Open vs Percutaneous TOPAZ Coblation for the Management of Plantar Fasciitis: Comparison of the Two Techniques in Obese Patients

PNG Wenxian¹, Kevin Koo Oon Thien²

ABSTRACT

Introduction: Plantar fasciopathy is known to be the most common cause of heel pain. Obese patients are known to have an increased probability of suffering from this condition. The technique of radiofrequency (RF) coblation, comparing open vs percutaneous methods, and its outcomes, has not been studied in the subgroup of patients.

Materials and methods: Patients treated operatively by RF coblation in our institution for plantar fasciitis between 2007 and 2015 were grouped into whether they received the open or percutaneous microtenotomy. The patients were interviewed at baseline and 3 months, 6 months, and 12 months postoperatively using the American Orthopedic Foot and Ankle Society (AOFAS) and 36-item Medical Outcomes Short Form (SF-36) questionnaires.

Results: Patients in both arms had an overall improvement in the visual analog scale (VAS) pain score and AOFAS ankle-hindfoot scores. The SF-36 scores also showed improvement across all areas postoperatively. There was also a significant improvement in expectation and satisfaction scores. However, those who had open RF microtenotomy fared better at 3 months, with regard to the visual analog score and both at 3 months and 6 months for the AOFAS hindfoot scores. There were no difference comparing both techniques with regard to the SF-36 scores.

Conclusion: Radiofrequency microtenotomy is a safe and effective procedure for the treatment of plantar fasciitis even in the obese group of patients. Both open and percutaneous methods have achieved good patient outcomes and expectation, although the open group showed superior pain and functional outcomes at early follow-up.

Keywords: Obesity, Open, Percutaneous, Plantar fasciitis, Radiofrequency coblation.

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INTRODUCTION

Plantar fasciitis is associated with pain and discomfort in the heel due to “fasciosis” at the insertion of the plantar fascia to the calcaneum. It is one of the frequent causes of heel pain, with up to 22% in runners suffering from this condition.¹ Lemont et al. described the condition more as a fasciosis, with more findings of thickened and degenerate tissue compared to inflammatory changes.²

Patients often do not seek specialist review in the orthopedic clinic unless they have recalcitrant symptoms. Majority of patients, up to 90%, with plantar fasciitis (PF) will have resolution of their symptoms at around 12 months with conservative treatment.³ The nonoperative treatment of plantar fasciitis includes anti-inflammatory medications, tendo-Achilles and plantar fascia stretching, steroid injections, shoe inserts, casting, night splints, and extracorporeal shock wave therapy. Surgical intervention can be an option after 6–12 months of failed conservative treatment.

The traditional method of planar fascia release has its successes but is also known to have a few undesirable effects, namely, long postsurgical recovery time, fascia rupture, and instability of the foot arches.^{4–6} More recently, radiofrequency (RF) coblation is used as a minimally invasive therapy for chronic plantar fasciitis. This treatment works by causing tissue destruction with little heat damage and healing taking place via controlled inflammation and targeted angiogenesis. This technique can be administered using the open or percutaneous (minimally invasive) approach, with

^{1,2}Department of Orthopedic Surgery, Singapore General Hospital, Singapore

Corresponding Author: PNG Wenxian, Department of Orthopedic Surgery, Singapore General Hospital, Singapore, Phone: +65 98361145, e-mail: wenxian.png@mohh.com.sg

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some studies showing the open technique to have superior early outcomes.^{7–9}

Body mass index (BMI) has been frequently associated with plantar fasciitis, though the exact mechanism for the association is uncertain. It is known that overweight or obese patients have up to a 1.4 times increased chance of suffering from plantar fasciitis^{10–11} Understanding obesity as an etiology for plantar fasciitis may affect management strategies. The technique of RF coblation has not been studied in the subgroup of patients who are overweight and obese. The aim of this retrospective study is to compare the open and the minimally invasive method of RF microtenotomy in the management of plantar fasciitis in the subgroup of obese patients as well as assess its long-term outcome over a 1 year follow-up.

MATERIALS AND METHODS

Patient Selection

The patients included in the study was from a database provided by our institution's Orthopaedic Diagnostic Centre. Data from all patients with plantar fasciotomy at our institution from December 2007 to September 2013 were considered for the analysis. Forty-five patients had complete follow-up data at 1 year postoperatively and they were analyzed for our study. Our selection criteria enrolled in the study only participants who have been symptomatic for at least 6 months, have undergone but failed conservative treatment, and have a BMI of >25.0 . Our exclusion criteria consist of patients who have diabetes mellitus, BMI of <25 , coagulopathy, peripheral vascular disease, infection, autoimmune disease, tumor, or had prior surgery to the same plantar fascia (Table 1). Evaluation of the patients preoperatively and perioperative management were identical for both populations. All surgeries were performed by senior orthopedic surgeons in the institution.

Operative Intervention

Based on surgeon and patient preference, surgery will be performed either with the open method or with the percutaneous method of RF ablation. The surgeons were adept with both techniques. Patients were told to expect a 3-cm wound for open RF microtenotomy and alternating small puncture wounds for the percutaneous procedure. For both procedures, patients were counseled to be discharged on the same day and postoperatively were allowed to fully bear weight as tolerated. Both procedures were performed under regional or general anesthesia. Preoperatively, the patient would indicate the most painful part of his or her heel, and the area was marked out. The details of open or percutaneous RF microtenotomy are briefly described below.

TOPAZ Microtenotomy Machine

We performed the RF-based microtenotomy procedure using the TOPAZ MicroDebrider device (ArthroCare, Sunnyvale, CA), connected to a System 2000 generator set at setting 4 (175V-RMS). This device uses an RF-based (coblation) process in a controlled plasma environment. The RF energy excites electrolytes in an electrolyte (saline) conductive solution, and this generates radicals within precisely focused plasma. The energized particles in the plasma generate adequate energy to disrupt covalent molecular bonds, and this results in the ablation of soft tissues at relatively low temperatures (typically $40\text{--}70.8^{\circ}\text{C}$).^{12,13}

The tip of the TOPAZ device has a surface area of 0.502 mm^2 and is about 0.8 mm in diameter. Following an incision on the plantar surface of the heel in the open technique, or a puncture wound in the percutaneous technique, the tip of the TOPAZ device is targeted to the region on the plantar fascia where there is most tenderness. The surgeon would activate the device for 500 ms, and the TOPAZ probe would move in a grid-like pattern with 5 mm intervals, with a depth of 3–5 mm within the fascia. If the microdebridements are performed at too close intervals, this would risk a rupture of the fascia. As such, a procedure with the TOPAZ microtenotomy would result in around 10–20 microdebridements to the plantar fascia.

Open Microtenotomy

A longitudinal incision of around 2–3 cm was made over the area of the foot that was most tender, and dissection of the tissues were made down to the plantar fascia (Fig. 1). After initiating sterile isotonic saline flow from a line connected to the RF system, the microtenotomy tip was then placed on the fascia and microdebridements were carried out in a grid-like fashion. After debridement, the wound was irrigated and closed in layers.

Percutaneous Microtenotomy

The most tender part of the heel was marked out before induction of anesthesia. A 2-mm K-wire was used to puncture the skin in a grid-like pattern about 5 mm apart (Fig. 2). The TOPAZ tip would be inserted through the puncture wound to a depth of about 3–5 mm into the fascia. The probe would then be activated for the RF microtenotomy to take place.

Outcome Measures

The primary aim of the study was to determine the pain scores and functional outcomes of the subset of overweight and obese patients undergoing plantar fasciotomy for up to 1 year postoperatively. The clinical data analyzed in our study were from our institution's Orthopaedic Diagnostic Centre during the follow-up visits, whereby patient-administered questionnaire was conducted.

The data collected included procedure performed, demographics, height, and weight. Our assessment included the American Orthopedic Foot and Ankle Society (AOFAS) ankle–hindfoot scale, the AOFAS component of the visual analog scale (VAS) pain score (HINDVAS), and the 36-item (SF-36) health survey results. The patients were also asked two questions adapted

Table 1: Study selection criteria

<i>Selection criteria</i>	
Inclusion	
	Chronic plantar fasciitis for >6 months recalcitrant to conservative treatment
	BMI >30
	Age >18 years and <80 years
	Full set of outcome data for 1 year
Exclusion	
	Lost to follow-up
	Diabetes mellitus, coagulopathy, infection, tumor, peripheral vascular disease, autoimmune disease, prior surgery to the foot
	Incomplete data set

Fig. 1: Open technique with direct vision of the plantar fascia

Fig. 2: Percutaneous technique with preoperative marking in a grid-like fashion of about 5 mm apart representing where the radiofrequency probe would puncture

from the North American Spine Society low back pain instrument about expectations (EXP) and satisfaction (SAT) about their surgery. Satisfaction was measured from 1–6, with 1 representing excellent satisfaction and 6 poor satisfaction. Expectation was measured from 1–7, with 1 representing expectations fully met and 7 expectations not met at all. The complications that were assessed included infection, osteomyelitis, wound dehiscence, pain recurrence, hypertrophic scar formation, and/or iatrogenic injury to the nerves, vessels, or bones. The patients were assessed preoperatively during their hospitalization and postoperatively at 3 and 6 months and 1 year.

Statistical Analysis

All statistical analyses were performed using SPSS version 21 (SPSS, Inc.; IBM Company, Chicago, IL), and $p \leq 0.05$ was considered significant. This was a retrospective study, and hence, there was no prestudy sample size calculation performed. Fisher's exact tests, Student's *t* test, Mann–Whitney test, and χ^2 test were used in the statistical analyses of the variables.

RESULTS

Forty-five patients who met our BMI inclusion criteria and had completed follow-up of 1 year with a complete data set were included in our study. Six (13.3%) patients underwent operations for both feet at the same setting. The median age was 46 years and with more females ($n = 26, 57.77\%$) as compared to males ($n = 19, 42.22\%$). Nineteen patients underwent percutaneous RF microtenotomy and 26 underwent the open procedure. There were a total of 20 right (44.4%) and 19 left feet (42.2%). There were no difference in BMI (28.4 kg/m^2 in percutaneous RF microtenotomy and 29.6 kg/m^2 in open RF microtenotomy; $p = 0.416$). Demographic characteristics are summarized in Table 2.

Analyzed as two separate groups, our results show that both techniques for RF microtenotomy showed an improvement in all functional scores, including the HINDVAS and AOFAS ankle–hindfoot score (HINDTOT) (Table 3). The SF-36 scores also showed improvement across all areas postoperatively (Figs 3 and 4). Both SAT and EXP were measured postoperatively and hence no comparison with preoperative scores were made. The mean

Table 2: Patient's demographics

Variable	Total (<i>n</i> = 45)	Open (<i>n</i> = 26)	Percutaneous (<i>n</i> = 19)	<i>p</i> value
Age (years)	46.45	47.15	46.05	0.344
Laterality				
Right	20	11	9	0.272
Left	19	11	8	0.274
Bilateral	6	4	2	0.327
Gender				
Male	19	11	8	0.63
Female	26	15	11	0.73
Preoperative BMI	28.8	29.6	28.1	0.437
Operation time (minutes)	22.29	23.25	17.5	0.32

score at 1 year follow-up was 3.06 and 3.56 respectively for the open and percutaneous groups, corresponding to good. Of the 45 patients, 31 (68.9%) reported “good” to “excellent” satisfaction with the procedure overall. As for the results on expectations for the procedure, which was on a scale of 1–7, the average score at 1 year follow-up was 2.40 and 2.10, respectively, for the open and percutaneous groups with 35 (77.8%) of 45 patients reporting that their expectations, at least more or less, had been met.

Twenty-six patients treated with the open procedure and 19 treated percutaneously. The demographics for both groups were comparable preoperatively. There was no significant difference with regard to postoperative SF-36 scores between the two groups at 3 months, 6 months, and 1 year follow-up (Figs 5 to 7). However, the open RF microtenotomy group had better HINDVAS scores at 3 months postoperatively. The difference was statistically significant (HINDVAS, 3.10 vs 4.53, $p = 0.027$). There was no difference between the two groups at 6 months and 1 year follow-up. The open RF microtenotomy group also had a better AOFAS hindfoot score both at 3 months (HINDTOT, 68.75 vs 59.56, $p = 0.015$) and at 6 months (HINDTOT, 80.94 vs 69.45, $p = 0.01$) postoperatively. There was no significant difference at 1 year follow-up (Table 4).

No infections, neurovascular injuries, deep venous thrombosis, or perioperative medical complications were noted throughout the follow-up period. There was one case who had persistent pain postoperatively in the open microtenotomy group that required pain management intervention. The patient subsequently made an uneventful recovery. No cases of lateral column pain or arch collapse were noted on final follow-up. No reoperations were done in both groups.

DISCUSSION

Chronic plantar fasciitis is often a self-limiting condition that can be treated with conservative treatment in almost 90% of patients. It is known that plantar fasciitis is similar to a tendinosis but is noninflammatory and associated with overuse.^{14,15} Radiofrequency-based microtenotomy using TOPAZ coblation for the treatment of plantar fasciitis has been found to be effective in stimulating an angiogenic healing response in fascial tissue. Early inflammatory response, new vessel formation, and elevated vascular endothelial growth factor were shown to be part of the process.^{16,17}

There are studies which clearly show a positive association between plantar fasciitis and obesity.^{18–21} There has been no clear biomechanical explanation on whether this might be due

Table 3: Both groups showed statistically significant improvements in visual analog scale (VAS) and American Orthopedic Foot and Ankle Society (AOFAS) scores

	Preoperative	3 months' postoperative	6 months	1 year	p value
VAS score					
Open RF microtenotomy	7.91	3.10	2.42	2	<0.01
Percutaneous RF microtenotomy	7.56	4.53	3.37	2.1	<0.01
AOFAS hindfoot					
Open RF microtenotomy	40.86	68.75	80.94	86.2	<0.01
Percutaneous RF microtenotomy	41.06	59.56	69.45	83.32	<0.01

Fig. 3: SF36 scores for percutaneous radiofrequency microtenotomy **Fig. 4:** SF36 scores for open radiofrequency microtenotomy

to increased stress loading on the plantar fascia, leading to microdamage and degeneration for patients who are overweight and obese as compared to their leaner counterparts. However, when comparing the breakdown of high BMI to that of a high fat mass group and fat-free mass group (high muscle mass), foot pain

is more strongly associated with fat mass rather than fat-free mass, therefore, suggesting another pathway such as adiposity-related inflammatory mechanisms that might play a role in the relationship between a high BMI and plantar fasciitis.^{22,23} When associating obesity with the heel fat pad, it has been shown that heel pad

Fig. 5: No statistically significant difference for SF-36 scores between the two groups at 3 months postoperative

Fig. 6: No statistically significant difference for SF-36 scores between the two groups at 6 months postoperative

Fig. 7: No statistically significant difference for SF-36 scores between the two groups at 1 year postoperative

Table 4: Patient outcomes

Outcomes	Open (n = 26)	Percutaneous (n = 19)	p value
Preoperative			
HINDVAS	7.91	7.56	0.355
HINDTOT	40.86	41.06	0.565
Postoperatively 3 months			
EXP	3.153	3.174	0.228
SAT	3.86	4.1	0.21
HINDVAS	3.1	4.53	0.027
HINDTOT	68.75	59.56	0.015
6 months			
EXP	2.857	3.107	0.192
SAT	3.16	3.85	0.165
HINDVAS	2.42	3.37	0.198
HINDTOT	80.94	69.45	0.01
1 year			
EXP	2.4	2.1	0.816
SAT	3.06	3.56	0.654
HINDVAS	2	2.1	0.336
HINDTOT	86.2	83.32	0.55

thickness was significantly greater in patients with plantar fasciitis. Some studies have also demonstrated greater compressibility of the heel fat pad in people with plantar fasciitis than controls.^{24,25}

This study is the first to analyze the effectiveness of RF coblation for chronic plantar fasciitis in a patient population consisting solely of overweight and obese individuals. As prior studies have shown a correlation between heel pain and body weight, it would be expected that chronic plantar fasciitis would be common in this patient population. Also it might be expected that in this group of overweight or obese patients, conservative treatment of plantar fasciitis has not been as successful as in the normal population.²⁶ When comparing the outcomes of surgical intervention, studies suggest that obesity does not predict poor outcome with endoscopic plantar fascia release.²⁷ Our results show that RF coblation is an effective modality in treating plantar fasciitis, with an overall satisfaction rate of 68.9% and meeting expectations of 77.8% of the patients at 1 year follow-up. Functional scores improved as well, with significant improvements in both pain scores and AOFAS hindfoot scores. In addition, patients reported better quality of life as measured by the SF36 questionnaire, in several components.

This study is also the first to compare the open technique vs the minimally invasive percutaneous technique of RF microtenotomy in the subset of overweight and obese patients. Previous studies have reported that the open technique is superior in terms of outcome at 1 year follow-up, with a significantly reduced pain score compared to the percutaneous technique.⁹ A patient with a high BMI may present with different hindfoot biomechanics, hence resulting in different plantar pressures on standing and with ambulation. Furthermore, we postulate that these patients may also have different heel fat pad thickness or compressibility as compared to a patient with a BMI within the normal range. We also aim to find out whether complications such as wound healing or prolonged pain or recurrent pain would be affected by the patient's BMI.

Our study findings show that the open technique results in better HINDVAS scores at 3 months' follow-up and better HINDTOT scores at both 3 and 6 months' follow-up. There was no difference

in both pain and functional scoring at the 1 year mark. It would be interesting to note that a bigger wound in the open group did not subsequently lead to poorer pain scores in the early stages of follow-up. As mentioned previously, chronic plantar fasciitis is a form of tendinosis, for which there is an absence of inflammatory cells. Fibroplasia hypertrophy with disorganized vascular hyperplasia dominates with avascular tendon fascicles. It is unlikely that the early improvements can be due to the revascularization and even reorganization of collagen in the treated tendons. An antinociceptive effect, similar to that produced by extracorporeal shock wave therapy, may be a plausible explanation.^{28–31} This may be affected by the level of accuracy at which the probe is able to target the symptomatic portion of the fascia. The open technique allows better visualization and accurate placement of the microtenotomy probe on the area of the fascia that was most symptomatic. In contrast, the depth of placement of the probe in the percutaneous technique may be affected by a number of variables, including soft tissue swelling and also thickness of the skin. As such, the amount of stimulation received by the fascia will be variable and most likely less than that provided by the open technique. To overcome this disadvantage, Shah et al. in his article described a novel method of performing the percutaneous procedure under ultrasound guidance.³² Our results show that in both groups, there is a plateauing of improvement in both pain and functional scoring at the 1 year follow-up mark. This is probably due to the short-lived antinociceptive effect being replaced by a longer-term angiogenic response, which was not affected whether the procedure was done in open or in the percutaneous manner.

One possible negative effect of the RF-based microtenotomy procedure would be potential excessive adjacent tissue damage.^{33–35} There is also always a risk cutting the plantar fascia, leading to the risk of rupture. We postulate that an open procedure with direct visualization of the plantar fascia would lead to a more precise and safe placement of the probe during the microtenotomy procedure. Our results show no difference in complications between both groups with no increase in wound complications or infection in the open technique group or increased occurrence of residual pain in the percutaneous group.

There are limitations to this study. First, as this is a retrospective study of prospectively collected data, there would be some inherent biases. Despite all treatment options being discussed with the patients before the operative procedure and having noted no difference in the demographics between both groups, there were a disproportionate number of patients in both groups which could inevitably be due to selection bias. Second, we have excluded patients without a full data set, and this may have included patients who missed their follow-ups. This could lead to a selection bias of results from the group of patients who were able to attend clinic appointments. However, the strengths of the study include the fact that this is one of the few or if not the first study to investigate the use of RF microtenotomy treatment on the subset of obese patients. We have a modest number of patients in our study groups with a good follow-up of 1 year.

CONCLUSION

We have shown that RF microtenotomy is a safe and effective procedure for the treatment of plantar fasciitis even in the obese group of patients. Both open and percutaneous methods have achieved good patient outcomes and expectation, although the open group showed superior pain and functional outcomes

at 3 and 6 months' follow-up. Larger, randomized, prospective studies with a longer follow-up period are needed to fully compare the postoperative outcomes of open vs percutaneous RF microtenotomy in this specialized subset of patients.

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