Plantar Fasciitis: Diagnosis and Therapeutic Considerations

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Abstract

Plantar fasciitis is the most common cause of inferior heel pain. The pain and discomfort associated with this condition can have a dramatic impact on physical mobility. The etiology of this condition is not clearly understood and is probably multi-factorial in nature. Weight gain, occupation-related activity, anatomical variations, poor biomechanics, overexertion, and inadequate footwear are contributing factors. Although plantar fasciitis is generally regarded as a self-limited condition, it can take months to years to resolve, presenting a challenge for clinicians. Many treatment options are available that demonstrate variable levels of efficacy. Conservative therapies include rest and avoidance of potentially aggravating activities, stretching and strengthening exercises, orthotics, arch supports, and night splinting. Other considerations include use of anti-inflammatory agents, ultrasonic shockwave therapy, and, in the most extreme cases, surgery. This article reviews plantar fasciitis, presents the most effective treatment options currently available, and proposes nutritional considerations that may be beneficial in the management of this condition. ***(Altern Med Rev* 2005;10(2):83-93)**

Introduction

Description

Plantar fasciitis (PF) is a degenerative syndrome of the plantar fascia resulting from repeated trauma at its origin on the calcaneus.[1] PF is reported to be the most common cause of inferior heel pain in adults.[2] Other names for PF include painful heel syndrome, heel spur syndrome,[3] runner's heel, subcalcaneal pain, calcaneodynia, and calcaneal periostitis.[4] The word "fasciitis" assumes inflammation is an inherent component of this condition. However, recent research suggests that some presentations of PF manifest non-inflammatory, degenerative processes and should more aptly be termed "plantar fasciosis."[3,5] In the United States, more than two million individuals are treated for PF on an annual basis, accounting for 11-15 percent of professional visits related to foot pain.[6] It is estimated that 10 percent of the U.S. population will experience plantar heel pain during the course of a lifetime.[7] PF affects individuals regardless of sex, age, ethnicity, or activity level. It is seen in physically active individuals such as runners and military personnel, but is also prevalent in the general population, particularly in women ages 40-60.[2,8,9]

Etiology and Pathophysiology

The plantar fascia is a thickened fibrous sheet of connective tissue that originates from the medial tubercle on the undersurface of the calcaneus and fans out, attaching to the plantar plates of the metatarsophalangeal joints to form the medial longitudinal arch of the foot. It provides key functions during running and walking. In general, the purpose of the plantar fascia is twofold – to provide support of the longitudinal arch and to serve as a dynamic shock absorber for the foot and entire leg.

As one walks, the heel makes contact with the ground. Just after this contact, the tibia turns inward and the foot pronates, stretching the plantar fascia and flattening the arch. This allows the foot to accommodate for irregularities in the walking surface

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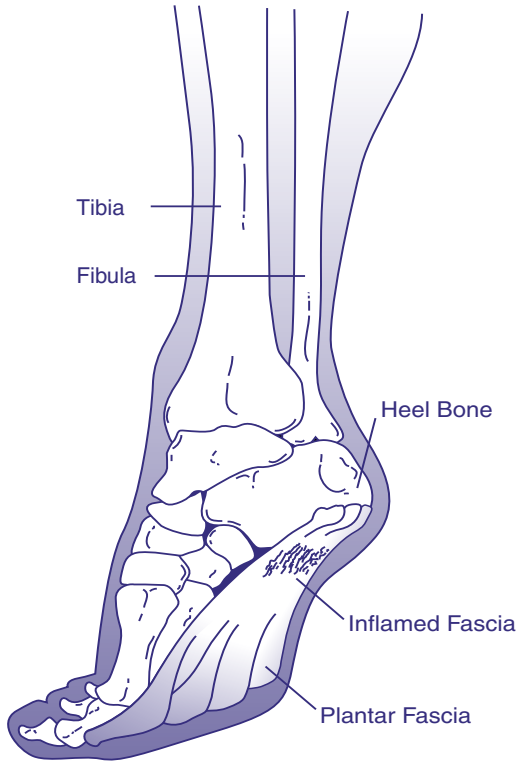
Figure 1. Micro-tears Lead to a Chronic Inflammatory Response



Adapted from: Singh D, Angel J, Bentley G, Trevino SG. Fortnightly review. Plantar fasciitis. *BMJ* 1997;315:172-175.

and absorb shock.

In the presence of aggravating factors, the repetitive movement of walking or running can cause micro-tears in the plantar fascia. The affected site is frequently near the origin of the plantar fascia at the medial tuberosity of the calcaneus (Figure 1). Biopsy specimens of the affected tissue reveal degenerative changes in the fascia, with or without fibroblastic proliferation and chronic inflammatory changes.[2,9]

The etiology of PF is poorly understood. While this condition can occur in association with various arthritides, the etiology is unknown in approximately 85 percent of cases.[10] In athletes, PF appears to be associated with overuse, training errors, training on unyielding surfaces, and improper or excessively worn footwear. Sudden increases in weight-bearing activity, particularly those involving running, can cause micro-trauma to the plantar fascia at a rate that exceeds the body's ability to recover.[11] When PF occurs in elderly adults, it is often attributable to poor intrinsic muscle strength and poor force attenuation, secondary to acquired pes planus (excessive pronation of the foot) and compounded by a decrease in the body's healing capacity.[11] Similarly, individuals with diabetes mellitus may suffer from PF as a result of peripheral motor neuropathy leading to muscle atrophy, changes in anatomical structure of the feet (clawtoes, pes cavus or high arches, prominent metatarsal heads, etc.), and functional alterations in gait.[12]

Risk Factors

PF is likely the result of multiple factors. Recent case-controlled studies have identified obesity or sudden weight gain, reduced ankle dorsiflexion, pes planus, and occupations that require prolonged weight-bearing as the greatest risk factors associated with PF.

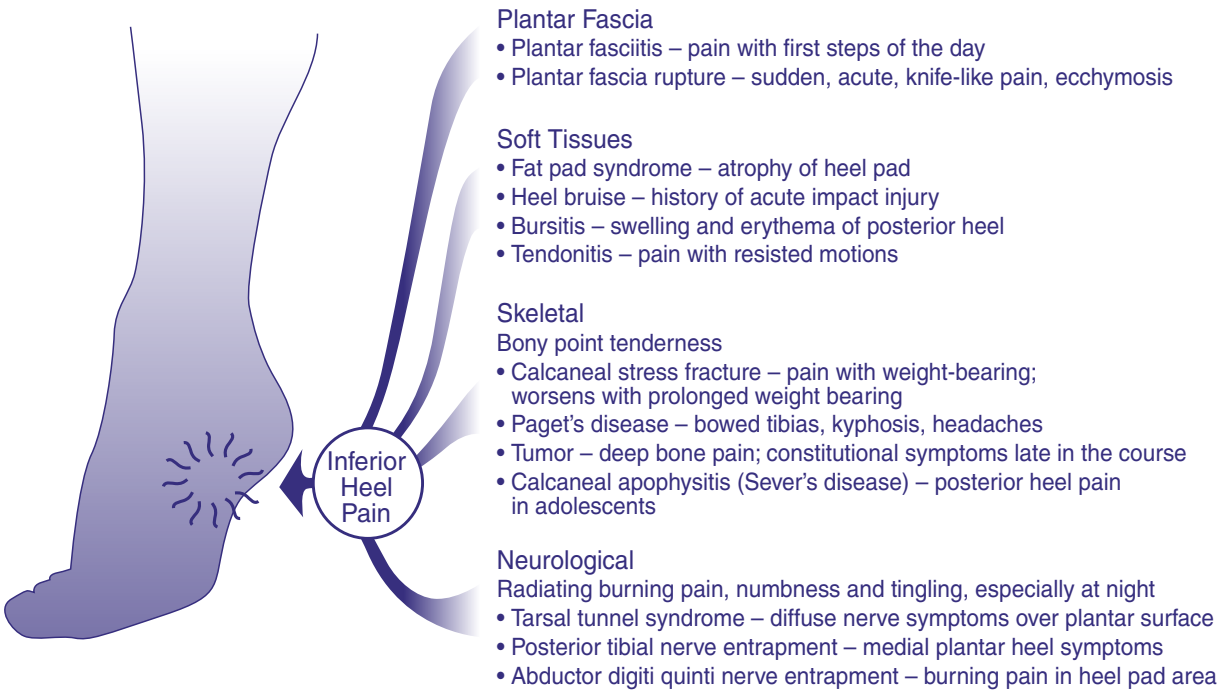
One study observed that individuals with a body mass index (BMI) > 30 kg/m^2 (the cutoff for grade-II obesity) had an odds ratio of 5.6 for PF compared to those with a BMI ≤ 25 kg/m^2.[10] The same study observed that risk of PF increases as the range of ankle dorsiflexion decreases. Individuals with <10° of ankle dorsiflexion had an odds ratio of at least 2.1 for PF. The ratio increased dramatically as the range of dorsiflexion decreased.[10]

Reports state that 81-86 percent of individuals with symptoms consistent with PF have excessive pronation.[1] Individuals with pes planus, associated with low arches or flat feet,[1,9-11] are thought to be at greater risk for PF. However, individuals with pes cavus[9,11,13] are also potentially at risk due to the inability to effectively dissipate tensile forces during weight-bearing activities.[1] Other potential anatomical risks include leg length discrepancy, excessive lateral tibial torsion, and excessive femoral anteversion.[11,14,15]

People with occupations requiring prolonged weight-bearing have long been considered at risk of PF because of the repetitive tensile load placed on the fascia.[2,9-11]

Heel spurs have commonly been implicated as a risk factor for PF. Approximately one-half of patients diagnosed with PF have heel spurs,[16] although it is unclear how much influence heel spurs actually

Figure 2. Causes of Inferior Heel Pain



Adapted from:

Young CC, Rutherford DS, Niedfeldt MW. Treatment of plantar fasciitis. *Am Fam Physician* 2001;63:467-474;477-478. Erratum in: *Am Fam Physician* 2001;64:570.

Singh D, Angel J, Bentley G, Trevino SG. Fortnightly review. Plantar fasciitis. *BMJ* 1997;315:172-175.

have on the condition. One study reviewing the radiographs of 1,000 patients found 13.2 percent had heel spurs; of these, only 39 percent (5.2% of the total sample) reported any history of subcalcaneal pain.[1]

Signs and Symptoms

The classic presentation of PF is pain on the sole of the foot at the inferior region of the heel. Patients report the pain to be particularly bad with the first few steps taken on rising in the morning or after an extended refrain from weight-bearing activity. The pain can be so severe the patient limps or hobbles around with the affected heel off the ground. After a few steps and through the course of the day, the heel pain diminishes, but returns if intense or prolonged weight-bearing activity is undertaken. Initial reports of the heel pain may be diffuse or migratory; however, with time it usually focuses around the area of the medial calcaneal tuberosity. Generally, the pain is most significant when weight-bearing activities are involved, and can often be correlated to increased amount or intensity of physical activity prior to onset of symptoms.

Diagnosis

Diagnosis of PF is usually made on the basis of history and physical examination. Pain on first rising in the morning is typical of PF, and may be helpful in distinguishing it from other forms of heel pain (Figure 2). For example, in the case of a calcaneal stress fracture or nerve entrapment, pain would actually increase with more walking, rather than diminish after the first few steps.[2,11] Associated paresthesia is not a common characteristic of PF.[9] Nocturnal pain should raise suspicion of other causes of heel pain, such as tumors, infections, and neuralgia (including

tarsal tunnel syndrome).[2] PF is usually unilateral, but up to 30 percent of cases have a bilateral presentation.[9] Bilateral disease in young patients may indicate Reiter's syndrome. Patients should also be questioned about other features of seronegative arthritides.[2]

Physical examination presents with localized tenderness at the antero-medial aspect of the calcaneus. Pain may be exacerbated by passive dorsiflexion of the toes or having the patient stand on the tips of the toes.[11] Tightness of the Achilles tendon (with dorsiflexion at the ankle limited by 5° or more) is found in almost 80 percent of patients.[2]

Diagnostic imaging is rarely indicated for initial evaluation and treatment, but may be helpful in certain cases to rule out other causes of heel pain. Plain radiographs can rule out calcaneal stress fracture and may detect an underlying spondyloarthropathy.[9] Bone scans and magnetic resonance imaging (MRI) may also serve useful, but are not routinely used.[9] Ultrasonography is another useful tool to diagnose PF.[17]

Current Treatment Options

PF is considered a self-limiting condition. However, the typical resolution time is anywhere from 6-18 months, sometimes longer,[11] which can lead to frustration on both the part of the physician and patient. Most experts agree that early recognition and treatment of PF leads to a shorter course of treatment and greater probability of success with conservative therapies.[2,9,11] Of the many treatment options available for PF, one of the most effective is also the most fundamental – rest and avoidance of aggravating activity provides significant relief. One study cited rest as the treatment that worked best for 25 percent of PF patients.[18]

Proper Shoes

Shoes should have adequate arch support and cushioned heels. Worn or ill-fitting shoes can exacerbate PF due to lack of proper cushioning. Over time, running shoes can lose a significant amount of shock absorption. Consequently, a new pair of running shoes can do much to decrease foot pain. For individuals with pes planus, shoes with longitudinal arch support can help decrease the pain associated with long periods of standing.[11] A change in footwear was cited by 14 percent of PF patients as the treatment that worked best.[18]

Arch Supports and Orthotics

Mechanical (strapping, taping, etc.) or accommodative (heel cups, orthotics, etc.) treatments may be effective components of a PF treatment plan.[19] A randomized clinical study of 103 patients compared three treatment categories: anti-inflammatory (corticosteroid injections); accommodative (viscoelastic heel cup); and mechanical (low-Dye taping for one month followed by rigid custom orthotics for two months). After three months of treatment, 70 percent of participants in the mechanical treatment group rated their outcome as "excellent" or "fair" compared to the anti-inflammatory and accommodative treatment groups, with only a 33- and 30-percent excellent outcome, respectively ($p=0.005$).[20,21]

In a study of 236 participants, prefabricated shoe inserts were superior to both custom-made orthotics and stretching alone, with over 80 percent of people in the prefabricated insert group showing improvement after eight weeks, compared to 68 percent with custom-made orthotics and 72 percent in the stretching group.[6]

Stretching and Strengthening

Stretching and strengthening programs are valuable because they can help correct functional risk factors, such as tightness of the Achilles tendon and weakness of intrinsic muscles of the foot. One study cited stretching and strengthening exercises as the treatment that worked best for 29 percent of PF patients.[18] Commonly used stretches are leaning wall stretches (Figures 3a and 3b) and curb or stair stretches (Figure 4), which focus on stretching the gastrocnemius and soleus muscles. Rolling the foot over a 15-oz can or tennis ball (Figure 5) helps stretch the plantar fascia. Cross-friction massage above the plantar fascia (Figure 6) can be beneficial on waking to help stretch and warm up the fascia before the first steps of the day. Strengthening exercises are focused on the intrinsic muscles of the foot and include towel curls (Figure 7), toe taps, and picking up marbles with the toes.[11,22]

Figures 3a and 3b. Leaning Wall Stretches

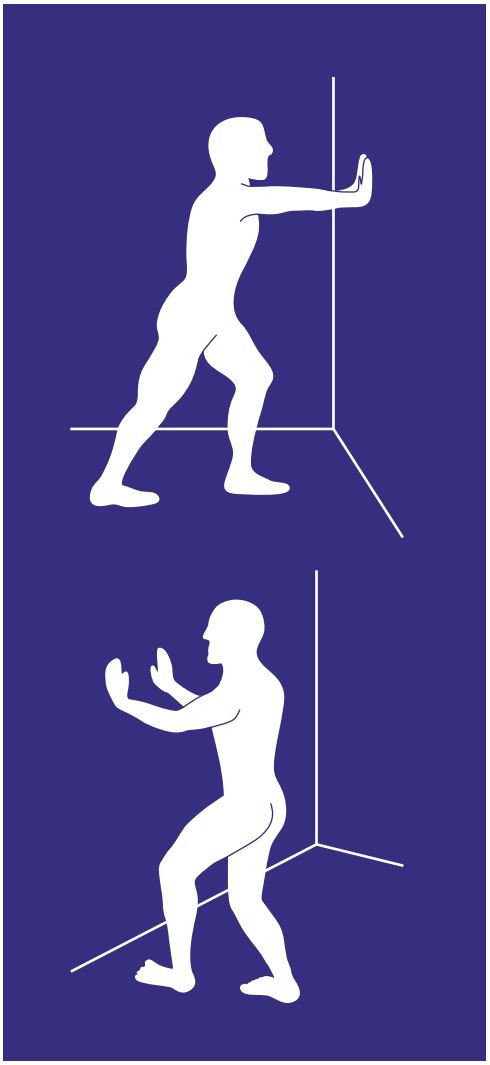


Figure 4. Curb or Stair Stretches

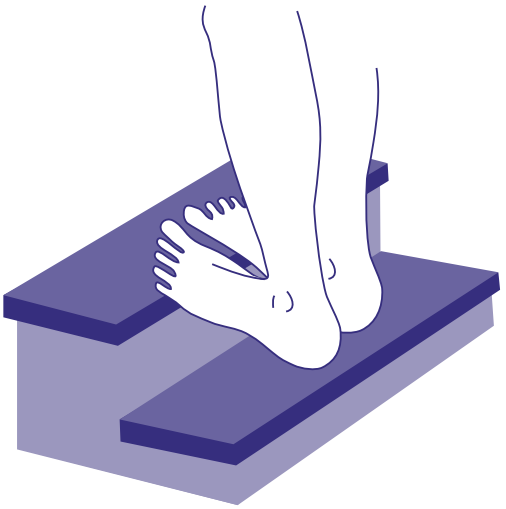
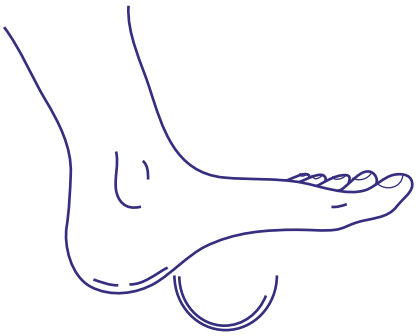


Figure 5. Ball-Rolling Exercise



Splinting and Walking Casts

The purpose of night splinting is to keep the patient's ankle in a neutral position overnight, passively stretching the calf and plantar fascia during sleep. The intent is to allow the fascia to heal. Clinical study of night splinting has yielded mixed reviews. Some reports claim improvement in approximately 80 percent of patients.[11] In contrast, one study of 116 patients showed no benefit after three months compared to no treatment.[9]

A walking cast provides rest for the heel, reduces pressure on the heel at heel strike, provides arch support, and prevents tightening of the Achilles tendon. The patient typically wears the cast for a period of 3-4 weeks. A retrospective review observed 46 percent of patients experienced a recurrence of pain, usually a month after the treatment.[9]

Figure 6. Cross-Friction Massage

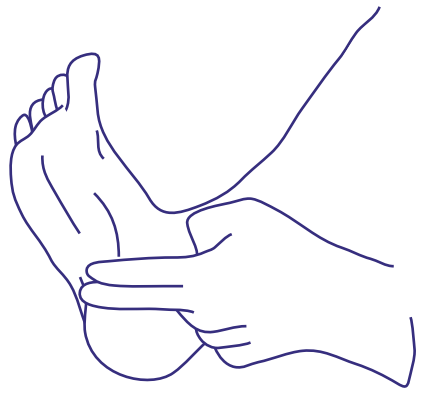
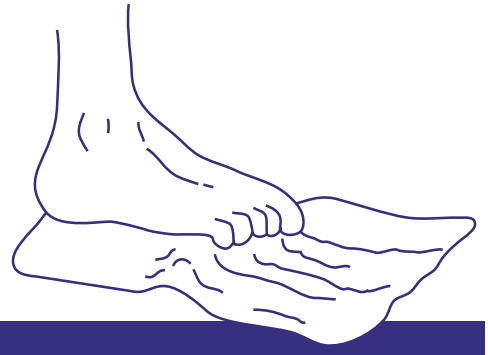


Figure 7. The Towel Curl



1. Place towel on smooth floor surface.
2. Step on towel with foot flat on the end of the towel.
3. Keeping the heel on the floor, pull the towel toward the body by curling the towel with the toes.

Anti-inflammatory Agents

The most common anti-inflammatory agents are cryotherapy (ice), non-steroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injections. Ice and oral NSAIDs (ibuprofen, naproxen) are beneficial for temporary relief of acute pain and inflammation; however, they are not curative.

Traditionally, corticosteroid injections were given for chronic heel pain. However, multiple corticosteroid injections have been associated with fascia weakness and rupture, as well as atrophy of the fat pad cushioning the heel.[13,23-25] As a result, corticosteroid injections are now reserved for intractable cases.

Surgery

Surgery for PF should be considered only after all other forms of treatment have failed. The most common procedure is a partial plantar fasciotomy that may be either open or closed. An open procedure requires a 3-6 cm plantar medial incision to release the fascia. Nerve decompression and/or resection of calcaneal spur may also be performed at this time. A closed procedure utilizes endoscopy to release the fascia. In this type of procedure, resection of a calcaneal spur is generally not performed. One study compared both procedures and found them equally effective.[1] Overall, the success rate for surgical release is 70-90 percent.[11] Recovery from this surgery can vary from several weeks to several months, with one study reporting the average recovery time to be 7.85 months.[4] Potential complications include transient swelling of the heel pad, calcaneal fracture, flattening of the longitudinal arch, damage to the posterior tibial nerve, heel hypoesthesia, and rupture of the plantar fascia.

Extracorporeal Shock-Wave Therapy

A new treatment being investigated is extracorporeal shock-wave therapy (ESWT), which uses pulses of high-pressure sound waves to bombard damaged tissue to relieve pain associated with PF. ESWT has been touted as the alternative to surgery for those with longstanding, recalcitrant heel pain. It is non-invasive, has a relatively short recovery time, and claims a success rate comparable to surgery.[26,27] There is some dispute regarding how this treatment actually affects the body. Some say it stimulates blood flow and perhaps elicits a beneficial immune response, while others contend the shock waves in effect re-injure the tissue, thereby initiating a healing response. Yet other experts propose the pulses bombard the central nervous system, essentially shutting the neuronal pathways down to relieve the pain.[26,28] Recent reports on the efficacy of ESWT, however,

have not been stellar. One randomized, double-blind, placebo-controlled trial from Australia determined it to be no better than placebo.[29] Two other trials conducted in Germany arrived at the same conclusion.[30,31] One study involving 150 patients demonstrated a success rate of 56 percent in the active group versus 45 percent in the control group.[26] Nevertheless, the U.S. Food and Drug Administration has approved two shock-wave machines for treatment of PF and tennis elbow.[28] More studies are necessary to determine how effective this treatment is for PF.

Alternative Treatment Options

Magnetic Insoles

Use of magnetic insoles has been considered by some clinicians as a treatment for PF, but available data regarding efficacy is limited, and results are mixed at best. One trial involved 375 patients with diabetic peripheral neuropathy, randomly assigned to wear either magnetized soles or placebo for four months. Results were marginal, showing 10-12 percent reductions in numbness and tingling, burning, and pain.[32,33] Another randomized trial of 101 patients with plantar heel pain concluded magnetic insoles were no more beneficial than placebo.[34]

Acupuncture

Acupuncture has been proposed as an effective treatment for PF; however, most reports have been anecdotal in nature.[35] Research regarding its efficacy is quite limited at this time, but does show promise. One study was performed on 11 patients using acupuncture in conjunction with electrical stimulation. Patients were treated once weekly for 3-6 weeks. Post-treatment results demonstrated a significant reduction in the mean score for overall pain (from 5.7 to 3.0 on a 10-point visual analog scale).[36]

Nutritional Considerations

There is a dearth of clinical research regarding nutrition in the specific management of PF. This is not to say, however, that support is unavailable. The following are selected considerations to assist the clinician as part of the overall management of PF.

Vitamin C

Widely known for its antioxidant properties,[37,38] vitamin C is also an essential component for healthy connective tissue repair. It is necessary for the hydroxylation of proline and lysine residues in procollagen, a precursor to collagen. Hydroxyprolines stabilize the triple-helix structure of collagen.[39] A deficiency in vitamin C can result in abnormal collagen fibers, as well as other changes in the intracellular matrix, that can contribute to decreased tensile strength of fibrous tissues,[40] such as those found in the plantar fascia. Recommended dosing of vitamin C for the purpose of tissue repair is 1-3 g daily until resolution.[41-43]

Zinc

Zinc, an essential trace mineral, is utilized in over 300 known enzymatic reactions. It is a key element in tissue regeneration and repair, working in concert with vitamin C to increase tensile strength of wounded tissue.[44] Research conducted on animal models suggests decreased protein and collagen synthesis may be due in part to zinc deficiency, leading to delayed wound healing.[45,46] Zinc deficiency is a common occurrence,[47] particularly in individuals with chronic injuries and high stress levels. Intense exercise can affect zinc utilization.[47] Further investigation is required to determine the efficacy of zinc supplementation for wound healing. However, existing data suggests supplementation to be a reasonable consideration to prevent consequences of deficiency. Recommended dosage for zinc is 15-30 mg daily.[47,48]

Glucosamine

Glucosamine may be helpful in the management of PF because it serves as a potential alternative to NSAID use and is a key biochemical component in the repair and regeneration of connective tissue.

Several studies have compared glucosamine sulfate (GS) with NSAIDs.[49-52] Although the context of these studies on GS has been with regard to treatment of osteoarthritis, it may be reasonable to consider its application in PF. Three independent, double-blind studies (involving 200, 178, and 40 patients with osteoarthritis, respectively) compared the effects of GS to ibuprofen.[49-53] In the first study, over a four-week period, pain and function improved more

rapidly in the ibuprofen group compared to the GS group for the first two weeks. However, at the end of the fourth week, there were no significant differences between the two groups, suggesting GS was as effective as ibuprofen in alleviating OA symptoms.[50] Similar results were determined in the second study.[51] The third study observed patients over an eight-week period. At the end of the study, the GS group reported greater improvement than the ibuprofen group.[52] Fairly consistent in these trials was the observation that GS provided longer lasting benefit and was better tolerated than NSAIDs, despite the fact that GS has little direct anti-inflammatory effect and no direct analgesic properties.[53] This may be explained in part because, although NSAIDs provide symptomatic relief from pain and inflammation, they do nothing to repair tissue trauma. By contrast, GS provides the nutritional components that not only improve symptoms but aid in the body's reparative process.

Glucosamine is the foundational structure of many compounds associated with repair and regeneration of connective tissue. It is the essential substrate for hyaluronic acid and other glycosaminoglycans used in maintaining healthy joint function.[54] *In vitro* studies suggest glucosamine stimulates the synthesis of glycosaminoglycans and collagen.[55] Recommended dosage for glucosamine is 500 mg three times daily in the form of glucosamine sulfate.[53,56]

Bromelain

Bromelain is the singular name used for a family of proteolytic enzymes found in the pineapple plant (*Ananas comosus*). Bromelain is commonly used in treating inflammation and soft tissue injuries and, as such, may be beneficial in the management of PF. It has been shown to accelerate healing from bruises and hematomas.[57] One open-case observation study demonstrated the efficacy of bromelain on 59 patients with blunt injuries to the musculoskeletal system. It was reported that use of bromelain reduced swelling, tenderness, and pain, both at rest and during movement.[58]

The anti-inflammatory activity of bromelain may be due in part to inhibition of bradykinin production at the site of inflammation by way of limiting plasma kallikrein and fibrin formation.[59-61] Furthermore, bromelain has been shown to stimulate conversion of plasminogen to plasmin, thereby increasing fibrinolysis.[61]

There are several designations used to indicate the activity of bromelain. The most common measures of bromelain activity are milk clotting units (mcu) and gelatin dissolving units (gdu). One gdu approximately equals 1.5 mcu. Typically, enzymatic activity is given as a measure of mcu or gdu per gram of bromelain; e.g., 2,000 mcu/g or 1,333 gdu/g, respectively.

Recommended dosage for bromelain is 500-2,000 mg daily (with at least 2,000 mcu/g) in divided doses.[62,63]

Fish Oil

Oils from deep sea fish are a rich source of omega-3 polyunsaturated fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fish oils have been observed to suppress production of inflammatory mediators in patients with autoimmune conditions, such as rheumatoid arthritis. A double-blind, placebo-controlled study on 49 patients with rheumatoid arthritis found those given fish oil daily for 24 weeks showed less morning stiffness and fewer tender joints than control group counterparts.[64] This may be due to reduced synthesis of key inflammatory mediators – leukotrienes, interleukin-2, and tumor necrosis factor. Such anti-inflammatory properties may in turn be beneficial in the management of PF.

The natural ratio of EPA to DHA is approximately 3:2, accounting for 30 percent of the fatty acid content in fish oil. Therapeutic dosages for fish oil range from 1-10 g daily, depending on severity, and may require 2-6 months to manifest effect. Recommended dosage for PF is 2-3 g daily.

Conclusion

PF is generally regarded as a self-limited condition, with more than 80 percent of cases resolving within 12 months, regardless of therapy. A variety of treatment options are available to patients. The most prudent approach to therapy is to employ conservative treatments first. Primary considerations for treatment should include temporary refrain from intense weight-bearing activity as much as possible; avoidance of walking barefoot on hard surfaces; and

replacement of any worn or ill-fitting shoes with new, more accommodating footwear. Stretching and strengthening exercises can be beneficial for treatment and prevention of recurrence.

Use of mechanical devices may be an option for individuals for whom the condition does not improve. However, efficacy of these treatments is questionable. Other treatment options may be beneficial, including extracorporeal shockwave therapy, magnetic insoles, and acupuncture. Surgery should only be considered for patients with considerable disability for whom conservative treatment has not helped after at least 12 months.

Non-steroidal anti-inflammatory drugs are used conventionally for temporary pain relief, but offer no support for resolution of the condition. Corticosteroid injections provide temporary relief from pain and are recommended only in extreme cases, as they may increase the risk of infection and contribute to further degeneration of the plantar fascia and heel fat pad. Alternatively, nutritional considerations such as vitamin C, zinc, glucosamine sulfate, bromelain, and fish oil may be incorporated to address the pain and inflammatory symptoms associated with PF, and to help support the healing process systemically.

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