

# EXTERNAL NEUROLYSIS WITH RELEASE OF THE DEEP TRANSVERSE INTERMETATARSAL LIGAMENT FOR INTERMETATARSAL NEUROMAS, A RETROSPECTIVE STUDY

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### INTRODUCTION

Morton's neuroma is a painful pedal condition of the forefoot that involves the common digital plantar nerves. T.G. Morton in 1876 described this phenomenon as "a peculiar and painful affection of the 4th metatarsophalangeal articulation."<sup>1</sup> Earlier in 1835, de Civinini, an Italian anatomist, illustrated the localized nerve enlargement followed by Durlacher in 1845 who characterized the neurologic symptoms of the plantar nerve between the third and fourth metatarsals.<sup>2,3</sup>

A neuroma is described as a benign enlargement of the third common digital plantar nerve located between and distal to the heads of the third and fourth metatarsals. The nerve passes plantar to the deep transverse intermetatarsal ligament. The nerve is accompanied by the vascular vessels and the third lumbrical tendon.

Bickel and Dockerty first described the early microscopic changes of the nerve. They described it as spotty interstitial edema with demyelination of the entire nerve trunk.<sup>4</sup> Winkler also found that there was no definite demarcation between the neuroma and the surrounding soft tissue.<sup>5</sup> Gross later described the neuroma as having a whitish-yellow color with a fusiform shape. He also described it as being enclosed by a fibrous connective tissue.<sup>6</sup>

The etiology of the condition has been described as having a biomechanical origin.<sup>7,8</sup> It has been observed that most neuromas occur in a pronated foot in which there is increased motion between the medial and lateral columns that can traumatize the nerve. Additionally, as the foot everts, abducts and dorsiflexes in pronation of the subtalar joint, a stretch is placed on the medial and lateral plantar nerves as they dive deep into the arch.<sup>4</sup> It appears that this syndrome is caused by a

mechanical entrapment of the nerve, most often thought to be due to the deep transverse intermetatarsal ligament.<sup>9-17</sup> It is thought that there is excessive stretch on the interdigital nerves as well as compressive and shearing forces from the surrounding hypermobile metatarsal heads. Activities that require repetitive hyperextension of the metatarsophalangeal joints can also lead to the development of this painful condition.<sup>4,17</sup> Compressive forces such as narrow shoes have also been indicated to exacerbate this situation, especially high-heeled shoes that compress the metatarsal heads and maintain the toes in a hyperextended position.

A neuroma is a commonly diagnosed condition. Of 4000 clinical patients seen for pedal complaints, Youngswick demonstrated that 9.3% of these were diagnosed with neuromas.<sup>18</sup> Eighty-eight percent of patients diagnosed with a neuroma ranging in age from 30-86 years of age were found to be women.<sup>19</sup> It has often been shown that the third interspace is the most common area to be affected followed closely by the second interspace. Rarely is the first or fourth interspace affected.<sup>7,20-23</sup>

Many types of conservative and surgical treatments have been described. Conservatively, such things as change in shoe gear, padding and injection therapy are often utilized.<sup>24-26</sup> There are many different types of injection therapies that have been described such as corticosteroids, alcohol, vitamin B12 and phenol-glycerol.<sup>22,27-32</sup> Overall the success rate of conservative therapy has been noted to be about 80%.<sup>33</sup>

When conservative treatment fails to relieve the patient's symptoms various types of surgical procedures have been described for further treatment. The most common type of procedure performed is resection of the involved interdigital

nerve. The approach to this procedure has been described in many different ways including a dorsal longitudinal, a plantar longitudinal and a plantar transverse incision.<sup>18,19,21,23,34-38</sup> Another well-described procedure for the treatment of a neuroma is neurolysis.<sup>12,39-42</sup> This term is often used to describe a broad range of procedures. The two main types of neurolysis utilized for interdigital neuromas are external neurolysis and internal neurolysis. The first describes the freeing of the nerve from the surrounding tissue external to the nerve or epineural neurolysis. The later describes freeing of the individual fascicles within the nerve or inter-fascicular neurolysis. Decompression of the nerve through release of the intermetatarsal ligament is also gaining popularity.<sup>43</sup> Various other procedures include cryogenic denervation, carbon dioxide laser treatment, and radiosurgical destruction.<sup>44-48</sup> All of these procedures have varying outcomes.

The most commonly described complication of neuroma surgery is a recurrent neuroma, most often described after resection of the nerve. It seems that the end of the nerve produces immature axon sprouts that attempt to reconnect with the distal nerve. In doing so they often grow into joint capsule, scar tissue or tendons, which can become quite painful. The symptoms of a recurrent neuroma are often described as sharp or burning increased with gait. The symptoms are often worse than prior to resection. Other complications include hematoma, digital ischemia, hammertoes, infection, edema and prolonged pain.

In this study a retrospective analysis was performed on patients treated for intermetatarsal neuromas with external neurolysis and transection of the deep intermetatarsal ligament. The study looked at the subjective outcomes of the procedure to determine if it is a viable treatment option for neuromas while avoiding the possibility of a stump neuroma.

## MATERIALS AND METHODS

From August 2002 through September 2003 one surgeon performed external neurolysis on the interdigital nerve with transection of the deep intermetatarsal ligament for intermetatarsal neuromas that had failed conservative treatment. A total of 24 patients had neurolysis performed, 20 patients were available for follow-up. This included 22 feet and 26 neuromas.

Each patient's chart was reviewed retrospectively for any postoperative complications including infection, difficult wound healing, systemic complications or prolonged pain or recurrence. The postoperative notes were also reviewed to ensure that each procedure was performed in the same fashion. Also noted was the operative foot, including the interspace(s), and any additional procedures that were performed at the same time.

A questionnaire was also provided to each patient to evaluate him or her subjectively. The questionnaire assessed the patient's pain level preoperatively and at the time of the study. There were also questions on shoe gear before and after the surgery as well as activity levels. If the patient continued to have pain postoperatively they were asked to describe the pain since surgery. Each patient was asked about their satisfaction level with the surgery on a scale of 0-100% (100% being complete satisfaction). The patient was also questioned as to whether they would have the surgery performed again and if they would recommend it to someone else.

## Surgical procedure

A local anesthetic was used on the area of surgery. Using aseptic technique a dorsal incision was made over the affected interspace and electrocautery was utilized for hemostasis as needed. Under loupe magnification, the deep intermetatarsal ligament was identified and transected sharply (Figures 1, 2). The



Figure 1. Vascular bundle overlying the nerve.



Figure 2. Nerve underlying the vascular bundle.

neurovascular bundle was then identified and any surrounding attached fibrous tissue was dissected away. The nerve, artery and vein in the neurovascular bundle were then each identified, followed by retraction of the nerve away from the other structures. The nerve was then followed distally to the bisection of the nerve into the digital branches. At this time any further soft tissue attachments were freed from the nerve. No changes to the surgical technique were made in those patients in whom an obvious bulbous appearance of the nerve was noted. The wound was flushed, closed without reapproximation of the ligament and a sterile dressing applied.

## RESULTS

There were 16 females (75%) and 4 males with a mean age of 56.4 (range 46- 69) years. There were 22 total feet with 10 right and 12 left feet. There were 13 (50%) second interspace and 13 (50%) third interspace procedures. Four feet had both the second and third interspaces operated on at the same time. There were 2 patients that had bilateral neuromas. The mean follow-up time was 13.1 (range 8 - 19.5) months. There were 6 patients (30%) with 8 feet (36%) that had additional procedures performed. These procedures included base wedge bunionectomy, 4th metatarsal osteotomy (x2), Austin bunionectomy (x2), foreign body removal, mini-Keller of the second metatarsal phalangeal joint, and a plantar fascial release.

The patients average level of pain on a scale of 0 to 10 (10 being the most severe) before surgery was 7.5, with a range of 4 to 10. At the time of this study the postoperative pain level was 2.0, with a

Table 1

SHOE GEAR		
Type of Shoe	Before Surgery	After Surgery
No Shoe	6 (27%)	3 (14%)
Sandal	2 (10%)	0
Athletic	10 (45%)	7 (32%)
Walking	3 (14%)	1 (5%)
Dress	1 (5%)	8 (36%)
High Heels	0	3 (14%)

Table 2

LIMITATION OF ACTIVITIES		
Limitation of Activities	Before Surgery	After Surgery
None	0	7 (32%)
Some	4 (18%)	8 (36%)
Moderate	13 (59%)	6 (27%)
Severe	5 (23%)	1 (5%)

Table 3

OVERALL SATISFACTION		
Satisfaction	# of feet (22 total feet)	% of feet
Excellent (90-100%)	8	36%
Good (75-89%)	5	23%
Fair (50-74%)	3	14%
Poor (<50%)	6	27%
<b>Excellent &amp; Good (&gt;75%)</b>	<b>13</b>	<b>59%</b>

range of 0 to 10, with the activities of daily living. With heavier activity their average pain level was 3.7, with a range of 0 to 10. Five feet noted that they had no residual pain, 5 had the same kind of pain, while 12 described the pain as being different than it had been prior to surgery.

Upon reviewing the patient's shoe gear prior to surgery it was noted that 13 patients needed a shoe with a widened toe box, 2 required wearing a sandal for comfort and 6 reported not being able to wear a shoe comfortably. Post operatively 11 patients were able to wear tighter dress type shoe comfortably, 8 still required a shoe with a wider toe box and 3 reported still having the inability to wear shoes without pain (Table 1).

Each patient was also questioned regarding how much his or her activity level was limited due to the pain, both before and after surgery. Five patients stated that they were severely limited, 13 were moderately limited, and 4 had some limitations. Upon follow up, 1 stated that they still have severe limitations in their day to day activities, 6 have moderate limitations, 8 have some limitations and 7 have no limitations (Table 2).

The patients charts were reviewed for post-operative complications, which resulted in 3 feet that continued to have no resolution of their symptoms, 1 patient developed a deep vein thrombosis and 2 feet developed superficial infections with delayed healing of the surgical site.

All of the patients were asked to quantify how satisfied they were with the outcome of their surgery on a scale of 0% to 100% (100% being completely satisfied). Each was categorized as having an excellent (90% - 100%), good (75%-89%), fair (50%-74%) or poor (<50%) result. Eight of 22 feet (36%) had an excellent result, 5/22 feet (23%) had a good result, 3/22 feet (14%) had a fair result and 6/22 feet (27%) had a poor result. Of the 22 total feet, 59% had a good to excellent subjective result. Each patient was also assessed as to whether they would have the procedure performed again, 15/22 responded yes. When questioned as to whether they would recommend the surgery to someone else 16/22 responded yes.

## DISCUSSION

The most common surgical procedure for neuromas currently is resection of the neuroma through a dorsal longitudinal approach. The average success rate of this procedure is about 80%. Mann and

Reynolds reported that 80% of their patients improved,<sup>21</sup> Friscia et al had a success rate of 79% with an average follow up of 5.9 years.<sup>23</sup> Keh et al reported 93% success rate at an average of 4.8 years.<sup>19</sup> Ruuskanen et al had the longest follow up of 6 years and reported 80% improvement.<sup>34</sup> At 3.7 years Dereymaeker et al had a 81% satisfaction rate. Karges published results using the less popular plantar longitudinal approach that showed a 93% success rate.<sup>36</sup> Several authors have also reported on the plantar transverse approach, which has varied results. Viladot reported 94% success at 58 months while Burns and Stewart reported 100% success in a series of 5 patients with a short follow up. In contrast Youngswick reported 83% success with this approach.

The most discussed complication of neuroma resection is the stump neuroma or recurrent neuroma. The cause of a stump neuroma has often been theorized as incomplete regeneration of the nerve fibers that become attached to surrounding joint capsule or scar tissue. Young and Lindsey in 1993 also theorized that there are multiple accessory nerve branches that if not resected cause incomplete retraction of the resected nerve.<sup>49</sup> Bradley had a 6% recurrence rate in his resected neuromas while Mann and Reynolds reported a higher rate of 14%.<sup>21,50</sup>

There have been multiple studies that have reported the success rates of a second procedure for recurrent neuromas. Bradley et al showed a very low success rate of 20% while Mann and Reynolds had much better results of 82%.<sup>21,50</sup> Nelms et al also reported an 89% satisfaction rate using a plantar longitudinal approach with implantation of the nerve ending into the metatarsal.<sup>51</sup> Johnson et al had complete resolution of symptoms in 67% of his patients using 2 different approaches.<sup>52</sup>

In 1979 Gauthier was the first to describe the use of external neurolysis as a surgical treatment for neuromas. He advocated transecting the transverse intermetatarsal ligament in addition to freeing up the nerve. He theorized that this avoided the possibility of loss of sensation and sweat production as well as the development of a stump neuroma. In his study he performed this procedure on 304 neuromas with an average follow up of 21 months. He reported 83% good results.<sup>12</sup> Nemoto et al reported an 83% success rate using a plantar zig-zag approach in 6 patients.<sup>41</sup> Diebold also reported on a series of 40 patients in which there was a good to excellent result in 98% of patients.<sup>12</sup> Okafor reported on a series of patients a year later in which 74% were



subjectively very happy with the results.<sup>42</sup>

In our study, 59% of the patients had a good to excellent result meaning that they were at least 75% satisfied with the outcome of their procedure. There was an average of 73% improvement in their pain with normal daily activities and an average of 51% improvement with heavier prolonged activities. Sixty eight percent of our patients stated that they would in fact have the surgery performed again while 73% stated that they would recommend the surgery to someone else. The difference in these numbers is due to one patient that had a complication and therefore did not have a desirable outcome but stated that she thought that it was good procedure and would therefore recommend the procedure to someone else.

Before surgery only 5% of our patients were able to wear a tighter dress type shoe. Since surgery 50% of our patients reported that they were now able to wear these types of shoes. A majority of our patients reported having limitations of their daily activities due to their symptoms before surgery; only 18% reported none to minimal limitations. After surgery 68% of them now claimed to have none to minimal limitations.

There were 6 patients that were found to have postoperative complications. These patients overall average satisfaction was 25%. Therefore if these patients were excluded from the series, 81% of our patients would have had a good to excellent result.

In our series we also looked at those patients that had multiple interspaces operated on at the same time. Of those 4 feet, the average pain level before surgery was 8 (range 6-10). The average pain level after surgery with daily activities was 0.5 and with increased prolonged activity was 3.75. The average satisfaction of this small group of patients was 90%.

We also reviewed the pain levels of those patients that had both feet operated on at the same time. There were 2 patients in this group with a preoperative average pain level of 8.5. Postoperatively these patients had an average pain level of 2.5 and with increased activity averaged 5.75. The average satisfaction of this group was much lower at 58.75%.

In addition we also compared the second and third interspaces (IS). There were 9 feet in each group. Those feet included in any of the above groups were excluded. Those feet in which the second IS was operated on had an average

preoperative pain level of 7.3 while the third IS group averaged 7.4 making the two groups initial pain level comparable.

Postoperatively the average pain with normal daily activity was 3.1 for the second IS and 1.2 for the third IS group and with increased prolonged activity was an average of 5.7 and 1.8 respectively. It seems that those patients having surgery in the third IS had a much more significant improvement in there postoperative pain level. Those patients included in the second IS group had an average satisfaction rate of 51% with 22% having a good to excellent result. The third IS group had a slightly higher average satisfaction rate of 66% with 56% of those patients having a good to excellent result.

In our study it did not appear that our results compared with those in previous studies in which neurolysis was performed for the surgical correction of neuromas. The overall patient satisfaction in our study did not appear to correlate with our patient's average improvement in their pain level, limitation of activity and shoe gear. It also appeared that postoperative complications played a large role in patient dissatisfaction, which had a large impact on the percentage of patients that achieved a good to excellent result. When looking at those patients that had multiple interspaces operated on, they appeared to do very well on average although the total number of feet was low. Those patients that had bilateral procedures performed did not appear to do as well but the number of patients in this group was also low. It also seems that those patients that had neurolysis performed on the third IS versus the second IS had a higher average satisfaction.

It seems that patient expectation might have played a large role in the overall satisfaction of the patients in this study due to overall satisfaction not correlating with the improvement in pain, activity and shoe gear. In the future, improved patient education may improve the patient satisfaction of this procedure. It also appeared that each of the studies reviewed had different ways of reporting their outcomes. For this reason it is very difficult to compare other studies to our study and therefore the results from our study may appear falsely low. Our experience with this technique is also limited at this point, therefore with continued experience; the overall outcome could possibly improve. A side-by-side comparison of the popular resection procedure versus this neurolysis procedure would also be very enlightening.

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