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Morton's neuroma decompression: current insights & recommendations

Descompresión del neuroma de Morton: visión actual y recomendaciones

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Keywords:

Decompression, Morton's neuroma, intermetatarsal neuroma, Morton's neuralgia, podiatric surgery.

Abstract

Morton's neuroma or interdigital neuroma is an entrapment neuropathy of the common digital plantar nerve in which the deep transverse metatarsal ligament plays a dominant role. Classic surgical treatment of this condition has been a direct open neurectomy by an open approach with all potential complications associated with that technique. The present paper exposes the personal approach of the author for this condition which consists in surgical decompression of the nerve by means of section of the deep transverse metatarsal ligament by an minimally invasive approach. A detailed description of the technique is done and all the evidence regarding this technique, modifications and other surgical treatments for morton's neuroma is exposed in the discussion section of the paper.

Palabras clave:

Descompresión, neuroma de Morton, neuroma intermetatarsal, neuralgia de Morton, cirugía podológica.

Resumen

El neuroma de Morton, o neuroma interdigital, es una neuropatía por atrapamiento del nervio plantar digital común en el que el ligamento transverso metatarso profundo juega un papel fundamental. El tratamiento quirúrgico clásico de esta afección ha sido la neurectomía por medio de un abordaje abierto con las complicaciones potenciales asociadas a dicho procedimiento. El presente artículo explica el abordaje personal del autor de esta patología mediante una descompresión del nervio, seccionando el ligamento transverso metatarso profundo de forma mínimamente invasiva. Se hace una descripción detallada de la técnica y la discusión recoge toda la evidencia más actual con respecto a dicha técnica, y al abordaje quirúrgico en general, del neuroma de Morton.

INTRODUCTION

Morton's neuroma, or interdigital neuroma, is a common forefoot pathology that presents as an entrapment neuropathy of a common plantar digital nerve most frequently presenting in the third or second web spaces and the contiguous metatarsal heads. The Italian anatomist, Filippo Civinini, is credited with the first description of the condition in 1835 after noting it in a cadaver specimen[1,2]. In 1845, Durlacher[3] provided the first description of the complex clinical symptoms associated with the disorder. However, the condition is named after Thomas George Morton[4,5] who, in 1876, described "a peculiar and painful affection of the fourth metatarsophalangeal articulation." He attributed the pain to the fourth metatarsophalangeal joint. In 1883, Hoadley[6] was actually the first to excise an interdigital neuroma from the third web space of a foot. Although the term "neuroma" is used to describe the affliction, it has been shown histo-

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logically that the lesion is actually a proliferative, perineural fibrosis rather than a true nerve tumor. Over the years, several different theories have emerged regarding the etiology of this disorder, but there is now convincing evidence that the condition results from chronic, repetitive, micro-trauma to the nerve from impingement and compression of the nerve by the overlying deep transverse intermetatarsal ligament[7-10]. Women are most often affected, with a reported male:female ratio of 1:4, and the peak age for the condition is between 50 to 60 years[11]. Morton's neuroma predominantly occurs in the third intermetatarsal space followed by the second intermetatarsal space. Morton's neuroma is rare in the first and fourth intermetatarsal spaces. The pain associated with the neuroma has generally been described as a somewhat reproducible, linear, radiating ache, burning, lancinating, or cramping pain. Patients often also describe an associated tingling, numbness, or feeling of "fullness" or a "lump" under the ball of the foot. The diagnosis of Morton's neuroma with a definitive test has been investigated extensively, and most agree today that the "gold standard" for diagnosis remains the clinical examination. Clinical palpation with the elicitation of interspace pain, tenderness, and/or paresthesias, optimally with the identification of a Mulder's sign, is a good diagnostic clue to the presence of a neuroma. Currently, there is no absolute requirement to perform diagnostic imaging on a patient with suspected Morton's neuroma. Musculoskeletal ultrasound and magnetic resonance imaging (MRI) are most useful in confirming the presence of a neuroma or when the clinical assessment is equivocal, but they have also been shown to be associated with many false negative and false positive results.

As with most maladies, both conservative and surgical approaches have been advocated for Morton's neuroma. Unfortunately, Morton's neuroma is often responsible for chronic pain that is resistant to conservative management. Common options, often used in combination, for the non-surgical treatment of neuromas include: wider shoes, orthotics or insoles, metatarsal pads, corticosteroid or sclerosing injections, and anti-inflammatory medications. In the author's opinion, the use of corticosteroid injections should be limited to no more than 3 per year, and more frequent injections or large doses of non-soluble steroids (e.g., triamcinolone acetate) should be avoided as these injections do not predictably provide long-term relief and can directly damage the nerve and cause other deleterious effects, such as plantar plate ruptures. Newer, semi-invasive modalities such as radiofrequency ablation and cryoneurolysis, need additional study before they can be definitively espoused as useful modalities.

The most common surgical options for Morton's neuroma include neurectomy, osteotomy, and neuroma decompression. Classically, neurectomy has been the most frequently practiced or "traditional" approach, but has the well-documented sequelae of producing a permanent sensory deficit of the affected toes and interdigital space and the potential for the development of an amputation or "stump" neuroma. In contrast, preservation of the nerve with decompression methods provides for the maintenance of sensation and avoids the risk of amputation neuroma formation which can often lead to further, challenging, revisional surgery. In fact, almost all nerve compression syndromes in the human body, including other common conditions such as carpal tunnel and cubital tunnel syndromes are routinely addressed with simple nerve decompression. Osteotomies of one or both of the adjacent metatarsals to the involved nerve has been advocated by some, but these approaches have been less studied and have their own potential risks, including transfer metatarsalgia, malunion, nonunion, and digital deformity. Direct decompression of the nerve by release of the deep transverse intermetatarsal ligament arguably offers the potential for a favorable outcome with fewer complications and risks than are associated with neurectomy and osteotomies.

In 1979, recognizing that Morton's neuroma was a compressive neuropathy, Gauthier[12] was the first to introduce a surgical procedure for the release of the deep transverse intermetatarsal ligament through a dorsal incision. In his study, he treated 206 patients with this technique and reported that 83 % of the patients had rapid and stable improvement. An additional 15 % of the patients were improved but had some persistence of their pain. This study provided the initial evidence that the pain associated with Morton's neuroma can effectively by relieved by release of the deep transverse intermetatarsal ligament. Since Gauthier's initial study, numerous other authors have espoused neuroma decompression and various modifications as the procedure of choice for Morton's neuroma.

SURGICAL TECHNIQUE

The author has performed a Morton's neuroma decompression technique for over 25 years and well over 100 cases. In most instances, specialized instrumentation has been used, but the technique can easily be modified to perform the procedure with more simple, readily available, surgical instrumentation. The procedure is done with the patient supine on the operating room table and typically with the use of an ankle tourniquet. Intravenous sedation is usually provided with a local anesthetic block. The local anesthetic block is typically done in the interspace involved and the contiguous medial and lateral interspaces (e.g., if the 3rd interspace is being decompressed, the 2nd,3rd, and 4th interspaces are anesthetized).

Prior to making the surgical incision, the involved intermetatarsal space is carefully palpated and a skin marker is used to mark the interspace dorsally in linear fashion (Figure 1A-B). This outlining will ensure that the instrumentation is introduced longitudinally in the direction of the proximal intermetatarsal space from the distal web space. Next, a 1.0 cm-1.5 cm vertical, web-splitting incision is made over the distal interspace (Figure 1C). A hemostat is then used to

bluntly dissect deeply until the deep transverse intermetatarsal ligament is palpated (Figure 1D). Any superficial veins are retracted or cauterized as necessary. Once the ligament is identified, it is fully transected from distal to proximal in line with the previously marked line on the dorsal skin. A Metzenbaum scissor, scalpel, or specialized instrumentation (e.g., KobyGard™ System) may be used for cutting the ligament (Figure 1E). To confirm that the ligament has been fully released and to assist in transpositioning the nerve unit more dorsally, one can move the contiguous metatarsals freely dorsal to plantar (Figure 1F). A blunt probe can also be passed from the plantar skin to the dorsal skin in the intermetatarsal space and no resistance should be encountered from the now released ligament. The blunt probe or other instrumentation can also be used gently to aid in the dorsal relocation of the now released nerve/neuroma. Inspection of the surgical wound will also confirm that the underlying nerve and neuroma are now free-floating within the interspace and freed from any perceived impingement throughout their distal course. No further exploration of the wound is typically done, although some investigators have advocated additional dissection to remove any fibrosis or scar tissue surrounding the nerve. The author rarely performs this additional maneuver and has left the neuroma/nerve intact irrespective of its appearance or neuroma size. The wound is then copiously lavaged with sterile saline. Prior to wound closure, the author prefers to infiltrate 1.0 ml of a soluble corticosteroid (e.g., dexamethasone phosphate 4 mg/ml) around the area of nerve hypertrophy. The subcutaneous tissue is closed with 3-0 or 4-0 absorbable sutures in horizontal mattress fashion and the skin is closed with 3-0 or 4-0 non-absorbable sutures in simple interrupted fashion (Figure 1G). A dressing is then applied with povidone iodine-soaked, non-adherent gauze in the web space, followed by a dry, sterile gauzed dressing and compressive wrap.

Postoperatively, the patient is instructed to elevate and ice the foot for 7-10 days. The patient is given a surgical shoe and allowed to do light weight bearing only in the surgical shoe for 14 days. The dressing is changed and replaced after 5-7 days and removed completely along with the skin sutures at 14 days. Bathing is started at 14 days, and the patient is returned to light activities in closed shoes in 14-21 days. Full activities are resumed as tolerated after 21 days. Long-term, appropriate supportive shoes and insoles/orthotics are recommended.

Complications following neuroma decompression are minimal. The most frequently reported complications are the continuation of symptomatology, wound infection, wound healing problems or hematoma formation (Figures 2A-B), or some residual neuritic symptoms (i.e., tingling and/or numbness). Amputation or "stump" neuroma has not been reported with neuroma decompression. A recent paper investigating the relationship between transection of the deep transverse intermetatarsal ligament in the third intermetatarsal space and metatarsal alignment in cadaver specimens found that no change occurred in the width of the third intermetatarsal space after ligament sectioning and simulated weight bearing[13].

DISCUSSION

Since Gauthier's original paper, the outcomes following neuroma decompression have been promising and recent studies examining the results of the technique continue to reveal good results. The procedure has now come to be known as the Minimally Invasive Neuroma Decompression procedure or MIND procedure. Many variations of the decompression approach have evolved.

In 1992, Dellon[14] strongly advocated Morton's neuroma decompression by transection of the deep transverse intermetatarsal ligament though a dorsal incision. Dellon performed a division of the ligament, a release of the intrinsic fibrosis, and opened the epineurium. He reported the results in 5 patients undergoing 11 procedures. At a mean follow-up of 33 months, 4 of the 5 patients (80 %) reported complete pain relief, and one patient (20 %) reported good pain relief. In 2020, Mischitz and colleagues[15] retrospectively assessed 12 patients treated by the Dellon technique and at follow-up of at least 6 months after surgery, the skin sensation was restored and the median Foot Function Index scores (FFI median pain preoperatively: 53; postoperatively: 7) and the median Visual Analog Scale scores (VAS median preoperatively: 8.5; postoperatively: 0) were significantly improved. These researchers stated that the decompression approach yielded a "highly positive outcome, and based on our findings, we consider it a reliable, technically simple and promising approach to treat Morton's neuroma."

In 1996, Diebold and associates[16] reported a series of 40 patients undergoing neurolysis for Morton's neuroma with a minimum of 5-years follow-up. 37 of the 40 patients (92.5 %) had an excellent result after neurolysis and 35 of the 40 patients (87.5 %) had normal toe sensitivity at the time of follow-up examination. 39 of the 40 patients (97.5 %) stated they would undergo the operation again if necessary.

Some authors have advocated performing the neuroma decompression with endoscopic instrumentation. This approach has been termed the Endoscopic Decompression of Intermetatarsal Nerve or EDIN procedure. In 1994, Barrett and Pignetti[17] introduced this minimally invasive endoscopic method for the decompression of a Morton's neuroma. In 2006, Barrett and Walsh[18] reported the results of this approach for release of the deep transverse intermetatarsal ligament. In slightly over 6 years, they performed 96 procedures on 69 patients. Of the 96 interspaces released, 39 (40.6 %) were second intermetatarsal spaces and 57 (59.4 %) were third intermetatarsal spaces. Of the 87 cases available for follow-up, 75 interspaces (86.2 %) had excellent or good results and 12 interspaces reported poor results (13.8 %). Of the interspaces with poor results, 5 (5.7 %) underwent a subsequent traditional neurectomy. In 2012, an additional,

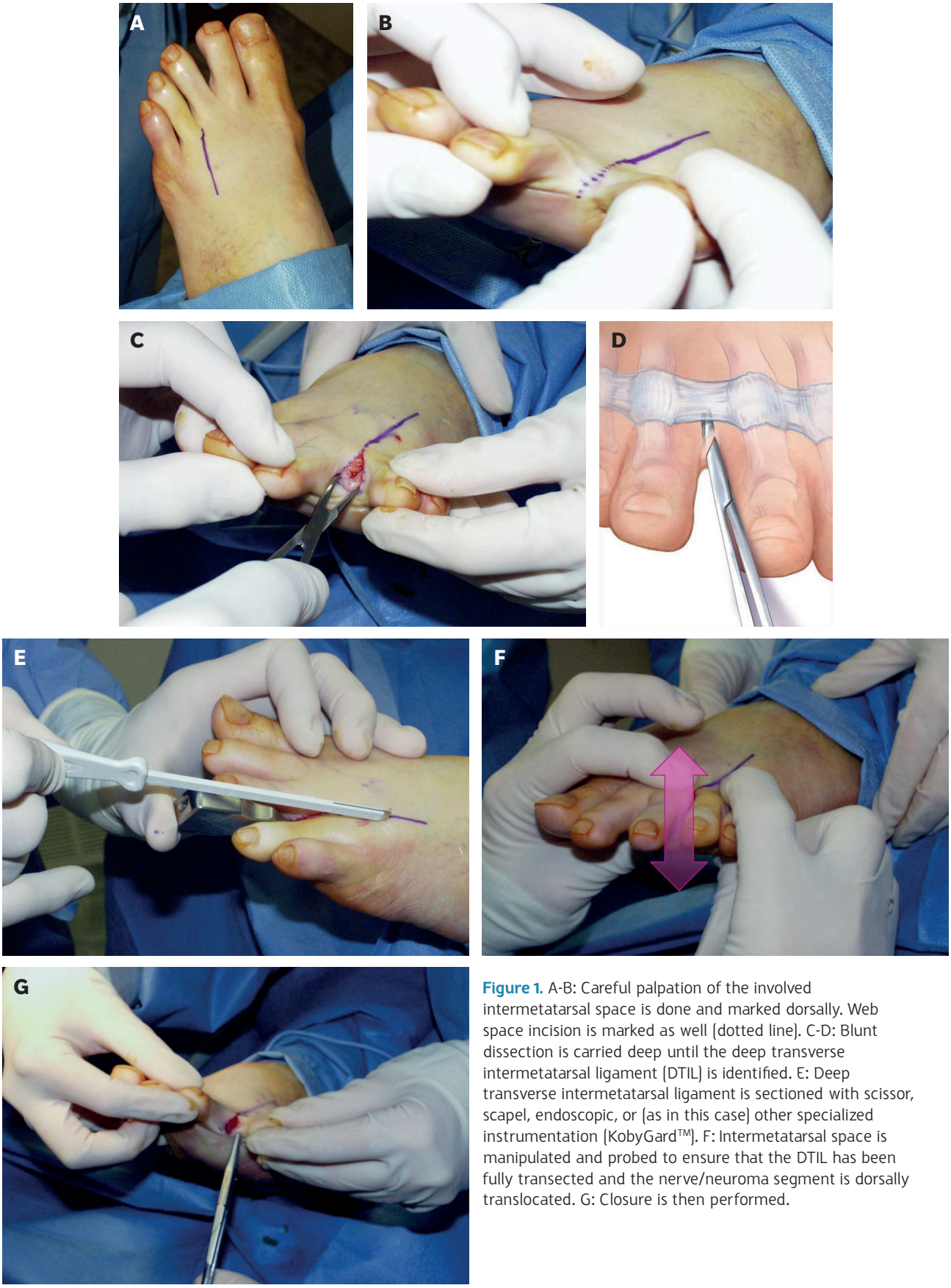

Figure 1. A-B: Careful palpation of the involved intermetatarsal space is done and marked dorsally. Web space incision is marked as well (dotted line). C-D: Blunt dissection is carried deep until the deep transverse intermetatarsal ligament (DTIL) is identified. E: Deep transverse intermetatarsal ligament is sectioned with scissor, scapel, endoscopic, or (as in this case) other specialized instrumentation (KobyGard™). F: Intermetatarsal space is manipulated and probed to ensure that the DTIL has been fully transected and the nerve/neuroma segment is dorsally translocated. G: Closure is then performed.

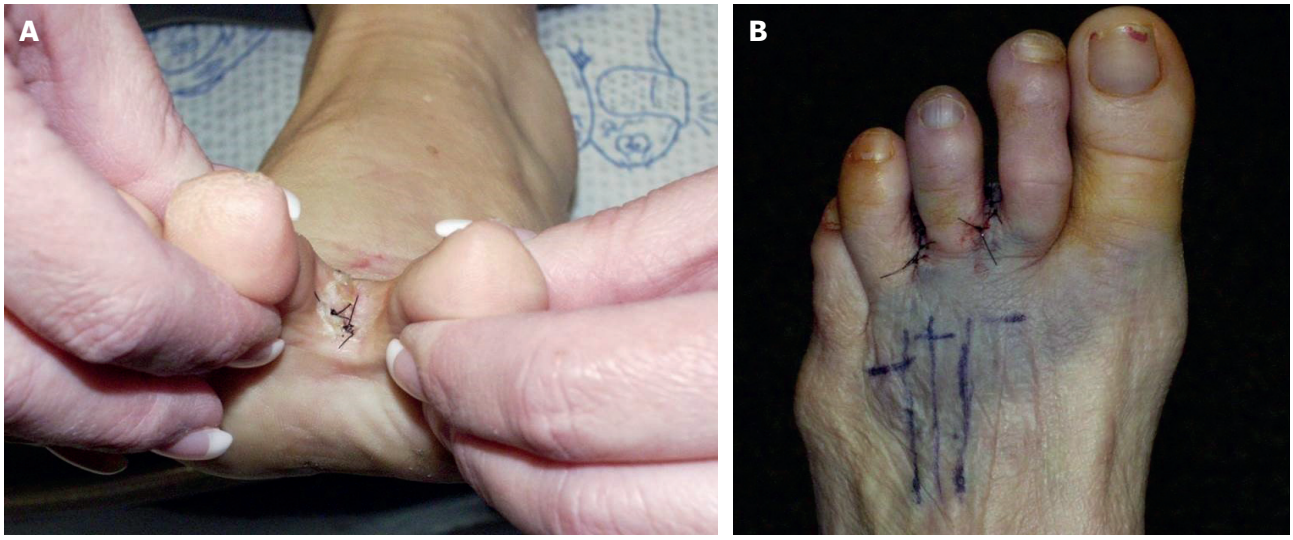

Figure 2. A: Superficial wound dehiscence with maceration of wound edges at 10 days postoperative. B: Hematoma formation at 5 days postoperative. Note decompression neurolysis was done on both the second and third intermetatarsal spaces in this case.

multi-center review of 193 EDIN procedures was undertaken with 178 of the 193 patients (92.2 %) reporting a good or fair outcome and only 15 patients (7.8 %) reporting a poor outcome. These surgeons reported higher success rates with 3rd intermetatarsal space decompression (95 %) compared to 2nd intermetatarsal space decompression (85 %). They attributed this difference to the greater complexity of the pathomechanics associated with the 2nd ray. Minimal complications were reported in their series, and 7 patients (3.6 %) with a poor outcome elected to undergo revision with a traditional neurectomy[19]. Shapiro[20] also advocated an endoscopic approach using different instrumentation through a single web space incision. He reported satisfaction with the technique and reported that his preliminary results in 40 patients were excellent with no hematomas or infections, and only 3 patients (7.5 %) necessitating a return to the operating room for neurectomy.

Instead of endoscopic instrumentation, in 2007, Zelent and colleagues[21] performed 17 Morton's neuroma decompressions in 14 patients using an instrument designed to release the transverse carpal ligament for carpal tunnel syndrome. Nine women and five men (3 bilateral) had the procedure performed. The mean follow-up for the 17 decompression procedures was 25.92 months. 11 of the 14 cases (78.6 %) obtained complete relief, 2 patients (14.3 %) had recurrence of their symptoms, and 1 patient (7.1 %) suffered a crush injury to the foot and could not be assessed. Both of the patients with recurrent symptoms underwent subsequent neurectomy. These researchers found no wound healing complications or iatrogenic digital deformities after the procedure.

Many authors have advocated dorsal transposition of the neuroma after release of the deep transverse intermetatarsal ligament. The thought behind this repositioning on the neuroma/nerve complex is to avoid re-fibrosis of the cut deep transverse intermetatarsal ligament and recurrent neuroma symptoms. Also, effective dorsal translocation of the nerve may move it away from the intermetatarsal bursa, which has also been hypothesized to contribute to nerve irritation. In 1997, Okafor et al.[22] examined a series of 35 patients who had undergone neurolysis for Morton's neuroma at a mean follow-up of 21.4 months. These surgeons primarily used a dorsal longitudinal incision and released the nerve sufficiently to allow it to easily transpose dorsally. They manipulated the foot until the nerve/neuroma was visualized to have moved to a more dorsal position. They reported 17 of their 35 patients (48.6 %) had complete relief of their pain and 12 or 35 (34.3 %) had minimal discomfort with activity. These authors advocated a preoperative diagnostic block with lidocaine (i.e., a local anesthetic), as they felt patients obtaining relief with the preoperative injection did better with the surgery. In 2020, Elghazy et al.[23] reported their results in a small series of 12 patients (12 cases) with neuroma decompression and dorsal repositioning of the nerve/neuroma at a mean follow-up of 13.5 months. They reported significant improvement in all their cases with a decrease in the Visual Analog Pain Scale from a mean of 6.4 preoperatively to a mean of 2.0 postoperatively. Vito and Talarico[24] proposed neuroma decompression with relocation of the nerve/neuroma dorsal to the transected deep transverse intermetatarsal ligament and suturing of the epineurium of the nerve to the deep fascia or an adjacent metatarsal at that level. They reported good short-term results with their technique, documenting that 78 of their 82 cases (78 patients) (95 %) obtained relief of their pain. In 2018, Song and associates[25] compared neuroma decompression with dorsal suspension of the nerve with traditional neurectomy. These investigators compared 38

patients (40 feet) undergoing the decompression with dorsal suspension to 36 patients (36 feet) undergoing neurectomy. The mean follow-up for the decompression group was 32.5 months and for the neurectomy group was 38.4 months. Both the Visual Analog Scale (VAS) scores and Foot and Ankle Ability Measure (FAAM) scores showed greater improvement (although the difference was not statistically significant) in the decompression group with fewer complications.

In 2020, Archuleta and associates[26] offered some caution regarding the decompression technique, when they reported their results in 25 patients (27 cases). These investigators performed a medical record review in their patient series and assessed patient demographic and clinical data along with postoperative patient satisfaction, complications, and the need for any follow-up neurectomy. 22 of the 27 procedures (81.5 %) had valid patient satisfaction data and reported satisfaction was excellent for 11 (50 %), good for 2 (9.1 %), fair for 0 (0 %), and poor for 9 (40.9 %). Five of the patients with a poor result (18.5 % of the entire series) underwent a subsequent open neurectomy. These investigators felt that patients with smaller neuromas did better with the procedure, as 5 of their 6 patients (83.3 %) without a positive Mulder's sign on physical examination preoperatively, which would potentially suggest a smaller neuroma, reported an excellent result. The authors concluded that "Minimally invasive nerve decompression may not be as effective as previously seen; however, it may be indicated in patients presenting with absence of a Mulder's sign, a physically small or nascent neuroma."

Comparative studies have found neurolysis and neurectomy to provide debatedly similar results in regards to pain relief. Villas and colleagues[27] retrospectively examined a group of 50 patients (69 feet) that underwent neurectomy in 46 cases and decompression neurolysis in 23 cases. Total relief of pain was obtained in all but one patient in each group. However, the study is of limited value as the decision of which procedure to perform was made intraoperatively. If the nerve showed visible (i.e., macroscopic) thickening it was resected, and if the nerve looked normal it underwent neurolysis. Lu and others[28] in 2021 performed a systematic review and meta-analysis of pain and satisfaction outcomes comparing injection therapy, neurolysis, and neurectomy for Morton's neuroma. They concluded from their appraisal that the consensus incidence of pain relief after injection was 43 %, after neurolysis was 68 %, and after neurectomy was 74 %. The consensus of the incidence of complete satisfaction after injection was 35 %, after neurolysis was 63 %, and after neurectomy was 57 %.

Finally, some investigators have advocated the combination of transection of the deep transverse intermetatarsal ligament along with osteotomies of the adjacent metatarsals[29,30] for Morton's neuroma. These techniques may have some merit, but due to the well-known sequelae of performing lesser metatarsal osteotomies, including the risks of transfer metatarsalgia, malunion, nonunion, and floating toes, more documentation is needed before they can be considered amongst the preferred techniques.

CONCLUSION

One of the tenet's of good medicine and the Hippocratic Oath is *primum non nocere* or at "first, do no harm." Clearly, from the evidence presented in this paper and the author's own experience, the decompression techniques for Morton's neuroma centered on transection of the deep transverse intermetatarsal ligament and dorsal translocation of the nerve/neuroma comply with this doctrine of non-maleficence. The decompression technique presented provides the clinician and their patient a reasonable expectation of significant pain relief and a good patient outcome. The technique also exposes the patient to nominal risk as the complications associated with the presented decompression technique are minimal and typically not any worse than the symptoms with which the patient first presented. Further, should the decompression technique fail to provide a satisfactory outcome, further surgery with neurectomy or decompression with metatarsal osteotomies can be considered. These later approaches also have good reported results and outcomes, but can be expected to be associated with greater risks and complications. If one accepts that Morton's neuroma is a compression, entrapment neuropathy, then the minimally invasive neuroma decompression technique should be a part of that physician's surgical repertoire.

CONFLICT OF INTERESTS

The author declares there is no competing interest.

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