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A literature review of Radiofrequency Coblation treatment for Plantar Fasciitis.

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Abstract: Plantar fasciitis (PF) is a common, disabling condition, affecting millions of patients each year. With early diagnosis and timely application of traditional nonsurgical treatments, symptoms generally resolve over time. However, despite adequate treatment, 20% of patients will experience persistent symptoms. In these patients, minimally invasive therapies that augment local hemodynamics to initiate a regenerative tissue-healing cascade have the greatest potential to resolve long-standing symptoms. (2) This review highlights emerging minimally invasive therapies that exploit these mechanisms in recalcitrant PF. Microtenotomy coblation using a radiofrequency (RF) probe is a minimally invasive procedure for treating chronic tendinopathy. It has been described for conditions including tennis elbow and rotator cuff tendinitis. There have been no studies to show the effectiveness of such a procedure for plantar fasciitis. is simple, minimally invasive, and has a rapid rehabilitation component. Results over 3 years have continued to show 90% to 95% good to excellent results.

Key words: Plantar Fasciitis, Radiofrequency Coblation

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Introduction

Microtenotomy coblation using a radiofrequency (RF) probe is a minimally invasive procedure for treating chronic tendinopathy. It has been described for conditions including tennis elbow and rotator cuff tendinitis and plantar fasciitis. (1)

Plantar heel pain is the most common reason for visits to foot and ankle specialists, accounting for 1-2 million annual visits in the US alone. Plantar fasciitis (PF) is the predominant diagnosis a condition characterized by degeneration of the plantar fascia and perifascial structures with isolated inferior heel pain, particularly with the first steps of the day and after prolonged sitting. Approximately 1 in 10 people will be diagnosed with PF during their lifetime, with women aged 40-60 years most commonly affected. Risk factors include limited ankle dorsiflexion, flatfoot deformity, obesity, and prolonged work-or activity-related weight bearing. PF negatively impacts health-related quality of life and is responsible for a significant societal economic burden, with almost 300 million dollars annually spent on physician visits and treatments. (2)

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With early diagnosis and timely application of traditional nonsurgical treatments such as activity modification, gastrocnemius and plantar fascia-specific stretching, anti-inflammatory medications, and/or shoe inserts, the prognosis is favorable with approximately 80% of patients achieving symptom resolution within 1 year. Symptoms may persist in some patients despite increasingly aggressive therapies such as corticosteroid injections, night splints, or cast/boot immobilization. Since the etiology of these recalcitrant cases is controversial and likely multifactorial, numerous therapies with various mechanisms of action have been attempted, although none have an ideal efficacy and safety profile. Conventional treatments for chronic PF may be misdirected, while therapies which augment local hemodynamics, thereby initiating a regenerative tissue healing cascade, have the greatest potential to resolve long-standing symptoms. (2)

Mechanism of plantar fascia injury

The plantar fascia connects the medial calcaneal tuberosity to the proximal aspect of the phalanges, plays a major role in supporting the medial longitudinal arch, and aids in dynamic shock absorption. The term plantar fascia is actually a misnomer since this structure is not a facial layer, but a tendinous aponeurosis that shares histological and mechanical traits with tendons and ligaments. Therefore, it is relevant to compare the etiology, pathophysiology, and treatment of PF to the analogous processes which occur in degenerative diseases of other tendons (tendinosis). (3)

It is generally believed that PF is initiated by excessive tensile strain within the fascia during repetitive loading producing microscopic tears and an acute inflammatory response. Macrophages, lymphocytes, and plasma cells infiltrate the calcaneal enthesis causing tissue destruction. If the insult persists, and the reparative process is unable to keep up with the ongoing mechanical demands, then the attempted healing instead produces immature vascularization and fibrosis. Tissue degeneration (fasciosis), rather than inflammation, then becomes the cardinal pathologic feature. A number of studies have analyzed tissue samples from patients with chronic PF and have found no evidence of inflammation. Similarly, histological analyses of surgical biopsies of tendons affected by "tendonitis" have revealed no evidence of inflammatory cell invasion. (3)

Plantar fascia thickening and loss of normal tissue elasticity play an important role in the genesis of persistent inferior heel pain. There is a fivefold increase in the mechanical stiffness of the plantar fascia in pathologic feet compared with healthy ones. This increased stiffness results in higher tissue hydrostatic pressure within the plantar tissues during loading, consequently acting on the external surface of blood vessels to reduce the flow cross-section area local blood supply. This cascade of events has been hypothesized to cause tissue necrosis and replacement with undifferentiated scar tissue and is the presumed reason for lack of response to traditional nonsurgical therapies. (2)

Once damaged, the biological and biomechanical properties of connective tissue are never completely restored. Healing times in chronic tendinopathies are often prolonged since local blood flow is only about one-third of that delivered to the muscles. Moreover, augmenting the local blood flow has been shown to hasten regeneration of damaged connective tissue. The proximal plantar fascia is relatively hypovascular, as it is perfused by only a few vessels with none at its insertion onto the calcaneus – the point of maximal tenderness in chronic PF. These findings form the rationale for our hypothesis that exogenous stimulation of local circulation via increasing blood flow, angiogenesis, or by direct application of blood-derived products may hasten healing with chronic PF. (1)

Signs and symptoms

When plantar fasciitis occurs, the pain is typically sharp and usually unilateral (70% of cases). Heel pain worsens by bearing weight on the heel after long periods of rest. Individuals with plantar fasciitis often report their symptoms are most intense during their first steps after getting out of bed or after prolonged periods of sitting. Improvement of symptoms is usually seen symptoms include numbness, tingling, swelling, or radiating pain. (2)

If the plantar fascia continues to be overused in the setting of plantar fasciitis, the plantar fascia can rupture. Typical signs and symptoms of plantar fascia rupture include a clicking or snapping sound, significant local swelling, and acute pain in the sole of the foot. (6)

Pathophysiology

The cause of plantar fasciitis is poorly understood and is thought to likely have several contributing factors. The plantar fascia is a thick fibrous band of connective tissue that originates from the medial tubercle and anterior aspect of the heel bone. From there, the fascia extends along the sole of the foot before inserting at the base of the toes, and supports the arch of the foot. (2)

Plantar fasciitis is a non-inflammatory, degenerative condition associated with overuse, and often encountered in clinical practice. Its pathology is similar to a tendinosis or tendinopathy. Non-surgical therapy has often been the more common modality of treatment, including analgesia, rest, foot orthotics and support, physiotherapy, and steroid injection. (5)

Tendinosis is characterized by the absence of inflammatory cells, an abundance of disorganized collagen and fibroblastic hypertrophy, as well as disorganized vascular hyperplasia with avascular tendon fascicles. Nutritional flow through the affected tendon is decreased from non-functional vessels, resulting in reduced and compromised repair and re-modeling of extracellular matrix required for healing . (5)

It has also been shown that laser and radiofrequency (RF) trans myocardial revascularization can lead to increased localized angiogenesis, with improvement in clinical parameters, and better histological and biochemical findings. Fibroblastic growth factor (FGF), vascular endothelial growth factor (VEGF), vascularity and vascular cells were all found to increase. (5)

The possibility for treatment of a tendinosis by a RF-based approach might therefore be valuable. This hypothesis was studied and pre-clinical research found that RF-based microtenotomy was effective in simulating an angiogenic healing response in tendon tissue. Early inflammatory response, new vessel formation, elevated VEGF and a-v integrin were all shown . RF-based microtenotomy was thus started for the treatment of tendinosis, and has been successfully used in the management of conditions such as tennis elbow and rotator cuff tendinosis .Improved clinical parameters in the study would include reduced pain and improved function. Improved expectation and satisfaction scores would also be indicative of a successful procedure or intervention. (2)

Due to this shift in thought about the underlying mechanisms in plantar fasciitis, many in the academic community have stated the condition should be renamed plantar fasciosis. The structural breakdown of the plantar fascia is believed to be the result of repetitive microtrauma (small tears). Microscopic examination of the plantar fascia often shows myxomatous degeneration, connective tissue calcium deposits, and disorganized collagen fibers. (5)

Disruptions in the plantar fascia's normal mechanical movement during standing and walking (known as the Windlass mechanism) are thought to contribute to the development of plantar fasciitis by placing excess strain on the calcaneal tuberosity. Other studies have also suggested that plantar fasciitis is not actually due to inflamed plantar fascia, but may be a tendon injury involving the flexor digitorum brevis muscle located immediately deep to the plantar fascia. (5)

Management

Treatment decision-making

Treatment decision-making for chronic PF is challenging given that there are dozens of available treatment options with no clear gold standard. Unfortunately, the effectiveness of continued conservative treatment for inferior heel pain diminishes if symptoms have not resolved with 3-6 months of standard treatment. In these cases, patients must consider more invasive options to achieve satisfactory symptom relief. Treatment decision-making is further complicated by the lack of evidence for emerging therapies. (2)

Given the compelling evidence that chronic subcalcaneal heel pain stems from a degenerative process, it is imperative that the rationale for use of currently available therapies be reevaluated. For example, corticosteroid injections are extensively utilized in patients with chronic inferior heel pain. However, given the absence of a measureable inflammatory response, the utility of corticosteroid injections appears to be misdirected and may partially explain their limited effectiveness in recalcitrant cases. (2)

The reluctance to adopt noninvasive or minimally invasive therapies for chronic PF was evident from a survey of 84 orthopedic surgeons who were asked to provide treatment recommendations for a hypothetical patient presenting with PF resistant to 10 months of non-operative management. Over 50% of surgeons chose surgery (gastrocnemius recession or open plantar fasciotomy) as their preferred next step in management despite only moderate patient success rates, extended recovery times, and potential complications such as nerve injury, plantar fascia rupture, medial longitudinal arch destabilization, and altered loading patterns. Consideration of emerging treatments focused on augmenting local hemodynamics, which is hypothesized to play a major role in lingering PF cases, is warranted to fill the therapeutic gap between ineffective conservative care and invasive surgical options in the patient with chronic PF refractory to conventional therapy. (4)

Radiofrequency microtenotomy

The radiofrequency microtenotomy technique has been applied to chronic tendinopathies for over a decade with promising results. Radiofrequency microtenotomy stimulates angiogenesis in the avascular, fibrotic fascia, which promotes secretion of fibroblastic growth factor, vascular endothelial growth factor, and vascular cells. Histologic evaluation of treated tendons shows an early inflammatory response, with extensive proliferation of vascular cells and new blood vessel formation by 28 days. (6). Patients with chronic isolated Achilles tendinopathy refractory to nonoperative treatment rated their clinical outcome with radiofrequency microtenotomy as good or excellent with an average of 2.5 years follow-up. Several case series have reported promising outcomes in recalcitrant PF, with the open method more efficacious than the percutaneous technique. No comparative studies have been performed to date with radiofrequency microtenotomy and follow-up data is limited to 1 year or less in all studies. (1)

Procedure

The TOPAZ Microdebrider device (ArthroCare, Sunnyvale, CA), connected to a System 2000 generator set at setting 4 (175 V-RMS), was used to perform the RF-based microtenotomy. The device works by using a controlled plasma-mediated RF-based process(coblation). (1)

The RF energy is used to excite the electrolytes in a conductive medium, such as an electrolyte (saline) solution, to generate excited radicals within a precisely focused plasma. The energized particles in the plasma thus generate sufficient energy to break up covalent molecular bonds, resulting in the ablation of soft tissues at relatively low temperatures (typically 40–70 8C). (1)

The tip of the TOPAZ device is about 0.8 mmin diameter and has a surface area of 0.502 mm2. The tip is placed on the plantar fascia that has been exposed following an incision on the plantar surface of the foot. Using a light touch, the surgeon activates the device (at setting 4), for 500 ms, and microdebridement was performed in a grid-like pattern at 5 mm intervals, to a depth of 3–5 mm within the fascia. Having microdebridements too close to each other would otherwise increase the risk of rupture as more fascia than necessary is ablated.

Assuming that the mean depth of each microdebridement is 4 mm, each perforation would remove about 2 mm^3 of tissue. A typical plantar fascia microtenotomy procedure would consist of 10–20 microdebridements (removing 20–40 mm3 of tissue), depending on the patient. (1)

Complications

In the series of patients described in an article by Sorensen and Hyer, 4.76% of patients developed FHL tendonitis. Although the precise cause of this complication is not clearly known, it is possible that the bRf probe was passed to an excessive depth, placing it into, or close to, the FHL tendon or its sheath. The patient in question was also dissatisfied with the procedure, based on the FHL tendinitis that persisted throughout the observation period. (8)

Literature review of study results

Hormozi et al (10) studied 16 similar percutaneous procedures, with a 15-month average follow-up period. They used a more rapid transition to activity, with regular show wear allowed at 2 weeks and activities as tolerated at 4. They reported no complications, and a 78% satisfaction rate, with an average postoperative AOFAS score of 82.1. (10)

Weil et al (7) prospectively studied 10 patients who had undergone a percutaneous approach. They also reported on early significant improvement in pain and function at 7 to 14 days postoperatively, with maximal improvement at 6 months. The reported AOFAS hindfoot score improved from 57.4 to 88.1. They also reported no complications, with 90% satisfaction at 1 year postoperatively. (7)

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Sorenson et al (9) previously reported on a prospective group of 21 patients who had undergone a technique identical to that used in the present study. They reported that 33% of patients demonstrated maximal improvement within 4 weeks, with 81% obtaining these results at 4 months. They had an 86% satisfaction rate, with subjective good and excellent outcomes at an average follow-up period of13 weeks. They had no wound complications, scar formation, or lateral column pain postoperatively. All patients were allowed to return to regular shoe wear with orthotics at 4 weeks postoperatively and activities, as tolerated. The American Orthopedic Foot and Ankle Society (AOFAS) hind foot scores improved from an average of 22.1 to 59.6. (9)

Sean et al (11) studied 15 patients prospectively who had undergone a similar technique, but they used an open approach. They allowed weight bearing as tolerated immediately postoperatively. They reported that 57% of patients noted significant pain reduction within 48 hours. They reported no complications and good and excellent outcomes in 86% at 6 months. The AOFAS hindfoot scores improved from 34.5 to 69.3 postoperatively, with improvement in the Medical Outcomes Study short form 36-item questionnaire for pain and function. All patients' improvement had plateaued at 3 months. They concluded that their patients had experienced earlier improvement, an earlier return to activity, and earlier maximal improvement compared with patients who had undergone traditional procedures. (11)

A study by Christopher F. Hyer, DPM, MS, FACFAS showed an 83.6% satisfaction rate in patients with recalcitrant chronic plantar fasciitis at an average of nearly 3 years of follow-up. Future studies are needed to identify those patients in whom treatment with percutaneous bRfs microtenotomy might fail. The present study was the largest series published to date, with the longest follow-up period, and adds to the body of knowledge that points to this technique as a reasonable next step in the treatment of recalcitrant plantar fasciitis. (12)

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