Current Treatment of Plantar Fasciitis

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Introduction

Plantar fasciitis is the most common cause of rearfoot heel pain, with an estimated 2 million visits per year resulting from this chronic condition of repetitive microtears and degeneration secondary to stress overload [1••]. It remains the most common cause of rear foot pain associated with either overuse or predisposing factors [2•]. As a greater emphasis is placed on physical fitness and running, the incidence of plantar fasciitis will likely increase. Clinical presentation is severe heel pain that occurs upon weight-bearing activity after periods of rest, most commonly in the morning. During the night, the foot assumes an equenes position, thereby allowing contracture of the plantar fascia for an extended period of time. The pain normally resolves within the hour, but will return if the person is sitting, driving, or stationary for extended periods of time.

The clinician should be aware that predisposing factors such as obesity, pes planus, pes cavus, and tight Achilles tendons or hamstrings may contribute to this overuse injury. However, there are additional neurologic and autoimmune conditions to consider, such as diabetes with associated peripheral vascular neuropathy, Paget’s disease, and Reiter’s syndrome.

Plantar fasciitis is one of the most common complaints of chronic rearfoot heel pain seen by primary care providers. The etiology and differential diagnosis are numerous, as are treatment options. This article includes a definition of plantar fasciitis, anatomy, predisposing factors, physical examination techniques, differential diagnosis, and conservative nonsurgical treatment options. Plantar fasciitis may be acute, but is more often a chronic condition that is directly related to physical activity. The most common complaint is intense heel pain with the first step from bed in the morning and initial step after resting. This pain subsides with time, but returns in the evening after prolonged standing.

Anatomy

The foot functions as a shock absorber, serves to support the body, and facilitates ambulation. Foot-related complaints account for 20% of visits to orthopedic surgeons and a majority of podiatry evaluations [3]. In order to fully understand plantar fasciitis, a brief review of anatomy is required.

The foot consists of 25 bones divided into three distinct zones: the rearfoot, midfoot, and forefoot. These various anatomic sites play different roles in foot function. The talus and calcaneus make up the rearfoot. The navicular, cuboid, and three cuneiform bones develop the midfoot. Finally, the metatarsals, sesamoids, and phalanges define the forefoot.

The arches define the contour of the foot and function as a spring to absorb energy during activity.

Plantar fasciitis, the densest of fibrous membranes, originates at the medial border of the calcaneus and attaches distally to the proximal phalanges (Fig. 1). The central portion is thick, with thinner medial and lateral bands that help maintain the longitudinal arch. This allows the membrane to lengthen enough to provide some shock absorption.

Predisposing Factors

There are several predisposing factors that contribute to plantar fasciitis, the most common being obesity. As Americans become increasingly active, millions still remain grossly overweight. This additional weight increases the stress upon the plantar fascia. During normal walking, the foot absorbs approximately 1.2 times body weight [4]. As Americans increase their physical activity to include running, the extrinsic force applied to the lower extremity can increase to 2.0 times body weight [4]. The foot structures, including the plantar fascia, directly absorb this force. If the patient is overweight, weight loss is an integral part of the treatment program.

Pes planus foot type will also increase the risk for obtaining plantar fasciitis. The phases of gait consist of heel strike, followed by plantar flexion with the foot flat, while maintaining a mild pes cavus; the last phase consists of push off. During the second phase of landing, pes planus allows for excessive pronation. This abnormal subtalar pronation, associated with flat foot, results in an unstable foot at the time when a rigid lever is required at toe-off, imposing a greater load on the body [5].

Pes cavus, which is a high-arch foot, is usually genetic, resulting in a heightened plantar fascia and foot that is rigid and unable to absorb shock. During activity, if the
plantar fascia is shortened secondary to pes cavus, the fascia is excessively strained during the toe-off phase of gait. This is known as the windlass mechanism. A tight Achilles tendon will increase this windlass mechanism phenomenon because the foot will experience an early heel lift during gait and cause further plantar fascia strain. The most common observation is a "bouncy" gait.

History
In order to perform any thorough musculoskeletal examination it is imperative to obtain a good history. The patient will typically give a history of pain with the first few steps in the morning. This eventually resolves, only to return after a period of rest and/or later in the day; the pain is usually described as a dull achy pain at the heel. Inquire how much time the patient spends in weight-bearing activities. Also ask questions about overuse, and the age and condition of running or work shoes. If the patient is a runner, find out how many miles per week he or she runs, and if there has been an increase in frequency or duration of runs in the past 2 months. Increases of more than 10% per week will predispose one to overuse injuries. The examination should help confirm the diagnosis and is solely based upon the key points discussed above.

Physical Examination
Eighty percent of the population will have some type of foot pain, and a majority can be treated conservatively [4]. This pain is directly related to daily activity, in which the foot absorbs approximately 1.2 times the body weight during walking and up to 2 times during running [4]. Physical examination of the entire foot above and below the joint, along with biomechanical evaluation, is vital to determine the etiology of the pain. Physical examination techniques include viewing the patient during weight-bearing activities. A posterior view is essential to compare calf muscles and note any differences. Variations may indicate peripheral nerve lesions, nerve root problems, or atrophy resulting from compensation. The Achilles tendons on each side should be compared. If a tendon appears to curve out, it may indicate a fallen medial longitudinal arch, resulting in pes planus condition (Helbing’s sign) [4]. Runners often have pump bump secondary to callus formation as a result of pressure on the heel. Finally, the malleoli should be compared. The lateral malleolus should extend farther distally than the medial; however, the medial malleolus should extend farther anteriorly.

Special tests

Fick angle
The Fick angle is formed by the long axis of the foot relative to the sagittal axis of the body. It is affected by the hip, knee, tibial torsion, and rearfoot or forefoot structure. A normal angle is between 12° and 18° [4].

Feiss line
Mark the apex of the medial malleolus and the plantar aspect of the first metatarsophalangeal joint while the patient is non–weight-bearing (Fig. 2). Palpate the navicular tuberosity on the lateral aspect of the foot, noting where it lies relative to a line joining the two previously made points. The patient should stand with the feet 8 to 15 cm apart. The tow points are checked to ensure they still represent the apex of the medial malleolus and the plantar aspect of the metatarsophalangeal joint. Palpate the navicular tuberosity again. The navicular tuberosity normally lies on or very close to the line joining the tow points. A one-third fall represents a first-degree flatfoot, two thirds represents a second-degree flatfoot. If it rests on the floor, it represents a third-degree flatfoot [4].

A final evaluation of foot type involves having the patient lay prone with one leg crossed over the other in a...
figure-four position (Fig. 3). Again, the foot is placed in a subtalar neutral position after assessing the available passive range of inversion and eversion. Load the fifth metatarsal head anteriorly. Viewing the forefoot (metatarsal heads) and rearfoot (calcaneus) will reveal any valgus/pronation or varus supination tendencies [4].

Forefoot/midfoot observation should include obvious deformities such as metatarsus adductus, hammertoes, tailors bunion, and mallet toes. First and second metatarsal should be observed for Egyptian foot or Morton’s foot, respectively. Rearfoot varus/vulgus, which is done by placing the foot in the neutral position, compares the calcaneal
line and the tibia, which should be parallel. If calcaneal line is inverted this is heel varus, if everted it is heel valgus. Forefoot varus/valgus compares the vertical calcaneal line with the plane of the metatarsal heads, which should be perpendicular to each other. If the medial side of the foot is higher than lateral, this is forefoot varus. When the lateral side is higher than medial, this indicates forefoot valgus.

Finally, a measurement of range of motion should include all joints. Ankle plantarflexion 50°, ankle dorsiflexion 15°, and heel inversion 40°, forefoot inversion/eversion 25°, forefoot adduction 30°, heel eversion 20°, and forefoot abduction 15° [6].

**Biomechanical requirements of the plantar fascia**

The biomechanical requirements of the plantar fascia center around two functions. First, the spring, long plantar, short plantar, and plantar aponeurosis provide ligamentous support to the longitudinal and transverse arches. The second requirement of the plantar fascia involves phases of gait. During the stance phase, the body moves from eccentric shock absorption and weight acceptance to limb advancement and generation of thrust. This transition occurs from the mid-stance through the swing phases of gait and relies on a stable first ray. During mid-stance, the progression of center-of-pressure locks the calcaneal cuboid joint at the mid-tarsal region. Locking the mid-tarsal joint allows a pulley action of the peroneus longus muscle to stabilize the first ray. A now-rigid first ray promotes further locking of the tar-sus by tightening the plantar fascia. Tightening of the plantar fascia, termed Spanish windlass, assists the gastrocnemius-soleus complex initiate swing phase. Because the plantar fascia proves vital in the transition to plantarflexion, injury will become most apparent at this time.

Thorough review of biomechanical requirements should include an analysis of foot types and gait. Key observations for foot types start with a barefoot view of stance. Although pes planus feet benefit the patient with high shock absorp-cibility, the ensuring overpronation may result in plantar fasciitis, shin splints, and patellar femoral pain syndrome. Pes cavus feet reside on the opposite end of the spectrum. A cavus foot lack intrinsic shock absorption cap-a-bilities and poses a higher risk of stress fractures to metatarsals and tibia regions. Normal arches usually exclude the patient from the most common lower extremity injuries. It is essential that a patient presenting with a pes planus foot be directed to a motion control shoe; pes cavus feet belong in high-cushion shoes, and neutral fee in stability shoes. A review of gait may reveal the degree of pronation or supination through slow anterior and posterior observations through approximately 20 feet of ambulation.

**Differential diagnosis**

The primary differential diagnosis in our practice is calcaneus stress fractures. This condition can be difficult to diagnosis if one is not familiar with stress fractures. In calcaneus stress fractures, most often sclerosis will be the primary identifier when reviewing radiographs of a patient with plantar or heel pain. Normally, the first set of radiologic pictures will be negative; however, a repeat film 1 week later may show stress reactions. If these two radiologic films appear negative, and the patient continues to complain of heel pain, a bone scan should be ordered.

Tarsal tunnel syndrome or posterior tibial nerve entrap-ment should also be considered when examining a patient with heel pain. Normally, a patient complains of numb-ness/tingling that progresses to a burning sensation into the plantar aspect of the foot, which may start insidiously and gradually increase. Physical examination consists of a loss of two-point discrimination with positive tinel sign over the tunnel. Symptoms may be reproduced with in-ver-sion and eversion of the calcaneus.

Medial plantar nerve entrapment results in pain radiating from the medial aspect of the arch into the toes or ankles, secondary to compression along the plantar aspect of the flexor digitorum longus and Master Knot of Henry. The patient normally complains of navicular tuber-osity tenderness, increased by eversion and standing on the ball of the foot upon examination. Use of new orthosis is commonly noted.

Lateral plantar nerve entrapment is a result of compres-sion between the abductor hallucis and quadratus plantae muscles, commonly seen in runners, dancers, and soccer and tennis players who are pronators. The patient complains of chronic dull aching heel pain, which radiates to the ankle and increases with activity.

Posterior tibial dysfunction results in the loss of the support-ing arch and acquired pes planus. Patients normally complain of pain and swelling around the medial ankle with weight-bearing activity. Examination will reveal swell-ing to the area of the medial malleolus, and tenderness along tendon. Normally there is exquisite point tenderness just inferior and distal to the medial malleolus, which is the most common place for tears of the tendon sheath.

Lumbar radiculopathy or sciatica can result in lower extremity foot pain secondary to herniated nucleus pulpo-sus most commonly occurring in the fifth lumbar and first sacral nerve. Clinical symptoms usually consist of burning pain in the lower extremity with or without focal low back pain. Sensory, reflex, and muscular distribution will help locate the lesion.

**Imaging**

The use of plain radiographs for the diagnosis of plantar fasciitis is only helpful in evaluating for a stress fracture. The presence of a calcaneal osteophyte as the etiology for heel pain is not substantiated. Plain radiographs are also useful for placement of steroid injections. The presence of a heel spur is not diagnostic in and of itself, nor does it mandate the presence of heel pain. In one study of radiographs from 1000 patients, only 13.2% revealed a spur, and only 5.2% reported history of heel pain [7•].
Nonsurgical Treatment

The diagnosis and treatment of plantar fasciitis requires a multidisciplinary approach with initial intervention emphasizing a combined approach of nonsurgical modalities. The Branch Medical Clinic (Parris Island, SC) integrates the physical therapy department and podiatrist to provide additional treatment and evaluation. The team concept management process is designed to expedite the patient’s return to training.

**Initial conservative treatments**

First, ensure the correct diagnosis and eliminate or control the pain. Conservative treatment begins by informing the patient that the cause of his or her pain is directly related to a specific activity that increased dynamic stress upon the plantar fascia. By educating the patient, not only does it make him or her feel actively involved in the treatment process, but it minimizes future flare-ups.

Currently, the step approach to healing begins by controlling the pain through the following treatments. An informative article by O’Connor et al. [8] gives an overview of treating overuse injuries. The plan consists of a pyramid approach: stop pain, promote healing, control abuse, increase fitness, and return to full activity.

**Stop the Pain**

**Active rest**

Change to non–weight-bearing activity using stationary bike and/or swimming/deep water running for 20 to 30 minutes 3 to 5 days per week. Patients should employ a moderate pace, as long as it does not exacerbate symptoms. This keeps the cardiovascular system active and helps guard against mental stagnation. It also provides oxygenated blood to the area of repair.

**Nonsteroidal anti-inflammatory drugs**

The use of nonsteroidal anti-inflammatory drugs (NSAIDs) for overuse injuries is debatable. The histopathology behind the pain of plantar fasciitis is usually caused by collagen degeneration. This degeneration is similar to chronic necrosis of tendonosis, features loss of collagen continuity, increases in ground substance (matrix connective tissue) and vascularity, and presence of fibroblasts rather than inflammatory cells seen in tendinitis [7•]. With the cellular response to injury not being one of inflammation, NSAIDs may not halt inflammation. However, their use for stopping pain is commonly employed by clinicians. Currently, the use of any NSAID remains provider-dependent. As always, kidney and liver disease, gastrointestinal disorders, and pregnancy must be considered.

**Ice**

Ice is the most common pain control modality used. For plantar fasciitis, an ice massage is the best vehicle to provide it. Have the patient freeze a bottle of water and then roll his or her foot over the bottle to provide relief.

**Nighttime splinting**

There are many variations employed in the use of nighttime splinting. Studies show that tension night splints are highly effective if used in conjunction with other treatment modalities [9]. However, improper fit and patient discomfort greatly reduces patient’s compliance, thereby lessening effectiveness. The underlying theory promotes maintaining the foot in mild dorsiflexion. Five degrees of dorsiflexion is recommended to deter contraction of plantar fascia during hours of sleep. This eliminates the ensuing microtears associated with painful morning first step, although it can cause the patient’s nighttime partner some pain. The patient may awaken with a parathesis of the sural nerve from compression of the straps. Also, they are bulky and difficult to sleep with.

A cam walker prevents dynamic strain from being placed on the arch structures, and the foot will roll through a range of motion. If these measures do not work, a 2- to 4-week non–weight-bearing cast can be used. If the patient has bilateral plantar fasciitis, crutching with four-point gait is appropriate.

**Promote Healing**

**Stretching**

A study by Pfeffer et al. [1••] compared custom and prefabricated orthosis as the initial treatment of proximal plantar fasciitis. The study had 236 participants with five different research centers. They excluded patients with systemic disease, musculoskeletal disorders such as sciatica, and nerve entrapment. One group performed stretching only; four received different heel inserts, including custom orthosis. The results indicated that stretching with silicone inserts resolved the plantar fasciitis in approximately 95% of the patients, rubber inserts in 88%, felt inserts in 81%, and custom orthosis in 68%. The conclusion is stretching plays a major role in recovery and paying a lot of money for custom orthosis may not be beneficial.

This simple activity plays an important part in how soon the patient returns to normal pain-free activity. We recommend stretching three times daily for 10 repetitions until symptoms subside. Once the patient returns to activity, good stretching before and after working out are key to preventing a relapse. There may be an increase in pain with stretching for up to 3 to 4 weeks initially, but this discomfort will eventually resolve. Stretching provides the patient with control of his or her illness, and ultimately will determine the healing process.
Control the Abuse

Supportive shoes
Comfortable shoes for everyday activity such as walking or jogging are essential to decrease stress. Inserts are very important, and soft, over-the-counter orthotics are cheaper and provide the same support as custom orthotics that can cost hundreds of dollars. This does not imply that custom orthotics do not work, just that they are provider-dependent and expensive.

Walking with slippers, sandals, or barefoot should be avoided, as this will only increase the stress on the plantar fascia. Physicians should inform their patients that a new pair of shoes should be purchased every 400 miles or 6 months.

Motion control shoes
These are recommended for runners who are moderate to severe over-pronators and need maximum rear foot control and extra support on the medial (arch) side of their shoes. They are also best suited for big or heavy runners who need plenty of support. Between 81% and 86% of individuals with symptoms consistent with plantar fasciitis have been classified on examination as having excessive pronation [8].

High cushion shoes
These are recommended for runners who need maximum midsole cushioning and minimum medial (arch-side) support. They are best suited for biomechanically efficient runners (minimum pronation), and midfoot or forefoot strikers.

Stability shoes
These are recommended for runners who need medial (arch-side) support and good midsole cushioning. They are best suited for runners who are mild to moderate over-pronators and/or need added support and durability.

Increase Fitness

Non-weight-bearing exercises
Patients should minimize their daily weight-bearing activities. Once the pain subsides, they can increase the duration and intensity of non-weight-bearing cardiovascular fitness activities. This is beneficial to maintain cardiovascular conditioning throughout the rehabilitative process. It can be used as a transition back into running, as well as a supplement to running.

Return to Activity
We have a walk/run program we use to progress a patient with a stress fracture back to full running. A similar program would be helpful for patients with plantar fasciitis, by providing a guide to evaluate progression. As the patient returns to activity, he or she must not increase by more than 10% per week [10]. Before advancing to the next level of activity, patients should complete 3 pain-free days at the same level. Each day should have a total duration of 20 to 30 minutes of activity. Day 1, walk only; day 2, run for 1 minute then walk 4 minutes; day 3, run for 2 minutes then walk 3 minutes; day 4, run for 3 minutes then walk 2 minutes; day 5, run for 4 minutes then walk 1 minute; day 6, run 1.5 miles; day 7, run 2.0 miles; day 8, run 2.5 miles; day 9, run 3.0 miles.

Steroid injection
This in itself has numerous risks as described by Acevedo and Beskin [11]. They reported that in a group of 765 patients with the diagnosis of plantar fasciitis, 51 were diagnosed with plantar fascia rupture. Of the 51 patients diagnosed with rupture, 44 ruptures were associated with corticosteroid injection.

Deep tissue injection is the last initial conservative treatment when all others have failed. Keep in mind, this provides great relief but may incur additional sequelae that may include fat pad atrophy, plantar fascia rupture, and infection. There are two techniques used for injection of the plantar fascia. First is the plantar approach, which is employed at the point of maximal plantar fascia tenderness. This procedure is easy to perform but may heighten the risk of sinus tract infection. Second, the medial approach discussed below utilizes soft tissue measurements from plain view radiographs. This technique decreases the risk of infection by injecting from the medical aspect, thereby eliminating contact with potential bacteria imbedded within the shoe inserts.

The mixture of long-acting steroid and anesthetic solution is prepared with a 10-mL syringe, 21-gauge needle. The area of maximal tenderness is then prepped under sterile conditions, using the measurement from the radiograph as a guide. The calcaneus is palpated medially where it begins...
to curve upward. The needle is inserted in this area, which is approximately 2 cm from the plantar surface of the foot (Fig. 4). The needle is advanced down to bone, and the tip of the needle walked distally along the bone to the plantar surface of the calcaneus. The needle is advanced to pepper the area of maximal tenderness, ensuring that when withdrawing the needle to aspirate, this will decrease the risk of fat pad atrophy secondary to preparation in the subcutaneous tissue. The puncture site is then dressed with sterile bandage. The patient should be informed that numbness of the heel may occur and pain may return in several hours after the anesthetic has worn off. The corticosteroid solution may take a few days to take effect [3].

Conclusions

Plantar fasciitis remains one of the most common complaints of heel pain. The diagnosis and treatments vary depending on etiology and predisposing conditions. Currently, the conservative nonsurgical approach remains the best choice. Appropriate physical examinations prior to exercise will deter future flare-ups; however, as with every overuse injury, common sense by the patient regarding increasing physical activity is the key.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:

• Of importance

•• Of major importance

1. •• Pfeffer G, Bacchetti P, Deland J, Lewis A: Comparison of Custom and Prefabricated Orthoses in the Initial Treatment of Proximal Plantar Fasciitis. Seattle: American Orthopaedic Foot and Ankle Society; 1999. This article is a randomized controlled trial comparing various methods of treatment. It emphasizes the need for stretching, but shows over-the-counter supports are better than custom-made orthotics.

2. • Tisdel CL, Donley BG, Serra JJ: Diagnosing and treating plantar fasciitis: a conservative approach to plantar heel pain. Cleve Clin J Med 1999, 66:231–235. This article discusses the importance of stretching as the mainstay of treatment. It also covers the difference in stretching the achillies tendon complex and plantar fascia.


