Assessing The Evidence On Alternative Treatments For Plantar Heel Pain

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Plantar fascia pathology can pose a significant challenge for many providers and patients. With this in mind, this author reviews the most recent evidence for alternative treatments such as extracorporeal shock wave therapy (ESWT), laser therapy and platelet-rich plasma (PRP).

The challenge of treating patients with plantar heel pain lies in the lack of universal agreement about the etiology of the condition.[1,2] A general consensus among clinicians is that most patients with plantar heel pain have degenerative changes of the plantar fascia at the fibrocartilaginous enthesis attachment to the calcaneus.[1,3]

The histopathology of plantar fascia specimens taken from patients with chronic plantar heel pain show collagen degeneration with fiber disorientation, increased mucoid ground substance, angiofibroblastic hyperplasia and calcification.[4-6] Accordingly, some authors proposed the term “fasciosis” or “fasciopathy” in place of “fasciitis” when describing the pathologic state of the plantar fascia causing plantar heel pain.[6,7] Others argue that inflammation may precede the degenerative changes in the plantar fascia that have only been documented in surgical specimens taken from patients with long-standing heel pain.[1]

One should note that, besides degeneration within the plantar fascia, imaging and histologic studies show that plantar heel pain may also be caused by thickening of the plantar fascia, calcaneal spur, periosteal edema of the calcaneus and bone marrow edema of the calcaneus.[8-10] Few accepted treatments can actually target a specific pathology causing plantar heel pain because advanced diagnostic testing is necessary to identify this pathology. However, this type of

imaging, due to cost and issues with payor approval, is not routinely justified in the clinical setting.

Traditional treatments of plantar heel pain focus on relieving mechanical load on the insertion of the plantar fascia at the calcaneus. These interventions include stretching, taping, insoles, custom foot orthoses, heel pads, heel lifts and plantar fascia night splints.[11] Other treatments focus on reducing inflammation or pain. These modalities include corticosteroid injections, oral nonsteroidal anti-inflammatory drugs (NSAIDs), ice and physical therapy modalities.[12]

Regardless of medical specialty, there is universal agreement that no specific treatment or therapeutic approach gives rapid or predictable results for relieving plantar heel pain.[3,13,14]

As a result, medical practitioners continue to seek new or alternative treatments for plantar heel pain. Besides implementing measures to offload the plantar fascia, clinicians are now interested in technologies used for tendinopathy, fracture healing and ulcerations as there is increasing recognition that chronic heel pain is really a form of a non-healing wound of the tissues attached to the inferior aspect of the calcaneus. Accordingly, let us take a closer look at alternative or "non-traditional" treatment interventions for chronic plantar heel pain and recent clinical studies assessing their treatment effects.

Pertinent Considerations In Understanding The Mechanism And Impact Of Extracorporeal Shock Wave Therapy (ESWT)

Shock waves are sound waves that create vibrations within tissue. In medical applications, one applies shock waves to a body part in order to create a controlled injury and stimulate healing. Extracorporeal shock wave therapy (ESWT) by definition uses unique sets of acoustic pressure waves produced outside the body to treat musculoskeletal conditions.[15,16] The mechanism by which shock waves enhance healing is still not well understood but there is evidence that the local tissue injury causes neovascularization with increased production of tissue growth factors.[15] Other proposed mechanisms revolve

around analgesia created by the physical alteration of small axons as well as chemical alteration of pain receptor neurotransmission.[16]

Shock waves, depending upon the source, have various physical properties that affect how acoustic energy transfers to tissue. In addition, the dosage and penetration depth will ultimately determine therapeutic levels achieved inside the body at the target tissue. Focal shock waves have high tissue penetration power and impact force. Electrohydraulic, electromagnetic or piezoelectric methods produce these focal shock waves.[17] Radial shock waves, which are actually radial pressure waves, have lower tissue penetration with less impact. An air compressor generates these radial shock waves ballistically. The shockwave device reaches the maximum energy of radial shock waves at the tip of the applicator on the surface of the skin. With focused shock waves, however, the device can achieve the maximum energy in a focal zone within the treated tissue.[17]

Whether focused or radial, the intensity of the shock wave treatment can affect outcomes. A systematic review and meta-analysis of 11 high-quality randomized clinical trials showed that moderate- to high-intensity shock waves are more effective in treating plantar heel pain in comparison to low-intensity shock waves.[18] Chang and colleagues reported a similar dose-response relationship in their systematic review and meta-analysis of 12 clinical trials.[19] This study showed that medium- to high-intensity focused shock wave therapy was more effective than low intensity. Ironically, studies of radial shock wave treatment showed comparable results to medium- and high-intensity focused shock wave. To add to the dilemma of choosing one type of shock wave over another, there is evidence that applying local anesthesia will hamper results as getting biofeedback from the patient will enhance targeting of the shockwave to the proper location.[20]

This may explain why early studies of high-intensity, focused shock wave treatment showed no benefit in treating plantar heel pain.[21,22] Both of these studies utilized a single session of focused shock wave treatment performed with the patient under local or general anesthesia.

Since that time, researchers began testing the efficacy of moderate- to low-intensity shock wave, which one can administer without anesthesia, in order to obtain biofeedback from the patient to target the affected tissue.[20] When researchers performed ESWT without anesthesia in multiple sessions, regardless of intensity levels, ESWT showed favorable outcomes in many prospective clinical trials evaluating the treatment of plantar heel pain.[23-28] Systematic reviews and meta analyses of randomized controlled trials studying ESWT verify that the treatment is safe and effective in relieving plantar heel pain for up to 12 months.[18,19,29-31]

The studies selected for review and meta-analysis covered a wide range of treatment protocols. The shock wave treatments averaged one to three sessions per patient with a rest period of three days to two weeks between sessions.[31] The number of impulses per session ranged from a minimum of 1,500 to a maximum of 4,000 with an energy range between 0.08 mJ/mm^2 (low intensity) to 0.64 mJ/mm^2 (high intensity) per impulse.[31] Adverse effects included pain during treatment, edema, skin redness, temporary paresthesia and one case of syncope due to pain.[18,19]

Comparing ESWT To Corticosteroid Injection: Which Is Superior?

Four studies demonstrate a superiority of ESWT over corticosteroid injection to relieve plantar heel pain and improve function measured over time.[32-35] Two of these studies used focused shock wave while the other two used radial shockwave.[32-35] Clinicians did not use anesthesia in any of these studies and ESWT produced better pain relief than corticosteroid injection at both three-month and six-month follow-ups.

In summary, studies of treatment of plantar heel pain with ESWT show favorable results with minor risks of temporary adverse reactions. However, there is no consensus regarding what type of shock wave technology or what dosage of treatment will provide the best long-term results. Meta-analysis of randomized controlled trials evaluating ESWT, using both focused and radial shock wave technologies, reveal a wide range of impulses and energy dosage. This poses a

dilemma for the practitioner in deciding which technology and protocol will work best in his or her hands when treating plantar heel pain.

Furthermore, as several different anatomic structures and pathologies may cause plantar heel pain, modifying the type of shock wave, dosage and frequency could optimize treatment outcomes if the practitioner was certain of the etiology. Further research is required to provide insight into these issues as this could improve the efficacy of ESWT therapy for plantar heel pain.

What Does The Literature Tell Us About Laser Therapy?

Multiple authors have reported applying visible or invisible laser light to the surface of the body to treat a variety of musculoskeletal conditions.[36-38] Most of these studies of laser treatment of musculoskeletal conditions employed low-level laser light (LLLT) using either a gas laser (He-Ne), which produces visible red light of wavelength between 594 and 632 nm, or semiconductor lasers (GaAs or GaAlAs) that have a wavelength between 780 and 905 nm.

The primary effects of laser therapy are on the photoreceptors present in the mitochondria and on cell membranes. This process, known as photobiostimulation, reportedly enhances cellular functions and cell proliferation rates.[39,40] There is also evidence that low-level laser light therapy can dilate capillaries and activate angiogenesis.[41] Finally, low-level laser light therapy exerts an anti-inflammatory effect by decreasing the level of proinflammatory cytokines, such as interleukin-1 alpha and interleukin-1 beta, and increasing the level of other cytokines and anti-inflammatory growth factors.[42]

Bashford and coworkers were the first to study the use of low-level laser light therapy for the treatment of plantar heel pain in 1998.[43] In this study, 28 patients received 12 sessions of irradiation from a 830 nm gallium aluminum arsenide (GaAlAs) laser with a dosage of one joule (J) to the plantar heel area and two J to the medial side of the calcaneus. A control group received sham or placebo treatment. There was no significant difference in pain when comparing the two groups after treatment so the investigators concluded that low-level laser light therapy was ineffective for the treatment of plantar fasciitis.

After the study by Bashford and coworkers, the World Association for Laser Therapy recommended a treatment dose of a minimum of eight J for low-level laser light therapy for plantar fasciitis.[44] Using these guidelines, Kiristi and associates used the same gallium aluminum arsenide laser with an infrared wavelength of 904 nm, output of 240 mW and applied 8.4 J to the plantar and medial calcanei of 30 patients with plantar heel pain.[45] This was a double-blind, randomized, placebo-controlled trial in which patients received low-level laser light therapy or sham treatment three times a week for six weeks. At the end of the six-week treatment, the pain decreased by 59 percent in the irradiated group and by 26 percent in the placebo-treated group. Interestingly, ultrasound showed decreased thickness of the plantar fascia at the end of six weeks for both the treatment group and the sham group.

Two other studies report on an eight-week follow up as well as a 12-month follow up of treatment of patients with chronic heel pain using low-level laser light therapy from a He-Ne red light (635 nm) laser generating 17 mW output and giving a total dose of 1.476 J/cm^2.[46,47] At an eight-week follow up, the treatment group participants demonstrated a mean improvement of 30 points on a 100-point visual analog scale (VAS) in comparison to a mean improvement of five points with the placebo group.[46] Patients receiving low-level laser light therapy showed continued improvement with reduction of pain at six months and 12 months.[47]

Macias and coworkers also reported a small (0.4 mm) but statistically significant reduced thickness of the plantar fascia, as measured by Doppler ultrasonography, in the treatment group.[46] In the study by Jastifer and colleagues, the treatment group also showed significant improvement in the pain, disability and activity limitations subscales of the Foot Function Index with the greatest improvement occurring in the first six months after treatment.[47]

Two other studies comparing low-level laser light to placebo or traditional treatment showed significant reduction of visual analog scale pain scores attributed to the laser treatment.[48,49] At a three-month follow up, pain scores were significantly lower for the low-level laser light treatment group in comparison to the control group. Researchers also found that functional outcomes, as measured

by the function subscale of the American Orthopaedic Foot and Ankle Society Score (AOFAS-F) and the Foot Function Index, were significantly better for the group of patients receiving low-level laser light treatment.

High-Intensity Laser Therapy Versus Low-Intensity Laser Treatment: Which Is More Effective?

Recently, the implementation of high-intensity laser technology (HILT) has emerged for the treatment of osteoarthritis of the knee, low back pain, facial paralysis and epicondylitis.[50-53] High-intensity laser therapy uses a pulsed neodymium-doped yttrium aluminum garnet (Nd:YAG) laser to deliver a significantly greater amount of energy than low-level laser light therapy.

Ordahan and colleagues tested the effectiveness of high-intensity laser therapy in comparison to low-intensity laser therapy for the treatment of plantar fasciitis.[54] In this randomized study, seven patients received high-intensity laser therapy and seven patients had low-intensity laser therapy for plantar fasciitis, which had been present for over six weeks.

After three weeks of treatment, both groups showed significant improvement in all parameters of the VAS, heel tenderness index and Foot And Ankle Outcome Scores.[54] The high-intensity laser group demonstrated better improvement in all parameters than the low-intensity laser group. This study, like others testing ESWT for treating plantar heel pain, reveals that high-energy treatment seems more efficacious than low-energy therapy. However, the small patient pool of this single study warrants further investigation comparing intensity levels of laser therapy to treat plantar heel pain.

Comparing ESWT To Laser Therapy: What Do The Studies Reveal?

Two randomized, prospective comparative studies compare the efficacy of low-level laser light therapy and ESWT to treat patients with plantar heel pain of more than six months duration.[55,56] Both studies showed that ESWT and low-level laser light therapy had similar positive effects on reducing plantar heel pain and

plantar fascia thickness at a one-month follow-up, but neither modality showed superiority over the other as both treatments were equally effective.

In conclusion, laser therapy treatment of plantar heel pain has shown positive effects without any adverse reactions. The number and quality of studies of laser treatment of plantar heel pain does not approach that of ESWT. However, the evidence thus far suggests that laser therapy has gained credibility and may warrant consideration as an alternative treatment when conventional interventions fail.

Assessing The Potential Benefits With Platelet-Rich Plasma (PRP) Treatment

The production of platelet-rich plasma (PRP) takes place from a sample of autologous whole blood that is centrifuged to produce platelet concentrations above baseline values. Depending upon the preparation protocol, PRP contains varying levels of platelets as well as other blood components including leukocytes and red blood cells.[57]

Due to wide variation among studies of PRP treatments in terms of preparation and administration protocols, one must be cautious in drawing conclusions.[58] As a result, several authors propose classifications of various techniques available to prepare and administer PRP depending upon centrifuge speed, use of anticoagulants and content of platelets as well as the application method.[59,60]

Platelets possess biologically active growth factors and 70 percent of these growth factors are released upon activation of the platelets.[61] These growth factors include insulin-like growth factor, fibroblast growth factor, vascular endothelial growth factor, transforming growth factor (TGF-β) and platelet-derived growth factor (PDGF).[62]

Platelet-rich plasma also reduces the transactivation of NF-kB, which is the critical regulator of the inflammatory process.[63] In addition, PRP reduces other pro-inflammatory enzymes such as COX-2 and COX-4 as researchers have demonstrated with in-vitro studies.[64] Thus, the combination of growth and anti-

inflammatory components of PRP are suited to initiate a healing phase in chronic plantar fasciopathy.[65]

In terms of plantar fasciopathy, hypovascularity and hypocelluarity are thought to be contributors to poor healing of degeneration of the plantar fascia at the insertional site on the calcaneus.[66] Platelet-rich plasma may partially reverse this hypovascularity through the release of cytokines to stimulate cellular proliferation and angiogenesis.[67]

A Closer Look At Recent Studies Of PRP For Plantar Heel Pain

Most clinical studies evaluating PRP fail to adequately report the preparation methods so clinicians are unable to duplicate the protocols to reproduce the same outcomes.[68] Also, we now know that various levels of leukocyte concentration in the PRP mixture can have differing effects on various pathologies.[69,70] Finally, the method of administration of the PRP mixture, the timing and number of injections as well as the post-treatment activity protocols vary among clinical studies.[71]

Despite these shortcomings, it is worth evaluating clinical studies testing the efficacy of PRP to treat plantar heel pain. To this date, there are at least 20 randomized controlled trials reporting the results of treating plantar heel pain with PRP and the majority of these studies used a corticosteroid injection as a control treatment.[71-73]

Hurley and coworkers published a systematic review of nine randomized controlled trials comparing PRP treatment with corticosteroid injection.[71] At all follow-up assessments (one, three, six and 12 months), VAS scores showed significant differences in pain with PRP having better results. Functional outcomes using the AOFAS score showed no difference between PRP and corticosteroid injection at one and three months. However, at six and 12 months, AOFAS scores were higher in patients treated with PRP.

There are two different published meta-analyses of nine RCTs comparing the effectiveness of PRP and corticosteroid injection.[72,73] One study showed a

significantly improved efficacy of PRP over corticosteroid injection at a 24-week follow-up.[72] Functional scoring using the Foot and Ankle Disability Index (FADI), the AOFAS score, and the Roles and Maudsley score (RMS) showed no differences in the efficacy of PRP versus corticosteroid injection treating plantar heel pain at any point in follow-up although both groups demonstrated improvement.[72]

Another study showed no difference in pain reduction comparing PRP and corticosteroid injection at one, three and six months.[73] However, at a 12-month follow-up, PRP showed significant reduction in VAS pain score in comparison to steroid injection. With AOFAS scoring, PRP and steroid injection had similar improvements at one, three and six months with PRP showing superior improvement only at the 12-month follow-up.[73]

Two other studies show that PRP and corticosteroid injection are similar in reducing plantar heel pain at three- and six-month follow-ups.[74,75] However, a study with a 12-month follow-up demonstrated superiority of PRP over steroid injection in long-term pain relief.[76]

Alkhatib and coworkers published the most recent systematic review and meta-analysis of PRP treatment.[77] In comparison to the previously discussed meta-analyses,[72,73] Alkhatib and team included two recent randomized controlled trials and four prospective cohort studies, providing a total number of 679 patients from 13 studies. Similar to findings from previous meta-analysis studies, PRP did not show superiority over corticosteroid injection until the six- and 12-month follow-up intervals using VAS and AOFAS scores.[77]

These systematic reviews comparing PRP to corticosteroid injection show consistent findings. Both PRP and steroid injection can provide rapid pain relief at a one-month follow-up. In some cases, the pain relief is more profound with steroid injection but over time, PRP shows better long-term pain relief at six and 12 months. It is important to note that PRP has immediate pain relief effects owing to the anti-inflammatory properties of released cytokines while the longer-term effects are thought to be due to augmentation of the natural healing response through cellular proliferation and neoangiogenesis.[67]

Comparing PRP And ESWT: Which Modality Provides Better Results For Chronic Plantar Heel Pain?

Two studies compare the effectiveness of PRP to ESWT. In a randomized study, Chew and coworkers assessed 54 patients with chronic plantar heel pain (six months or greater), who were divided into three treatment groups.[78] The three treatments were either focused high-intensity ESWT, PRP or "conventional treatment," consisting of stretching and two visits of physical therapy. There was no statistically significant difference in VAS pain score improvements between the PRP and ESWT groups at one, three and six months. However, there was a significant improvement of pain with both of these treatments in comparison to conventional treatment. The PRP group demonstrated significant improvements in plantar fascia thickness at the three- and six-month follow-ups in comparison with the ESWT group.

In a 2018 randomized study, Ugurlar and colleagues compared the use of PRP, ESWT (radial), corticosteroid injection (40 mg betamethasone) and prolotherapy (5% dextrose) injection in 154 patients with chronic plantar heel pain (average 12 months duration).[79] Clinicians administered each treatment three times over a three week period. At the end of the 36-month follow-up period, there were no differences between any of the four treatment groups in visual analog scale scores and Foot Function Index, and all regressed back to their original pain levels. At six and 12 months, ESWT had the best improvement of visual analog scale pain score in comparison to the other three treatments. This study demonstrates that when patients experience heel pain for greater than 12 months, any intervention given over a limited three week treatment time may not provide long-standing relief beyond 12 more months.[79] It is likely that those patients with 12 months of heel pain or more will require extended treatment beyond three weeks.

In the final analysis, when comparing PRP to corticosteroid injections, PRP appears to have some superiority in both reduction of pain and improvement of function. However, the reduction of pain at six and 12 months, while statistically significant, only differs by about two points on a 10-point scale in favor of PRP

over steroid injection. The increased cost of PRP in comparison to corticosteroid injection may not justify the small but significant improvement of pain relief. The cost versus benefit ratio of PRP over steroid injection is ultimately determined by the patient, who is paying for the treatment. Certainly, the potential adverse effects of a corticosteroid injection for plantar heel pain, including fat pad atrophy and potential rupture of the plantar fascia, warrant consideration by the patient and the treating physician.[80,81] Conversely, multiple studies show that PRP injections into the proximal calcaneus do not demonstrate any adverse reactions.[71-73]

In Conclusion

When evaluating the biologic effects of ESWT, PRP and laser therapy, all three technologies reduce inflammation, stimulate angiogenesis and have the capacity to release growth factors to enhance tissue healing. Considering the histopathology of plantar fasciopathy, these interventions appear to have the potential to address the multiple factors leading to degeneration and an impaired healing response of the injured tissue.

In comparison to local corticosteroid injection, multiple studies show the superiority of ESWT, PRP and laser therapy to achieve long-standing reduction of pain. Future studies are necessary to clarify how to achieve optimal outcomes with each of these treatments in terms of technology options as well as the appropriate dosage and frequency of application.

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