Conservative therapy for plantar fasciitis: a narrative review of randomized controlled trials

Kent Stuber, BSc, DC*
Kevyn Kristmanson, BSc, DC**

A narrative literature review of RCTs only, was conducted to ascertain which conservative treatments provide the best results for plantar fasciitis patients. Stretching, prefabricated and custom-made orthotics and night splints have all been scrutinized in numerous studies with mixed results. Chiropractic manipulative therapy has been examined in one study, with favorable results. Therapeutic ultrasound and low intensity laser therapy have been examined in one study apiece with unsatisfactory results. Based on the trials reviewed a trial of therapy beginning with low-cost, patient-centered treatments is recommended, particularly stretching, over-the-counter orthotics, and patient education. Several (but not all) of the reviewed articles indicated that custom-made orthoses are more beneficial for plantar fasciitis than over-the-counter orthotics. In the event these treatments do not provide satisfactory results, use of night splints should be considered. Based on this review, there is no support for the use of magnetic insoles for plantar fasciitis. Most of the studies were found to have at least one methodological flaw, including inadequate sample sizes, high drop-out rates, comparing multiple interventions to multiple interventions (thus making it difficult to determine the effect of each

Une étude de documentation portant spécifiquement sur un échantillon aléatoire et contrôlé a été conduite afin de déterminer quels sont les traitements conservateurs qui donnent les meilleurs résultats pour traiter les patients atteints de fasciite plantaire. L'étirement, les orthèses préfabriquées et faites sur mesure et les attelles à usage nocturne sont des méthodes qui ont toutes été scrutées lors de nombreuses études qui ont établies que ces méthodes procuraient des résultats mitigés. La thérapie manuelle de chiropratique a fait l'objet d'une étude qui a conclu à des résultats positifs. Les ultrasons thérapeutiques et la thérapie au laser de faible intensité ont fait l'objet d'une étude qui n'a pas établie que ces méthodes s'avéraient satisfaisantes. Résultats: après étude des essais, nous recommandons une thérapie d'essai commençant par des traitements à faible coût et axés sur le patient, tout particulièrement la pratique d'étirements, l'utilisation d'orthèses en vente libre et l'enseignement aux patients. De nombreux articles de revue (mais non pas la totalité) indiquent que les orthèses faites sur mesure donnent de meilleurs résultats pour soulager la fasciite plantaire que les orthèses en vente libre. Si ces traitements ne donnaient pas les résultats escomptés, l'usage d'attelles de nuit pourrait être envisagé. Cette étude nous révèle qu'il n'existe pas de soutien en matière d'utilisation des semelles magnétiques pour la fasciite plantaire. La plupart des études accusent au moins une faille méthodologique, notamment des taux d'échantillons inadéquats, des taux d'abandon élevés, des comparaisons entre interventions multiples (ce qui rend difficile de déterminer l'effet de chaque intervention individuelle) et

* Bachelor of Science in Cellular, Molecular and Microbial Biology,
  Doctor of Chiropractic, Post-graduate faculty University of Bridgeport Chiropractic College, Private Practice,
  19-8 Weston Drive SW, Calgary, Alberta T3H 5P2, Phone 403-685-5252.
** Bachelor of Science in Anatomy, Doctor of Chiropractic, Private Practice, Swift Current, Saskatchewan.

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Introduction
Plantar fasciitis (also referred to as plantar heel pain syndrome, heel spur syndrome, or painful heel syndrome) is, by definition, an inflammation of the plantar fascia.[1] The injury itself is an enthesopathy (an abnormality or injury at the site of attachment of a ligament or tendon to bone) of the origin of the plantar fascia at the medial tubercle of the calcaneus due to excess traction often characterized by pain on the first step in the morning.[2–7] Plantar fasciitis is generally believed to be due to repetitive partial tearing at this enthesis with associated chronic inflammation.[2–4] Plantar fasciitis is the most common cause of heel pain with a lifetime prevalence of ten percent, accounting for eleven to fifteen percent of all foot symptoms, and affecting two million people in the United States alone.[7–10]

Plantar fasciitis is usually seen as an overuse injury in athletes, runners in particular (accounting for nearly 10% of running injuries), but is also seen in the general population.[1,2,4,5,7,9,11,12] Some of the factors frequently believed to precipitate plantar fasciitis include aberrant foot biomechanics and/or foot types, improper footwear, and obesity.[4,5,7,13] More specifically, foot over-pronation is believed to put increased tension on the plantar soft tissues and create the potential for injury to occur.[3]

Treatment for plantar fasciitis can be divided into numerous categories as listed below:
1. Conservative care (chiropractic therapy, electric modalities, patient education, soft tissue therapy/massage, acupuncture, taping, night splints, stretching, ice, heat, strengthening, orthotics)
2. Extra-corporeal shock wave therapy
3. Injections and medication
4. Surgical intervention

The natural history of plantar fasciitis is often self-limited and generally resolves within one year.[6] The treatment outcome for most plantar fasciitis cases is favorable and numerous authorities have indicated that plantar fasciitis will normally respond to conservative treatment modalities.[1,2,5,8–10,13–15] A trial of conservative therapies is generally advised for plantar fasciitis patients before more invasive treatments are attempted.[1,8,9,14] One important question that needs to be answered is, "Which particular forms of conservative treatment are most effective in treating plantar fasciitis?"

For this paper, only published randomized clinical trials that included at least one of the above mentioned conservative care modalities in the treatment of plantar fasciitis (or plantar heel pain syndrome, heel spur syndrome, or painful heel syndrome) were reviewed. These forms of treatment were chosen for this review as they are the modalities that chiropractors are most likely to use when treating a patient with plantar fasciitis.

A literature search was conducted in English only, from 1980 to March 2005 on the following databases: Medline, Cinahl, Alternative Medicine (AMED), the Cochrane Library, MANTIS, and the Index to Chiropractic Literature. The following search terms were used: plantar fasciitis, heel pain, conservative, treatment, chiropractic, physical therapy/physiotherapy, taping, education, acupuncture, night splints, stretching, ice, heat, exercise, and orthotics. All retrieved articles were also hand-searched for additional published citations not found through the literature search. Randomized controlled trials (including randomized cross-over design studies) were included, while prospective and retrospective case series were not included. The objective of this review was to determine which conservative modalities had the best outcomes for

plantar fasciitis patients in randomized controlled trails.

Discussion

The search yielded 15 randomized controlled trials. Certain modalities were studied or included in trial protocols more frequently than others, as follows:

Orthotics or insoles: 10 studies[1,2,4–8,12,13,16]
Stretching: 7 studies[1,2,4,8,13–15]
Night splints: 4 studies[4,7,15,17]
Taping: 2 studies[5,7]
Patient education: 2 studies[2,15]
Therapeutic ultrasound: 2 studies[3,13]
Chiropractic (manipulative therapy): 1 study[1]
Low intensity laser therapy: 1 study[18]
Soft tissue therapy/massage: 0 studies
Heat: 0 studies
Ice: 0 studies
Acupuncture: 0 studies

In addition, anti-inflammatory and other medications were included in the protocols in five different studies that we examined (piroxicam,[15] ibuprofen,[4] DayPro (oxaprozin),[13] and celecoxib[2] once each, and one trial that used dexamethasone sodium phosphate, bupivacaine hydrochloride and Etodolac (or piroxicam) and potentially dexamethasone acetate if patients did not respond to the previous medications).[5] One study also allowed patients a steroid injection of Celestone soluspan if they so desired.[13]

Chiropractic

Chiropractic care, more specifically manipulative therapy, aims to increase the mobility of joints with decreased or altered motion. Only one study of chiropractic manipulative therapy for plantar fasciitis was identified, that by Dimou, Brantingham, and Wood (Table 1).[1] This study compared chiropractic adjustments/manipulation of the joints of the ankle and foot along with a daily stretching program to custom orthotics alone and was carried out for a one month period with a one month follow-up. The authors noted a significant improvement in both groups in almost all outcome measures. The only significant difference between groups favored the chiropractic care with stretching over orthotics in pain rating at day 15.[1] This study was limited by a small sample size as well as a short treatment and follow-up period.

Electrical Modalities

Laser

Laser irradiation is purported to affect cellular metabolism, protein synthesis, wound healing, and the immune response in order to improve the speed of healing of soft tissue injuries and decrease pain levels.[18]

Basford et al. reported on a trial comparing low-intensity laser therapy with an inactive laser control group (Table 1).[18] The authors concluded that laser therapy was ineffective in treating plantar fasciitis, as results were no better than in the control group after twelve treatments or at one-month follow-up.[18] The authors noted that this was not the first study to find laser ineffective in treating musculoskeletal conditions.[18] A small sample size was used in this study, but the lack of encouraging results from this small group would make it difficult to justify further study of this modality.

Ultrasound

Ultrasound is a high frequency sound wave with an affinity for tendons and ligaments (highly organized, without high water content).[19] Ultrasound heats these tissues and the tissues absorb the energy, resulting in an increase in tissue temperature and metabolism, tissue softening, and an increase in circulation.[19] Ultrasound has also been purported to increase chemical activity in tissues, increase cell membrane permeability, deform molecular structures, and alter diffusion and protein synthesis rates, all potentially affecting the speed of tissue repair.[19]

Crawford and Snaith reported on a study comparing therapeutic ultrasound to sham ultrasound (Table 1).[3] Ultrasound did not significantly outperform sham ultrasound after eight sessions over four weeks. The authors concluded that this treatment was no more effective than placebo, although a small sample size, short treatment period, and lack of follow-up all contribute to a less than ideal study design.[3]

Turlik et al. reported on their study of shoe inserts for plantar fasciitis, and patients in their protocol could have ultrasound therapy if they so desired (patients could have NSAIDs, steroid injections, ultrasound or no additional treatment beyond the heel pads or functional foot orthotics they were given).[13] These patients received 1.5 watts/

Table 1   Randomized controlled trials of chiropractic and physical therapy modalities for plantar fasciitis

Authors and Year	Intervention	Comparison intervention	Outcome Measures	Results	Comments
Dimou, et al. 2004	Chiropractic adjustments of foot and ankle, twice weekly for four weeks, and at one month follow-up. Achilles tendon stretching (knee straight and bent) for 20 seconds, ten times each, three times per day for eight weeks.	Custom functional shock-absorbing orthotics from subtalar and midtarsal and neutral casts. Manufactured by a podiatrist, worn for eight weeks.	Numeric Pain Rating Scale 101, first step pain scale, effect of heel pain on leisure, work, and exercise. Algometry pressure pain threshold on maximal area of tenderness. Baseline measurements were taken, as were measurements at 15 days, 29 days, and one month follow-up (eight weeks after baseline).	No adverse events reported in either group. Both groups saw significant improvements in pain rating, first step pain, heel pain during leisure, and algometer measurements. There was not a significant difference between the interventions, except for pain ratings on day 15 which favored chiropractic adjustments with stretching over orthotics.	Due to a very small sample size (n=10 per group) it is difficult to draw any meaningful conclusions. A longer treatment period, more treatments, and longer follow-up are also advised. No drop-outs from this study protocol.
Basford et al. 1998	30mW continuous-wave 0.83 micrometer GaAlAs IR diode laser, the probe was held for 33 seconds over plantar fascia insertion on the calcaneus, and for two 33 second sweeps over the medial plantar fascia. Three times per week for four weeks (12 sessions total).	Same protocol, except a placebo laser treatment using a non-energized probe was employed. Three times per week for four weeks	Physical exam results (heel walking, windlass testing, pain on palpation). Subjective pain rating compared to baseline, reports of pain on first step in morning, duration of pain, effect of pain on activities, medication use, activity level, side effects, and use of orthotics. Measures taken at first, sixth, and twelfth session, and one month follow-up. Follow-up also asked for assessment of treatment effectiveness and group assignment.	No significant differences were observed between groups during treatment or at follow-up. No significant adverse events were reported.	28 subjects completed the trial and follow-up, a small sample size. Authors concluded that laser therapy is ineffective in treating plantar fasciitis. 12.5% drop-out rate when considering treatment and follow-up, 3.1% drop out rate for treatment phase only.
Crawford and Snaith 1996	Therapeutic ultrasound at an intensity of 0.5w/cm2, 3MHz, pulsed 1:4 for eight minutes along with coupling gel. Two times weekly for four weeks.	Sham ultrasound with coupling gel for eight minutes. Two times weekly for four weeks.	Visual analogue scale at first and last (eighth) visit.	Both groups showed a decrease in pain, the treatment group averaged 30% improvement, while the placebo group averaged 25% improvement. There was not a statistically significant difference in outcome between the treatment and placebo groups. None of the subjects experienced a complete resolution of pain. No adverse effects reported although two patients in each group reported worse pain at the end of the trial, one patient in each group neither improved nor worsened.	19 patients with 26 painful heels entered the trial, a small sample size. No drop-outs from this study protocol. No long term follow-up. The authors recommend additional studies using different ultrasound parameters.

cm^2 for four minutes two times per week for three weeks. Only two patients out of sixty obtained ultrasound therapy in this study, and the results for these patients were not commented on by the authors.[13]

Orthotics

The aim of orthotic therapy is to reduce strain on the plantar fascia by cushioning and elevating the heel and/or providing medial arch support. Orthotics may also be useful for overweight plantar fasciitis patients, as they help to reduce shock and cause more even weight distribution over the plantar fascia and its insertion on the calcaneus.[4]

As mentioned previously, the study by Dimou, Brantingham and Wood compared custom orthotics to a regimen of chiropractic adjustments/manipulation of the foot and ankle along with a daily stretching regimen (Table 1).[1] The custom orthotics group reported significant improvements in almost all outcome measures, but these improvements were not statistically different or superior to those obtained in the chiropractic and stretching group.[1]

Pfeffer et al. conducted a randomized controlled trial comparing Achilles tendon and plantar fascia stretching alone to stretching along with one of four different shoe inserts (Table 2).[8] Three of the inserts were prefabricated (one rubber, one felt, and one silicone) and the last was a custom-made polypropylene orthotic.[8] After eight weeks, the subjects were re-assessed and the authors found that the custom-made orthotics produced the lowest percentage of responders (subjects with at least a slight improvement subjectively) and the least reduction in pain among the different interventions, including the stretching only group.[8] The silicone prefabricated insert had the highest percentage of responders (95.2%), followed by the rubber insert group (88.3%), and the felt insert group (80.9%).[8]

The differences between the stretching group and the silicone insert group were statistically significant, as were the differences between the custom orthotic group and the silicone and rubber insert groups respectively.[8] The rubber insert group experienced the greatest reduction in pain as seen on the pain subscales of the Foot Function Index(FFI), followed closely by the silicone insert group and the felt insert group.[8] The differences in pain reduction were not statistically significant between any of the groups.[8] The authors concluded that prefabri-

cated shoe inserts along with stretching were more likely to provide relief for plantar fasciitis patients than a program of stretching and custom-made orthotics.[8] The authors also noted the cost-effectiveness of using prefabricated inserts (the prefabricated inserts in their study had a maximum cost of $40 US) compared with custom orthotics (with a cost of approximately $300 US).[8] This study again lacked a long-term follow-up group, and had a 15.3% drop-out rate, causing concern for the usefulness of the results.[8]

Lynch et al. compared an anti-inflammatory therapy, accommodative therapy and mechanical therapy (Table 3).[5] The anti-inflammatory group received of an initial injection of 0.5 ml of dexamethasone sodium phosphate at a concentration of 4 mg/ml together with 1ml of .5% bupivacaine hydrochloride without epinephrine at the area of maximum tenderness. Patients also took two 300-mg capsules of etodolac daily, unless contraindicated, in which case 20 mg piroxicam was used.

At two weeks, if the subjects VAS had improved by 3 or more points, they received the same injection. If minimal or no improvement was noted, then 0.2 ml of dexamethasone acetate at a concentration of 16mg/ml was given in addition to that already injected. This was repeated at the week 4 appointment. No more than three injections were administered to avoid possible adverse affects. The accommodative therapy group was initially given a viscoelastic heel cup that was to be used for the twelve week duration of the study, in addition, the subjects could use acetaminophen as needed, but could not take additional NSAIDs. The mechanical therapy group had plaster impressions taken in neutral position. For four weeks prior to delivery of their custom-made orthotics, the subjects were taped weekly, using a low-dye strapping with a long metatarsal pad. No statistically significant differences were noted between treatment groups on heel pain with leisure, work or exercise, nor with first step pain at the conclusion of the study. A statistically significant difference in VAS change was found to favor the mechanical group over the accommodative group. Statistical significance was also noted on final VAS scores, with 45% of the anti-inflammatory group, 23% of the accommodative group, and 64% of the mechanical group scores improving to a score of 0–2 on the final VAS. The anti-inflammatory group had excellent or fair outcomes in 33% of the subjects, compared with 30% of the accommodative

Table 2   Randomized controlled trials of stretching for plantar fasciitis

Authors and Year	Intervention	Comparison intervention	Outcome Measures	Results	Comments
DiGiovanni et al. 2003	Non-weight bearing plantar fascia stretching program (count of ten, ten repetitions, 3 times per day for eight weeks), 3 week course of celecoxib, over the counter soft insoles, educational video on plantar fasciitis	Achilles tendon stretching program (count of ten, ten repetitions, 3 times per day for eight weeks) , 3 week course of celecoxib, over the counter soft insoles, educational video .	Foot Function Index pain subscale, and a 6 question subject-relevant outcome measure questionnaire. Patients evaluated at baseline and at eight weeks.	Both groups reported improvements in pain levels at 8 weeks, significantly greater improvements were seen in the plantar fascia stretching group in the pain subscales of the Foot Function Index, as well as in patient satisfaction and activity limitations. Overall superior results were obtained in the plantar fascia stretching group.	101 patients enrolled in the study, 82 completed the eight week evaluation (18.8% drop-out rate). 28% of subjects in the Achilles stretching group dropped out compared to 9.8% of the plantar fascia stretching group. No long-term follow-up with patients.
Porter et al. 2002	Sustained Achilles tendon stretching by hanging the heel off a step with the knee straight (three minutes, three times daily) for four months.	Intermittent Achilles tendon stretching by hanging the heel off a step with the knee straight (five sets, 20 seconds each, twice daily) for four months.	Patient compliance (recorded with an exercise diary), the American Academy of Orthopaedic Surgeon's Lower Limb Core Module and Foot and Ankle Module questionnaires, and ankle dorsiflexion (measured with a goniometer). Measurements were taken at baseline and monthly for four months.	Dorsiflexion in both groups improved at each evaluation and neared those of a control group by the end of the four months; no significant differences between the groups observed. Compliance was higher in the intermittent stretching group (81.2% of stretches were done by this group compared with 74.5% of stretches in the sustained group), although not significantly. Pain levels and foot and ankle function improved in both groups at each monthly evaluation, although with no significant differences between groups at any time, scores were higher in the intermittent stretching group at each evaluation for both pain and function.	94 subjects (122 feet) were initially included in the study. 14 subjects withdrew from each group (28 in total), leading to a 29.8% drop-out rate, including 35% from the intermittent stretching group and 26% from the sustained stretching group. 41 asymptomatic subjects served as a control comparison group for ranges of motion, foot and ankle function and pain. No long term follow-up to this study.
Pfeffer et al. 1999	Achilles and plantar fascia stretching only for ten minutes, two times per day.	4 different orthotics groups in addition to all groups performing Achilles and plantar fascia stretching for 10 minutes, 2 daily: - Prefabricated silicone heel pad - Prefabricated felt insert - Prefabricated rubber heel cup -Custom-made polypropylene neutral orthosis	A modified Foot Function Index (including the pain subscale) completed at baseline and eight weeks. At eight weeks, subjective impression of improvement was assessed. Secondary outcome measures included time to start of improvement, change in pain in different situations, and change in activity.	71.8% of subjects in the stretching group responded (reported being at least slightly better), compared with 67.6% of patients in the custom orthotic group, 95.2% in the silicone heel pad group, 88.3% in the rubber heel cup group, and 80.9% in the felt insert group., revealing significant differences between the custom orthotics and the silicone and rubber heel groups, and between the stretching and silicone groups. All groups had improvements in the pain subscale of the FFI, prefabricated inserts produced more improvements than custom orthotics or stretching (the greatest decrease in pain was in the rubber and silicone insert groups), although not to a statistically significant degree.	236 patients were randomized, 200 returned for the 8-week follow-up appointment, giving a 15.3% drop-out rate. The costs of the different inserts were $8 for the felt insert, $12 for the rubber insert, $40 for the silicone, and $300 for the custom orthotics. No long-term follow-up

Table 3   Randomized controlled trials of orthotics for plantar fasciitis

Authors and Year	Intervention	Comparison intervention	Outcome Measures	Results	Comments
Rome et al. 2004	Functional orthosis (attempted to achieve proper weight bearing alignment and load bearing of the lower limbs and redistribute the stressors from a localized area, with gait)	Accommodative orthosis (attempted to aid in cushioning and absorbing the forces of gait.)	Clinical effectiveness was ascertained using the Foot Health Status Questionnaire (FHSQ) and the EuroQol (EQ5D). Cost effectiveness was estimated from all costs, including those not covered by the National Health Service (NHS).	On the FHSQ, foot pain showed significant differences between all time intervals for the functional orthosis, whereas the accommodative orthosis only showed a significant difference between baseline and four weeks and baseline and eight weeks, not between four and eight weeks. Foot function improvements were significant between all intervals for the functional group, and not significant between any of the time interval for the accommodative group. No significant differences noted for the accommodative at any interval in quality of life. Significant differences in quality of life were noted with the functional orthosis from baseline to 8 wks, and between 4–8 wks. The mean total cost ± SD – was statistically significant: the functional orthosis cost exceeded that of the accommodative by 17.99 pounds. Quality-adjusted life years increased in both groups, with only a small difference between the groups that did suggest that the functional orthoses were slightly better than accommodative orthoses.	First study to ascertain the cost-effectiveness of different modalities of foot care. Sample size was small (n=48) with a 27.1% drop-out rate. Functional orthotic cost $45.50, accommodative orthosis $12.74. Both orthoses were manufactured at the same company. No long term follow up with patients.
Winemiller et al. 2003	Cushioned insoles with magnetic foil embedded in the foam under the proximal arch worn at least four hours per day, four days per week, for eight weeks	Cushioned insoles with non-magnetized foil in the foam under the proximal arch worn at least four hours per day, four days per week, for eight weeks	10 cm VAS for morning, evening, and average daily pain, 5 point categorical response to treatment. Adverse effects, pain-related interference with employment performance and enjoyment were also monitored. Measures taken at baseline, four and eight weeks.	Both groups reported improvements in morning foot pain intensity; but no significant differences between groups were noted in outcome measures at 4 or 8 week evaluations. At 8 weeks 33% in the non-magnetic group reported being all or mostly better, compared with 35% in the magnetic group. No serious adverse effects in either group.	101 subjects completed the study, although 6 were lost at follow-up, giving a 5.9% drop out rate. Good compliance in both groups. Adequate blinding of both groups was obtained.

Study	Intervention		Outcome Measures	Results	Sample / Drop-out
Turlik et al. 1999	Functional foot orthotics devices developed from plaster impressions, worn daily with the option of NSAIDs (DayPro®/1200 mg daily), steriod injections (1 injection of .4 cc of Celestone Soluspan®) or Ultrasound (1.5 watts/cm² for four minutes, two times a week for 3 weeks)	Heel Pad group received Dr. Fabricant's Sport Heel® with ¼ inch thick polyurethane heel pads worn all day in all foot wear, with the option of NSAIDS, Steroid Injections or Ultrasound (as outlined in the intervention group category).	5 point questionnaires completed before and after the 3 months of treatment evaluating the frequency and how bothersome 1st step pain was, as well as overall improvement, and satisfaction with treatment.	The functional foot orthoses group noted more improvement than the heel pad group, with all comparisons showing statistical significance. Patients in the heel pad group utilized the options of NSAIDs, steroid injections, or ultrasound more often than the functional orthotic group, increasing the cost and risk of the therapy. NSAIDs were the most common adjunctive therapy used.	60 patients were initially enrolled, 55 patients completed the study protocol giving an 8.3% overall drop-out rate, including 16.7% from the functional foot orthotic group. Use of well-validated and reproducible outcome measures (such as a VAS, or Functional Foot Index, etc.) would have been more desirable.
Lynch et al. 1998	Mechanical therapy group consisting of 4 weeks (awaiting arrival of orthoses) of taping using low-dye strapping then 8 weeks of wearing custom molded orthoses. Materials used for the custom orthoses were not mentioned.	-Accommodative therapy consisting of viscoelastic heel cup, and permission to use acetaminophen (but not NSAIDs) for pain. -Anti-inflammatory group that received injections (maximum of 3 successive injections) into the affected heel as well as etodolac or peroxicam as indicated	11-point VAS to ascertain degree of initial discomfort and improvement over a 12-week period on heel pain. Effects on leisure, work and exercise were measured as well as first step pain.	On the final evaluation 45% of the anti-inflammatory group, 23% of the accommodative group reported excellent improvements and 64% of the mechanical group noted excellent outcomes (VAS score of 0-2). 33% of the anti-inflammatory group, 30% of the accommodative group and 70% of the mechanical group, had excellent or fair outcomes, demonstrating a statistically significant difference. No data was provided for the 4 week interim period with taping only.	103 subjects were enrolled and 85 completed the study. Drop out rate was 17.5%, including 11.4% from the anti-inflammatory group, compared with 21.2% and 20% from the accommodative and mechanical groups, respectively. No long term follow-up in this study.
Caselli et al. 1997	Firm molded insoles with magnetic foil inserted into the heel and placed into a closed shoe for a period of 4 weeks	Firm molded insoles without magnetic foil in the heel and placed into a closed shoe for a period of 4 weeks	Foot Function Index to determine foot function relative to pain, disability and activity restriction via VAS, with a 4 point situation response to treatment ranging from no pain to worst pain imaginable. Total foot function was scored by calculating the average of the subscales at baseline and 4 weeks	58% of the group using the insoles with magnetic foil for 4 weeks noted improvements and 60% of the non-magnetized insole group noted improvements in foot function; this difference was not statistically significant.	34 patients completed the study, 6 patients did not return, meaning an overall drop out rate of 15% (including 5% from the magnetic foil group and 25% from the group without magnetic foil). Sufficient blinding was achieved. No daily timelines for wearing the insoles were set out.

group and 70% of the mechanical group. Treatment failure rates were also of significance as the mechanical group had a significantly lower rate of failure (4%), when compared with anti-inflammatory (23%) and accommodative (42%) groups. The authors concluded that mechanical therapy with taping and orthoses was the most effective of the three trials evaluated in this study.[5] No long term follow-up was performed in this study and the overall drop-out rate of 17.5% was high (including an 11.4% drop-out rate from the anti-inflammatory group, 21.2% from the accommodative group, and 20% from the mechanical group), once again limiting the usefulness of the conclusions from this study.

Martin et al. used a randomized study design to ascertain whether custom orthoses, over the counter arch supports, or tension night splints were more beneficial in the treatment of plantar fasciitis over a 3 month period (Table 4).[7] The custom orthotic group and the over the counter group were taped using a low-Dye technique for the first two weeks while the custom orthotic group awaited arrival of their orthotics. The tension night splint group had their splints dispensed at the initial visit. 68% of the custom orthotic group rated their pain during the day as good or excellent after the three month period was over (with an average change in VAS of 3.4 over time), compared with 57% of the over the counter arch support group (with an average change in VAS scores of 3.2), and 51% in the night splint group (with an average change of 2.8 in VAS scores). These differences were not statistically significant, nor were the differences noted between the groups in first step pain, which favored the night splint group (with an average change of 6.1 in VAS score over time and 57% of the subjects rating their outcome as good or excellent on first step pain) over the over the counter arch support and custom orthotics (which averaged 5.3 change in VAS over time each, and 57% and 61% rating their first step pain outcome as good or excellent, respectively). Patient compliance was strongest in the custom-made orthotic group, which may indicate that they provide the best long term result, but additional long term studies would be needed to evaluate this result.[7] A high overall drop-out rate of 24.3% was noted, including 7% of patients that withdrew from the custom orthotic group, compared with 26% and 21% who withdrew from the right splint and over the counter arch support groups respectively.

Rome et al. compared the clinical effectiveness and cost-effectiveness of functional and accommodative foot orthoses in the treatment of plantar heel pain (Table 3).[16] The functional foot orthoses were full length ethyl vinyl acetate with a 25 Shore A top cover and a four degree medial rearfoot ethyl vinyl acetate post at a cost of approximately 25 English pounds ($45.50 US). The accommodative foot orthoses were full-length low-density ethyl vinyl acetate with a polyurethane heel pad with a price of 7 pounds ($12.74 US). Outcomes were measured using the EuroQol and the Foot Health Status Questionnaire at baseline, four, and eight weeks. No significant clinical differences were noted for either orthosis at any time interval for general foot health and footwear domains. The functional orthosis noted significant improvements from baseline through the eight week mark for foot pain, whereas the accommodative orthosis only demonstrated an improvement in foot pain from four to eight weeks. Significant improvements were also noted with the functional orthosis for foot function and overall health status over the duration of the 8-week study period. Evaluation of cost effectiveness revealed a significant difference in average total costs for the accommodative versus the functional orthoses (16.18 pounds ± 5.54 pounds *versus* 34.17 pounds ± 5.18 pounds) a net difference of 17.99 pounds. Both groups had an increase in quality adjusted life years, but when compared against one another, the functional orthosis was more cost effective than the accommodative orthosis.[16] No long term follow-up was administered with the subjects of this study, and there was a high drop-out rate of 27.1%.

Turlik et al. compared generic heel pads to functional foot orthotics over a 3 month period (Table 3).[13] Assessments were performed prior to the initial treatment and again at the end of the study (3 months total duration).[13] During the study, subjects could request the use of NSAIDs, local steroid injections, or ultrasound, in addition to the functional foot orthotics or generic heel pad interventions. At the conclusion of the study, the functional foot orthotic group noted statistically significant improvements in all measured domains, leading the authors to conclude that the functional foot orthotics were more effective than generic heel pads in relieving the symptoms of heel spur syndrome.[13]

Caselli et al. evaluated the outcomes of magnetic foil placed in the heel of firm molded insoles against firm

molded insoles without magnetic foil (Table 3).[6] Subjective reports were evaluated at baseline and at the four week conclusion using subscales of the Functional Foot Index (FFI).[6] At the conclusion of the study both groups noted significant improvements in foot function. When the two groups were compared, statistical significance was not noted between the groups, indicating that the magnetic foil offered no benefit over the insole alone.[6] This study had a fifteen percent drop-out rate.

Winemiller et al. reported on a study comparing cushioned insoles with magnetic foil embedded in the foam under the proximal arch to cushioned insoles with non-magnetized foil in the foam (Table 3).[12] Both groups reported improvement in morning foot pain intensity at eight weeks, but differences between groups were insignificant.[12] The authors concluded that the magnetic foil did not provide any additional benefit over the non-magnetized foil at either four or eight week evaluations.[12]

As Rome et al. mention, [16] assessing the effectiveness of orthotics as a group can be difficult due to the different materials that can used and the variety different methods of casting and creating orthotics (particularly if using custom orthotics). Landorf et al. concluded that there is no agreement in the literature as to whether prefabricated or custom orthoses perform better for plantar fasciitis patients, and the largest studies comparing the two so far indicate that there is no difference.[10] It can be deduced from the studies to date that magnetic foil embedded in insoles or orthotics does not confer any significant benefits for plantar fasciitis patients.

Stretching
Stretching of the plantar fascia and Achilles tendon is considered to be one of the hallmark treatments in the management of plantar fasciitis.[8] The goal of a stretching program is to relieve the stress put on the plantar fascia by either the plantar fascia itself being tight or the fascia being tightened by a tight Achilles tendon, as both the plantar fascia and Achilles tendon insert onto the calcaneus.[8]

DiGiovanni et al. compared a program of non-weight bearing plantar fascia stretching along with three weeks of celecoxib, over the counter soft insoles, and a patient educational video to a similar regimen that used Achilles tendon stretching instead of the plantar fascia stretching for patients with chronic plantar fasciitis (for at least ten

months) (Table 2).[2] The authors found that the plantar fascia stretching program significantly outperformed the Achilles tendon stretching program in numerous outcome measures after eight weeks and concluded that plantar fascia stretching is superior to Achilles tendon stretching for plantar fasciitis.[2] However, this study lacked a long-term follow-up and had a nearly twenty percent drop out rate (18.8%, with 28% dropping out of the Achilles stretching group compared with 9.8% from the plantar fascia stretching group) meaning that study design improvements are needed in future studies before a definitive conclusion can be made.

Porter et al. conducted a study comparing sustained with intermittent Achilles tendon stretching on dorsiflexion, pain and function over a four month period (Table 2).[14] This well-designed study randomized subjects into the two groups and a third group of asymptomatic controls was also recruited for comparison sake. No significant differences were noted between the two stretching groups at any point in the study in any of the outcome measures.[14] However, both groups did improve from baseline in pain and function scores, as well as in dorsiflexion and the results in both groups approached the scores of the asymptomatic controls.[14] A trend was noted where the intermittent stretching group tended to improve more over the first month. In addition, compliance was slightly higher in the intermittent stretching group. Increased Achilles tendon flexibility was found to correlate with decreased foot and ankle pain and increased foot and ankle function, an important point for consideration.[14] The authors concluded that the critical element was that patients did some stretching each day, and that the type of stretching was not important. This study lacked a long-term follow-up and once again had a high drop out rate of 29.8%, including 35% from the intermittent stretching group and 25.9% from the sustained stretching group.

As mentioned previously, the study by Pfeffer et al. had a stretching only group (Achilles and plantar fascia stretches were performed) (Table 2).[8] This group had a 71.8% response rate to treatment (subjects had at least some improvement) over eight weeks.[8] This was significantly lower than the 95.2% response rate in the silicone insert group, but was higher than the 67.6% response rate in the custom orthotic group. The stretching group also had a greater reduction in pain scores in the pain sub-

Table 4 Randomized controlled trials of night splints for plantar fasciitis

Authors and Year	Intervention	Comparison intervention	Outcome Measures	Results	Comments
Martin et al. 2001	- Tension night splints prefabricated with 5° of ankle dorsiflexion. Given to the subjects at the initial visit, only to be worn at night.	- Over-the-counter arch supports made of rigid plastic. Foot was taped for 2 weeks, as a control comparison against the custom-made orthoses group. - Custom-made 5 mm Polydur plastic orthoses. Subjects were laser scanned in non-weight bearing subtalar neutral with midtarsal full pronation. 4° rearfoot varus and intrinsic foot posting was used. Low-Dye taping technique used for the 2 week period prior to delivery of the custom orthoses.	Effect of heel pain on leisure work and exercise, first step pain, type and amount of exercise per week and the number that subjects spent on their feet daily were measured. Two 11 point VAS were used, one to measure daily discomfort, the other to assess first step pain. Follow-up measurements were taken at 2, 6 and 12 weeks.	No statistically significant differences were noted between or among treatment groups for pain felt during the day or for first step pain. The custom-made orthoses group showed the largest improvement at the end of the study (12 weeks) for pain felt during the day. The mean change over time for first step pain was greatest with tension night splints. When comparing final outcomes, no group was significantly better than the others. Excellent or good outcomes for pain felt during the day was 68% for the custom-made orthoses group, 57% for the over-the-counter arch support group and 51% for the night splint group. First step pain outcomes were reported as excellent or good for 61% of the custom-made orthoses group, and 57% each for the over-the-counter arch support and night splint groups. Drop out rates and poor compliance rates were significantly significant, being higher in the over-the-counter arch support group and tension night splints group than the custom-made orthoses group.	255 patients were enrolled, 193 patients completed the 12 week study, a 24.3% drop-out rate. 7% of patients in the custom orthotic group withdrew compared with 26% from the night splint group and 21% from the over the counter arch support group. No long term follow-up with patients. No results were given with respect to the 2 week taping period of for the custom-made orthoses group.
Probe et al. 1999.	Five degree ankle dorsiflexion night splint worn for 3 months. Ankle dorsiflexion stretches/exercises, 10 repetitions of 10 seconds three times per day. 20mg Piroxicam daily for 30 days, advice to wear shoes with supportive arches and cushioned heels	Ankle dorsiflexion stretches/exercises, 10 seconds three times per day. 20mg Piroxicam daily for 30 days, advice to wear shoes with supportive arches and cushioned heels	4-point subjective pain scale, SF-36, perception of treatment effectiveness. Measures were taken at baseline, 4, 8, and 12 weeks, and a 19 month (on average) follow-up.	No statistically significant improvement noted between groups (71% of subjects in the night splint group improved compared with 66% of subjects in the no night splint group). Overall, 68% of subjects reported subjective improvement at 12 weeks, and 84% reported improvement at 19 months. 89% of night splint group patients felt improvement in morning pain compared to 84% in the comparison group. SF-36 scores improved at 3 months of care and were up to age-matched norms at 19 month follow-up in both groups, with no significant difference between groups.	116 patients entered the study, and there was a 25% drop-out rate for follow-up evaluation. 59% had heel spurs. At 12 weeks patients older than 45 years old did not improve as much as their younger counterparts (57% improved compared with 78%). SF-36 scores revealed that plantar fasciitis patients had lower scores for pain, general health, role performance, social and physical functioning compared with age-matched norms.

Study	Treatment	Control	Outcome Measures	Results
Powell et al. 1998	Dorsiflexion night splint worn for one month.	Functioned as a control for one month and then wore the dorsiflexion night splint for one month.	Subjective pain level (rated 0 to 10), Mayo Clinical Scoring System (MCSS), the AOFAS Ankle-Hindfoot Rating Scale (AHRS), and physical examination findings (plantar heel tenderness, Windlass maneuver, neuropathy) were taken at baseline, 30 days, 60 days, and 6 months	88% of patients improved in subjective pain levels, the average improvement for those who improved was 5.9 out of 10. 36.4% were pain free at the end of the study. 59.5% indicated satisfaction with the treatment, 13.5% were satisfied with reservations. MCSS scores improved significantly when groups used the night splint. AHRS results were similar to MCSS. Scores improved significantly after wearing the splint, and at 6 month follow-up.	37 patients were included in the study (52 feet total). 18.9% drop-out rate. Patients with bilateral involvement were more likely to be dissatisfied with the treatment and have lower MCSS and AHRS scores. 81% of patients and 85% of the affected feet had heel spurs. Patients had chronic plantar fasciitis, and were referred by their family doctors or podiatrists due to lack of response to other therapies.
Batt et al. 1996	Custom fitted posterior night splint, ibuprofen, Viscoheel sofspot heel cushion, stretches for the gastrocnemius and soleus.	Ibuprofen, Viscoheel sofspot heel cushion, stretches for the gastrocnemius and soleus. Patients in this group who did not respond after 8-12 weeks were crossed to the night splint group.	Pain on VAS, activity level, and compliance measured at 4 week intervals. Plantar fascia discomfort and ankle ROM. Patients discharged after resuming normal activities with minimal or no discomfort (weeks to cure).	100% of the patients in the night splint group were cured in an average of 12.5 weeks. 35.3% of patients in the non-night splint were cured at an average of 8.8 weeks. The remaining 64.7% of non-night splint patients were moved to the night splint group. 72.7% of these subjects were cured after an average of 13 weeks.	32 out of 40 patients completed the study (33 feet total), producing a 20% drop-out rate. 59% of subjects had at least one calcaneal spur. Outcome measures and additional interventions poorly described. Six subjects did not use or discontinued ibuprofen use due to gastrointestinal issues or asthma. No long-term follow-up.

scales of the Foot Function Index than the custom orthotic group, but the prefabricated insert groups all had further reductions compared with the stretching only group, although not to a statistically significant degree.[8] The authors opined that a stretching program should be a fundamental component of any plantar fascia treatment plan.[8]

Numerous other studies included stretching as part of their protocol, such as those by Turlik et al.,[13] Dimou et al.,[1] Batt et al.,[4] and Probe et al.[15] In all of these studies, the stretching exercises that were performed were done along with other interventions, including chiropractic care,[1] piroxicam,[15] ibuprofen,[4] night splints,[4,15] patient education,[15] and orthotics or heel cups.[4,13] In the study by Turlik et al., patients also had the option of a steroid injection, anti-inflammatory, therapeutic ultrasound, or none of the above.[13] The use of these different interventions along with the stretching programs makes it impossible to determine the effect of the stretching itself on the results of these studies.

Night splints

The goal of night splint therapy is to prevent overnight plantar flexion of the ankles. This plantar flexion relaxes the plantar fascia and allows the fascia to heal in a relaxed, shortened, and non-functional state.[4,7,15,17] If overnight plantar flexion occurs, when the patient arises in the morning the first few steps are often painful as the patient's plantar fascia resumes its full functional length (and re-enters a tightened state in order to do so) and has to bear the patient's weight; creating the potential for additional microtrauma at the injured site.[4,15,17] Night splints aim to maintain dorsiflexion of the ankle and (in some cases) toes overnight.[4,15,17] By placing the patient in dorsiflexion overnight and under consistent strain, the fascia stays lengthened and heals at or near its functional configuration.[4,17]

Probe et al. conducted a study comparing one group treated with a night splint, ankle stretching, piroxicam, and patient education to a second group treated in the same manner, but without the night splints (Table 4). [15] No statistically significant improvements were observed between the two groups in any of the outcome measures after 12 weeks of care, or at a nineteen month follow-up (on average). There were impressive improvements noted in both groups at 12 weeks and 19 months in both pain

levels and SF-36 scores.[15] The authors commented that night splints were likely best employed for patients who do not respond quickly to other conservative treatments.[15] 25% of the subjects did not complete the study protocol.

Batt, Tanji and Skattum performed a uniquely designed RCT using tension night splints along with heel pads, ibuprofen, and gastrocnemius and soleus stretching (Table 4).[4] The control group received the same interventions without the night splints. The interesting aspect of the study design was that control subjects not responding after eight to twelve weeks were crossed over to the night splint group. Each subject randomized to the night splint group was "cured" at an average of 12.5 weeks, compared with 35.3% cured in the control group (after 8.8 weeks). [4] This represents a statistically significant difference in response to the two treatment regimens. Nearly three quarters of the patients that were unresponsive to the control intervention obtained curative results when crossed over to the night splint group. The authors concluded that tension night splints (along with ibuprofen, heel pads, and gastrocnemius/soleus stretching) are a highly effective means of treating plantar fasciitis.[4] This study was generally weak in describing treatments and outcome measures employed, it had a high drop-out rate of 20%, did not have a tremendously large sample size, and again there was no follow-up to this study.

Powell et al. conducted a crossover prospective randomized outcome trial of dorsiflexion night splints on chronic plantar fasciitis patients who were unresponsive to previous conservative therapies (Table 4).[17] This trial used only night splints and no other interventions, thus truly testing the effect of the night splint alone. Use of the dorsiflexion night splint produced impressive relief for most patients, 88% reported some improvement, and the average improvement for those who noted improvement was 59%.[17] Significant improvements were seen in additional outcome measures, leading the authors to conclude that dorsiflexion night splints provide relief for most patients with chronic plantar fasciitis.[17] The drop-out rate of 18.9% was again quite high, meaning that caution should be used when interpreting these results.

As previously mentioned, Martin et al. compared tension night splints to custom-made orthoses and over-the-counter arch supports (Table 4).[7] The authors found that patients using the over-the-counter arch supports and the

tension night splints had the poorest compliance rates as well as highest withdrawal rates at 21% and 26%, respectively.[7] The custom orthoses group showed the greatest improvement over time in daily VAS score, although the results were not significantly better than in the night splint and over the counter arch support groups. When first step pain was compared among the three groups, the differences were again insignificant, though the tension night splints did far better in reducing first step symptoms. When comparing pain felt during the day, excellent or good outcomes were noted in 68% of the custom-made orthoses group, 57% of the over-the-counter arch supports and 51% of the tension night splint group. Sixty one percent of the subjects in the custom-made orthoses group reported excellent or good outcomes on first step pain, compared with 57% for both of the other groups.[7]

One of the factors that could lead to differences in results between the night splint studies could be the differences between the splints used in each study. Batt et al. used a custom-fitted posterior night splint with an upward curve at the distal end applied to the patient's lower leg and foot with an elastic bandage in a figure-8 weave to achieve near maximum dorsiflexion at the ankle and toes.[4] Powell et al. used a dorsiflexion night splint made of polypropylene that placed the patient in five degrees ankle dorsiflexion along with a wedge that created 30 degrees of dorsiflexion at the MTP joints.[17] The splint was applied to the lower leg and foot with Velcro straps.[17] Probe et al. used a similar polypropylene splint with Velcro straps, but this splint lacked the 30 degrees of dorsiflexion at the MTP joints.[15] Martin et al. used a posterior tension night splint prefabricated with five degrees of ankle dorsiflexion.[7]

Taping
Taping of the foot provides medial arch support for plantar fasciitis patients and potentially removes strain from the plantar fascia. As previously mentioned, Martin et al. compared custom orthoses, over-the-counter arch supports, and tension night splints in the treatment of plantar fasciitis.[7] Taping was used in the custom orthoses group and the over-the-counter arch support group for two weeks while awaiting delivery of the custom orthoses. No data on the effectiveness of the taping was given; therefore the specific effects of taping cannot be determined. Lynch et al. compared anti-inflammatory

therapy, accommodative therapy and mechanical therapy in the treatment of plantar fasciitis.[5] Subjects in the mechanical therapy group were taped for 4 weeks, while awaiting delivery of their orthoses. Again data on the effectiveness of taping in the first four weeks was not made available. Despite this, the authors concluded that the mechanical treatment with taping and orthoses was more effective than the other two groups. Conclusions with respect to the effectiveness of taping in the treatment of plantar fasciitis cannot be made at this point in time; further study is awaited.

Patient education
The studies conducted by DiGiovanni et al. and Probe et al. both included patient education components to their multi-faceted treatment regimes (Tables 2 and 4, respectively).[2,15] DiGiovanni et al. had subjects in both of their treatment groups watch an educational video on plantar fasciitis.[2] Probe et al. gave all of their subjects advice on footwear, advising them to wear shoes with supportive arches and cushioned heels.[15] Since both of these studies had complex multi-intervention treatment plans, and all patients received the same advice it is impossible to ascertain the effect of the education/advice on the outcomes.

Limitations in the literature
Of the studies reviewed, most suffered from at least one methodological flaw, most frequently the lack of a long term follow-up or small sample size. High drop out rates (greater than fifteen percent) were also noted in several of the studies[2,4–8,14–17], making their usefulness suspect.[10]

A further problem with many of the studies is that many of the modalities were not assessed alone, i.e. they were used in combination with other treatments, thus making it difficult to assess the effectiveness of each individual treatment.[5] This means that further studies are needed that evaluate the effectiveness of the numerous different modalities by themselves and potentially in combination with other treatments to find the most useful and cost-efficient way to treat plantar fasciitis. In addition, very few studies compared interventions to placebo or no-treatment groups, this may be desirable to ensure that an actual treatment effect is being achieved by the different interventions.

Numerous modalities that are frequently used in treat-

ing plantar fasciitis simply have not yet been examined in an identified randomized controlled trial for said condition (acupuncture, soft tissue therapy/massage, ice, heat). Additional studies are needed to assess the efficacy of these modalities for plantar fasciitis. In addition, studies that compare conservative treatments with medical interventions (medication, injection, surgical, etc) are still needed.

The studies included in this review lacked uniformity or consistency between them in outcome measure usage (in both the measures used and the frequency of measurement). Most studies used some form of subjective pain rating systems (such as the visual analog scale or numeric pain rating scale). In addition to pain measurements, most studies also obtained some measure of subjective foot function (such as the Foot Function Index or Foot Health Status Questionnaire). Numerous studies used unique outcome measures such as perception of treatment effect or first step pain, or attempted to assess the impact of the plantar fasciitis on lifestyle, work enjoyment, etc (including the SF-36). Some studies used physical examination markers (windlass maneuver, ranges of motion, point tenderness, algometer measurements). Future studies should ideally use validated and reliable outcome measures and should consistently use the same measures of pain, foot function, impact on lifestyle and physical examination procedures so that comparisons between studies can be made for statistical pooling or so meta-analyses can be performed. Crawford and Thomson also recommend that researchers evaluate how long patients spend standing each day.[11]

Conclusions
There are certainly some interventions for plantar fasciitis that the literature appears to support. There is at least one study that can be identified that favors the use of the following treatments either alone or in combination with other modalities: chiropractic care, stretching of the plantar fascia or Achilles tendon, prefabricated orthotics (including functional foot orthotics), custom-made orthotics with taping prior to orthotic delivery, and night splints. It is difficult to determine which of these treatments is the most effective, as one study will conclude that one treatment outperforms another and the next study will assert the reverse. The treatments that should likely be attempted first are those that are low-cost and

low-risk such as stretching of the plantar fascia and/or Achilles tendon, patient education, and prefabricated orthotics.[9] Custom-made orthotics may also be a suitable option in the beginning stages of treatment, as several (but not all) studies comparing them with prefabricated orthotics found that they were more beneficial than over-the-counter orthotics; they are however, far more costly, perhaps precluding their use as a first choice option.[10] It also appears that chiropractic manipulative therapy could be given a trial of therapy as well, particularly in combination with a stretching regime. If these interventions are not sufficiently effective after a suitable period, then night splints appear to be a reasonable option.

Based on this review, there is no support for the use of magnetic insoles for plantar fasciitis. Therapeutic ultrasound and low-level laser have been shown to be ineffective in the treatment of plantar fasciitis (when compared to sham ultrasound and laser), and acupuncture, soft tissue therapy, ice, and heat have not been scrutinized in a randomized controlled trial at this point in time, so use of these therapies is either unadvised or should be carried out with the understanding that the literature does not support the use of these modalities. If significant improvement has not been achieved after several months of conservative therapy, then referral for medical intervention (such as shock wave therapy, anti-inflammatory medication, or surgery as a worst case scenario) is warranted. Further high-quality research, randomized controlled trials in particular, into the conservative management of plantar fasciitis with any and all of the above-listed modalities is clearly needed.

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