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PLANTAR HEEL PAIN SYNDROME: OVERVIEW AND MANAGEMENT

The plantar fascia as a source of pain—biomechanics, presentation and treatment

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Abstract That plantar fasciitis is one of the most common causes of heel pain is beyond dispute. It is also by far the most common sports injury presenting to the office of the sports podiatrist (Bartold, 2001, Sports Medicine for Specific Ages and Abilities. Churchill Livingstone, Edinburgh, p. 425) and accounts for approximately 15% of all foot related complaints (Lutter, 1997, Med. J Allina. 6(2) http://www.allina.com). The term plantar fasciitis itself has been responsible for considerable confusion, since the condition usually presents as a combination of clinical entities, rather than the discrete diagnosis of plantar fasciitis. For this reason, it may be preferable to consider the condition a syndrome, and alter the nomenclature to plantar heel pain syndrome (PHPS).

Despite its wide distribution in the sporting and general communities, there remains widespread debate on its aetiology and dissatisfaction with a lack of reliable treatment outcomes. This paper describes the unique anatomical and biomechanical features of plantar fasciitis which may in part explain its resistance to treatment. The history and physical examination are described along with potential differential diagnoses. Because plantar fasciitis is multi-faceted in nature, treatment may be directed at the wrong focus, resulting in poor outcomes and prognosis. The most common conservative management techniques are described, and a new, reliable method of taping is proposed.

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What is plantar fasciitis?

Plantar fasciitis was first described by Wood in 1812, and he attributed it to tuberculosis (Leach et al., 1996). Since then, plantar fasciitis is known by many pseudonyms, including; jogger's heel, heel spur syndrome, plantar fascial insertitis, calcaneal enthesopathy, subcalcaneal bursitis, subcalcaneal pain, stone bruise, calcaneal periostitis, neuritis and calcaneodynia (DeMaio et al., 1993). It is important to recognize that plantar fasciitis has a much reported association with the specific enthesopathies occurring in diffuse connective tissue disease, especially rheumatoid arthritis, and the spondyloarthropathies—ankylosing spondylitis and psoriatic arthritis. The inciting inflammation may therefore be local or systemic, and that inflammation may stem from the plantar fascia proper or may be secondary to inflammation in surrounding tissues. For this reason, this author believes it is useful to consider plantar fasciitis as a syndrome

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that may comprise one or more conditions, including the specific diagnosis of plantar fasciitis. This is similar to the concept of chondromalacia patella and its role in anterior knee pain. Previously the specific diagnosis of chondromalacia patella has been used to describe all anterior knee pain. This practise has now fallen out of favour, with the more generic descriptive terms of patellofemoral syndrome or patellofemoral arthralgia in common use.

Distribution

Plantar fasciitis has been reported across a wide sample of the community. In the non-athletic population, it is most frequently seen in the weight bearing occupations, especially factory workers, storemen and nurses. Lutter (1997) reports that 65% of the non-sports demographic are over weight, with unilateral involvement most common in 70% of the cases. Most of the literature is in agreement that plantar fasciitis occurs most commonly after the fifth decade, and has been attributed to atrophy of the fat pad (Sherreff, 1987). However, a recent study by Tsai et al. (2000) investigated ultrasound profiles of the heel fat pad in plantar fasciitis patients. They concluded that the heel pad thickness was not altered in the control group compared to subjects with plantar fasciitis. It is perhaps more feasible that other mechanical properties of the heel pad, for example relative compressibility or shock absorbency, or changes to the plantar aponeurosis origin as a result of altered connective tissue characteristics with age, may contribute to the increased prevalence of plantar fasciitis with age. It is important to note that plantar fasciitis may however occur at any age.

There is conflicting data in the literature in relation to gender distribution of plantar fasciitis. Lutter (1997) reports a female to male predominance of 3:1, however, several authors have reported the reverse, with males more commonly affected than females (Fury, 1975; Lapidus and Guidotti, 1965; McBryde, 1984). It seems likely that changes in social dynamics, with more women employed in industry and weight bearing jobs, and especially the increased participation of women in sport, may be responsible for an increase in plantar fasciitis reporting in females.

The second major distribution of plantar fasciitis is in the athletic population, with the same rate of reporting—approximately 10% of all running athletes—as the general population. Basketball, tennis, football and dance have all noted high frequencies of plantar fasciitis, however long distance running is the activity most often associated with this condition. There appears to be little correlation between mileage and plantar fasciitis, with cases reported from both high and low mileage runners. Given the accepted preponderance for plantar fasciitis to occur in older individuals, middle-aged distance runners represent the most common demographic for this condition.

Anatomy

The plantar fascia is perhaps more correctly called the plantar aponeurosis, and lies superficial to the muscles of the plantar surface of the foot. The plantar fascia has a thick and strong central part which covers the central muscle of the 1st layer, flexor digitorum brevis and is immediately deep to the superficial fascia of the plantar surface. It is attached proximally to the calcaneus at the anterior calcaneal tubercle, the site of the muscle attachments, while distally it blends with the skin at the creases of the base of the digits, and also sends five slips, one to each toe. Each of these split into two, which pass deeply, one on each side of the flexor tendons of that toe, and finally fuse with the deep transverse metatarsal ligaments.

This anatomical arrangement is integral to the pathogenesis of plantar fasciitis. Also of great importance anatomically are the perifascial structures, most notably the subcalcaneal bursa and medial tibial branch of the posterior tibial nerve,

Figure 1 The anatomy of the plantar fascia and perifascial structures.

see Fig. 1. Both these structures may be involved in what is seen as the general symptom complex of plantar fasciitis, especially in the more chronic cases. The calcaneal tuberosity comprises both a medial and lateral tubercle. The larger medial tubercle provides the attachment for the abductor hallucis, flexor digitorum brevis, and the plantar fascia. The central portion of the plantar fascia is the thickest and strongest. It narrows proximally at its origin and fans out to its distal insertion into the phalanges. The foot has four layers: Superficial, 2nd, 3rd and 4th. The superficial layer contains the flexor digitorum brevis, abductor hallucis, abductor digiti minimi and the plantar fascia. Many of the foots' vital neurovascular structures are in close proximity to this layer. The medial and lateral plantar nerves travel together under the abductor hallucis. The medial plantar nerve travels beneath the abductor hallucis distally, where is emerges to give off its digital branches. The lateral plantar nerve emerges from the abductor hallucis and courses obliquely through the central compartment. It lies between the flexor digitorum brevis and quadratus muscle.

Biomechanics of the plantar fascia

The unique anatomical features of the plantar fascia have been described, and it is these features that allow the plantar fascia to link the major tarsal bones with the ligaments of the forefoot. In this way, the plantar fascia acts as a mechanical truss (Kwong et al., 1988) or a platform that passively stabilises the foot (Cooper, 1997) maintaining the integrity of the medial longitudinal arch. Kogler et al. (1996) made the interesting observation that although the foot manifests an arciform appearance, it is not a true arch structurally, that is, it cannot maintain its arched shape solely as a result of its own geometry. Rather, the foot arch is heavily reliant on adjacent soft tissues to maintain its arched position. The plantar fascia plays a major role in this regard, primarily as a result of its anatomical position, great mechanical strength and biomechanical properties.

Rupture and partial or complete surgical sectioning of the plantar fascia, may lead to progressive pes planus with associated complications (Sharkey et al., 1998). This is, however dependent upon site of rupture or surgical release. Changes in arch confirmation after partial sectioning may be very small, however Sharkey et al. (1998) report that any change from normal may be enough to precipitate a cascade of events eventually leading to symptomatic pes planus.

The passive support role of the plantar fascia is therefore established. The dynamic role of the plantar fascia, particularly its ability to assist in the propulsive phase of gait, is critical to normal foot function. The function of the plantar fascia during gait is augmented by the dynamic actions of several other extrinsic muscles of the foot. Tibialis posterior is particularly important in this regard, with the anatomic location and activity profile of the tibialis posterior muscles suggesting that it helps maintain the medial longitudinal arch during locomotion. The actions of flexor digitorum longus (FDL) and flexor hallucis longus (FHL) are also critical to arch stability and may assist the actions of the plantar aponeurosis in the later stages of the stance phase of gait. The plantar fascia however remains the most important arch stabilising structure. It elongates with increasing loads, and stores this elastic energy, acting as a shock absorber (Wright and Rennels, 1964). It has a limited ability to elongate however, and plantar fascial tissue stiffens with increasing tension (Perry, 1983). These mechanical properties, linked with the manner of its insertion into the medial calcaneus, means the plantar fascia has a vital role in resupination of the foot during the propulsive period of the stance phase of gait (Bartold, 2001). This is achieved through the so called "windlass mechanism", as first described by Hicks (1954). During this action, the plantar fascia tightens when the metatarsophalangeal joints are extended passively. This pulls on the medial insertion of the plantar fascia at the calcaneus, shortening the truss and raising the height of the arch.

History

Plantar fasciitis presents in a most characteristic manner, and the diagnosis clinically is often made within the first few minutes of history taking. Typically plantar fasciitis is:

- *Insidious*. The onset is gradual and worsens over a period of time, often weeks or even months. Eventually the pain degenerates to a stage where the patient is compelled to seek treatment. Plantar fasciitis is invariably preceded by some traumatic incident. Interestingly, if the history is complete enough, the examining practitioner will often elicit the report of injuries at the general region of the plantar fascia at the time the pain first started. An example of this would be catching the heel on

the edge of a footpath whilst crossing the road. At the time this does not cause pain, but at a microscopic level it may be enough to cause separation of the cross linking structure of the collagen fibres of the plantar fascia and precipitate symptomatic, chronic condition.
- *Painful in the morning on rising from rest*. The patient will report pain, severe on first weight bearing in the morning or on rising after a prolonged period of rest (e.g. after a long car journey). This pain will inevitably improve after a short period of walking. Likewise, the pain is worse at the commencement of sporting activity and improves after a period of "warm up". The pain is, however, likely to worsen after cessation of sport. The basis of this pain after rest is presumed to be due to the accumulation of inflammatory by-products which impinge on the nerve endings when compressed during weight bearing (Bartold, 1997). This pain is absolutely characteristic of plantar fasciitis and is one of the most reliable and characteristic features diagnostically.
- *Localized over the medial slip of the origin of the fascia. A pain localized over the medial slip of the origin of the fascia*. Plantar fasciitis is usually a very well localized condition and this assists greatly in making the diagnosis. It is relatively uncommon for pain to be spread over a more diffuse area, but there may be poorly defined pain in the mid-substance of the fascia or even spreading up the medial and lateral aspects of the calcaneus (see Box 1).

Box 1 Clinical point

Heel spurs

- Bony spurs are frequently associated with plantar fasciitis, but are generally not associated with the cause of pain.
- There are no clear studies to show the association of heel spurs and plantar fasciitis.
- Heel spurs are frequently present in the asymptomatic population (10–30%).
- Fat pad atrophy may be a consequence of subdermal infiltration of cortico-steroid. In this instance, heel spurs may be symptomatic.
- Heel spurs may fracture secondary to direct heel trauma.
- Heel spurs have been noted in greater proportions in the obese population, lending weight to the theory they are associated with traction as the enthesis.
- Heel spurs may be associated with systemic disease (Fig. 1).

Physical examination

- *Local tenderness*. Pain will usually be localized over a small area near the origin of the fascia at the proximal insertion into the medial tubercle of the calcaneus. The pain response to palpation over this small area involves considerable apprehension, evasive action may be taken by the patient to avoid further investigation! See Fig. 2.
- Commonly there will be *pain over the midline of the plantar surface* of the calcaneus, which may be either diffuse or localized in nature. This pain may characteristically be seen in patients with

Figure 2 The area of pain is often very localized over the medial origin of the medial band of the plantar fascia.

weight bearing occupations (nurses, storemen etc.) and probably represents some inflammation of the subcalcaneal bursa.

- There is often *diffuse tenderness* up the medial or lateral aspect of the calcaneus, which is typical of the more severe inflammatory processes. This needs to be differentiated from calcaneal stress fracture or referred pain from the subtalar joint, see Fig. 3.
- *Positive windlass manoeuvre*, i.e. pain with passive dorsiflexion of the hallux, thereby loading the plantar fascia. This positive windlass test is often quoted in the texts, but in reality is seen in only a tiny percentage of cases, and then only the most severe. A positive windlass response may indicate rupture of a significant proportion of the fascia. In this instance, significant gapping in the plantar fascia may be palpated, see Fig. 4.
- *No swelling*. Swelling with plantar fasciitis is relatively rare and usually reserved to the most severe cases or an acute fascial injury. The presence of swelling, however, can be an important diagnostic clue and may indicate other injuries such as fracture, muscle injury or rupture to the fascia.
- *Nodular change to the fascia* is a very common finding and represents fascial granulomata formed as the result of repeated fascial injury which has healed with scarring. These granulomata can become quite large (the size of a golf

Figure 3 There is often diffuse tenderness up the medial or lateral aspect of the calcaneus, which is typical of the more severe inflammatory processes. This needs to be differentiated from calcaneal stress fracture or referred pain from the subtalar joint.

Figure 4 Positive windlass manoeuvre, i.e. pain with passive dorsiflexion of the hallux, thereby loading the plantar fascia. This positive windlass test is often quoted in the texts, but in reality is seen in only a tiny percentage of cases, and then only the most severe. A positive windlass response may indicate rupture of a significant proportion of the fascia. In this instance, significant gapping in the plantar fascia may be palpated.

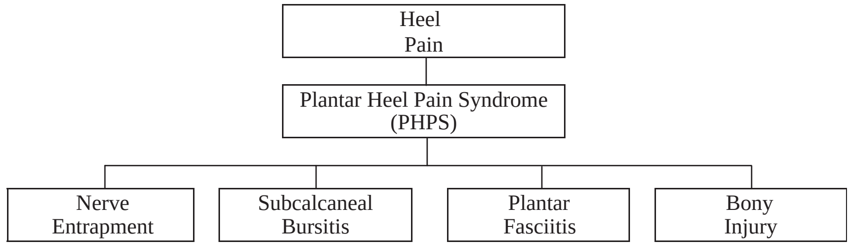

Plate 1

ball is not uncommon), and therefore very uncomfortable during weight-bearing. If these lesions cannot be accommodated with the appropriate orthotic devise, surgical intervention is appropriate.

- *Pain with passive talocrural joint dorsiflexion*. Because of the intimate anatomical relationship between the plantar fascia and the triceps surae, dorsiflexion of the ankle joint will commonly elicit pain. Stretching of a tight posterior group is mandatory in the rehabilitation of plantar fasciitis (Plate 1).

Differential diagnoses

As with any sporting injury, making an accurate diagnosis is of the utmost importance. This is particularly highlighted when one considers that some of the more serious systemic diseases and tumours can present as simple overuse injuries such as plantar fasciitis. The practitioner must therefore always take the most complete history and listen to the patient for the clues that may indicate a more sinister diagnosis. The following are some of the diagnoses that may result in heel pain:

- Complete rupture of the plantar fascia.
- Subcalcaneal bursitis.
- Medial calcaneal nerve entrapment.
- Tarsal tunnel syndrome.
- Rupture fat pad Sever's disease.
- Calcaneal stress fracture.
- Seronegative arthropathy, e.g. ankylosing spondylitis.
- Reiter's Syndrome.
- Psoriatic arthritis.
- Diffuse connective tissue disease especially rheumatoid arthritis but including.
  - Behcet's Syndrome.
  - Systemic Lupus Erythematosus.
  - Necrotizing vasculitis and other vasculopathies.
  - Sjögren's Syndrome.
- Tumour.

Management

Plantar fasciitis remains one of the most frustrating sports injuries despite the high number of conservative and surgical options available for treatment. The tendency towards chronicity of this disease process, frustrates athletes and physicians alike. This notwithstanding, Lutter (1997) reports that 85% of patients with symptomatic plantar fasciitis will respond to conservative management, with surgery indicated for the remaining 15%. However this reports concludes that plantar fasciitis is a degenerative, not inflammatory process, which contradicts the bulk of the literature and the pathology and imaging studies.

Conservative treatment

The immediate treatment for plantar fasciitis is as with all overuse injuries, i.e. activity modification or rest, ice, compression and medication to reduce inflammation and control pain (Bartold, 2001). The specific management revolves around a sequentially phased regime;

- Activity modification and stretching—this is arguably the single most important component of treatment for plantar fasciitis. Training techniques need to be carefully reviewed, and potential contributing factors, for example hill running, running on non-supportive surfaces for example sand, stair climbing, bounding, sudden increase in training or sudden changes to training routine, should be addressed. Stretching remains the simple cornerstone of treatment for plantar fasciitis. A report by Pfeffer (1997) to the American Orthopaedic Foot and Ankle Society, supports this comment. In this prospective randomized blinded study of 256 patients with isolated heel pain syndrome, 72% improved over the 8 week study period with stretching alone. This number increased to 88% with the addition of a simple, off-the-shelf, heel insert.

Specific stretching should be to the gastrocnemius/soleus complex, the hamstrings and the plantar fascia itself. DeMaio et al. (1993) recommends specific stretching to these muscle groups before consideration of night splints or a short leg walking cast. Non-ballistic stretching of the gastrocnemius/soleus complex is demonstrated in Fig. 5. Stretching of the plantar fascia itself may be achieved by rolling the foot over an ice filled bottle as shown in Fig. 6. Stretching continues indefinitely and is prescribed for 10 min three times per day. Concomitant strengthening of the foot intrinsic muscles, and tibialis posterior in particular, is also recommended, see Fig. 7. Stretching the plantar fascia and Achilles complex by passively dorsiflexing the foot with a towel around the forefoot should be performed in the morning before weight bearing.

Figure 5 Non-ballistic stretching of the gastrocnemius and Soleus is an essential part of the management program.

Figure 6 Stretching of the plantar fascia itself may be achieved by rolling the foot over an ice filled bottle.

Orthoses in the treatment of plantar heel pain syndrome

The use of orthoses in the treatment of plantar fasciitis is based on the principle of reducing tissue stress. Orthoses come in many forms, and may include heel cuffs, viscous elastic heel pads, accommodative inlays, prefabricated and custom made orthoses. In many cases, the primary reason orthoses have been used in the treatment of plantar fasciitis has been based on the assumed association between excessive foot pronation and the development of the condition. Many authors labelled excessive foot pronation as a cause of plantar fasciitis, with Kwong et al. (1988) and Kosmahl and Kosmahl (1987) stating that subtalar joint pronation everts the calcaneus and lengthens the plantar fascia, thereby increasing the intrafascial tension. In addition, pronation is presumed to cause increased mobility of the foot, and thereby increase the level of stress applied to the myofascial and related tissues to the plantar fascia (Cornwall and McPoil, 1999).

Trigger point therapy

Myofascial pain

Myofascial pain syndrome (MPS) is quite common, but it can be quite difficult to recognize and distinguish from underlying entities. It is frequently confused with fibromyalgia, a syndrome comprising 16% of all rheumatology visits (Goldenberg, 1992). Fibromyalgia is more frequent in females and tends to have a more widespread presentation. Myofascial pain syndrome by contrast is a more regional condition, affecting men and women equally, and has a much better prognosis than fibromyalgia (Wolfe et al., 1990).

Myofascial pain syndrome

Myofascial pain syndrome (MPS) has been defined as "a muscular pain disorder involving regional pain by trigger points (TrPs) within the myofascial structures, local or distant from the origin of pain" (Travell and Simons, 1983). The reported

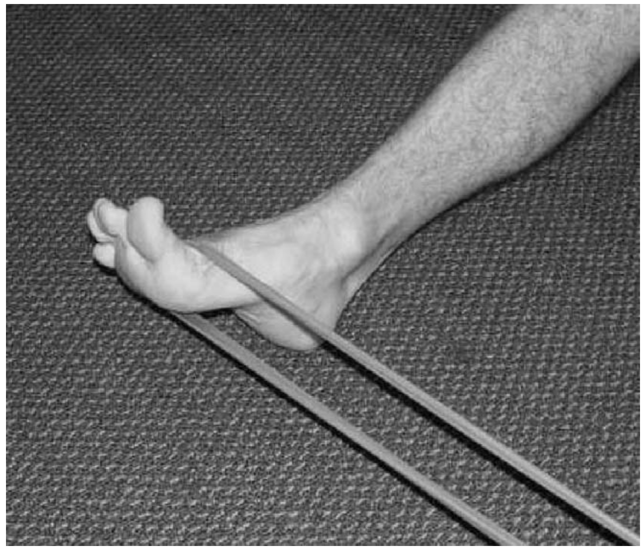

Figure 7 Concomitant strengthening of the foot intrinsic muscles, and tibialis posterior in particular, is also recommended. In this instance, a rubber band is used for active resistance training of tibialis posterior and the peroneals.

prevalence of MPS varies greatly ranging from between 5% and 93% of the population (Auleciems, 1995; Fomby and Mellion, 1997; Simons, 2000). This variance is due in part to non- uniform diagnostic criteria (Simons, 2000), lack of satisfactory laboratory or imaging tests (Simons, 2000) and more simply, because of the sheer number and locations that TrPs can exist throughout the body.

There is a large body of evidence in the literature of TrPs and MPS in the upper body, with relatively little attention devoted to the lower extremity. Given its reported prevalence, MPS remains an important differential diagnosis to consider in patient's with persistent pain, especially those that have not responded to more traditional treatment for the provisional diagnosis. Travell and Simons (1983) define a TrP as "a hyper-irritable spot, usually within a taut band of skeletal muscle in a muscle fascia. The spot is painful on compression and can give rise to characteristic referred pain, tenderness and autonomic phenomena". This definition describes the cardinal sign of a trigger point, that is referred pain, in other words the trigger point sending pain to some other site. This is a reason conventional treatment of pain so often fails. TrPs can be characterized as active, latent or satellite. With an active TrP describing a source of on going pain that is familiar to the patient, a latent TrP is produces unfamilar pain when compressed, and a satellite TrP develops within the area of referred pain of an other active TrP (Starlanyl and Copeland, 1996). The pathophysiological mechanism behind the formation of TrPs remains controversial. Most authors accept the theory that implicates the interaction of calcium with adenosine triphosphate (ATP). Following either acute or chronic trauma, the sarcoplasmic reticulum in the muscle cell is damaged leading to a release of calcium, which binds to triponin and results in contraction of the muscle fibre. Because the sarcoplasmic reticulum is damaged, it is suggested that the re-uptake of calcium cannot be facilitated and the muscle fibre remains contracted. High levels of calcium increase the energy demands for ATP, and this may lead to localized hypoxia. The disabled calcium deposited in the sarcoplasmic reticulum is thought to perpetuate this cycle. The hypoxia may result in local inflammatory response and the release of serotonin, histamine, kinins and prostaglandins. These substances are pain mediators and are believed to sensitize muscle nociceptors which converge with other visceral and somatic inputs and are thought to lead to the perception of local and referred pain (Rachlin, 1994; Schneider, 1995).

It is important to recognize that TrPs and MPS may contribute to heel pain, mimicking plantar fasciitis. One of the most common locations for a TrP is in either muscle belly of gastrocnemius, or in the soleus. This may refer pain to the heel and result in symptoms leading to the incorrect diagnosis of plantar fasciitis. The diagnosis is further clouded by the fact that biomechanical abnormalities can lead to an increase in stress on the musculoskeletal systems and promote the formation and perpetuation of TrPs (Fomby and Mellion, 1997). There is also an element of 'chicken and egg' in relation to the formation of TrPs and biomechanical abnormality. For example heel pain can radically alter a gait pattern, which may result in the development of an abnormal muscle firing pattern and the development of a TrP, in, for example the soleus muscle. In this instance the diagnosis may on an on-going basis be assumed to be plantar fasciitis and will be resistant to most forms of local treatment since the pain is actually now originating from the soleal TrP.

Physiotherapy is most useful in the treatment of heel pain referred from a TrP and therapies may include the spray and stretch technique which involves the use of a vapocoolant spray as a distraction to block the reflex spasm and sensation of pain (Auleciems, 1995). Cryotherapy via an ice pack over the area of referred pain has also been shown to be effective in reducing pain. One of the most important treatment modalities is deep cross fibre friction or ischaemic compression which allow for a mechanical reduction of the taut muscular or fascial bands associated with a TrP. The use of heat and manipulation is effective on its own or in combination with the spray and stretch technique. Miller (1994) has also commented on the use of transcutaneous nerve stimulation (TENS), phonopherisis, iontophoresis and cold laser. In relation to plantar heel pain referred from TrPs, passive stretching of the gastrocnemius/soleus complex is very important to allow for quicker rehabilitation and also to limit the recurrence of MPS.

TrPs may also be treated via injection therapy and this is regarded as the definitive treatment for recalcitrant cases of MPS which represents some 20–30% of all cases (Kantu and Grodin, 1992). Injection therapy may comprise the so-called dry needling (acupuncture) or wet needling which involves infiltrating the area with either saline or local anaesthetic. This latter technique helps to disrupt the fibrous banding within the TrP and Hong et al. (1997) has reported that this technique is associated with significantly reduced post-injection soreness compared to acupuncture (see Box 2).

Box 2 Practice points

Plantar heel pain syndrome

- Early, aggressive, non-surgical treatment offers the best chance of a good outcome in PHPS.
- It is critical to rule out systemic disease of nerve entrapment.
- Patients with idiopathic heel pain should be screened for sero-negative and sero-positive arthritides and sarcoidosis.
- The foot is second only to the knee as the site of presence of rheumatoid arthritis.
- Men under 40 presenting with bilateral heel pain should be evaluated for Reiter's syndrome and ankylosing spondylitis.

Taping for plantar fasciitis

Specific taping techniques are available for the treatment of plantar fasciitis, and they represent one of the most reliable short-term treatment options. The technique described in this text has been developed by the author and it is most useful in the management of the acute phase of plantar fasciitis. This method is also used as a tool to guide the short to medium term treatment regime, and specifically to confirm or otherwise a mechanical role in the generation of symptoms. This taping method can be used to predict the success of potentially costly orthotic therapy, and is an important indicator to specific goals of orthotic therapy.

The rationale of this specific taping technique is based on its ability to;

- Reinforce the plantar fascia both statically and dynamically.
- Facilitate the action of peroneus longus which stabilises the 1st ray.
- Provide compression over the site of pain.
- Plantar flex the forefoot on the rearfoot, thereby increasing the calcaneal inclination angle (CIA).
- Invert the calcaneus beyond vertical.
- Reduce motion through the midfoot, and in particular through the midtarsal joint.

This taping technique is designed specifically to address the factors present that may increase tension in the plantar fascia. It is particularly aimed at the mobile or pronating foot, which is presumed to be a contributing factor. This technique is contraindicated in a cavus or supinated foot type. When applied correctly it is a most effective treatment method.

Method

This method uses rigid 1.5 and 2.0 inch taping. It is important to ascertain previous plaster allergy reactions to zinc oxide tape since underwrap cannot be used with this technique.

The method of application of tape is critical, especially with direction of tape application. The technique will fail if the tape is applied from medial to lateral where it should be applied from lateral to medial.

The first strip is applied using 1.5 in tape and extends from the base of the 5th metatarsal head along the lateral border of the foot behind the calcaneus but on its posterior surface and finishes at the base of the 1st metatarsal head, see Fig. 8. The tape must be applied from lateral to medial as this helps to apply a supinatory moment to the calcaneus. At the same time the 1st ray should be held in the plantar flexed attitude so that the taping will finish somewhat dorsally over the 1st metatarsal head. The second strip of 1.5 in tape starts dorsally over the 1st metatarsal head, medial to the 2nd metatarsal head. Maintaining a plantarflexion pressure over the 1st ray, the tape is pulled plantarly (to further plantarflex the 1st ray). The tape is then placed from medial to lateral and finishes dorsally over the 5th metatarsal head, see Fig. 9. This has now induced an everted position of the forefoot with a plantarflexed 1st ray. The 1st ray is unable to dorsiflex significantly and is stabilized and facilitated by peroneus longus. In addition due to its plantarflexed attitude, the tension of the plantar fascia has now been reduced.

The third strip of tape runs from lateral to medial from below the lateral malleolus, finishing distal to

Figure 8 The first strip is applied using 1.5 in tape and extends from the base of the 5th metatarsal head along the lateral border of the foot behind the calcaneus but on its posterior surface and finishes at the base of the 1st metatarsal head.

Figure 9 The second strip of 1.5 in tape starts dorsally over the 1st metatarsal head, medial to the 2nd metatarsal head. Maintaining a plantarflexion pressure over the 1st ray, the tape is pulled plantarly (to further plantarflex the 1st ray). The tape is then placed from medial to lateral and finishes dorsally over the 5th metatarsal head.

the medial malleolus. Once again this strip inverts the calcaneus and care should be taken to achieve this inversion whilst applying the tape. This strip is applied very tightly and should cover the area of maximal discomfort providing significant compression.

The next stage in this taping method is a series of five (or four in a smaller foot) 1.5 in tape strips running longitudinally from the metatarsal heads to the posterior surface of the calcaneus. The first strip runs from the 1st metatarsal head to the heel—the fifth strip from the 5th metatarsal head to the heel. As they pass over the posterior surface of the calcaneus, the tape strip should overlap completely, see Fig. 10. Once again these strips are applied with considerable tension, plantarflexing the forefoot on the rearfoot. It will be necessary to plantarflex the forefoot on the rearfoot to get the tape to conform to the arch. This part of the taping method offers considerable reinforcement of the injured plantar fascia while enabling it to "rest" since nearly all the tension has now been removed from the fascia.

Figure 10 The next stage in this taping method is a series of five (or four in a smaller foot) 1.5 in tape strips running longitudinally from the metatarsal heads to the posterior surface of the calcaneus. The first strip runs from the 1st metatarsal head to the heel—the fifth strip from the 5th metatarsal head to the heel. As they pass over the posterior surface of the calcaneus, the tape strip should overlap completely.

Figure 11 The final stage of the taping uses 2 in rigid tape. Strips are placed from medial to lateral commencing as far distally as possible and overlapping by one half until about the midfoot. This process is then continued right up to the posterior heel, but wrapping from lateral to medial. This once again maintains the heel in an inverted position.

The final stage of the taping uses 2 in rigid tape. Strips are placed from medial to lateral commencing as far distally as possible and overlapping by one half until about the midfoot. This process is then continued right up to the posterior heel, but wrapping from lateral to medial. This once again maintains the heel in an inverted position. The final strip of 2 in tape runs from the styloid process on the lateral aspect of the foot, posterior to the heel and finishes medially and distal to the site of pain. This is demonstrated in Fig. 11. Firm pressure is once again applied to provide compression. To conclude this is a tight strapping, and needs to be so for success. All taping loses contact the skin fairly quickly and to achieve its goal this taping needs to be firm.

Precautions and contractions

This is not an effective method with a rigid forefoot valgus foot type or rigid plantar flexed 1st ray foot type. Plantar fasciitis in these foot types is often caused by repetitive shock based trauma and making the foot even rigid will not help.

This taping method places the foot into what could be considered an abnormal or even pathological position. It is designed to unload to the plantar fascia by inducing the forefoot plantarflexion on rearfoot and inverting the calcaneus. It is for the short-term management of acute plantar fasciitis or as a trial for the potential success of orthotic therapy. It should not be considered for the long-term management of the condition. It may safely be applied in the acute phase for 3 to 4 day periods for up to 2 weeks. The realistic patency of the tape is 48–72 h. Used in this manner this taping technique has been of great success in short term management and shaping long-term protocol. Because of its ability to almost completely eliminate midfoot motion, it is also very effective in the treatment of forefoot varus based posterior medial shin pain. The effectiveness of this taping technique will be greatly improved with a concomitant stretching programme as described above, and also the routine use of cryotherapy.

Summary

Plantar fasciitis in its many forms remains an enigmatic condition for the treating sports physician. Confusion reigns to this day, with disagreement on the aetiology, histopathology investigation natural history and treatment of this troublesome condition. However, most researchers and clinicians alike agree that athletes with insertional plantar fascial pain can achieve good results without resorting to surgery. There is no agreement on one treatment of choice for plantar fasciitis, however, it appears that early, aggressive, non-surgical treatment within 12 months of the onset of symptoms offer the best change of a good outcome (Martin et al., 1998). There appears to be a lower chance of a good prognosis, the longer non-surgical management has been unsuccessful. Despite this, most research indicates that conservative management is preferable to surgical intervention, and that the indications for surgery in insertional plantar fascial pain are therefore limited. Education and encouragement are key components to the management plan for plantar heel pain syndrome, since pain resolution can often be very slow.

References

Auleciems, L.M., 1995. Myofascial pain syndrome: a multidisciplinary approach. Nurse Practitioner 20 (4), 18–28.

Bartold, S.J., 1997. Conservative management of plantar fasciitis. Sport Health 10 (3), 17–28.

Bartold, S.J., 2001. Biomechanical problems of the lower limb. In: Marfuli, N., Chan, K.-M., McDonald, R., Malina, R., Parker, A. (Eds.), Sports Medicine for Specific Ages and Abilities. Churchill Livingstone, Edinburgh, pp. 425–435.

Cooper, P., 1997. Current concepts on the management of heel pain. www.metscape.com/metscape/orthosportsmed/journal.

Cornwall, M.W., McPoil, T.G., 1999. Plantar fasciitis; etiology and treatment. Journal of Orthopaedic and Sports Physical Therapy 29, 756–760.

DeMaio, M., Payne, R., Mangine, R.E., Dres, D., 1993. Plantar fasciitis. Orthopaedics 16 (10), 1153–1162.

Fomby, E.W., Mellion, M.B., 1997. Identifying and treating myofascial pain syndrome. The Physician and Sports Medicine 25 (2), 67–75.

Fury, J.G., 1975. Plantar fasciitis. The painful heel syndrome. Journal of Bone and Joint Surgery 57A, 672–673.

Goldenberg, D.L., 1992. Fibromyalgia, chronic fatigue, and myofascial pain syndromes. Curr Opin Rheumatol 4 (2), 247–257.

Hicks, J.H., 1954. The mechanics of the foot: Part 2. The plantar aponeurosis and the arch. Journal of Anatomy 88 (25), 345–357.

Hong, C., Kuan, T., Chen, J., Chen, S., 1997. Referred pain elicited by palpation and by needling of myofascial TiPs. Archives of Physical Medicine and Rehabilitation 76 (9), 957–964.

Kantu, R.I., Grodin, A.J., 1992. Myofascial Manipulation: Theory and Clinical Application. Aspen Publishers, USA.

Kogler, G.F., Solomonidis, S.E., Poole, J.P., 1996. Biomechanics of longitudinal arch support mechanisms in foot orthoses and their affect on plantar aponeurosis strain. Clinical Biomechanics 11 (5), 243–252.

Kosmahl, E.M., Kosmahl, H.E., 1987. Painful plantar heel, plantar fasciitis and calcaneal spur: etiology and treatment. Journal of Orthopaedic and Sports Physical Therapy 9 (1), 14–17.

Kwong, P.K., Kay, D., Voner, R.T., White, M.W., 1988. Plantar fasciitis. Clinical Sports Medicine 7, 119–126.

Lapidus, P.W., Guidotti, F.P., 1965. Painful heel: report of 323 patients with 364 painful heels. Clinical Orthopaedics 39, 178–186.

Leach, R.E., Seavey, M.S., Salter, D.K., 1996. Results of surgery in athletes with plantar fasciitis. Foot and Ankle 7, 156–161.

Lutter, L.D., 1997. Plantar fasciitis: A guide to appropriate diagnosis and treatment. The Medical Journal of Allina 6 (2) http://www.allina.com.

Martin, R.L., Irrgang, J.J., Conti, S.F., 1998. Outcome study of subjects with insertional plantar fasciitis. Foot Ankle Inter 19 (12), 803–811.

McBryde, A.M. Jr., 1984. Plantarfasciitis. In: Murray, J.A. (Ed.), AAOS Sentence Case Instructional Course Lectures 33, 278–282.

Miller, B., 1994. Manual therapy treatment of myofascial pain and dysfunction. In: Rachlin, E.S. (Ed.), Myofascial Pain and Fibromyalgia. Mosby-Earp, USA.

Perry, J., 1983. Anatomy and biomechanics of the hindfoot. Clinical Orthopaedics 177, 9–15.

Pfeffer, G.B., 1997. The conservative management of plantar fasciitis: a prospective randomised multicentre outcome study. Presented at the 27th Annual Meeting of the AOFAS, February 16th 1997 San Francisco, CA.

Rachlin, E.S., 1994. History and physical examination for regional Myofascial Pain Syndrome. In: Rachlin, E.S. (Ed.), Myofascial Pain and Fibromyalgia. Mosby-Earp, USA.

Schneider, N.J., 1995. Tender points/fibromyalgia versus triggerpoint/myofascial pain syndrome: a need for clarity in terminology and differential diagnosis. Journal of Manipulative and Physiological Therapeutics 18 (6), 390–406.
Sharkey, N.A., Ferris, L., Donahue, S.W., 1998. Biomechanical consequences of plantar fascial release or rupture during gait: part 1—disruptions in longitudinal arch confirmation. Foot and Ankle International 19 (12), 812–819.
Sherreff, M.J., 1987. Geriatric foot disorders: how to avoid under treating them. Geriatrics 42, 69–80.
Simons, D., 2000. Update of myofascial pain from TrPs. Retrieved September 18, 2000, from World Wide Web: http://goldenorb.atnet.net.au/simon/HTML/davidpercentage20simonspercentageupdate.htm.
Starlanyl, D., Copeland, M.E., 1996. Fibromyalgia and Chronic Myofascial Pain Syndrome: A Survival Manual. New Harbinger Publications, USA.
Travell, J., Simons, D., 1983. . Myofascial Pain and Dysfunction: The Trigger Point Manual-The Upper Extremities, Vol. I. Williams and Wilkins, Baltimore.
Tsai, W.C., Chiu, M.-F, Wang, C.-L., Tang, F.-T., Wong, M.-K., 2000. Ultrasound evaluation of plantar fasciitis. Scand Journal of Rheumatology 29, 255–259.
Wolfe, F., Smythe, H.A., Yunus, M.B., et al., 1990. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia: report of the multicenter criteria committee. Arthritis Rheumatol 33 (2), 160–172.
Wright, T.G., Rennels, D.C., 1964. A study of the elastic properties of plantar fascia. Journal of Bone and Joint Surgery 46A, 482.

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