Reduction in plantar heel pain and a return to sport after a barefoot running intervention in a female triathlete with plantar fasciitis.

Key Points

- Treatment reduced heel pain (6/10 to 2/10) but scores increased (4/10) on running.
- Two 15 minute bouts of barefoot running reduced heel pain to 0/10.
- Barefoot running as a treatment option for plantar fasciitis warrants a case series.

Key words: foot-strike, running injury, calcaneal insertion

Abstract

Patient characteristics: In a 27 year-old female triathlete, magnetic resonance imaging revealed mild thickening and oedema at the calcaneal insertion of the plantar fascia in keeping with a degree of plantar fasciitis. **Intervention:** After 6 weeks of conservative treatment failed to elicit a return to sport, the patient engaged in 6 sessions of barefoot running (15 – 30 minutes) on a soft grass surface, without further conservative treatment. **Comparative outcome:** After two sessions of barefoot running the patient was pain free before, during and after running. This outcome was maintained at the 6 week follow up period. **Interpretation:** This is the first case report to use barefoot running as a treatment strategy for chronic heel pain. Barefoot running has the potential to reduce the load on the plantar fascia and warrants further investigation using a case series.

Introduction

Plantar fasciitis or plantar fasciopathy occurs as a result of overload to the plantar fascia. It is characterised by an insidious onset of pain under the plantar surface of the heel, most noticeable with the first steps after waking or after pro-longed inactivity.[1] It is identifiable using magnetic resonance imaging (MRI) as a thickening of the plantar fascia, particularly at its origin on the medial tubercle of the calcaneus.[2] It is the most common running related injury associated with the foot and represents ~8% of all running injuries.[1] A recent epidemiology study indicated that plantar fasciitis was the most commonly reported lower limb disorder (~34%) and related to years of running, days of running per week and distance ran per week.[3] The function of the plantar fascia is to provide support for the medial arch of the foot and therefore, factors which increase load in this region have been studied to identify risk factors for its development. Reduced ankle dorsi-flexion as a result of posterior lower limb muscle tightness,[4] prolonged

foot pronation,[5] proximal hip muscle weakness,[6] and greater vertical load rates and impact peaks[7] have been suggested as risk factors for increasing load on the plantar fascia. While there are plausible biomechanical mechanisms and some evidence from small studies for these risk factors, a recent systematic review suggests plantar fasciitis remains multi-factorial and poorly understood.[8]

Conventional treatment to reduce biomechanical overload of the plantar fascia and pain include but are not limited to manual therapy, stretching,[9,10] taping,[11,12] dry needling of myofascial trigger points in the triceps surae region,[13] proximal and distal lower limb muscle strengthening,[6,14] orthotics and night splints.[15] A recent meta-analysis[16] suggested that the insertion of a needle to the Achilles tendon promotes a similar reduction in pain compared to platelet rich plasma or placebo injections. Corticosteroid injections have been shown to reduce pain in patients with plantar fasciitis[17] but whether dry needling to the plantar fascia can produce a similar reduction in pain is unknown. One of the proposed mechanisms for the use of dry needling in musculoskeletal medicine is a reduction in pain perception via segmental and extra segmental inhibition on nociceptive transmission i.e. the "gate theory of pain control". Dry needling stimulates low threshold (A-beta) and high threshold (A-delta) fibres causing an afferent input to the central nervous system which causes synaptic inhibition of central nociceptive transmission cells in the central nervous system with an associated reduction in pain severity.[18] Existing literature does not support one management strategy for plantar fasciitis and as a result, treatment of the individual can often contain a combination of the above where appropriate.[19]

It has been suggested that barefoot running could be beneficial to those suffering or recovering from plantar fasciitis.[20] The basis for this suggestion comes from research which demonstrates that female runners with a history of plantar fasciitis have greater vertical load rates and impact peaks compared with healthy control participants during sub-maximal running.[7]

Approximately 75% of shod runners have a rearfoot strike pattern when running long distances.[21] A rearfoot strike pattern is associated with a more extended lower limb and a more defined impact peak on contact with the surface. Barefoot running is associated with a reduction in stride length and an increase in knee flexion and ankle plantar flexion angles and this is suggested to lower the impact peaks and loading rates experienced by the runner.[22] This suggestion is underpinned by research demonstrating greater pre-activation of the posterior chain muscles prior to foot contact during barefoot running.[22-24] Barefoot running has also been reported as an effective method to increase the strength of intrinsic foot musculature.[25] This suggestion is underpinned by research demonstrating an increase in cross-sectional area of foot intrinsic musculature following a period of minimalist shoe running.[26] These muscular adaptations may help to reduce tensile loads on passive structures of the foot and ankle such as the plantar fascia. To the best of the author's knowledge barefoot running has never previously been reported as a treatment for a patient with pain arising from the condition.

Case Presentation

Patient Characteristics

A 27-year-old female triathlete presented with left sided pain on the medial calcaneal tubercle which had been ongoing for 12 months. She had been a runner for 4 years and a triathlete for 2 years (Sprint and Olympic Distance; 13 – 15 hours training per week). Her self-reported past medical history included left sided medial tibial stress syndrome (3 years previous), right sided peroneal tendonopathy (2 years previous), left sided achilles bursitis (2 years previous) and a left sided mild ankle sprain (2 years previous). The patient developed plantar heel pain whilst undertaking a running programme. The programme consisted of 5 running days (30 miles per week), 1 rest day and 1 swimming day. The 5 days were described as comprising of a 5 – 7

mile moderate run, a fartlek session (8 miles in total), a 3-mile run at estimated lactate threshold, a 13-mile easy paced run and a 30-minute easy run.

The patient reported pain during the first few steps upon waking sometimes to a point where she had an antalgic gait. Aggravating factors included getting up after a pro-longed period of sitting, such as at lunch time. At the point of onset ~12 months previous, the patient self-managed the condition conservatively for a period of 3 months. Progression of symptoms led the patient to self-refer to a private physical therapy clinic. The patient received 3 treatment sessions within a 3-month period abstaining from running. The patient returned to asymptomatic running on 3 days per week for 3 months before the heel pain returned. The patient then ran intermittently for 4 months in order to complete some Olympic distance triathlons. At the end of this period, the patient presented to the author.

MRI examination revealed mild thickening and oedema at the calcaneal insertion in keeping with a degree of plantar fasciitis. Physical therapy examination was conducted by the author. Palpation of the medial calcaneal tubercle was acutely painful. Passive stretching to the plantar fascia reproduced the familiar medial arch pain. Passive range of motion assessment using a universal goniometer revealed ankle (seated, knee extended) dorsi (25°) and plantar (90°) flexion to be symmetrical and above normative values[27] which has previously been reported in females with a history of plantar fasciitis.[7] Passive straight leg raise (95°), hip extension (prone; 25°) and knee flexion (supine; 140°) were above normal but symmetrical. Manual muscle testing[28] of side lying hip abduction was 3+/5 on the left side compared to 4/5 on the right side. All other manual muscle tests were 4+/5. Functional assessment began with a double leg squat which other than a forward torso lean was unremarkable. A single leg squat introduced knee valgus and evidence of instability on both sides which was greater on the left side which may have been indicative of previous ankle sprain and the presenting condition.

Intervention

Physical therapy treatment is illustrated in Figure 1 and consisted of myofascial trigger point[29] dry needling to the triceps surae, dry needling of the plantar fascia insertion and taping of the ankle and plantar region. The taping technique was a modified version of the ankle stability taping procedure described by Bruckner and Khan.[30] The aim of the taping procedure was to provide medial longitudinal arch support and hence off-load the plantar fascia. Concurrent with physical therapy treatment was a progressive strength and proprioceptive training programme for the proximal and distal muscles of the lower limb (Table 1).[31]

Six weeks after the initial consultation the patient's morning pain score had been reduced from 6/10 to 2/10. The patient was instructed to perform a 15-minute jog in her normal shoes using a grass pitch surface to attenuate impact from the road. The following morning the pain scores returned to 4/10. The last treatment session prior to a return to running was repeated with no change in subsequent morning pain scores for the following 2 weeks. At this point the author made a decision to attempt an alternate treatment strategy. The patient was observed running for ~20m on a grass surface in both shod and barefoot conditions to observe gait and foot strike patterns (Figure 2). To the naked eye the patient appeared to make contact using the heel when shod and using the midfoot when barefoot. Subsequently, the patient completed a 15-minute jog at a self-selected pace in the barefoot condition. The following morning, a pain score of 3/10 was recorded. Due to a small reduction in pain, despite loading the injured tissue, the author suggested the same exercise was repeated the following day. The morning after the second 15-minute jog the pain score had fallen to 0/10. The treatment was repeated every other day building to 30 minutes and the pain score remained at 0/10 (Table 2). The morning pain score remained the same until the point of discharge where the patient was able to carry out a 23 minute shod run.

Comparative Outcome(s)

The athlete completed a numeric rating scale (NRS) for pain during each visit to the clinic and reported morning pain scores remotely every morning after each treatment session. The NRS which is a uni-dimensional 11 point scale (0 = no pain, 10 = worst pain imaginable) appropriate for representing pain intensity in adults.[31]

Discussion

Plantar fasciitis is the most common foot problem in runners.[1] The etiology of plantar fasciitis is multi-factorial and poorly understood[8] and perhaps as a consequence there is no single management strategy with the highest level of evidence.[19] Plantar fasciitis has the longest recovery time of the top 10 running related injuries with a recovery time for runners between 2 and 10 months (median = 5 months).[32] In our patient clinical diagnosis occurred 12 months since the condition first started but at a point when the patient had yet to cease running.

For our patient, a multimodal, conservative treatment approach appeared to reduce symptoms over a 6-week period. However, the reduction in the NRS for pain scores (-4 points) must be interpreted cognisant of the fact that no running was undertaken during this period. Immediately, upon a gradual return to running (15 minutes), symptoms increased by 2 points and remained elevated for a further 2 weeks in spite of one further conservative treatment session. At this point the author asked the athlete to consider barefoot running, which had been suggested as a potential treatment option in the literature.[20,26] Despite loading the foot with 15 minutes of barefoot running, morning pain scores did not increase (-1 point). Repeating the same course of action 2 days later reduced morning pain scores (-3 points) to 0 (no pain at all). This progress continued when running for up to 30 minutes barefoot on a grass surface and up to 23 minutes of shod running when a road surface was introduced. Total time from initial consultation to the absence of pain both during running and the next morning was 8 weeks.

Total time from the introduction of barefoot running was 2 weeks. In either case, this is significantly shorter than the median recovery time of 5 months but in line with the shortest recovery time (7 weeks) reported.[32]

Initial examination and treatment information prior to consulting the author were limited with the exception of the MRI report. Although, pain scores were collected consistently throughout the conservative and barefoot running treatment course, no measure of function other than the ability of the athlete to run and be symptom free the next morning were recorded. The reason for this was to focus on morning pain specifically linked to previous day's activity or treatment. However, in future practitioners might want to consider adding a functional measure to chart recovery in parallel with pain scores. The Foot and Ankle Ability Measure (FAAM)[48] may be a useful functional measure as it provides a standardised framework that would facilitate comparison of results across similar studies.[33]

The relative contributions of dry needling, taping, rehabilitation exercises and running cessation which led to the initial reduction in pain scores are unknown. Although the response to the barefoot running intervention appeared immediate and spontaneous we do not know what influence the previous conservative treatment or the passage of time had on this response. Furthermore, the results of this case apply to an athlete who had the condition for ~12months, had not been in a regular run programme for 5 months and appeared to be a rearfoot striker. This may have assisted in her adaptation to a barefoot running intervention compared to if her condition had been in the more acute stages of the pathology. These are important considerations in light of recent research which demonstrates that reductions in impact peaks and loading rates do not occur equally in all runners when transitioning to barefoot running.[24] The barefoot running intervention was undertaken on a soft grass surface during winter in the United Kingdom which means a soft and pliable surface was present for the athlete underfoot. Therefore, the authors are unsure of the relative contributions of the surface to the improvement

in the condition independent of the barefoot running. Technically, lower impact loading rates and impact peaks may have occurred due to barefoot running, the softer surface or both. We suggest that both played a role as previously when shod running on a grass surface pain had increased (2 points).

Whilst a reduction in loading rates might be expected to arise due to increased pre-activation of the plantar flexors during barefoot running, it is also plausible that some of the improvement in pain and function demonstrated in this case arose from increased activation of the intrinsic foot musculature.[34,35] The medial longitudinal arch has been described as 'spring-like' during running. This is due to the requirement for eccentric contraction of the intrinsic foot musculature during stance before a subsequent recoil to assist the foot moving about a fixed hallux.[36] The increase in foot strength thought to occur as a result of barefoot running interventions is hypothesised to be due to the removal of arch support which would increase the requirement for this 'spring-like' action.[37,38] Furthermore, acute increases in muscle activity has been shown to have an analgesic effect on chronic pain associated with tendinopathy[39] and longer term restoration of function has been reported in interventions which have improved eccentric muscle strength.[40] These improvements in muscle activity and subsequent analgesic effects are hypothesised to occur due to a reduction in corticospinal inhibition and subsequent increase in motor unit recruitment.[39,41]

Clinical Bottom Line

This case demonstrates a successful outcome from treatment using barefoot running for a female triathlete who had plantar fasciitis for ~12 months and appeared to be a habitually rearfoot striker. In conclusion, barefoot running on a soft grass surface may be considered as an alternative treatment for athletes when a conservative treatment strategy has failed. This

case report provides a basis for a case series to be undertaken in athletic patients suffering from plantar fasciitis and for whom conservative treatment has failed.

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Table 1: Progressive Exercise Intervention for Plantar Fasciitis.

Impairment	Exercise	Progressions
Hip Abductor Recruitment	Side lying hip abduction[42]	3 x 8 – 15 repetition
Hip Abductor Recruitment	Gluteal Bridge[43]	3 x 10 – 30 second holds
Dynamic weight bearing hip abductor strength	Lateral band walks[42]	2-3 x 15 steps left and right
Deceleration during hip flexion and preparation for single limb stance.	Double Legged Squat[44]	3 x 8 – 15 repetitions. Half Squat – Full Squat Progressions
Deceleration during hip flexion in single stance.	Single-Legged Squat[42,45]	3 x 8 – 15 repetitions. Half Squat – Full Squat
Triceps surae endurance.	Calf Raises (To parallel)[46]	3 x 10 – 30 Double Leg – Single Leg.
Ankle instability. Distal muscle recruitment.	Wobble Board Training[47]	2 x 1 minute left and right Double Leg – Single Leg.

Table 2: Pain responses to conservative and barefoot intervention strategies

Date	Treatment	Morning of Treatment Pain Score	Morning After Treatment Pain Score
22/10/2015	1 hour history and examination.	6/10	6/10
29/10/2015	Dry Needling Triceps Surae	5/10	5/10
04/11/2015	Dry Needling Triceps Surae	4/10	4/10

12/11/2015	Dry Needling Plantar Fascia/Taping	4/10	3/10
19/11/2015	Dry Needling Plantar Fascia/Taping	2/10	2/10
27/11/2015	Attempt 15 minute jog	2/10	4/10
05/12/2015	Dry Needling Plantar Fascia/Taping	4/10	4/10
13/12/2015	Barefoot Run 15 minutes	4/10	3/10
16/12/2015	Barefoot Run 15 minutes	3/10	0/10
19/12/2015	Barefoot Run 15 minutes	0/10	0/10
21/12/2015	Barefoot Run 20 minutes	0/10	0/10
23/12/2015	Barefoot Run 20 minutes	0/10	0/10
08/01/2016	Barefoot Run 30 minutes	0/10	0/10
11/01/2016	Road Run Shod 23 minutes	0/10	0/10

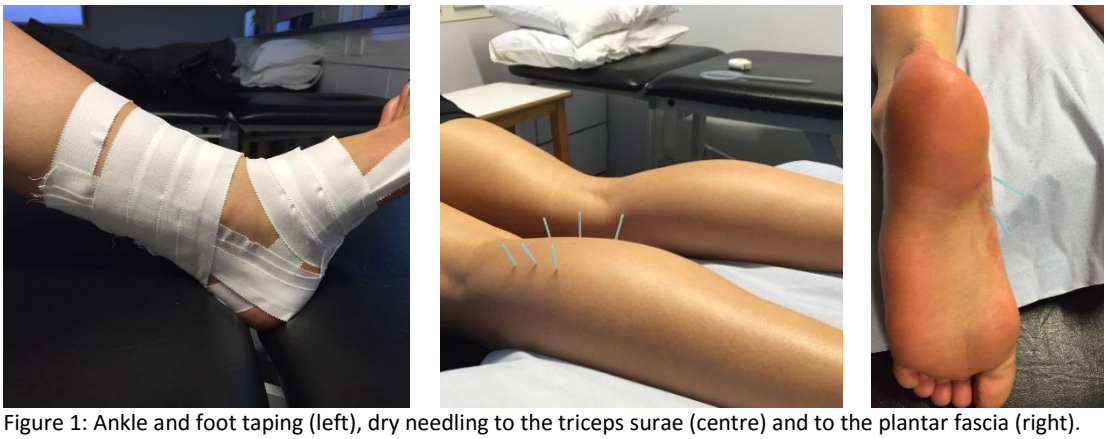

Figure 1: Ankle and foot taping (left), dry needling to the triceps surae (centre) and to the plantar fascia (right).

Figure 2: Observation of shod (left) and barefoot (right) running at a grass park.