The Journal of Foot & Ankle Surgery 51 (2012) 20–22

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Radiofrequency Thermoneurolysis for the Treatment of Morton's Neuroma

Joshua L. Moore, DPM [1], Ritchard Rosen, DPM, FACFAS [2], Jeffrey Cohen, DPM, FACFAS [3], Brad Rosen [4]

[1] *Podiatric Surgical Resident (PGYIII), University Hospital, Newark, NJ*
[2] *Chief, Podiatric Surgery, Holy Name Medical Center, Teaneck, NJ*
[3] *Chief, Podiatric Surgery, Englewood Hospital and Medical Center, Englewood, NJ*
[4] *BA Candidate, Ramapo College of New Jersey, Mahwah, NJ*

ARTICLE INFO

Level of Clinical Evidence: 4
Keywords:
ablation
foot
nerve
surgery

ABSTRACT

Pedal neuroma is a common disorder. The authors undertook a review of 32 feet in 29 patients with a symptomatic neuroma treated between January 2007 and January 2010 to evaluate the effectiveness of radiofrequency thermoneurolysis therapy in alleviating symptoms. Overall relief of symptoms was rated as complete by 24 (83%) patients, with 5 patients experiencing minimal to no relief. Two patients were lost to follow-up after 1 month, 2 patients opted for no further intervention, and 1 patient went to open resection of the neuroma. Average follow-up was 13 months and total recovery time was 2 days. Complications included 1 foot with cellulitis treated by a course of oral antibiotics. The results of this retrospective study indicate radiofrequency thermoneurolysis therapy is a safe, effective, and minimally invasive alternative treatment for symptomatic neuromas of the foot.

Pain to the forefoot often presents as a problematic entity in foot and ankle surgical offices. Often this pain can be associated with peripheral nerve entrapment as the branches of the plantar digital nerves course through the intermetatarsal spaces. Nerve entrapment of localized nerves was first described by di Civinini in 1835 (1), but was not named until 1876 by Morton of Philadelphia (2).

Morton's neuroma has since been described as a benign enlargement of the third common digital branch of the medial plantar nerve, which is identified most frequently between the third and fourth metatarsal heads. The incidence of Morton's neuroma in the general population has yet to be determined, but has been estimated by Youngswick to be in upwards of 9% of all presenting patients to foot clinics (3). Diagnosis is often achieved through clinical presentation, but may also be aided through ultrasound, radiograph, computed tompgraphy, magnetic resonance imaging, electromyography, and diagnostic injections. Patients often present with symptoms of a burning sensation to the affected toes, pain in the forefoot, and the feeling of walking on a marble, often relieved with removal of shoe gear.

Neuromas can further be linked to the second interspace and rarely within the first and fourth interspaces. Neuromas are more frequent in women by 8 to 10 times than in men (4–6) and are commonly diagnosed between the fourth and sixth decades of life. Current treatments include both conservative and surgical modalities consisting of ice, nonsteroid anti-inflammatory drugs (NSAIDs), shoe gear modifications, orthoses, corticosteroid injections, neurectomy, and transverse intermetatarsal ligament release or decompression.

Radiofrequency ablation has been described and studied in the foot and ankle most frequently involving the plantar fascia, but rarely is it mentioned as a viable alternative to open surgical excision of neuromas. Today, radiofrequency ablation is commonly used in the treatment of trigeminal neuralgia, osteoid osteoma, lumbar disc herniation, coronary vascular disease, essential tremors, cardiac arrhythmias, cervical pain syndromes, lung cancers, and varicosities (7–14).

Radiofrequency ablation works via lateral heat dissipation from the electrode. When the electrode is placed near the nerve to be treated, the impedance of the surrounding tissues conducts the electromagnetic energy into the tissues, generating heat into the tissues. The current from the electrode heats the surrounding tissues, denaturing and disrupting the physiologic functions of proteins. This increase in temperature destroys peripheral nerve endings, as well as the myelin sheath in tissues immediately surrounding the electrode (15).

The authors present the first retrospective evaluation in over 21 years with the goal of showing radiofrequency thermoneurolysis therapy (RTT) as an effective and low morbidity treatment for symptomatic neuroma pain in feet.

Financial Disclosure: None reported.
Conflict of Interest: None reported.

Address correspondence to: Joshua L. Moore, DPM, Podiatric Surgical Resident (PGYIII), University Hospital, 150 Bergen Street, Newark, NJ 07103.
E-mail address: jlmoore@dmu.edu (J.L. Moore).

Patients and Methods

A retrospective study was conducted on 29 patients treated with RTT for symptomatic neuroma pain of the foot not relieved by routine conservative

1067-2516/$ - see front matter © 2012 by the American College of Foot and Ankle Surgeons. All rights reserved.
doi:10.1053/j.jfas.2011.10.007

modalities. Twenty-two patients were women, and 7 were men. Patient age ranged from 23 to 73 years. Three patients had neuroma pain bilaterally. All neuromas were located within the second or third intermetatarsal space. The minimum follow-up period was 6 months with maximum follow-up of 3 years and an average follow-up of 13 months.

Diagnosis of neuroma was deemed by clinical presentation. Patients presented describing numbness and burning to the affected digits with concomitant complaint of feeling like "I am walking on a marble," all of which was alleviated with removal of shoe gear. On further physical examination, positive Mulder's click was noted in all patients as was parasthesia and pain with local palpation and percussion. All patients reported that they could no longer walk in normal shoe gear comfortably and requested further intervention. There were no inclusion or exclusion criteria within the study, but 1 patient was noted to have type II diabetes.

Conservative therapies were attempted over a period of 4 to 8 weeks with either a course of injections consisting of either 2.5 cc 0.5% bupivacaine plain and 0.3 cc 40 mg/mL triamcinolone (3 total injections administered at 2-week intervals) or a mixture of 0.5 cc 1% xylocaine plain, 2 cc 2% dehydrated alcohol, and 0.5 cc of B12 (3 total injections administered at 1-week intervals). All 29 enrolled in the current study were nonresponsive to conservative modalities and were offered RTT as an alternative to open surgical intervention.

RTT was performed in a surgical suite between January 2007 and January 2010. The chief surgeons and their surgical team used the same RTT system and technique. Recovery time was determined as the amount of time provided by the patient until return to work or regular daily activities after surgical intervention. Relief of pain was determined through patient verification of complete relief, some relief, or no relief.

Surgical Technique

On the day of surgery in preoperative holding, patients were asked to identify the area of maximum pain to the affected foot. The area was then marked with a permanent marking pen for later identification after induction of anesthesia (Fig. 1). Upon obtaining informed consent, the surgical candidates were brought to the surgical suite and placed on the operating room table in a supine position. Monitored anesthesia alone was then administered (the surgical team opted against local infiltration of anesthetic to prevent foreign media in the surgical field along with unknown effects of the local hematoma on the electrodes' mechanism of action) and the symptomatic foot sterilely prepped in routine aseptic fashion. Attention was then made to the site of maximum pain identified preoperatively. Using the Radiofrequency ablation system (Smith & Nephew, Durham, NC), a 5-cm cannula with a 22-gauge, 4-mm, sharp-straight tip probe (Fig. 2) was inserted from dorsal to plantar at the area of maximum pain (Fig. 3). By means of fluoroscopy, the probe was identified, making sure to be within the correct intermetatarsal space (Fig. 4). After proper placement was confirmed, the sharp probe was removed from the cannula and the RTT electrode inserted. Motor stimulation to a machine setting of 4 was then tested to prevent RTT of the muscle bellies within the interspace. The RTT process was initiated at a temperature of 85°C with impedance values between 350 and 550 and for 90 seconds in total.

Fig. 1. Preoperative identification of point of maximum pain intensity.

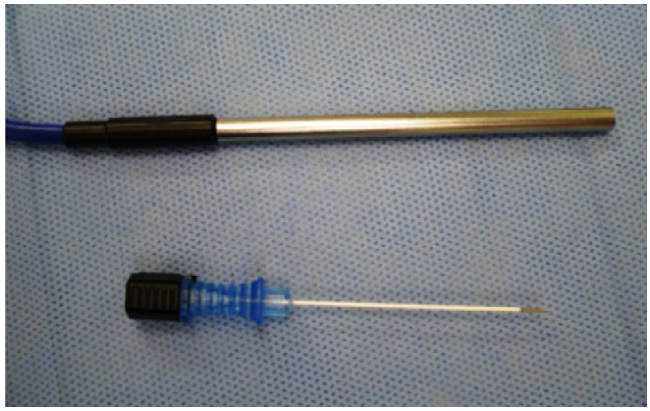

Fig. 2. A 22-gauge, 4-mm sharp-straight probe (*bottom*) and electrode (*top*).

After the 90 seconds had concluded, the probe and cannula were removed from the affected foot and 4 mg of dexamethasone was injected into the surgical field. An adhesive bandage was then applied to the foot and the patient was transported to postanesthesia recovery.

Patients were instructed to bear weight as tolerated in normal shoe gear postoperatively and were told to use the NSAID of their choice as needed for pain. Initial follow-up was within 7 to 10 days postoperatively and then at 2 weeks, 4 weeks, 3 months, and 6 months postoperatively. Initial evaluation of pain relief was assessed and recorded in the office of the chief surgeons at 1 month postoperatively with final assessment recorded at 6 months postoperatively. The same question was asked of all patients: Since undergoing radiofrequency ablation, do you have some relief, complete relief (complete return to activity without pain or disability), or no relief? At the time of final pain relief assessment, none of the study patients were using NSAIDS for additional pain relief.

It should be noted that 4 patients were unable to pinpoint a single area of maximum pain intensity preoperatively and thus received a second 90-second RTT within the same interspace for assured pain relief.

Results

Of the 29 patients and 32 feet, 24 (83%) patients expressed complete relief of symptoms 1 month after RTT and no one reported more pain. The remaining (17%) had minimal to no relief of symptoms (Table 1). Two patients were satisfied enough with their results that they sought no further intervention. One patient with continued pain underwent open resection with pathology confirmation of neuroma. Two patients were lost to follow-up after the initial evaluation at 1 month.

One patient reported a recurrence 9 months later, which was successfully treated with a bupivacaine/triamcinolone injection. One patient encountered superficial cellulitis 5 days postoperatively and was treated with a week's course of amoxicillin/clavulanic acid. All patients returned to normal shoe gear and activities within 2 days.

Fig. 3. Probe inserted at area of maximum pain intensity.

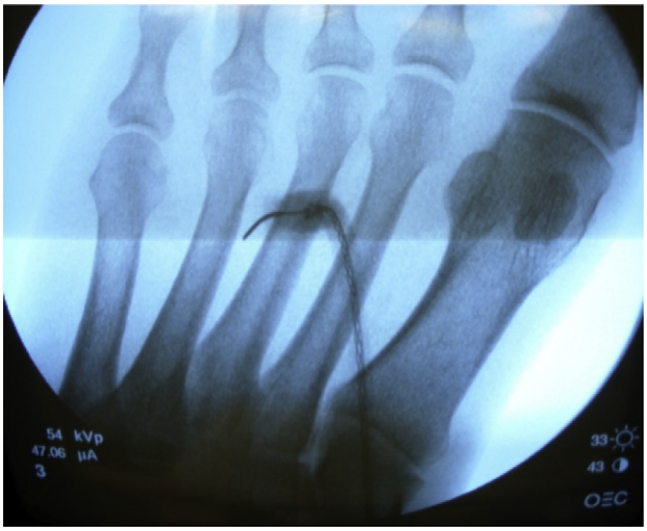

Fig. 4. Anteroposterior radiograph showing probe inserted in the correct interspace.

Discussion

Many treatments have been proposed for the treatment of neuromas, often conservative in nature and focusing on the inflammatory aspect of neuromas. Surgical measures include excision of the lesion and intermetatarsal ligament resection. Although minimal complications are noted with open neurectomy, just as with any surgical procedure there are risks. With open neurectomy, the greatest risks are deep space abscess, hematoma, or stump neuroma.

Table 1
Patient demographics and results (N = 32 feet in 29 patients)

Age	Sex	Interspace	Conservative Treatment	Resolution	No/Some Resolution
40	F	Right 3rd	Bupivacaine/Triamcinolone	X	
56	F	Left 3rd	Bupivacaine/Triamcinolone	X	
73	F	Right 2nd	Alcohol/Xylocaine/B12	X	
73	F	Left 2nd	Alcohol/Xylocaine/B12	X	
65	F	Right 2nd	Alcohol/Xylocaine/B12		X – lost to follow-up
54	M	Left 3rd	Bupivacaine/Triamcinolone	X	
54	M	Right 3rd	Bupivacaine/Triamcinolone	X	
58	F	Right 3rd	Alcohol/Xylocaine/B12		X - no additional treatment
44	F	Right 3rd	Bupivacaine/Triamcinolone	X	
55	F	Left 3rd	Bupivacaine/Triamcinolone	X	
67	M	Left 3rd	Bupivacaine/Triamcinolone		X – open resection
43	M	Right 3rd	Alcohol/Xylocaine/B12	X	
42	F	Right 3rd	Bupivacaine/Triamcinolone	X	
58	F	Left 3rd	Bupivacaine/Triamcinolone	X	
57	M	Right 3rd	Alcohol/Xylocaine/B12	X	
47	F	Right 3rd	Bupivacaine/Triamcinolone	X	
68	M	Right 3rd	Bupivacaine/Triamcinolone	X	
23	F	Left 3rd	Bupivacaine/Triamcinolone	X	
72	F	Left 3rd	Bupivacaine/Triamcinolone		X – no additional treatment
55	M	Left 3rd	Bupivacaine/Triamcinolone	X	
54	F	Right 2nd	Bupivacaine/Triamcinolone	X	
63	F	Right 3rd	Bupivacaine/Triamcinolone		X – lost to follow-up
48	F	Left 3rd	Bupivacaine/Triamcinolone	X	
37	F	Right 3rd	Bupivacaine/Triamcinolone	X	
59	F	Left 3rd	Alcohol/Xylocaine/B12	X	
61	F	Left 3rd	Bupivacaine/Triamcinolone	X	
61	F	Right 3rd	Bupivacaine/Triamcinolone	X	
54	F	Right 3rd	Bupivacaine/Triamcinolone	X	
50	F	Right 3rd	Bupivacaine/Triamcinolone	X	
56	F	Left 3rd	Alcohol/Xylocaine/B12	X	
43	F	Right 3rd	Alcohol/Xylocaine/B12	X	
37	M	Left 3rd	Alcohol/Xylocaine/B12	X	

In the absence of relief from conservative measures, RTT may be considered as a more beneficial procedure than open neurectomy. RTT causes destruction to the peripheral nerve endings as well as myelin sheath at the site of maximum tenderness (15). RTT not only has minimal side effects, but also provides minimal disability and allows early return to activity.

Finney et al originally illustrated the effectiveness of RTT in the treatment of neuromas. The study conducted between 1977 and 1986 enrolled 71 patients with 79 lesions. Their results were illustrated using a pain scale from 0 to 5, patient satisfaction, and relief in symptoms expressed as worse, the same, improved, or gone. In our study, we simply evaluated the symptoms as complete resolution or some/no resolution of symptoms. Finney et al recorded overall satisfaction with the procedure in 54 cases (68%) and nonsatisfactory results in 25 cases (32%) (16). Although the prior study showed success in only 68%, the current study expresses a success rate of 83%.

Our study has many limitations. We understand that pain is very subjective and varies within patient populations. The current study enrolled 4 patients who were unable to accurately provide a pinpoint area of pain preoperatively and resultantly a second portal of RTT was performed distally near the webspace to assure relief of symptoms. The second portal was determined by the area at which pain on deep palpation ceased. The current study had minimal correspondence in regards to pain rating, whereas patients merely rated their symptoms preoperatively as pain and postoperatively as complete relief, some relief, or no relief. We also recognize our sample size is small and larger sample size prospective studies should be performed to show a more statistically significant role of RTT in neuroma treatment, compared with other surgical treatments.

In conclusion, RTT is a minimally invasive alternative to open surgical intervention for treating symptomatic neuroma pain of the feet not alleviated by conservative measures. The procedure has minimal to no side effects or disability and is a very good second line of therapy for patients hoping to avoid open surgery.

References

1. Pisani G. *Sindrome di Givinini-Morton (III nervo digitale commune). Tattoo di Chirugia de Piede*, ed 2, Edizioni Minnerva Medica, Turin, 1993. pp. 505–510.
2. Morton TG. A peculiar and painful affection of the fourth metatarsophalangeal articulation. Am J Med Sci 71:37–45, 1876.
3. Youngswick FD. Intermetatarsal neuroma. Clin Podiatr Med Surg 11:579–592, 1994.
4. Bartolomei FJ, Wertheimer SJ. Intermetatarsal neuromas: distribution and etiologic factors. J Foot Surg 22:279–282, 1983.
5. Bennett GL, Graham CE, Mauldin DM. Morton's interdigital neuroma: a comprehensive treatment protocol. Foot Ankle Int 16:760–763, 1995.
6. Berry K, Gonzalez P, Bowman R. Morton neuroma. Available at: http://www.emedicine.medscape.com 2010. Accessed October 16, 2011.
7. Taha JM, Tew JM, Buncher RC. A prospective 15 year follow up of 154 consecutive patients with trigeminal neuralgia treated by percutaneuos stereotactic radiofrequency thermal rhizotomy. J Neurosurg 83:989–993, 1995.
8. Rosenthal DI, Springfield DS, Gebhardt MC, Rosenberg AE, Mankin HJ. Osteoid Osteoma: percutameuos radiofrequency ablation. Radiology 197:451–454, 1995.
9. Troussier B, Lebas JF, Chirossel JP, Peoc'h M, Grand S, Leviel JL, Phelip X. Percutaneous intradiscal radiofrequency thermocoagulation. Spine 20:1713–1718, 1995.
10. Yamashita K, Satake S, Ohira H, Ohtomo K. Radiofrequency thermal balloon coronary angioplasty: a new device for successful percutaneous transluminal coronary angioplasty. J Am Coll Card 23:336–340, 1994.
11. Lesch MD, Van Hare GF, Epstein LM. Radiofrequency catheter ablation of atrial arrhythmias. Circulation 89:1074–1089, 1994.
12. Van Kleef M, Spaans F, Dingemans W, Barendse GAM, Floor E, Sluijter ME. Effects and side effects of a percutaneous thermal lesion of the dorsal root ganglion in patients with cervical pain syndrome. Pain 52:49–53, 1993.
13. Lakie M, Arblaster LA, Roberts RC, Varma TRK. Effects of stereotactic thalamic lesion on essential tremor. Lancet (London) 340:206–207, 1992.
14. Shepherd AC, Gohel MS, Brown LC, Metcalfe MJ, Hamish M, Davies AH. Randomized clinical trial of VNUS ClosureFAST radiofrequency ablation versus laser for varicose veins. Br J Surg 97:810, 2010.
15. Cione JA, Cozzarelli J, Mullin CJ. A retrospective study of radiofrequency thermal lesioning for the treatment of neuritis of the medial calcaneal nerve and its terminal branches in chronic heel pain. J Foot Ankle Surg 48:142–147, 2008.
16. Finney W, Wiener S, Catanzariti F. Treatment of Morton's neuroma using percutaneous electrocoagulation. J Am Podiatr Med Assoc 79:615–618, 1989.