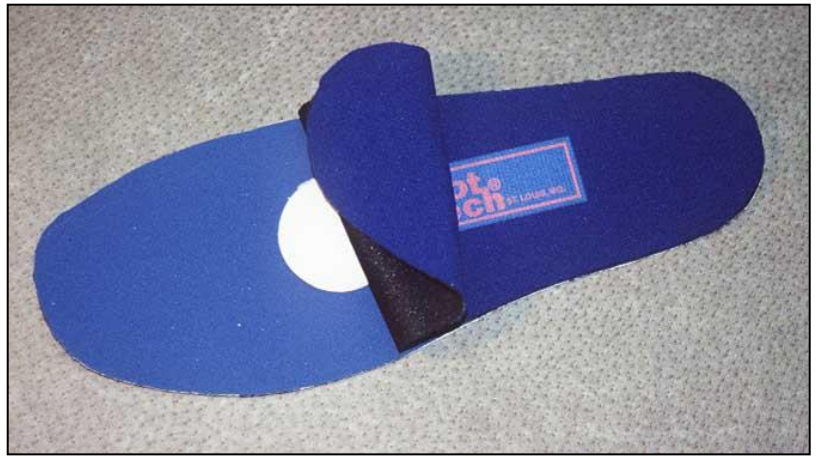
Interdigital Neuroma

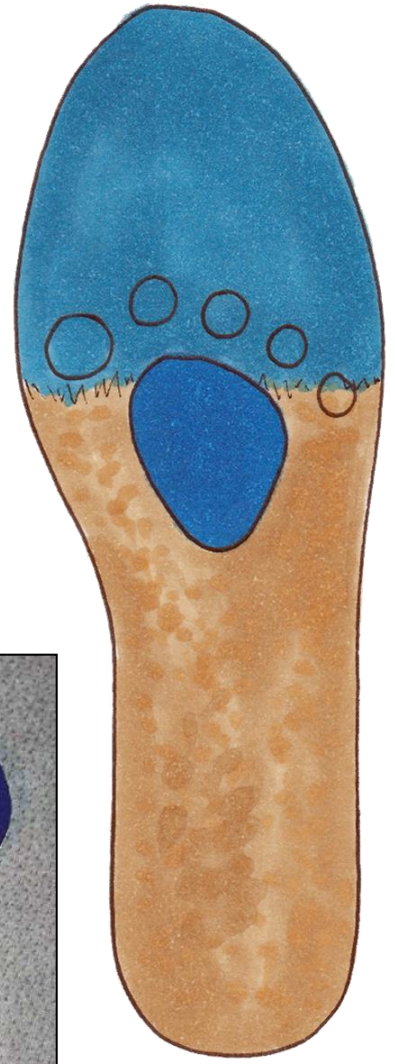
- Commonly associated with:
  - Narrow, pointed toe-box footwear
  - Hyperextension of the toes in high-heeled shoes
  - Deviation of the toes
  - Inflammation of the intermetatarsal bursa
  - Thickening of the transverse metatarsal ligament
  - Forefoot trauma
  - High-impact sporting activities
  - Other MTPJ pathology
- Very rarely bilateral, although not uncommon to have two in the same foot.
- Incidence in women 5x that in men.

Interdigital Neuroma

- Pedorthic Treatment
  - Footwear
    - Wide toe box, low or no heel, extra depth to accommodate FO.
    - Shock absorbing material with built-in rocker sole. Walking or running shoes are often effective.
  - Foot Orthoses
    - Custom Vs. Prefab with small focalized pad placed just proximal to and direct centered between the two involved metatarsal heads
    - Prefab can be a good “trial” orthosis.
    - Improper MT pad placement can exacerbate the problem.
  - Shoe Modifications
    - Rocker soles to unweight forefoot

- Note – any treatment (conservative or surgical) for nerve-related conditions is unpredictable. Do not overpromise. Set realistic expectations with your patient.



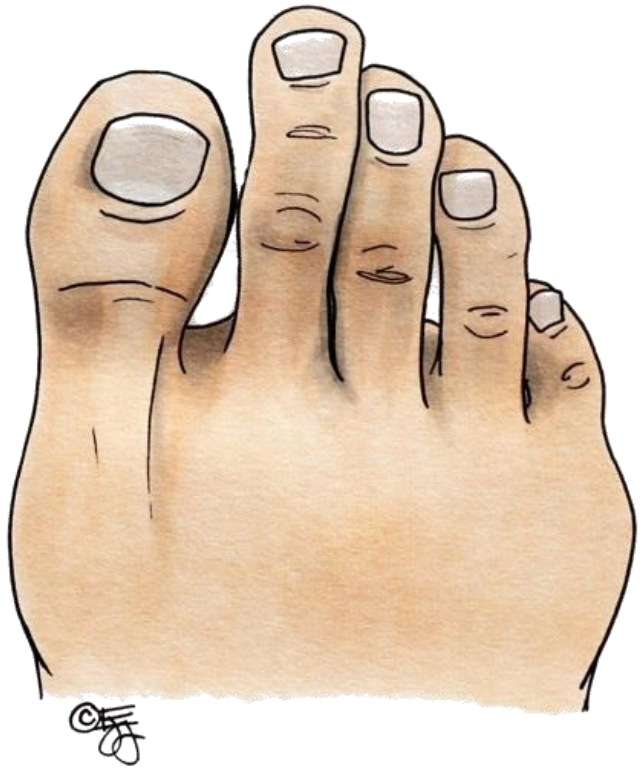


2-3 MTH Overload

- Secondary to hallux valgus
  - Once 1st MTH drifts medially, it is no longer able to bear the same amount of weight it did before.
  - The progression of plantar pressure entering and through toe-off changes, as well.
  - The weight/pressure is shifted to the 2nd and 3rd MTHs.
- s/p bunion correction
  - Most bunion correction procedures involve the shortening of the 1st metatarsal…resulting in the same problems outlined above.

2-3 MTH Overload

- Secondary to Morton's toe
  - Congenitally short 1st metatarsal creates overload of 2nd MTH as the smaller 2nd MTH is forced into the biomechanical role of the much larger and better-suited 1st MTH.
  - "Morton's extension" was originally a soft post under orthotic designed to transfer weight over to the first ray and off of the 2nd MTH. It was not the rigid "Morton's extension" we think of today.

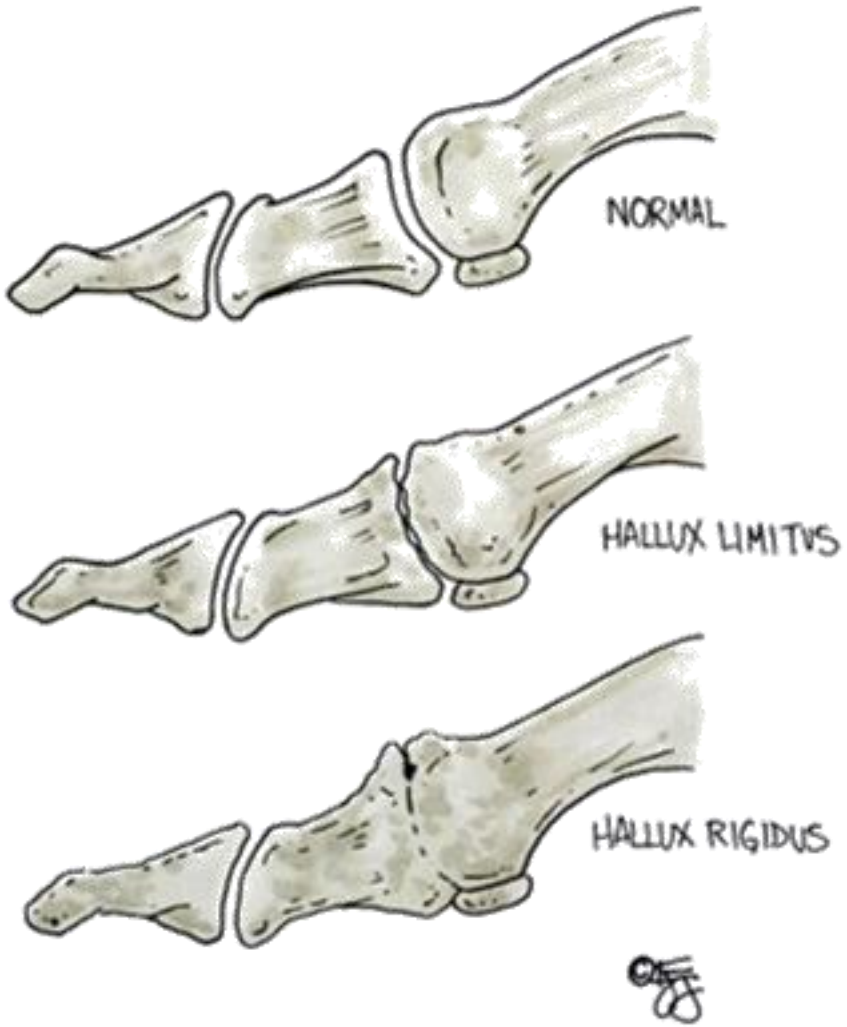


2-3 MTH Overload

- Pedorthic Treatment
  - Footwear
    - Well-fitted, in-depth shoe with aggressive rocker sole and room to accommodate both forefoot deformities and custom foot orthoses
  - Foot Orthoses
    - Custom foot orthoses to provide cushion and offloading for affected MTH(s)
  - Shoe Modifications
    - Rigid rocker soles
    - Possible internal excavation for prominent MTH(s)

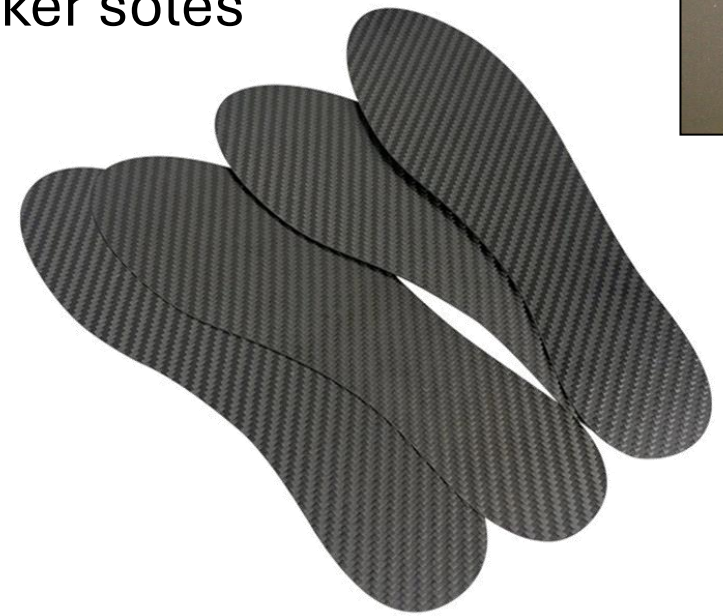
Hallux Limitus

- Why not hallux *rigidus*?
  - Remember, arthritic joints hurt when they *move*.
  - There is no motion at the MTPJ with hallux rigidus. The joint has essentially "auto-fused". No motion…no pain.
  - There may be toe-tip pain or midfoot pain.
- The terms *hallux limitus* and *hallux rigidus* describe different stages on the progression of first MTPJ osteoarthritis.
- May be old age, wear-and-tear or post-traumatic joint degeneration.
- Pain with weightbearing, ambulation – especially toe-off, and crouching or kneeling movements that require dorsiflexion at the ball of the foot.



Hallux Limitus

- Pedorthic Treatment
  - Restrict painful motion and replace lost motion to restore pain-free, efficient, functional ambulation.
  - Extended steel shank, carbon footplate + rocker soles



Freiberg's Infarction

- Osteochondrosis that affects the lesser metatarsal heads, especially the second.
- Most commonly seen in females (3:1 over males) aged 13-15.
- Localized pain over dorsal and plantar MTPJ with swelling of joint area.
- Osteophyte-like prominences over the MTH can often be palpated.
- Joint ROM is often limited.

- What is osteochondrosis?
  - A self-limiting developmental derangement of normal bone growth, primarily involving the centers of ossification in the epiphysis. Typically begins in childhood as a degenerative or necrotic condition. Technically speaking, osteochondrosis is an aseptic ischemic necrosis.

An infarction is an obstruction of the blood supply to an organ or region of tissue causing local death of the tissue.

Frieberg's Infarction

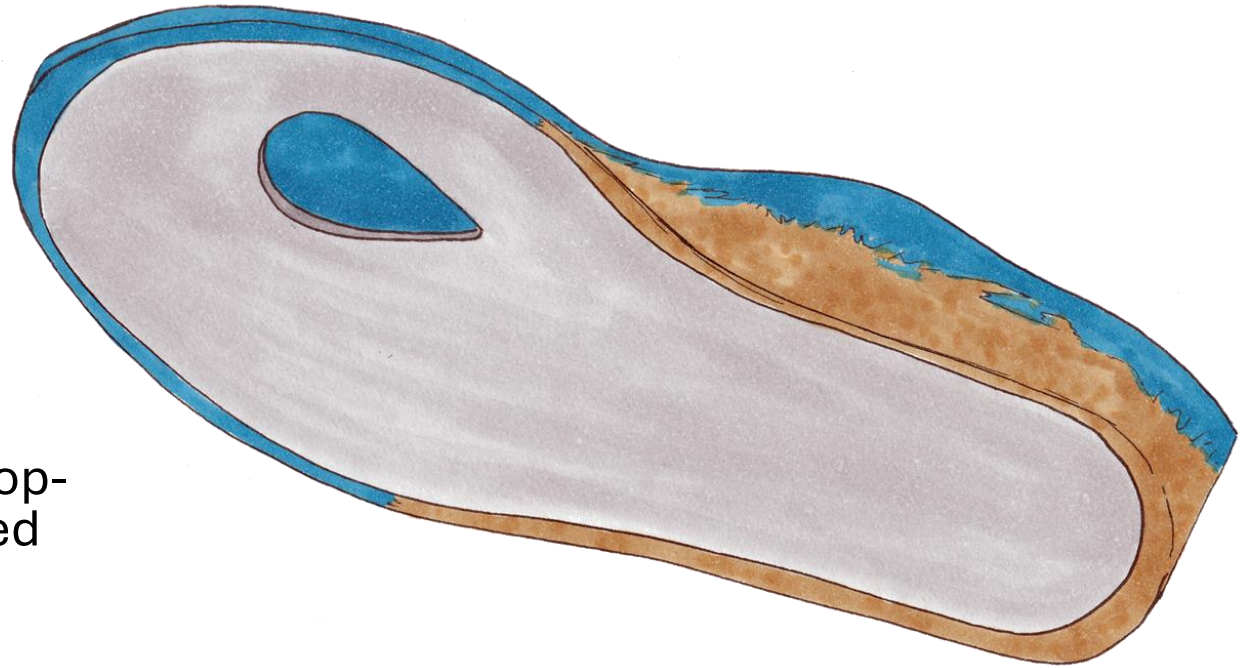
- Pedorthic treatment:
  - Properly selected and fitted shoe to ensure ample forefoot space to prevent side-to-side compression and adequate width to alleviate dorsal pressure on the joint.
  - Foot orthoses designed to offload the affected metatarsal head. Metatarsal pad, horseshoe pad, metatarsal bar, depression, excavation, etc. Combination of cushioning and offloading may be used, but offloading takes precedence.
  - Rocker soles (with distal apex just proximal to MTHs) may also be used to provide additional offloading to the forefoot.

Flexor Tenosynovitis

- Inflammation within the tendon sheath. Theoretically, can happen to any tendon, but it most commonly seen in the hand, wrist and foot.
- Tenosynovitis is the inflammation of the fluid-filled synovium within the tendon sheath. It produces pain, swelling, and contractures, depending on the etiology.
- Remember, the tendon sheath has two main functions:
    1. The synovial fluid nourishes the tendon and provides a low-friction environment, allowing the smooth gliding of the tendon and reducing wear and tear of the tendons from excessive friction.
    2. The fibrous sheath provides anchor points for the tendon to prevent 'bowstringing.' For example, in the hand, they help anchor the tendons to the bony plane of the phalanges and interphalangeal joints to prevent the tendons from bowing when the digits are flexed.
- When flexor tenosynovitis occurs in the forefoot and toes, it can make walking, running and other activities difficult and painful.

Flexor Tenosynovitis

- Pedorthic Treatment
  - Footwear
    - Well-fitted depth shoe to accommodate foot orthosis, inflexible sole, rocker sole
  - Foot Orthosis
    - Custom foot orthosis with rigid plastic footplate, reverse teardrop-shaped cutout under the affected MTH
  - Shoe Modification
    - Rigid rocker sole to offload ball of foot and prevent dorsiflexion at MTP joints



Conclusion

- Regardless of etiology, most cases of metatarsalgia are treated similarly.
- Some will resolve, others will need lifelong management.
- Most cases will respond best if all three modalities – shoes, inserts and shoe mods – are used and optimized.
- Remember, providing additional cushioning and providing offloading are not the same and, in many cases, may be at odds with each other.

The End