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Pulsed Radiofrequency Combined with Continuous Radiofrequency Ablation for the Treatment of Morton's Neuroma: A Case Report

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Morton's neuroma is a benign enlargement of the third common branch of the medial plantar nerve resulting in a compression neuropathy. First line treatments usually involve shoe modification, non-steroidal anti-inflammatory medications, stretching, and local corticosteroid injections. If these measures fail, many patients will undergo surgical excision for pain relief. Recently, continuous radiofrequency (CRF) ablation has been used as an alternative to surgery; however, this is the first documented case that describes the use of pulsed radiofrequency (PRF) ablation combined with CRF for the treatment of Morton's neuroma. A patient with two Morton's neuromas, located in the second and third webspace of the right foot, was selected. Conservative management was attempted with no improvement before radiofrequency ablation was performed. The second and third web spaces were treated with PRF at 42 degrees for 120 seconds followed by CRF at 90 degrees for 25 to 30 seconds. Following the procedure, the patient's pain score decreased 100% and her quality of life improved significantly as she was able to enjoy dancing in high-heeled shoes once again. There were no complications after the procedure and the patient reported no pain at the six-month follow up visit. Although surgical excision has been the standard of care for treating Morton's neuromas when conservative measures fail, PRF combined with CRF ablation may be an effective treatment for relieving pain secondary to this condition.

Key Words: Morton's Neuroma, Radiofrequency Ablation, Pulsed Radiofrequency, Non-surgical treatment, Foot pain

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Morton's neuroma is a common medical condition of the foot characterized by pain between the toes. It was first identified by Civinini in 1835[1] but later named after Morton who illustrated the pathology in greater detail in 1876.[2]

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More recently, it has been described as a benign enlargement of the third common branch of the medial plantar nerve, frequently located between the third and fourth metatarsal heads.[3] This plantar digital nerve usually courses under the transverse intermetatarsal ligament so enlargement of the nerve results in a compression neuropathy.[4] 80% of Morton's neuromas are seen in women and they are usually diagnosed between the fourth and fifth decades of life.[5,6]

Patients often experience burning pain and parasthesias of their forefoot which are aggravated by walking, especially in high-heeled shoes.[7] First line treatments usually involve shoe modification, non-steroidal anti-inflammatory medications, stretching, and injections with corticosteroids and local anesthetics.[8] Repeated corticosteroid injections into the tight webspaces of the foot should be performed cautiously since it may lead to plantar fat pad atrophy[9] and eventually avascular necrosis. Another non-operative treatment that has been shown to have a high success rate in patients with Morton's neuromas is alcohol neurolysis under ultrasound guidance.[10] Even though these conservative measures are frequently effective; many patients who do not obtain significant pain relief will elect to undergo surgical excision.

Surgical neurectomy has been established as a viable treatment option with good outcomes for many patients with Morton's neuromas.[7,11,12] In a long term follow up study performed by Coughlin et al., 85% of the patients who underwent surgical excision were satisfied with the results from the surgery and 65% were pain-free 6 years later.[13] Another study demonstrated that 82% of patients reported excellent or good postoperative results, but 71% still had restrictions with footwear.[14]

Recently, continuous radiofrequency (CRF) ablation has been used as a less invasive method for the treatment of Morton's neuroma before considering surgical resection. CRF utilizes the electricity generated from a radiofrequency wave to disrupt soft tissue molecules, resulting in frictional heating. When the temperature rises to a certain point, normally higher than 70 degrees Celsius, instant tissue coagulation and cell death occur resulting in destruction of neural tissue.[15] In one retrospective study, 83% of patients with Morton's neuromas who underwent CRF expressed complete relief of symptoms after one month.[3] Additionally, in a longer term study, 87% of patients who underwent CRF had good results with a 70% reduction in the number of patients progressing to surgery.[8]

Pulsed radiofrequency (PRF) ablation is another type of radiofrequency applied intermittently at lower temperatures as compared to the continuous high heat seen in CRF. A higher voltage is used in PRF that produces a brief rise in temperature followed by elimination of heat at timed intervals. The mean tip temperature remains below the neurodestructive range, which preserves the structural integrity of the nerve[16]; but it still has ablative effects due to the temperature spikes and/or electrical field.[17,18] PRF may minimize the risk of nerve damage while still providing good clinical outcomes; however, there is limited data supporting this.[19]

By combining PRF with CRF, a shorter duration of CRF can be utilized thus decreasing nerve and tissue damage, while still achieving pain relief through the combined ablative effects. Based on a pubmed/medline search, this is the first documented case that describes the use of pulsed radiofrequency ablation combined with continuous radiofrequency ablation for the treatment of Morton's neuroma.

Case Report

A 53 year-old woman with a past medical history of asthma presented to an outpatient pain clinic complaining of right foot pain for the past 5 years. The pain was located on the plantar aspect of her forefoot between the third webspace and to a lesser degree between the second webspace. The patient described the pain as sharp, stabbing, throbbing, and tingling in nature. The pain was intermittent, exacerbated with walking and dancing, especially if wearing high-heeled shoes. On a numeric pain scale, her pain reached 10 out of 10 at its maximum and decreased to 0 out of 10 with rest; however, the pain was constant with ambulation. She wore supportive sandals in addition to taking ibuprofen and naproxen over the past few years, but these medications did not provide significant pain relief.

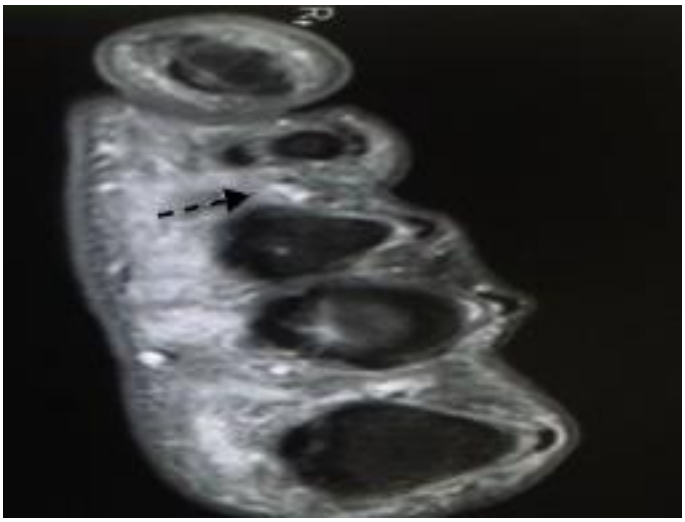

Figure 1 Magnetic resonance imaging of the right foot. Dashed arrow indicates Morton's neuroma located in the third webspace.

The patient was sent for a magnetic resonance imaging (MRI) of her right foot which revealed a prominent third webspace neuroma and a smaller second webspace neuroma with the confirmed diagnosis of two Morton's neuromas. (Fig. 1) Corticosteroid with local anesthetic was then injected into each neuroma with no improvement in pain. Subsequently, alcohol neurolysis was attempted with some symptomatic relief, but its effects only lasted for one month. The patient was then referred to our pain clinic after receiving each of these treatments.

On physical exam, her right foot did not have any scars, erythema or swelling. There was severe tenderness to palpation over the third webspace, tenderness over the second webspace, and diffuse tenderness when squeezing all of the toes together. No motor or sensory deficits of the right foot were noted and distal pulses were palpable.

As described above, conservative treatment with oral pain medications, shoe modification, local steroid injections, and alcohol neurolysis were all unsuccessful in relieving her pain. Thus, the decision was made to perform PRF combined with CRF ablation for the treatment of her condition as an alternative choice to performing an open neurectomy for removal of the neuroma.

Figure 2 Fluoroscopy of right foot. Needle placed in the third webspace.

Informed consent for radiofrequency ablation of the second and third medial digital branches of the plantar nerve was obtained and the patient was taken to the operating room. She was placed in the prone position and her right foot was prepped with ChloraPrep® and draped with sterile technique. No sedation was used for this procedure. The first needle entry point was identified with the use of a marker needle and fluoroscopy in the AP and lateral views. (Fig. 2) Then, 2ml of 1% lidocaine was infiltrated in the third webspace followed by insertion of a 20-gauge 3-inch radiofrequency ablation needle in the transverse direction.

Figure 3 Fluoroscopy of right foot. Needle placed in the second webspace.

The needle was inserted to the point of initiation of the metatarsophalangeal joint. Sensory stimulation was positive and motor stimulation was negative at this point. Next, 0.5ml of Marcaine® was injected then PRF ablation at 42 degrees Celsius for 120 seconds was performed followed by CRF ablation at 90 degrees for 30 more seconds. This was repeated two more times advancing the needle 1cm each time. For the second webspace, the needle was inserted in the same fashion to the point of initiation of the metatarsophalangeal joint with sensory stimulation positive and motor stimulation negative. Placement of the needle was confirmed with fluoroscopy in the anterior posterior and lateral views. (Fig. 3) Again, 0.5ml of Marcaine® was injected into the webspace then PRF ablation at 42 degrees Celsius for 120 seconds was performed followed by CRF ablation at 90 degrees for 25 more seconds. The patient felt pain at this point so the procedure was aborted and the needles were resected.

Otherwise, the patient tolerated the procedure well with no complications. When the patient returned to the clinic one month later, she reported 100% reduction in pain with no complaints related to the procedure. She was able wear regular shoes and enjoys dancing in high-heeled shoes once again. At the 6 month follow up visit, the patient still reported no pain and was very satisfied with the procedure.

Discussion

As described in this case, PRF combined with CRF for the treatment of Morton's neuroma is able to provide excellent pain relief while minimizing the neurodestructive effects of CRF. The two prior studies involving CRF for the treatment of this condition utilized longer exposure times of 90 seconds during the procedure thus causing more tissue damage.[3,8] A higher degree of surrounding tissue damage has been shown to be directly related to the rise in temperature and duration of CRF.[20,21] By using PRF prior to CRF, we were able to decrease the exposure time to 30 seconds of CRF, which minimized the amount of destruction to the nervous tissue while still being effective in relieving the pain. In another study, Li et al. demonstrated that when PRF was combined with CRF compared to CRF alone for the treatment of trigeminal neuralgia, there was a decrease in side effects secondary to CRF while the efficacy was preserved.[22]

One of the main benefits of PRF over CRF is that it does not require high temperatures so thermal destruction of nervous tissue does not occur. It has been proposed that PRF produces a very weak magnetic field without any significant biologic effects; however, the active tip of the radiofrequency needle produces an electric field with a very high current density (2 x 104 A/m2).[23] This electric field can induce charges on tissue and distort charged molecular structures, thus disrupting cell function without substantial elevations in temperature.[24] PRF alone has been successful in treating a number of peripheral neuropathies including sural, ilioinguinal, genitofemoral, and suprascapular.[25-27]

Despite these encouraging results, we opted to use PRF combined with CRF for our case of Morton's neuroma as opposed to only using PRF. By using both types of radiofrequency ablation, we were able to employ each of their different ablative mechanisms[15,17,18] to achieve significant pain relief while minimizing the thermodestructive effects of CRF. Also, as CRF has been documented to be an effective treatment for this condition[3,8], we thought it beneficial to utilize this type of ablation while at the same time using PRF to shorten the duration.

Definitive treatment for Morton's neuroma has traditionally been a surgical resection via an open neurectomy once conservative measures fail. However, as with many other medical conditions, minimally invasive procedures are becoming more accepted as an alternative prior to surgery. Additionally, many patients are seeking non-surgical treatments in order to avoid the risks associated with open surgeries. Radiofrequency ablation does not require any anesthesia, has minimal recovery time, minute scarring, and less risk of bleeding and infection as compared to larger incisions needed for surgical resection of Morton's neuromas. Regardless of which type of radiofrequency is performed, the risk of developing complications such as deep space abscesses, hematomas, or stump neuromas as observed by Coughlin, et al., is less than in open neurectomies.[13] Moreover, the potential benefits of complete pain relief after radiofrequency ablation, as seen in this case, make it a practical choice to attempt before considering surgical intervention.

Despite the advantages of using PRF combined with CRF ablation for the treatment of Morton's neuroma, there are some risks and limitations to this minimally invasive procedure that should be recognized. Correct placement of the needle tip is not only essential to achieving maximal ablative effects on the nervous tissue, but it is also important to avoid injury to non-targeted surrounding tissue. Unintentional thermal destruction by way of CRF can lead to permanent tissue damage in unwanted areas. The use of fluoroscopy to confirm correct placement of the needle may help avoid such complications.

Also, some patients are either not able to remain still during the ablation or tolerate the procedure secondary to pain which may shorten the anticipated duration, thus limiting the efficacy of the treatment. However, our patient achieved 100% pain relief even though the CRF ablation of the second webspace was terminated five seconds early due to pain.

In this particular case, there were no complications during or after the procedure and the patient was extremely pleased with her complete reduction in pain at the 6 month follow up visit. We will continue to use PRF combined with CRF ablation for the treatment of Morton's neuroma when conservative management fails; however, larger studies with long-term follow up are still needed to confirm the clinical feasibility of this procedure.

Conclusion

Radiofrequency ablation is a minimally invasive procedure that can be used to treat patients with Morton's neuromas who have failed conservative management. The findings from this case report suggest that PRF combined with CRF is a viable treatment for this condition with certain advantages over CRF alone. This procedure should be considered prior to surgical intervention due to its low risk and potential for complete pain relief; nonetheless, more studies are needed to confirm this.

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