A New Minimally Invasive Technique for Treating Plantar Fasciitis Using Bipolar Radiofrequency: A Prospective Analysis

Abstract: The purpose of this study was to evaluate the effectiveness of a new minimally invasive technique using bipolar radiofrequency in the treatment of plantar fasciitis. A prospective study was performed on 10 patients with recalcitrant plantar fasciitis that failed conservative care. A percutaneous microtenotomy was performed unilaterally with a Topaz microdebrider. Outcome measures included visual analog scale, American Orthopaedic Foot & Ankle Society (AOFAS) Hindfoot and Midfoot Scale, and patient satisfaction assessment. All patients had statistical improvement in outcome measures at 6 months and 1 year. One patient developed recurrent heel pain at the 1-year mark. There were no postoperative complications. This minimally invasive technique is a viable surgical treatment option in patients with plantar fasciitis that failed conservative care.

Keywords: plantar fasciitis (fasciosis); heel spur syndrome; tendinosis; bipolar radiofrequency

Approximately over 2 million Americans seek treatment for plantar fasciitis, and 10% of the population develops plantar fasciitis over a lifetime. Plantar fasciitis is reported to be most common in athletically active individuals and those with sedentary lifestyles. Patients often complain of pain with the first few steps in the morning, and the clinical presentation is tenderness and swelling to the plantar medial heel. Most authors agree that 90% to 95% of people diagnosed with plantar fasciitis have resolution of symptoms with conservative treatment alone. Conservative treatment options include rest, aggressive heel cord stretching, oral nonsteroidal anti-inflammatory drugs, night splints, steroid injections, and strapping. Recently, extracorporeal shockwave treatment has shown to be effective in 60% to 80% of recalcitrant cases and can be a bridge between conservative and surgical care.

Although plantar fasciitis is widely described in the literature, the etiology is multifactorial and debatable. The pain associated with this condition can be related to the degenerative changes associated with chronic overuse. With magnetic resonance imaging (MRI), acute plantar fasciitis can exhibit microtearing in the fascia, thickening at the insertion, edema, and inflammation of the adjacent subcutaneous fat. After continued repetitive trauma, recalcitrant plantar fasciitis shows less edema in the fascia. Histological studies have shown noninflammatory changes within the fascia, with evidence of localized fibrosis, collagen necrosis, and fibroblastic hyperplasia. Due to these noninflammatory and degenerative changes, Lemont and colleagues have suggested that plantar fasciitis is more accurately described as plantar fasciosis. The characteristics of plantar fasciosis are similar to tendinosis, which is characterized by the absence of inflammatory cells, fibroblastic hypertrophy, and avascularity. A treatment solution that can stimulate angiogenesis.

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Radiofrequency microtenotomy is a viable surgical treatment of recalcitrant plantar fasciitis. The technique is simple to perform and minimally invasive.
may be a viable option in the avascular, fibrotic, and degenerative fascia. Early research using bipolar radiofrequency (transmyocardial revascularization) to promote angiogenesis started in cardiology research in patients with congestive heart failure. The histologic and clinical results were superior to other procedures. In preclinical studies, radiofrequency-based microtomy was effective in stimulating an angiogenic healing response. Histologically, treated tendons showed an early inflammatory response and new blood vessel formation.

On the basis of this research, Tasto and colleagues evaluated the use of radiofrequency in chronic tendinosis. The investigators reported a simple and less invasive technique with improvement in pain and function through 24 months.

We propose a new minimally invasive technique using bipolar radiofrequency in the treatment of plantar fasciitis. Patients were followed prospectively for 1 year, and the primary objective was to evaluate the effectiveness of radiofrequency and determine overall pain relief. The secondary objective was to assess pre- and postoperative levels of function and activity.

Patients and Methods

We prospectively reviewed the results of 10 patients who underwent percutaneous microtomy of the plantar fascia between March 2005 and October 2006. The primary diagnosis was plantar fasciitis in all cases. Patients were chosen based on specific inclusion criteria from the senior authors' outpatient clinics. The surgical inclusion criteria included age (>18 years old), tenderness with palpation of the plantar medial heel, symptoms present >6 months, VAS (visual analog pain score) >5 with the first steps in the morning, and failed conservative treatments such as steroid injections, orthotics, physical therapy, and night splinting. Specific exclusion criteria included a body mass index (BMI) >40, prior surgical treatment of affected plantar fascia, heel pain with systemic comorbidities or nerve-related symptoms (radiculopathy, tarsal tunnel, or Baxter's entrapment), and bilateral heel pain combined with a VAS of >5. Appropriate institutional review board consent was obtained for this study.

Outcome measures were obtained prior to surgery (baseline), as well as 6 and 12 months postoperatively. Outcome measures included VAS, American Orthopaedic Foot & Ankle Society (AOFAS) Hindfoot and Midfoot Scale, and patient satisfaction assessment. The AOFAS Hindfoot (HF) and Midfoot (MF) scale was used to assess function, alignment, and pain. The AOFAS HF and MF scores at 6 months were statistically evaluated against those at baseline, and scores at 1 year were statistically evaluated against those at 6 months. The VAS was determined by using a 10-cm line anchored by 0 (no pain) and 10 (worst imaginable pain) at each end. Patients were asked to make a mark on the line, and the score was obtained by measuring from 0 to the mark in centimeters. VAS assessment was determined in the morning (VAS-AM) with the first few steps and at night before going to bed (VAS-PM). VAS scores at 7 to 14 days were statistically evaluated against those at baseline, scores at 6 months were statistically evaluated against those at baseline, and scores at 1 year were evaluated against those at 6 months. Patient satisfaction was determined at 6 months and 1 year postoperatively and took into account patients' function and pain level.

Normally distributed data were described using standard parametric statistics (mean and standard deviation). Statistical evaluation in improvement of pain scores and AOFAS scores was determined using the Student t test between test points. A P value of less than .05 was considered significant for all outcomes.

Operative Technique

Preoperatively, the area of tenderness is marked on the plantar heel. Using a template with a series of holes 5 mm apart, marks are placed throughout the area of tenderness in a grid-like pattern (Figure 1). Approximately 10 to 20 holes are placed within the affected area. Patients are placed supine on the operating table. Surgery is performed using a pneumatic ankle tourniquet. After sterilely prepping the foot, a medial calcaneal nerve block is administered with 0.5% Bupivacaine without epinephrine. A smooth 0.062-inch Kirschner (K) wire is used to puncture the skin at the marks placed around the affected area (Figure 2).

The ArthroCare bipolar control unit (Figure 3) is set to level 4 (175 V) and the timer attached to the control units automatically sets to 500 milliseconds (half of a second). Typically, the Topaz wand is attached to a saline drip, and 1 to 2 drops per 3 seconds is sufficient to flow out of the tip of the probe. After infiltration of local anesthetic, abundant fluid is in the surrounding soft tissues to interact with the tip of the Topaz wand so the saline drip is turned off.

Microtomy of the plantar fascia is performed by placing the Topaz wand through the percutaneous holes made by the smooth K-wire (Figure 4). The wand is advanced until resistance is felt and the radiofrequency is applied. The wand is advanced further through the fascia by another radiofrequency application. In total, 2 radiofrequency applications are made in 1 percutaneous hole, 1 superficial and another through the thickness of the fascia; thus, varying depths of radiofrequency are applied. Steri-strips are applied (Figure 5) as well as a dry sterile dressing.

Postoperative Period

The postoperative regimen was standardized for each patient. For postoperative pain control, patients were given a prescription for an anti-inflammatory. Immediately after surgery, patients were full-weightbearing in a CAM Walker and continued this for 1 to 2 weeks. Patients were encouraged to remove the CAM Walker for stretching exercises. Patients were seen for a postoperative evaluation at 1 week, at which time the dressings were removed, and patients transitioned into a running-type shoe as tolerated with...
Figure 1.
Identify the area of maximal tenderness preoperatively.

Figure 2.
Using a smooth K-wire to puncture skin down to the level of the plantar fascia.

arch-supportive devices. Patients were encouraged to perform calf stretching exercises and continue to use night splinting throughout the postoperative period. Typically, patients were back to full activities within 4 to 6 weeks postsurgery.

Results

Follow-up examination was performed in 10 cases at an average of 12 months. The average age was 47.4 ± 12.276 years (range, 36-70). In the patient selection, there were 6 (60%) women and 4 (40%) men. The mean duration of symptoms before surgery was 41.9 ± 53.288 months (range, 12-99). The duration of symptoms for 1 patient (10%) was 1 year, for 4 (40%) patients within 2 years, and for 5 (50%) patients greater than 3 years. The BMI (weight [lb]/[height [in]]²) was 29.994 ± 5.649 (range, 25.4-39). The operative side included 4 (40%) left and 6 (60%) right. No bilateral cases were performed.

The overall mean VAS-AM preoperatively was 7.61 ± 1.282 (range, 5-9.4), and VAS-PM was 7.64 ± 2.455 (range, 1.8-10). At 7 to 14 days postoperatively, the VAS-AM was 2.15 ± 2.625 (range, 0-6.7), and the VAS-PM was 2.46 ± 3.053 (range, 0-8.6). The VAS-AM and VAS-PM were statistically significant (P < .0001). At 6 months, the VAS-AM was 2.20 ± 2.268 (range, 0-6.2) and was statistically significant (P < .0001). The VAS-PM score improved to 1.84 ± 2.076 and was also statistically significant (P < .0001). At 1 year, the VAS-AM score was 1.68 ± 2.568 (P = .589), and the VAS-PM score was 1.70 ± 2.923 (P = .875) (Table 1). The baseline VAS scores statistically improved when compared with the 1-year VAS scores (P < .0001). Pain improved in all feet except 1 case, which continued to have a VAS-AM score of 8 at the 1-year mark and a VAS-PM score of 7 in the evening.

The mean AOFAS hindfoot score preoperatively was 57.40 ± 12.204 (Table 2). At 6 months postoperatively, the AOFAS hindfoot score was 88.10 ± 7.000 (P < 0.0002), and at 1 year, it was 88.50 ± 9.618 (P = .829). The baseline AOFAS hindfoot score compared with the 1-year score improved and was statistically significant (P < .0001). The mean AOFAS midfoot score preoperatively was 49.50 ± 13.109. At 6 months postoperatively, this improved to 87.80 ± 8.025 and was statistically significant (P < .0001). At 1 year, the AOFAS midfoot score was 87.30 ± 10.945 (P = 850). The baseline AOFAS midfoot score compared with the 1-year score improved and was statistically significant (P < .0001).

All patients returned to normal shoe gear within 2 weeks. No infections, deep vein thrombosis, or neurovascular
injuries were encountered. No reoperations were done in this patient group. One recurrence of symptoms was seen at the 1-year follow-up. Sixty percent (6) were extremely to very satisfied with their outcome 1 year from surgery. Thirty percent (3) were satisfied with their outcome. Only 1 patient was somewhat dissatisfied with the outcome at 1 year.

**Discussion**

In this study, using radiofrequency microtenotomy in recalcitrant plantar fasciosis has very promising results. At baseline, all patients failed a number of conservative treatments, and the duration of symptoms for the majority was greater than 2 years. The primary objective was to determine overall pain relief with this procedure. At baseline, the mean pain score was 7.6 in the morning and 7.64 in the evening. One to 2 weeks postoperatively, all patients (100%) had a statistical improvement in their pain in the morning and evening. This minimally invasive procedure does not require soft tissue dissection and retraction as compared with open procedures, so pain relief may be more rapid. Tasto and colleagues hypothesized that rapid pain reduction could be caused by an antinociceptive effect and not revascularization and reorganization of collagen. Signs of neovascularization are evident 2 to 3 weeks postoperatively. In the cardiology literature, Dietz et al found that localized vessel count increased 3 to 9 weeks after radiofrequency. In this study, all patients had significant improvements in pain at 6 months postsurgery and continued improvement 1 year after surgery. Patients' VAS scores at 6 months compared with 1 year continued to improve, but a significant improvement was not noted. Patients continue to improve at 1 year but may reach maximal improvement at 6 months or before.

Using this new minimally invasive technique, patients were able to transition into normal shoe gear quicker and within 2 weeks. No prolonged immobilization was necessary to allow incision healing. One advantage of this technique is the rapid return to daily activities. Patients were able to return to normal activities within 4 to 6 weeks with minimal loss of time from work. The AOFAS Hindfoot and Midfoot scores significantly improved at 6 months compared with baseline, and a slight improvement was noted between 6 months and 1 year. Postoperatively, patients were encouraged to continue aggressive calf stretching and to use night splinting, and this may have helped in rapid recovery as well. All patients were satisfied to extremely satisfied with their function and pain level. Only 1 patient in this small series had an increase in pain at the 1-year mark and was somewhat dissatisfied with the results. The patients' improvement at 6 months in the VAS-AM (3.40), VAS-PM
Figure 5.
Application of steri-strips and small dressing following procedure.

Table 1.
Visual Analog Pain Scores (Mean ± SD) at Baseline and 7 to 14 Days, 6 Months, and 1 Year Postoperatively

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<th>VAS-AM</th>
<th>VAS-PM</th>
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<td>Baseline</td>
<td>7.61 ± 1.283</td>
<td>7.64 ± 2.436</td>
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<tr>
<td>7 to 14 days</td>
<td>2.15 ± 2.625 (.0001)</td>
<td>2.46 ± 3.053 (.0001)</td>
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<tr>
<td>6 months</td>
<td>2.20 ± 2.268 (.0002)</td>
<td>1.84 ± 2.076 (.0001)</td>
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<tr>
<td>1 year</td>
<td>1.68 ± 2.568 (.590)</td>
<td>1.70 ± 2.924 (.875)</td>
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Statistical significance in parentheses and found using the Student t test. VAS-AM, visual analog pain score determined in the morning; VAS-PM, visual analog pain score determined in the evening.

Table 2.
AOFAS Hindfoot and Midfoot Scores (Mean ± SD) at Baseline and 6 Months and 1 Year Postoperatively

<table>
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<th>AOFAS–Hindfoot Score</th>
<th>AOFAS–Midfoot Score</th>
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<tr>
<td>Baseline</td>
<td>57.4 ± 12.204</td>
<td>49.5 ± 13.109</td>
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<tr>
<td>6 months</td>
<td>88.1 ± 6.999 (.0003)</td>
<td>87.8 ± 8.025 (&lt;.0001)</td>
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<td>1 year</td>
<td>88.5 ± 9.618 (.849)</td>
<td>87.3 ± 10.945 (.850)</td>
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Statistical significance in parentheses and found using the Student t test. AOFAS, American Orthopaedic Foot & Ankle Society.

(2,9), AOFAS HF (90), and AOFAS MF (90) statistically improved compared with baseline values (VAS-AM 8.3, VAS-PM 10, AOFAS HF 41, and AOFAS MF 38).

No complications were encountered with this small patient group. No plantar fascia ruptures were noted, even with immediate postoperative weightbearing. Published biomechanical data show no weakness of the tendon after making multiple perforations in an in vitro model.11 At the last follow-up at 1 year, no complaints of lateral column pain were recorded. Lateral column pain, alteration of foot mechanics, and nerve entrapment are potential complications of plantar fascia releases.11-9 In plantar fasciitis, using radiofrequency to help promote angiogenesis in chronic degenerative fascia and not releasing the plantar fascia may also allow a rapid recovery.

One disadvantage of this study is the small patient sample plus short-term follow-up. Long-term and prospective blinded studies are needed to determine the true beneficial effects of this procedure. The Well Foot and Ankle Institute is currently performing a large prospective, double-blinded, randomized controlled study to determine and compare the results of a percutaneous plantar fasciectomy and microfasciectomy using Topaz coblation.

Conclusion

Radiofrequency microtenotomy is a viable surgical treatment of recalcitrant plantar fasciitis. The technique is simple to perform and minimally invasive. Rapid pain relief was achieved in most patients, with early return to activity. This plantar fascia sparing method that is used reduces the chances of pain associated with other procedures that transect part or all of the plantar fascia.

References


