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Calf, Ankle, Foot

Chapter 8: Superficial Posterior/*Taiyang* and Deep Postero-medial Three Leg *Yin JingJin*
Diagnosis and Treatment

1. Posterior Calf Strains, Contusions, Ruptures, and Tendinopathies.
2. Posterior Heel Pain.
    a. Bursitis, retro-calcaneal and pre-Achilles
    b. Insertional Achilles tendinopathy
    c. Haglund Syndrome
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3. Tibialis posterior dysfunction
4. "Shin splints"
5. Medial Tibial Stress ("Shin Splints") Syndrome.
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Posterior Calf Strains, Contusions, Ruptures, and Tendinopathies.

Risk Factors, Etiology, Patho-Anatomy and Progression.

- Posterior calf muscles are subject to forces significant enough to cause strains, partial tears or complete ruptures, and are at particular risk when they are shortened or tight from prior injuries or excessive tension anywhere along the posterior leg chain from the plantar foot to the hamstrings, or from use of high-heeled footwear. Acute injuries most commonly result from:
    - Sudden jumping or sprinting, particularly when the muscle is cold or after disuse, such as upon sudden sprinting during stop-and-go and jumping sports such as baseball, basketball, football, and racquet sports. Complete ruptures occur most commonly in middle-aged "weekend warrior" men.
    - An athletic training error resulting in repetitive or sudden overuse can strain and sometimes partially tear the gastroc-soleus complex and/or Achilles tendon.
- Tendinosus and myofascial pain and dysfunction may develop from incomplete healing of acute strains and tears, and may also develop insidiously in association with alterations

and dysfunctions of gait biomechanics from causes including:
    - Knee, ankle and foot sprains and fractures
    - Arthrosis of the foot, ankle, knee, hip, SI joint
    - Congenital and acquired deformities (bunions, hammertoes)
    - Footwear choices
- Contusions, severe strains and tears occurring in the tight compartments of the posterior calf may lead to significant and lasting pain and disability because fascial sleeves cannot expand sufficient to accommodate the increased volume of blood and fluid.
- Musculo-tendinous injuries can progress to fibrosis, trigger points, contractures, accumulation of inflammatory fluid, and degenerative loss of strength and flexibility and nodular tendinopathies.
- The more chronic/recurrent the condition, the more likely that painful lesions and dysfunction spread along the entire chain, from the plantar forefoot to the proximal calf and on to the hamstrings and lumbo-sacral spine.

Symptoms.

- Locations:
    - Upper posterior calf, popliteal fossa:
        - Gastroc proximal tendon attachments to medial posterior aspects of femoral condyles are less commonly injured than the muscle bellies.
        - Gastroc heads. Medial head is much more commonly injured than lateral.
        - Soleus and tibialis posterior muscles lie underneath gastroc and are difficult to differentiate by location alone.
    - Lower posterior calf and heel:
        - Achilles tendon is most commonly strained or ruptured at 5-7 cm proximal to the calcaneal insertion.
        - A calcaneal bursa lies between the distal attachment of the Achilles tendon and the posterior tibia and is prone to inflammation in conjunction with elevated tension of the superficial posterior calf compartment.
        - Tibialis posterior, FHL and FDL tendons pass under medial malleolus (see Posterior Tibialis Dysfunction below)
        - (Peroneal tendons at lateral aspect are addressed in Chapter 10: Calf and Foot Lateral *Shaoyang* Chains Diagnosis and Treatment).
- Provocative and palliative factors, timing:
    - Acute injuries may be felt when non-weight bearing, but are significantly, promptly and progressively worse upon any weight-bearing activity.
    - Chronic injuries are usually felt only upon weight-bearing.

- Tendinopathies may initially cause pain, which then improves with activity until a particular incident of over-use threshold is reached;
- The posterior calf musculature is particularly sensitive to stair and hill-climbing, running and jumping.

Physical Exam. Tests and characteristic findings:

- Inspection/palpation:
  - Ecchymosis and swelling indicate significant (grade 2+) tear or contusion.
  - Atrophy and loss of tone at medial gastroc head suggest an old tear and loss of function.
  - Thickening, swelling, stiffness and development nodules of the Achilles tendon may be observed or palpated and may extend proximally from the calcaneal insertion as taut, granulated and fibrous bands in the gastroc and soleus muscles.
  - Highly-localized swelling and erythema at the distal Achilles tendon attachment suggests:
    - Partial or complete rupture or avulsion fracture
    - Calcaneal bursitis (see Posterior Heel Pain below)
  - Deep palpation may identify trigger points that are particularly noteworthy if they reproduce typical symptoms or refer pain deeper into or up or down the calf.
  - Reproduction of distal dysesthesias upon deep pressure between the medial and lateral gastroc heads suggests entrapment of the posterior tibial nerve in the soleal tunnel (see below).
- ROM: dorsiflexion and plantarflexion.
  - Dorsiflexion elongates the posterior compartment, and may thus be limited, as well as painful at the site of the injury, both actively and passively.
    - Painless normal dorsiflexion range with the knee flexed that becomes pain-limited with the knee extended localizes the lesion to the gastrocnemius (or plantaris), which are the only plantarflexors to cross the knee joint, and excludes the soleus.
  - Plantarflexion typically shows normal range.
    - Acute tears and tendinitis are likely to be painful at the site of the injury upon plantarflexion only when performed actively; passive plantarflexion is typically non-provocative.
    - Pain that occurs only deep to the distal Achilles tendon insertion and only on plantarflexion but not dorsiflexion suggests inflamed calcaneal bursa is compressed by plantarflexion between the calcaneus and posterior tibia.
- Strength testing:

    - Gastroc and soleus are among the strongest muscles in the body and manual testing is usually only sensitive enough to identify grade 2+ tears. Having the patient try to rise onto the ball of the foot on the affected side is a more sensitive test of strength than manual methods.
    - Isolation of the following plantar-flexors may allow for identification of pain-inhibited myofascial weakness by manual break-testing:
        - Painful weakness of plantarflexion with the knee extended which disappears with the knee flexed implicates the gastroc or plantaris, which are the only plantarflexors to cross the knee joint.
        - Tibialis posterior: foot in plantar flexion and inversion, practitioner dorsiflexes and everts the ankle (see below)
        - Flexor hallucis longus: practitioner extends the great toe.
- Special orthopedic tests:
    - Thompson Test. Purpose: to identify acute Achilles tendon rupture.
        - Procedure: Patient prone with knee and ankle flexed to 90°. Practitioner squeezes the posterior calf musculature against the posterior aspect of the tibia and fibula while watching for plantarflexion of the ankle..
        - Abnormal findings: failure of ankle to plantarflex suggests Achilles tendon rupture. Finding is most reliable within first 48 hours.
    - Passive stress testing of the ankle (inversion, eversion, and anterior drawer) is indicated to identify any hyper- or hypo-mobility which may contribute to posterior chain pain and dysfunction.

Treatment.

Local Electro-Acupuncture. *Strong, deep trigger needling technique with thicker needles (30-gauge +) is inappropriate in the posterior calf because of the risk of a hematoma leading to increased intra-compartmental pressure and potential compartment syndrome.*

Locations may be chosen on the basis of symptoms, inspection, palpation and other physical exam findings.

Gastroc/soleus and tibialis posterior:

- UB 55-58
- Kidney 9 *(xi*-cleft of *yin wei mai)*
- Spleen 6-9 provide access to the deeper aspects of the anterior aspect of the gastroc heads, soleus and tibialis posterior.
- "Crack needling": insertion through or along fascial planes and muscle belly interfaces

- Medial-lateral gastroc heads
- Gastroc-soleus planes

Achilles tendon: the lesions are at primarily at the anterior, often medial and sometimes lateral (but never posterior except in full-thickness tears) aspects of the tendon. Inquiry and palpation should be used to identify the scope of the injured area, all which should be penetrated with needles. Placing the foot in supported in full dorsiflexion is often useful to expose lesions and nodules. Candidate entry locations include:

- UB 59, 60
- K 3, 7, 8, 9
- M-LE-10 *quanshengzu* (just above the middle of the posterior calcaneus, in the tendon).

As the injury typically involves a bundle of longitudinally-oriented fibers that have been strained or partially-torn, inserting needles distally to the lesion and threading proximally at a shallow angle usually allows the most complete penetration of the injured site.

Manual therapies. May be applied anywhere along the posterior compartment as indicated by symptom location and physical exam findings.

1. Stage I. First 72 hours-two weeks.
    a. Contraindications: deep tissue massage, long-fiber massage, joint mobilizations.
    b. Lymphatic drainage: should be used with patient's knee partially flexed to keep the gastroc on slack. Elevation of the leg above the hip will assist with drainage.
2. Stage II-III. > week 2 + or after ecchymosis is no longer visible.
    a. Place the patient's ankle supported in full dorsiflexion to expose the tendons and muscles.
    b. The gastroc heads, soleus and the Achilles tendon junction may be freed from fascial adhesions by:
        i. Grasping the gastroc heads and Achilles tendon individually and wringing them side-to-side.
        ii. Using a *gua sha* tool along the muscle interfaces to separate them.
    c. Add progressively stronger cross-fiber and *gua sha* massage to address associated musculo-tendinous TrPs, adhesions, and imbalances and restore muscle tone and mobility. Locations to check:
        i. Proximal gastroc attachments to medial-posterior femoral condyles: gentler technique is effective and indicated.
        ii. Gastroc heads, medial > lateral
        iii. Gastroc-soleus fascial planes, accessed from their medial and lateral edges.

iv. Achilles tendon at its musculo-tendinous junction and at its calcaneal insertion.

d. Long-fiber massage and *gua sha* should be avoided for the first 2 months post-injury where a partial tear is known or suspected, but is useful to apply to chronic myofascial conditions following cross-fiber massage.
   i. Longitudinal massage should only be applied in a distal-to-proximal direction. Proximal to distal risks pooling of blood and edema in the distal limb, and with repetition may lead to varicose veins.
e. Muscle energy techniques and concurrent AROM during deep tissue massage may be helpful to lengthen contracted posterior calf muscles.
f. Distal Achilles tendinosus requires:
   i. Mobilizing and separating the tendon from the posterior tibia by grasping the tendon at its most fibrotic portion and wringing side-to-side, up-and-down, and front-to-back.
   ii. Friction massage to the anterior, medial and lateral aspects by:
      1. Placing the ankle in full supported dorsiflexion.
      2. Pushing and holding the tendon sideways with one hand, while massaging the exposed opposite and anterior aspect with the other hand or *gua sha* tool.
g. *Note for all of the above techniques: the force required to break up adhesions and loosen the tight fascial compartments of the posterior calf is considerable (except at the proximal gastroc attachments in the popliteal fossa, where deep pressure is contraindicated). Analgesic linaments may be considered to support patient tolerance.*

Posterior Heel Pain.

9. Bursitis, retro-calcaneal and pre-Achilles
10. Insertional Achilles tendinopathy
11. Haglund Syndrome
12. Calcaneal stress fracture

Risk Factors, Etiology and Patho-anatomy, Progression.

In addition to the general risk factors for posterior calf injuries described above, the posterior heel can become insidiously inflamed and painful secondary to specific local factors including:

- Recurrent pressure and abrasion from tight, rigid heel cups of footwear (“pump bump”).

- A prominent posterior process (exostosis or "bone spur") of the calcaneus can develop in response to sustained irritation and overloading, which then begins to impinge on the Achilles tendon.
- Various soft-tissue aspects of the posterior heel--the Achilles tendon insertion, the pre-Achilles (posterior) and retro-calcaneal (anterior) bursae can become injured in isolation. "Haglund Syndrome" describes posterior heel pain when multiple tissue aspects are involved and radiography identifies calcaneal exostosis.
- Stress fractures can occur from sudden increases in intensity and duration of weight-bearing activity, usually involving running or jumping and landing on hard surfaces.
- Tendinopathic medications: fluoroquinolone antibiotics, amlodipine

Diagnosis.

History and Symptoms.

- Location, radiation/referral: pain, swelling and tenderness are highly-localized to the posterior heel and the insertion of the Achilles tendon.
- Onset and progression:
    - Atraumatic.
    - Sudden onset suggests stress fracture or bursitis/tendinitis.
    - Bursitis and tendinitis can also develop insidiously.
    - Insidious onset is characteristic of Haglund syndrome.
- Palliative/provocative factors:
    - Provocation on passive plantarflexion and lack of provocation on dorsiflexion suggests isolated bursitis without tendinitis.
    - Wearing shoes with a tight, rigid heel cup is consistently provocative.
    - Pain that persists when non-weight bearing suggests stress fracture or severe inflammation.
    - Palliative and provocative factors are otherwise the same as other posterior calf injuries.
- Qualities, severity: burning, tight, pinching pain, tenderness and swelling, rarely so severe as to cause resting pain or prevent walking.

Physical Exam Findings.

- Inspection/palpation:
    - Visible/palpable superficial swelling, erythema and tenderness suggest pre-Achilles bursitis or insertional tendinitis.

    - A bony prominence projecting posteriorly from the calcaneus suggests Haglund syndrome.
    - Tenderness upon squeezing anterior to the distal Achilles tendon insertion suggests retro-calcaneal bursitis, which only become visibly red and swollen if severe.
    - Sharp, highly-localized tenderness at the bony surface of the calcaneus suggests calcaneal stress fracture.
- AROM:
    - Active dorsiflexion/plantarflexion range is typically unaffected.
    - Increased pain upon active plantarflexion suggests insertional tendinitis, retro-calcaneal bursitis, and Haglund Syndrome.
    - Increased pain upon active dorsiflexion suggests insertional tendinitis, and Haglund Syndrome, but excludes isolated bursitis.
    - Stress fractures do not limit and are not aggravated by AROM.
- PROM:
    - Passive dorsiflexion/plantarflexion range is typically unaffected.
    - Lack of provocation on passive plantarflexion suggests pre-Achilles bursitis or insertional tendinitis.
    - Provocation upon passive dorsiflexion suggests insertional tendinitis and excludes isolated bursitis.
    - Provocation on passive plantarflexion and lack of provocation on dorsiflexion suggests isolated retro-calcaneal bursitis.
    - Provocation on both plantar- and dorsi-flexion suggests Haglund Syndrome.
    - Stress fractures do not limit and are not aggravated by PROM.
- Manual strength testing: pain-inhibited plantarflexion suggests insertional tendinitis. Strength is unaffected with other causes of posterior heel pain.
- Special orthopedic tests: Negative Thompson test (positive suggests tendon rupture).

Differential Diagnosis.

- A positive Thompson test signifies complete rupture of the Achilles tendon.
- Haglund Syndrome and stress fractures are confirmed by PFXR.

Management and Treatment.

- Suspicion of stress fracture warrants prompt referral to ambulatory urgent care, orthopedics or podiatry.

- Evaluation and treatment of other posterior chain lesions and ankle/foot abnormalities is likely to yield better outcomes than local treatment alone.

Local Acupuncture/Electro-Acupuncture.

- K 3, 4.
- UB 60, 61.
- 7-star needling + cupping.

Manual Therapies.

- Insertional tendinitis may be treated by manual therapy methods as described above for Achilles tendinopathies.
- Manual therapy is contraindicated for all other causes of posterior heel pain.

Exercise and Adjunctive Therapies and Lifestyle Counseling.

- Exclusive use of non-aggravating footwear may be necessary for satisfactory treatment outcomes.
- See Chapter 6A: Calf and Ankle Rehabilitation.

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.

- Bursitis may self-resolve without treatment.
- Prognosis for tendinitis and Haglund Syndrome is fair-to-poor without footwear modification and correction of biomechanical faults in gait and calf/ankle/foot function.
- Only stress fractures present significant risks of progression to disability if not identified and managed effectively.

Tibialis Posterior Dysfunction

Risk Factors, Etiology and Patho-anatomy, Progression.

Pathoanatomy and Progression.

The tibialis posterior is the deepest, most centrally-located muscle in the calf and is the primary muscle that actively maintains the medial foot arch. Its long tendon originates from the muscle belly at the distal medial calf, and, along with the FHL and FDL tendons, wraps under the medial ankle retinaculum inferior to the medial malleolus, and inserts distally into the plantar surfaces of the bases of the 2nd, 3rd and 4th metatarsals, 1st, 2nd and 3rd cuneiforms, the navicular and cuboid, and the medial-anterior calcaneus.

- Insidious degeneration is most common, but is usually more pronounced in one leg that has suffered prior injuries.
- Traumatic rupture is rare.
- Dysfunction of the tendon allows the arch to flatten, and leads to a fixed and inflexible *pes planus* deformity and arthritic degeneration of the hindfoot.

Risk Factors and Etiology.

- Excess body weight
- Congenital or acquired deformities including wide Q-angle, *genu valgum*, and tibial torsion that place the heel in valgus and forefoot in varus.
- Ankle, foot hypermobility from incompletely-healed sprains
- Diabetes
- Hypertension
- Local steroid injections

Diagnosis.

History and Symptoms.

- Location, radiation/referral: symptoms may be bilateral but are typically more severe on one side.
    - Initially, pain, swelling and tenderness is felt under the medial malleolus at the exposed portion of the tendon.
    - Pain and swelling may also occur at the distal tendon insertions to the plantar forefoot, but cannot be distinguished from plantar fasciitis by location alone.
    - TrPs may develop in the muscle belly in the deep posterior calf, and are difficult to access, or distinguish from TrPs in the soleus or flexor digitorum longus except by manual strength testing.
    - With progression, the distal fibula contacts the lateral calcaneus and causes lateral ankle pain.
- Onset and progression:
    - Typically insidious and degenerative.
    - Traumatic ruptures are rare.
        - May occur in conjunction with rupture of the Achilles tendon.
        - If isolated, ruptures may be dismissed as tendinitis because they are not (initially) as disabling as Achilles tendon ruptures.
- Palliative/provocative factors: Symptoms are typically felt only on weight-bearing or direct compression from tight footwear.

- Qualities, severity: Aching pain, swelling and tenderness are typically mild and rarely severe.

Physical Exam Findings.

- Inspection/palpation:
    - The hallmark of tibialis posterior dysfunction is visible loss of the medial arch, hindfoot valgus, sub-talar pronation, and forefoot varus with the patient standing.
    - Tender fibrous bands and sometimes mild local swelling and rarely erythema may be notable postero-inferior to the medial malleolus.
- AROM: Ankle joint motion is usually unaffected when non-weight-bearing (open chain).
- PROM: Ankle inversion, eversion and/or anterior hypermobility may be present and should be treated. Plantarflexion and dorsiflexion are typically unaffected.
- Strength testing:
    - Functional strength test: ask patient to rise onto the ball of the affected foot, with the other leg un-weighted. Failure of the foot to invert, or complete inability to rise onto the ball of the foot suggests tibialis posterior dysfunction.
    - Manual break-test: place the patient's foot in inversion and plantarflexion, then ask patient to resist dorsiflexion and eversion. Painful weakness to manual tests is uncommon and suggests severe musculo-tendinous dysfunction.

Differential Diagnosis.

- Dysesthesias and positive Tinel or compression signs under the medial malleolus suggest Tarsal Tunnel Syndrome.
- Plantar fasciitis may co-exist, but in isolation plantar fasciitis does not cause muscular weakness or tenderness or swelling below the medial malleolus, and pain occurs upon walking on the heel instead of the toes.
- Deltoid ligament sprain: history of trauma, muscular strength and function are intact.
- Medial ankle stress fracture: tenderness is highly-localized to bony aspect of medial ankle, muscular strength and function are intact.

Treatment.

Local Acupuncture/Electro-Acupuncture.

Tendon:

- Kidney 2, 5, 6
- M-LE-4 *zuxin* (1 unit posterior to K 1)

Muscle: use of 32 gauge or thinner needle with gentle insertion and no lift-and-thrust advised to avoid accidental hematoma in deep posterior compartment.

- UB 55-58
- Kidney 9 *(xi*-cleft of *yin wei mai)*
- Spleen 6-9 provide access to the deeper aspects of the anterior aspect of the gastroc heads, soleus and tibialis posterior.

Manual Therapies.

- Place the ankle in dorsiflexion and eversion to expose the tendon. Roll across the tendons with light pressure using fingers or a *gua sha* tool to tolerance for 5-10 minutes at the following locations, focussing on tender segments:
    - At the exposed segment inferior to the medial malleolus and under the retinaculum.
    - Above the malleolus, anterior to the Achilles tendon.
    - At the plantar aspect of the mid-foot.
- The proximal muscle bellies may be accessed by deep pressure in a lateral direction along the posterior medial tibial border, through the medial soleus. *Attempting to massage the tibialis posterior through direct downward pressure through the bellies of the gastroc and soleus and the Achilles tendon is both difficult and contraindicated. The pressure required risks bruising the superficial and deep compartments and causing acute compartment syndrome.*
- Manual therapy at any aspect is enhanced by having the patient actively and repetitively plantarflex and invert the foot and toes during massage.

Exercise and Adjunctive Therapies and Lifestyle Counseling.

See Chapter 6A Calf and Ankle Rehabilitation .

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.
Prognosis is progressively poorer with chronicity and development of flat-foot deformity. Referral to podiatry is indicated where medial arch is lost and flat foot has developed.

Medial Tibial Stress ("Shin Splints") Syndrome.

Risk Factors, Etiology and Patho-anatomy, Progression.

The etiology of shin splints is not well understood, but typically involves a training error (sudden significant increase in running or similar weight-bearing activity). Tight/shortened posterior compartments and ankle, foot, or footwear hypermobility may be risk factors.

Patho-anatomy or progression is also not well understood but may involve inflammation of the fascial-periostial attachments between the medial soleus and tibialis posterior and anterior to the tibia. Severe cases may progress to multiple pin-point avulsion fractures.

Diagnosis.

History and Symptoms.

- Location, radiation/referral: Pain and tenderness along the posterio-medial tibial border, typically worst at distal third.
- Onset and progression: insidious and progressively worsening.
- Palliative/provocative factors:
    - Weight-bearing activity is usually non-provocative until a threshold is reached during significant exertion such as running past a certain mileage. Running on hard, uneven or steep terrain may be more provocative.
    - Cessation of provocative activity typically resolves symptoms promptly.
    - Not painful at rest.
- Qualities, severity: dull, local aching and tenderness, may become severe.

Physical Exam Findings.

- Inspection/palpation:
    - Pain and tenderness along the posterio-medial tibial border, typically worst at distal third.
    - Mild diffuse swelling and erythema in the affected area is typically only present during and immediately after exertion.
- AROM: unaffected.
- PROM: evaluate ankle and foot joint stability as a potential contributory factor.
- Manual strength testing: evaluate tibialis posterior strength for dysfunction as a contributory factor.

Differential Diagnosis.

- Sharp, highly-localized pain suggests stress fracture.
- Pain, tension and tenderness felt more in the musculature vs. along the medial tibial border suggests chronic/exertional compartment syndrome,

- Tingling dysesthesias suggest entrapment of the posterior tibial nerve or popliteal artery compression syndrome.

Management and Treatment.

Local Acupuncture/Electro-Acupuncture.

- Liver 5, 6.
- Spleen 6-8.
- 7-star needling post *gua sha,* followed by suction cupping.
- Also important to evaluate and treat entire posterior calf per above, and ankle/foot hypermobility as described in Chapter 7.

Manual Therapies.
Gua sha distal-to-proximal along the entire medial tibial border from malleolus to tibial condyle. Wringing, cross- and long-fiber manual therapies as described above under treatment of Gastroc-Soleus and Achilles tendon injuries above.

Exercise and Adjunctive Therapies and Lifestyle Counseling.
Relative rest and keeping intensity, duration and frequency of provocative activities below the pain threshold is likely to be necessary for several months during treatment to prevent relapses.

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.

- Prognosis is good if patient is willing/able to comply with relative rest recommendations.
- No risks of inadequate treatment are known other than inability to perform at prior levels.
- Pain refractory to relative rest and AOM treatment should be referred to orthopedics for further evaluation for possible fractures or exertional compartment syndrome.

Posterior Tibial Nerve Entrapment and Tarsal Tunnel Syndrome.

Risk Factors, Etiology and Patho-anatomy, Progression.
The posterior tibial nerve can become entrapped anywhere along its course from the popliteal fossa under the soleus, through the tarsal tunnel and as it branches out into its medial and plantar divisions.

The most common site of entrapment is at the tarsal tunnel which lies just infero-posterior to the medial malleolus, and is formed by the medial surfaces of the distal tibia and talus and the

overlying medial retinaculum. Not only the posterior tibial nerve but also the tendons of the tibialis posterior andd flexors digitorum and hallucis longus and the posterior tibial artery and vein pass through the tarsal tunnel.

Compared with carpal tunnel syndrome, entrapment of the posterior tibial nerve is much less common, and its etiologies much less clear, but may include, in approximate descending prevalence:

- Fallen medial arch resulting in significant sub-talar pronation displacing the nerve into abnormal contact with adjacent structures.
- Swelling in the tarsal tunnel, secondary to:
    - Ankle sprain or arthritis.
    - Tendinopathies of the tibialis posterior or flexors digitorum and hallucis longus.
    - Pedal edema from congestive heart failure, diabetes or other medical causes.
- Mass effects in the tarsal tunnel from cysts, tumors, exostoses, varicose veins etc.
- Compression in the deep posterior calf compartment from chronic/exertional compartment syndrome.
- A rare accessory soleus muscle that forms a mass in the superficial posterior calf compartment. proximal to the medial malleolus.

Diagnosis.

History and Symptoms.

- Location, radiation/referral:
    - Diffuse pain and tingling, burning dysesthesias originating most commonly at the medial ankle, or rarely in the proximal medial calf, sometimes radiating to the medial arch and plantar foot.
- Onset and progression:
    - Traumatic or insidious.
- Palliative/provocative factors:
    - Weight-bearing tends to provoke pain when the etiology involves flat feet or swelling.
    - Pain can persist when non-weight bearing when the etiology involves mass effects or an accessory soleus.
- Qualities, severity: diffuse burning, tingling pain.

Physical Exam Findings.

- Inspection/palpation:

- Tenderness and reproduction of dysesthesias upon pressure or percussion (Tinel's sign) infero-posterior to the medial malleolus is the only physical sign likely to present regardless of etiology.
- Swelling and erythema may also be visible and palpable over the carpal tunnel.
- Sensory loss over the distribution of the posterior tibial nerve may present in severe or chronic cases.

Differential Diagnosis.

- Absence of dysesthesias and a negative Tinel's sign suggest tendinopathies of the tibialis posterior and/or flexors hallucis and digitorum longus.
- Hyperalgesia to light touch, discoloration of the foot, and skin, nail, hair and temperature abnormalities suggest complex regional pain syndrome.
- Dysesthesias that radiate to great toe or proximally to calf or thigh suggest L 4 radiculopathy.
- Dysesthesias that involve the entire plantar aspect and/or calf suggestion sciatic entrapment neuropathy.
- Bilateral stocking distribution of dysesthesias suggests peripheral neuropathy of systemic origin, or popliteal artery compression syndrome.
- Vascular symptoms and signs of pricking pain, cyanosis and mottling that occur only on significant exertion suggest popliteal artery compression syndrome.

Treatment.

The primary principle of treatment is to decompress the tarsal tunnel, thus methods depend upon identification and correction of the cause of compression, including:

- Correction of tibialis posterior dysfunction.
- Correction of sub-talar pronation and *pes planus.*
- Treatment of ankle arthritis or eversion hypermobility.
- Treatment of pedal edema.

Local Acupuncture/Electro-Acupuncture.

- K 2, 4, 5, 6, 7.
- Sp 5, 6
- Thread under medial retinaculum.

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.

- May self-resolve or respond to AOM modalities, depending on etiology, but prognosis without correction of underlying cause(s) is poor.
- Without adequate treatment, may progress to lasting pain and numbness, plantar ulcers, or complex regional pain syndrome.
- Severe or progressive symptoms, motor deficits, hyperalgesia to light touch, and trophic abnormalities indicate prompt referral to physiatry, neurology or podiatry for further evaluation.

Plantar Fasciitis, Fibromas, Fibromatosis, and Baxter's Nerve Entrapment.

Risk Factors, Etiology and Patho-anatomy, Progression.

- Strains and tearing of the plantar fascia cause local inflammation.
- Most common as a transitional stage in the flattening of the foot arch in the 5th and 6th decades, twice as common in women.
- Tissue studies of the medial tibial plantar fascial insertion to the medial tubercle of the calcaneus have shown tissue necrotization which may be due to ischemic compression of the medial tibial artery as the medial foot arch breaks down.
- With progression from inflammation to degeneration, symptoms typically resolve spontaneously within 6-24 months, with no sequelae.
- *Plantar fasciitis is **not** associated with a particular foot type or morphology, nor with particular weight-bearing activities.*
- Risk factors:
    - Excess body weight is the primary risk factor, and can perpetuate symptoms past their normal resolution.
    - Ankle hyper- or hypo-mobility, Achilles tendinopathies, gastroc-soleus strains, and posterior tibialis dysfunction may increase the risks of plantar fasciitis.
- Plantar fibromas are a benign thickening of the plantar fascia of unclear etiology, and may progress to fibromatosis/nodular fasciitis, histologically similar to Dupuytren's contracture of the palmar fascia, but less likely to cause deformities or disability.
- Flexor hallucis longus tenosynovitis where its tendon crosses over the flexor digitorum longus tendon at the Master Knot of Henry just under the navicular can mimic plantar fasciitis at the mid-arch.
- Baxter's nerve entrapment occurs when a branch of the lateral plantar nerve that supplies the abductor digiti minimi becomes entrapped.

Diagnosis.

History and Symptoms.

- Location, radiation/referral: anywhere at the plantar aspect of the foot, but most commonly at the posterior-medial insertions to the calcaneus.
- Onset and progression: onset can be acute or insidious but is atraumatic.
- Palliative/provocative factors:
    - Weight-bearing is provocative:
        - Particularly during the first few steps after non-weight bearing.
        - Particularly in bare feet and/or on hard surfaces.
    - Unweighting provides relief, but pain may persist even when unweighted in severe stages of the condition.
- Qualities, severity: often sharp, burning, and highly-localized, and may be severe enough to cause antalgic limping.

Physical Exam Findings.

- Inspection/palpation:
    - Highly localized swelling and erythema are common over the sites of plantar fasciitis, most commonly at medial posterior insertions to calcaneus.
    - Tenderness may only be elicited upon very strong manual pressure or with use of a blunt (*gua sha*) tool.
    - Concurrent stiffening, thickening, and development of nodules in the Achilles tendon is common.
- AROM: ankle/foot AROM are largely unaffected, although dorsiflexion may show slight end-range pain inhibition or limitation.
- PROM: passive dorsiflexion of the toes may cause “stretch”-type pain.
- Manual strength testing: strength is unaffected.

Differential Diagnosis.

- Ecchymosis: acute traumatic rupture of the plantar fascia.
- Pain or weakness upon active plantar flexion and/or inversion, tenderness and swelling inferior-posterior to medial malleolus: tibialis posterior tendon dysfunction.
- A thin sub-calcaneal fat pad and prominent calcaneal tuberosity in a middle-aged or older patient: fat pad atrophy syndrome and a very poor prognosis with AOM modalities. Consistent use of a gel pad in the heel cup is the only form of relief.
- Dysesthesias and sensory deficits: tarsal tunnel syndrome or other plantar nerve entrapment neuropathy.
- Calcaneal stress fractures are only identifiable upon PFXR.

Treatment.

Best results are often obtained by treatment of any concurrent posterior chain dysfunctions (gastroc/soleus, Achilles tendon, tibialis posterior) and ankle joint hyper- or hypo-mobility.

Local Acupuncture/Electro-Acupuncture. Placing the foot in dorsiflexion assists in locating and exposing the lesions.

- TrPs in plantar fascia, most commonly found at posterior insertions to medial calcaneus. A proliferative therapy approach of partial withdrawal and re-angling to fenestrate the affected area is more effective, if tolerated, than single insertion.
- K 2, 6 angled towards TrPs.
- M-LE-5 *Shimian* (center of the plantar heel).

Manual Therapies.

- Plantar fasciitis requires gentler manual techniques than at the posterior calf. Use of a *gua sha* tool is likely to be tolerated only at the posterior insertions to the calcaneus, and strong or prolonged massage risks flares which make weight-bearing too painful for a day or more.

Exercise and Adjunctive Therapies and Lifestyle Counseling.

- Weight loss is essential in overweight patients.
- Stretching the plantar fascia and posterior chain is essential.
    - Self-mobilization by rolling the sole of the foot on a tennis or lacrosse ball and at least 5 minutes of light weight-bearing exercise is important to warm and loosen the plantar fascia and posterior calf prior to stretching.
    - Stretching should target the plantar fascia by dorsiflexing the mid-foot. A rocker-bottom stretching device such as the ProStretch provides a good way to control mid-foot stretching due to its angulation of the hind- and fore-foot surfaces.
    - Stretching the Achilles tendon, soleus (knee flexed), and gastroc and hamstrings (knee extended) is also indicated.
- OTC or custom orthoses and shoes that provide adequate mid-foot support, hind-foot stability, and heel cushioning may be helpful.
- Walking and running barefoot on both hard and also unstable, shifting surfaces (e.g. beach sand) should be minimized.
- Athletic taping to compress and support the calcaneal fat pad and medial arch provide relief and may help accelerate the course of healing if performed consistently.

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.
Short-term prognosis is variable, and poor in overweight patients and patients with significant concurrent foot/calf injuries or motion dysfunctions unless those conditions are addressed. Long-term prognosis is good with and without treatment. Unresponsiveness to AOM modalities after 6-12 visits over 6-8 weeks indicates referral to podiatry for further evaluation and treatment.

Metatarsalgia. A general diagnosis covering several types of conditions that cause pain in the plantar forefoot and can co-exist, including:

1. Sprains of the MTP joints, including "Turf Toe."
2. Toe flexor tendinitis.
3. MTP synovitis/capsulitis.
4. Sesamoid inflammation (sesamoiditis) and fractures.
5. Metatarsal stress fractures.
6. Distal plantar fasciitis and fibromatosis.
7. Osteoarthrosis of the MTP joints.
8. Sero-positive arthritis.
9. Morton's perineural fibrosis (commonly but inaccurately referred to as a neuroma).
10. Idiopathic metatarsalgia and age-related fat pad degeneration.
11. Formation of a metatarsal callus or intractable plantar keratosis

Risk Factors, Etiology and Patho-anatomy, Progression.
With the exception of sero-positive arthritis, all other types of metatarsalgia tend to share some of the following risk factors, etiology, patho-anatomy, and progression:

- Excessive body weight loads the forefoot beyond its capacity with each step, resulting in repetitive strains and inflammation that progresses to degeneration.
- Shortened, weak and tight posterior chain/plantarflexors results in reduced dorsiflexion at the ankle joint, and places disproportionate impact on the forefoot with each step. A rigid, high-arched foot can have the same effect of favoring landing on the forefoot instead of the heel during gait.
- Alternatively, a flat or flexible foot with loss of medial arch integrity requires more musculo-tendinous effort to plantarflex and invert the foot during the toe-off phase of

gait, leading to repetitive strains. A flattened medial arch tends to abut the metatarsal heads, and compresses the joint capsules and interdigital branches of the plantar nerves.

- Shoes with a narrow toe-box and inadequate cushioning also compress the metatarsal heads and joints and interdigital nerves while failing to protect the forefoot from the impacts of gait. High heels compound the problem by shortening the posterior calf muscles and reducing ankle dorsiflexion motion during gait.
- The metatarsal fat pad tends to thin with age, and may also be worn and displaced by toe deformities including claw and hammer toes and abnormal metatarsal length, which also increase loading on the metatarsal heads.
- Sprains and fractures of the mid- and fore-foot may alter gait biomechanics and foot architecture such that the metatarsal heads and MTP joints are subject to increased loading.
- Prolonged or recurrent inflammatory processes hasten degeneration.
- Repetitive overloading and fat pad atrophy can result in formation of a painful callus which can progress to an intractable plantar keratosis.

Diagnosis. Differentiation among different factors and causes of metatarsalgia may be made on the basis of history and physical exam, as follows:

History and Symptoms.

- Location, radiation/referral:
    - Pain only under the metatarsal heads suggests:
        - Idiopathic or age-related fat pad degeneration.
        - Formation of a plantar callus or intractable keratosis.
    - Pain under metatarsal ray(s) but ending at the head(s) suggests:
        - Distal plantar fasciitis and fibromatosis
        - Flexor tendinitis
    - Pain only at or involving the dorsal aspect of an MTP joint(s) suggests:
        - Capsulitis/synovitis
        - Traumatic, seropositive or degenerative arthritis
    - Highly-localized sharp pain at a bony surface suggests stress fracture.
    - Pain occurring only under the 1st ray suggests:
        - Sesamoiditis.
        - Turf toe/FHL tendinitis.
        - Gout (typically involves all aspects of 1st digit).
        - 1st MTP joint DJD.

- Pain occurring only at the space between the 4th and 5th, or less commonly, 3rd and 4th metatarsal heads, that radiates to the dorsum and digits on compression, suggests Morton's perineural fibrosis.

- Onset and progression:
  - Sudden traumatic onset suggests sprains, fractures, traumatic arthritis.
  - Sudden onset after overuse suggests tendinitis, synovitis/capsulitis, sesamoiditis, and plantar fasciitis.
  - Sudden atraumatic non-repetitive onset suggests Morton's perineural fibrosis and gout.
  - Insidious onset suggests non-gouty sero-positive or degenerative arthritis, capsulitis/synovitis, sesamoiditis, distal plantar fasciitis or fibromatosis, and formation of a callus or intractable keratosis.
- Palliative/provocative factors.
  - Weight-bearing is invariably provocative.
  - Pain that persists when non-weight bearing suggests sero-positive arthritis or other severe inflammatory condition.
- Qualities, severity:
  - Sharp, severe suggests fracture or Morton's perineural fibrosis.
  - Dysesthesias and a sensation of a pebble in the shoe under the forefoot suggests Morton's perineural fibrosis.
  - Hot, swollen, tender suggests capsulitis/synovitis, seropositive arthritis, sesamoiditis.
  - Tenderness and a bruised sensation suggests fat pad degeneration and/or formation of a callus or keratosis.

<u>Physical Exam Findings.</u>

- Inspection/palpation: tenderness is often the only finding, and is shared by all causes of metatarsalgia except perhaps DJD.
  - Ecchymosis suggests:
    - Fracture
    - Severe (grade 2+) sprain (most commonly the 1st MTP joint: "turf toe").
  - Severe, sharp tenderness localized to a bony surface suggests fracture.
  - A sub-cutaneous fibrotic thickening proximal to the metatarsal heads suggests plantar fibromatosis.
  - Thickening and roughening of the skin under the metatarsal heads suggests a callus or intractable keratosis.

    - Tenderness under the great toe that moves upon dorsiflexion/plantarflexion suggests sesamoiditis or sesamoid fracture.
    - Heat, erythema and swelling suggest an acute inflammatory process which may an aspect of any of:
        - Sesamoiditis
        - MTP joint sprains, capsulitis/synovitis, and sero-positive arthritis
        - Flexor tendinitis
- AROM:
    - Dorsiflexion and plantarflexion are typically unremarkable in non-weight bearing, however:
        - Pain under great toe upon open-chain dorsiflexion and plantarflexion suggests sesamoiditis.
        - Increased pain on closed chain/weight-bearing plantarflexion suggests:
            - Sesamoiditis
            - MTP joint sprains
            - Flexor tendinitis
- PROM and special orthopedic tests:
    - 1st digit dorsiflexion pain-limited to < 45° suggests:
        - Hard, bony end-feel: hallux rigidus and DJD of the 1st MTP joint.
        - Soft end-feel: MTP joint sprain ("turf toe").
    - Pain on axial rotation of the phalange on a fixed metatarsal shaft (grind test) suggests MTP joint dysfunction from degenerative or sero-positive arthritis.
    - Hypermobility and/or pain at the MTP joints to stress-testing in inferior/superior directions suggests MTP joint sprain or traumatic arthritis/capsulitis/synovitis.
        - Fix metatarsal shaft with one hand, then attempt to displace the digit inferiorly and superiorly with the other.
- Manual strength testing:
    - Painful weakness of toe flexion suggests:
        - Flexor tendinitis.
        - Great toe only: sesamoiditis.
- Special neurologic tests: manual horizontal compression of the metatarsal heads or pressure applied between the metatarsal heads that provokes sharp local pain and dysesthesias suggests a Morton perineural fibrosis.

Treatment.

AOM modalities are generally palliative more than curative. The essential aspects of treatment involve correction of gait and calf/ankle/foot biomechanics through:

- Addressing proximal injuries and dysfunctions that contribute to forefoot problems.
- Rehabilitative strengthening, stretching and proprioceptive exercises.
- Replacement/correction of dysfunctional/injurious footwear with corrective footwear, orthoses, pads, splints, taping etc.

Local Acupuncture/Electro-Acupuncture.

- K 1.
- M-LE-1 *Lineiting* (in the depression at the plantar aspect anterior to the MTP joints of the 2nd and 3rd digits).
- M-LE-2 *Muzhilihengwen* (at the middle of the transverse crease at the plantar aspect of the MTP joint of the 1st digit).
- Other local TrPs.
    - 1st MTP joint line: distract the 1st phalange to open joint, and confirm localization of the joint line by rotation of the phalange on a fixed 1st metatarsal before insertion. See Cyriax p. 127.
    - At sesamoids.

Manual Therapies.

- Distal plantar fasciitis and fibromatosis and flexor tendinitis/tendinosus may be treated with gentle cross-fiber massage with the toes and ankle in dorsiflexion to expose the affected areas.
- Manual therapy is of no value for other etiologies of metatarsalgia, and is contraindicated if fractures or sero-positive arthritis are known or suspected.

Exercise and Adjunctive Therapies and Lifestyle Counseling.

- Toe spreaders.
- Metatarsal pads.
- OTC and Rx orthoses.

Prognosis, Risks of Inadequate Treatment, Red Flags and Referrals.

- Short-term prognosis with AOM modalities alone varies with etiology, but is best with early intervention following acute sprains, tendinitis, capsulitis/synovitis and arthritis, and poorest with degenerative and idiopathic conditions and with Morton's perineural fibrosis.
- Prognosis is generally poor in overweight patients, patients with significant concurrent foot/calf injuries or motion dysfunctions, and patients who decline changes in injurious footwear habits.

- Known or suspected fractures warrant immediate referral to podiatry or orthopedics for further evaluation. Unresponsiveness to AOM modalities after 6-12 visits over 6-8 weeks indicates routine referral to podiatry for further evaluation and treatment.