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# Dextrose Prolotherapy Treatment for Unresolved "Morton's Neuroma" Pain

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*This study investigates the effectiveness of Dextrose Prolotherapy injections on a group of patients with "Morton's neuroma." These patients had failed previous conservative therapies, including surgical and non-surgical procedures as well as steroid injections. In this study, seventeen patients with neuroma pain were treated for six months. Every month, 10 to 20 injections containing 0.5 to 1 milliliter of Dextrose solution were given based on patient response. Pre- and post-treatment surveys utilized both objective data (i.e., solutions used, length and number of treatments, etc.) and subjective data (post-treatment visual analog scale or VAS ratings of pain relief/reduction). The results of this short-term study suggest that Prolotherapy, using injections of Dextrose into weakened ligaments, tendons, and joints, is a promising option among current treatment choices. Prolotherapy works by stimulating the body to repair these soft tissues. Future studies must confirm not only the efficacy but also the reduced risks of Dextrose Prolotherapy for one of the most common foot ailments.*

**Key words:** Morton's neuroma, neuralgia, metatarsalgia, paresthesias, intermetatarsal bursitis, inflammatory arthritis, osteomyelitis, rheumatoid arthritis, localized vasculitis, ischemia, tarsal tunnel syndrome, peripheral neuritis, synovitis, tendonitis, avascular necrosis, metatarsophalangeal joint capsulitis, Hackett-Hemwall Dextrose Prolotherapy

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Morton's neuroma (MN) is a painful condition that affects the ball of the foot. First described in the 1800s, this affliction continues to be a common cause of forefoot pain.[1] Seemingly benign, MN pain can cause extreme discomfort, making it difficult to walk. Those affected become so cautious that they are afraid to place the afflicted foot (or feet) on the ground to take a step.

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The word "neuroma" suggests a tumor of the nerve; however, the term is actually a misnomer since the condition is not necessarily an abnormal growth of the nerve.[2, 3] Also, the term neuroma does not describe what is seen with a microscope. Over time, other terms have been used to describe aspects of this pathology. Based on the shape, size, and structure (morphology) of tissues noted under the microscope, other terms may apply: perineural fibrosis, endoneural edema, neurofibromata, angioneurofibromata, local demyelination, and local vascular degeneration[4, 5] (Fig. 1).

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| | |
|---|---|
| perineural fibrosis | angioneurofibromata |
| endoneural edema | local demyelination |
| neurofibromata | local vascular degeneration |

**Figure 1** Possible tissue pathologies that explain interdigital pain.

What circumstances give rise to the onset of neuromas in the foot? Chronic irritation, trauma, or excessive motion induces a severe, intermittent pain between a pair of the five metatarsal heads in the bones of the fore foot. MN pain may then radiate through the nerves to the tip of the toes.[6] The shooting pain follows a path from that web space to the touching halves of adjacent toes. Seen most commonly in the second and third web space—any interdigital space between toes can be affected[7-9] (Fig. 2).

Typical symptoms in the region of the intermetatarsal spaces include sharp pains, burning sensations, and paresthesias (abnormal sensation) with weight-bearing activity. (Fig. 3) In fact, the sensation is often described as walking with a stone in the shoe or on a folded or creased sock. As the condition progresses, the pain becomes debilitating; and walking becomes more apprehensive, even to an observer. Noting these typical symptoms, an accurate diagnosis can then be made after a thorough review of the patient's history and a physical assessment.

Evidence on the frequency of this condition is minimal; however, a foot clinic computed the incidence of patients diagnosed with a "neuroma" at a rate of 9.3% of 4000 patients who complained of foot pain.[10-12] Although neuromas in both feet and multiple neuromas in one foot occur, both conditions are rare.[13, 14] Furthermore, neuromas are seen among patients of all ages; even so, they are more prevalent in middle-aged adults.[15-17] The condition most often affects women who frequently wear pointed, high-heeled, close-toed, ill-fitting shoes poorly designed for foot mechanics.[18] Footwear that transfers body weight to the metatarsal heads may be the reason women suffer from MN more frequently than men at a documented rate of eighteen to one.[19] The pain generally intensifies with walking, weight-bearing movement, and tight-fitting shoes.

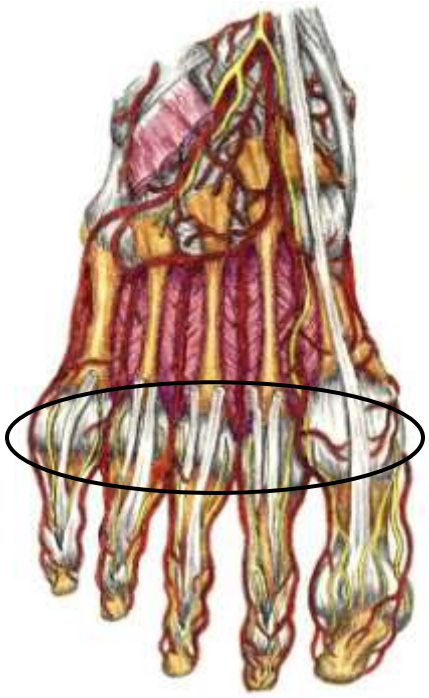

**Figure 2** Interdigital spaces.

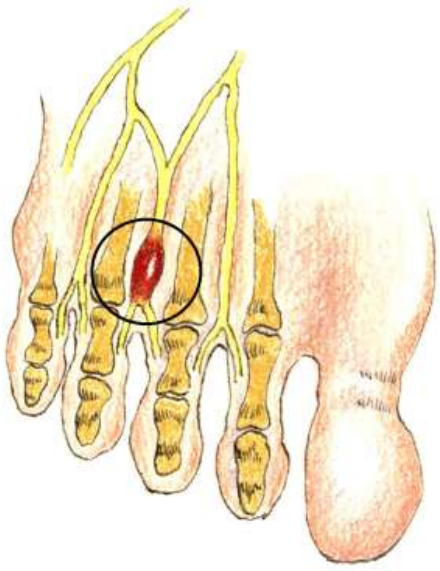

**Figure 3** Inflamed interdigital nerve.

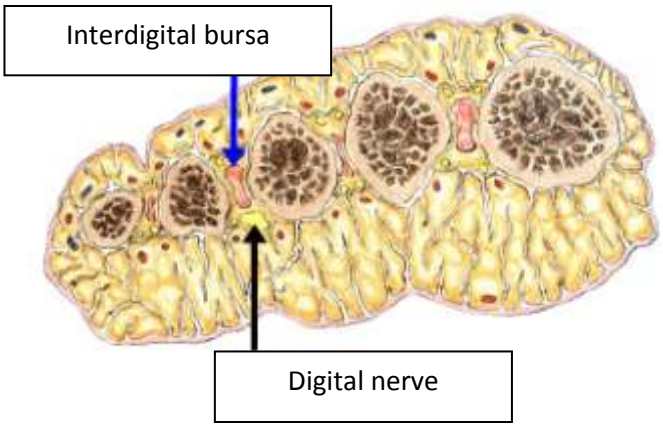


**Figure 4** Cross sectional view of the fore foot displaying the interdigital points of irritation/inflammation.

The discomfort, however, eases with rest and the removal or change of footwear.[20, 21] At the onset of the condition, additional relief may be gained by removing the shoe, massaging the foot, and wiggling the toes.

The etiology (cause) of Morton's neuroma is controversial. A longstanding entrapment theory maintains that the third digital nerve, which is large and formed by a branch of the medial and lateral plantar nerves, is compromised by mechanical irritation. With dorsiflexion—when the toes or foot are bent upward toward the nose—the unyielding transverse ligament fixates the proximal end of the digital nerve.[22, 23] (Fig. 4) However, this pinching does not always occur in one nerve; other intermetatarsal spaces can be affected.[24] Since it is not a true neuroma (tumorous nerve), some refer to the condition as Morton's metatarsalgia.[25] Metatarsalgia is pain related to the metatarsal bones of the foot.[26] Another explanation for the pain is an ischemia or lack of blood flow through the plantar digital artery, which precedes a fibrous thickening around the nerve, called a perineural fibrosis.[27] In addition, a pathophysiological theory for MN claims that the intermetatarsal bursa—distally located to the transverse metatarsal ligament and close to the neurovascular bundles—is irritated. Thus inflamed, secondary fibrosis in the bursa can lead to the symptoms of neuroma. Lateral compression of the foot will then invariably cause pain, probably due to the inflamed bursa—not the nerve—being squeezed between the metatarsal heads.[28] (Fig. 4)

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|---|---|
| metatarsal stress fracture | intermetatarsal bursitis |
| inflammatory arthritis | osteomyelitis |
| rheumatoid arthritis | localized vasculitis |
| ischemia | tarsal tunnel syndrome |
| peripheral neuritis | synovitis |
| tendonitis | avascular necrosis |
| metatarsophalangeal joint capsulitis | Morton's neuroma |

**Figure 5** Diagnoses to consider when interdigital pain is the main symptom.

The inflamed and enlarged bursa causes a click when the metatarsals are squeezed. This distinctive click, called "Mulder sign," can be used when diagnosing Morton's neuroma.[29]

A clear knowledge of conditions that affect the metatarsal region is critical to making a definitive diagnosis. Initially, possible diagnoses include metatarsal stress fracture, intermetatarsal bursitis, inflammatory arthritis, osteomyelitis, rheumatoid arthritis, localized vasculitis, ischemia, tarsal tunnel syndrome, peripheral neuritis, synovitis, tendonitis, avascular necrosis, metatarsophalangeal joint capsulitis, and others[30-32] (Fig. 5).

Many treatments have been developed for relief of the symptoms of Morton's neuroma, but initially, non-surgical approaches are preferred. Among these conservative treatments from simple to complex are changing the footwear; avoiding high-heeled shoes; resting the feet; applying ice; elevating the foot; taking anti-inflammatory medications; taping and strapping, padding, and immobilizing the foot; receiving physical therapy; wearing orthotics or other shoe gear; and injecting steroids. When conservative approaches are unsuccessful, surgery is generally sought as the next step. Surgical approaches include resection, transection, decompression, excision of the involved nerve, and cryogenic nerve ablation.

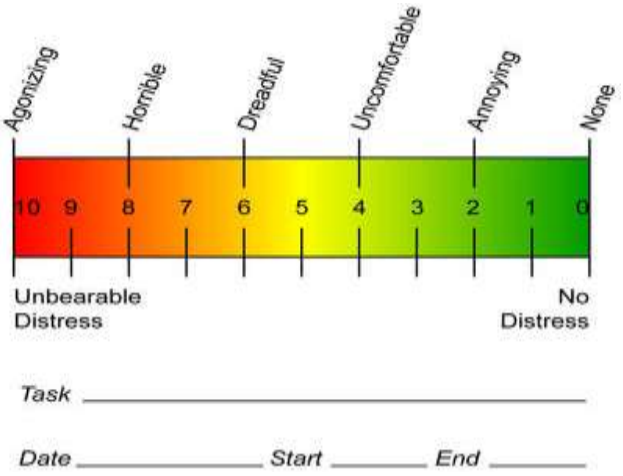


**Figure 6** Questionnaire used by patients to assess levels of pain.

Another conservative treatment for Morton's neuroma pain is Prolotherapy, which has a longstanding record of success with hypermobility, when joints are unusually loose or abnormally flexible.

If the goal of padding and strapping is to reduce forefoot motion and pain, it is reasonable to utilize a treatment, such as Prolotherapy, that not only reduces hypermobility, but also results in joint stabilization.[33]

Additionally, recent studies demonstrate that injection therapy, utilizing 4% sclerosing alcohol, has success rates of 84 - 89%.[34-36] Dextrose Prolotherapy injections will induce a proliferative response without the risk of alcohol infiltrating the surrounding tissue. The overall purpose of this study was to record the outcomes of Dextrose Prolotherapy on a group of patients with Morton's neuroma in a private pain clinic.

## Patients and Methods

In the study, an attending physician treated seventeen patients with Morton's neuroma at a private medical clinic. All subjects signed a consent form, stating that a minimum of three and a maximum of six monthly treatments might be needed.

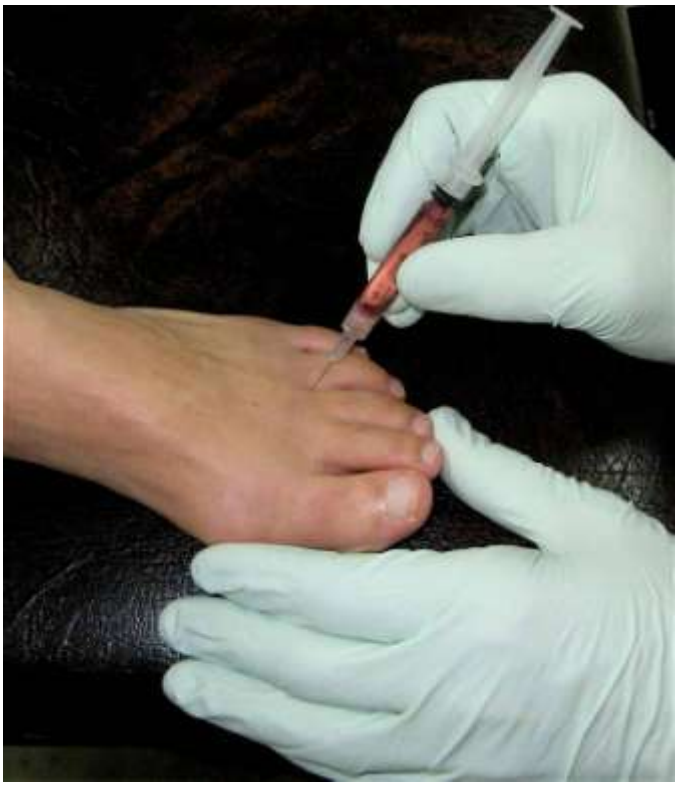

**Figure 7** Prolotherapist injecting the third interdigital space with sclerosant solution.

To meet the criteria for inclusion in the study, patients had to be at least 18-years-old, to have suffered unresolved Morton's neuroma at any intermetatarsal space, and to have failed previous conservative treatment.

At the clinic, a search of electronic medical records (EMR) to find patients with the diagnosis of Morton's neuroma was conducted.

To be included in the study, two criteria were paramount: 1) a diagnosis of Morton's neuroma, which had to be the primary condition, and 2) a six-month time lapse, since the patient's last Prolotherapy injections. The search revealed 31 patients diagnosed with Morton's neuroma; of these, five could not be contacted by phone (three attempts were made before discontinuing phone calls). Two patients chose not to participate.

Five patients were excluded because of multiple foot problems that took priority over Morton's neuroma: previous surgeries, osteoarthritis, and ankle problems. Two patients were excluded because not enough time had elapsed—at least six months—since their last Prolotherapy session.

Patients selected for the study had to complete preliminary oral, written, and visual surveys. Demographic information was obtained. Then the patient completed a visual analog scale (VAS), which includes ratings of pain at rest; pain with normal activities; pain while walking barefoot; ability to walk distances without pain; as well as stiffness and numbness/burning. (Fig. 6) Finally, an assessment interview with clinical staff members collected both subjective and objective data, such as the type and duration of symptoms, previous treatments and tests, limitations to activity, and previous medical opinion. Next, a physical examination determined objective data by checking for the following: the precise location of the pathology or point of maximal tenderness by palpating (light and/or deep touch) the affected web space; the presence or absence of Mulder's click; and the severe pain that results with lateral compression of the forefoot.

The end of the Prolotherapy treatment was determined when patients indicated a zero to 1 on the pain scale, or their personal goals for pain relief or for the ability to function were met. Although some had little pain, their main goal was to eradicate numbness, which they found disturbing. Some patients wanted to achieve a zero to 1 level of pain while walking, even with level 4 pain while jumping. Therefore, they would stop treatment with a low level of walking discomfort.

Following treatment, interviews and surveys were completed on a monthly basis. Monthly data collection included the total percentage of improvement; VAS score of pain; level of pain intensity; level of stiffness; degree of crepitation (grating sensations from a joint); range of motion; ability to perform the ADLs (activities of daily living) and to exercise the affected body part.

Six months after the last visit, patients were called to obtain information and answered detailed questions. Interviews provided data on the level of foot/toe pain (VAS scale), percent of overall improvement, limitations/improvements in activities and walking, duration of post-treatment pain relief, and assessment of the treatment by the patient.

For data analysis, patient responses were collected, calculated, and compared at three different times: prior to Prolotherapy, during monthly visits, and in phone interviews conducted six months after Prolotherapy. Statistical analysis using Graph Pad Software calculated the paired student t-test before and after Prolotherapy.

## Technique

The Hackett-Hemwall technique of Prolotherapy (www.hackettthemwall.org) was used. Each patient received 10 - 20 injections of 15% Dextrose, 0.2% Procaine, and a 10% Sarapin solution, for a total of 10 to 20 cubic centimeters of solution per foot. Each injection consisted of 0.5 to 1 cubic centimeter of solution and used a two-inch, 27-gauge needle. Injected areas were web spaces one through four—with attention given to metatarsophalangeal joints, dorsal and plantar surfaces, and joint capsules and ligaments (Fig. 7). If applicable, patients were advised to reduce or discontinue non-steroidal anti-inflammatory (NSAID), steroidal and narcotic medications, and other therapies. Prolotherapy treatments were discontinued, once a patient reached a clinical resolution of symptoms.

## Results

The final study group included 17 patients but 19 feet, since some patients suffered from MN in both feet. Ten right feet and nine left feet were treated. The average age of the 17 patients was 57 years: eleven were women, and six were men.

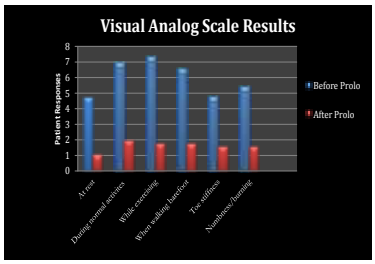


**Figure 8** Survey responses before and after Prolotherapy on levels of pain with various activities.

Before introducing Prolotherapy, study patients reported previous treatments. No one used pain medications for their symptoms. Some patients had tried wide-toed shoes, orthotics, padding, chiropractics, acupuncture, and steroid injections. Some patients had had MRI and radiographic diagnosis. One of seventeen had seen a podiatrist. A physician told three patients that surgery was required, but only one had surgery to remedy the pain on the other foot.

From patient questionnaires, averages were determined for periods of time. The average length of time patients experienced the pain of Morton's neuroma was 20 months before entering the clinic. Patients received an average of 3.7 Prolotherapy treatments.

The average time of follow-up was 13.3 months. To determine the efficacy of treatments, only those patients with follow-up more than 6 months were included.

Patients' subjective experience of pain offers the best measure for statistical accuracy. Patients were asked to rate their pain levels on a scale of 0 to 10—with 0 being no pain and 10 being severe crippling pain. All 17 patients reported pain as a symptom. Thus, patients were asked to report pain levels before and after Prolotherapy in these four categories: 1) pain at rest; 2) pain with normal activities; 3) pain with exercise, and 4) pain while walking barefoot.

Concerning 1) pain at rest: *prior* to Prolotherapy treatment, VAS pain levels averaged 4.68. None of the patients had a starting pain of less than three. *After* Prolotherapy treatment, VAS pain levels averaged 0.95.

Concerning 2) pain with normal activity and mobility: *prior* to Prolotherapy treatment, 15 of the 17 participants reported walking with some degree of pain, and a VAS pain level of 6.89. Eleven of 17 patients were unable to walk fifty feet without pain; 14 of 17 could not walk a half-mile without pain. Four of 17 patients reported an inability to walk barefoot. *After* Prolotherapy, all patients reported improvements in walking without pain, and a VAS pain level of 1.89. Fourteen of the 17 participants walked normally again and rated their pain relief at greater than 74%. Sixteen of the 17 could walk one block or more.

Concerning 3) pain with exercise: *prior* to Prolotherapy, 15 of the 17 patients reported decreased ability to exercise, and a VAS pain level of 7.27. Of those 15, eight were totally compromised and unable to exercise; five were moderately (only 30 to 60 minutes possible) to severely compromised (only 0 to 30 minutes possible). Nearly half of the patients were totally compromised in their athletic abilities prior to treatment. *After* Prolotherapy, 5 of the 17 patients reported being able to exercise as much as they wanted without impediments and with satisfaction, with a VAS pain level of 1.73. Other physical improvements occurred, notably, decreases in stiffness and numbness (burning). Thirteen to 14 patients reported a 100% improvement in the activities of daily living that continued to the end of the study. None reported an inability to exercise.

Concerning 4) pain while walking in bare feet: *prior* to Prolotherapy treatment, 10 of 17 patients could not walk barefooted without severe pain at levels eight, nine, or ten, and an average VAS pain level of 6.47. Furthermore, 12 of 17 patients could walk less than 50 feet before they experienced noticeable pain, with or without shoes. Only 3 of the 17 patients could walk more than a half-mile without pain.

*After* Prolotherapy, all patients had a pain level of four or less walking barefooted, and a VAS pain level of 1.65. As for walking distances without pain, all patients could walk at least one block or more. One patient was restricted to walking between 50 feet and one block. Among the 19 treated feet of the 17 patients in the study, eighteen feet could manage walking a half-mile or more, eight of the treated feet reported no walking restrictions.

When comparing the four previous categories before and after Prolotherapy, all reached a statistically significant outcome with a paired student t-test of $p = <0.0001$. This *p*-value confirms that the numerical results, when compared and tallied, exceed the mathematical probability of mere chance.

Thus, this prospective, non-controlled study demonstrates that Hackett-Hemwall Dextrose Prolotherapy decreases pain and improves the quality of life for patients with Morton's neuroma, which was unresolved by previous therapies, medications, and interventions. Prolotherapy provided a relief of 74% for 14 out of 17 of the patients. Among the three patients who were told they needed surgery, two patients felt sufficient pain relief with Prolotherapy to avoid surgery. After the study period, patients experienced overall improvement in range of motion, ability to walk and exercise, as well as relief of stiffness and numbness/burning (Fig. 8).

## Discussion

This study should not be compared to a clinical trial in which a treatment is studied under controlled conditions. Instead, the projected goal was to document the responses of patients with unresolved Morton's neuroma pain to the Hackett-Hemwall technique of Dextrose Prolotherapy. Clearly, the study's strength was the number of quality of life parameters examined. Quality of life conditions—such as the ability to walk and exercise, enhanced range of motion, reduced stiffness, enjoyment of activities of daily life, and reduced levels of pain—are all important factors affecting the person with Morton's neuroma.

Improvements in a large number of variables were most likely the result of Prolotherapy treatment. There is no medical test to quantify pain relief. However, observable, documented changes—such as the ability to walk or walk barefoot, to exercise, to work, and to use less pain therapies—are valid measures of success for patients whose health and vitality have considerably improved.

This study noted two empirical shortcomings. One is the subjective nature of the data gathered by the most reliable methods available. Surveys, for instance, relied on the patients to rate their pain, stiffness, and degree of disability. A second obvious weakness is the small number of patients involved in the study. However, on the positive side, this small study group made it possible to see results in a relatively short time span.

Many treatments for the relief of Morton's neuroma symptoms have developed over time. Although conservative, non-surgical, and surgical approaches have been used, their effectiveness as a treatment is variable, often leaving patients with mixed results and questionable improvement.

A review of three trials that involved 121 people was not able to determine the effectiveness of conservative, surgical, and non-surgical interventions because, as the authors noted, there was insufficient evidence and research flaws. For instance, there were only three randomized controlled studies of the various treatments. The authors were also unable to find any studies to identify the incidence or prevalence of this condition. In the review of the three trials, researchers found no evidence to support the use of pronation insoles, which are routinely used as a conservative approach. Furthermore, they found no evidence supporting the effectiveness of corticosteroids (non-surgical); and they gave a poor grade to the surgical approach due to high risks of amputation neuroma (minimum of 20%), painful plantar scars, and postoperative complications.[37]

Histomorphological findings are accepted as the gold standard for diagnosing Morton's neuroma. Of consequence is a histomorphologic study of 23 nerve biopsies from patients with typical Morton's neuroma symptoms compared to 25 plantar nerve autopsies of individuals with no record of forefoot problems. The study revealed that nerve biopsies from MN patients had the same characteristics as those removed from autopsies. Tissue samples were identical and could not be distinguished one from the other. However, none of the excised tissue in this study was found to be normal; all had the pathological features of fibrotic tissue (thickened, scarred).[38] Another study found identical histology when comparing Morton's neuroma and control patients, observing the same fibrotic changes in the symptomatic patients as in the asymptomatic patients.[39] From this research , the question arises as to whether the "neuroma" is actually the cause of the condition, caused by other conditions, or present in normal plantar nerves?

Searches with magnetic resonance imaging (MRI) for typical pathologies of Morton's neuroma did not discover any diagnostic features (symptomatology). In a retrospective study of 85 foot MRI examinations, 33% of patients with no clinical evidence of Morton's neuroma showed diagnostic "lesions" suggestive of the condition.[40] In a study of 70 asymptomatic volunteers, 30% were diagnosed with Morton's neuromas.[41]

In MR imaging after neuroma resection, a neuroma was found in 26% of the asymptomatic and 50% in the symptomatic web spaces.[42] Thus, MRI reveals neuroma-like abnormalities in both symptomatic and asymptomatic patients.[43]

Another retrospective study of steroid injections showed a 47% improvement in the recipients.[44] A study gauging symptom relief from a series of corticosteroid injections reported that 30% of the patients attested to total symptom relief.[45] In another study involving 60 patients, the results of conservative treatment were considered poor in 73% of the cases; thus, the authors recommended surgery as the initial treatment of choice.[46]

Surgical removal of the neuroma is reported to provide satisfactory relief in 76 - 85% of the patients.[47, 48] Nonetheless, there were exceptions. In a study of 56 patients with excised neuromas, two thirds of the satisfied patients continued to have tenderness at the cut end of the common digital nerve; 75% were still limited in their choice of footwear; and 14% failed to demonstrate any notable improvement. Those who did not respond to surgery continued their pre-surgical use of steroids, lidocaine, and broad-toed shoes.[49] Other complications of surgery include numbness of the affected toes, postoperative infection, tenderness at the incision, keratosis (scarring) of the sole of the foot, recurrence of pain, and an amputation neuroma. Nearly 20% of the patients continued to feel pain after the first surgery, and few found pain relief with additional surgery.[50] In view of these findings, patients should be informed of the possible results of surgery, since adverse outcomes are common.

Patients searching for alternatives to the mainstream medical care are prudent to consider Prolotherapy for reasons of which practitioners of Prolotherapy are aware. First, Prolotherapists know that ligaments need to be tighter, shorter, and stronger. If the intermetatarsal ligament is weak and loose, however, the interdigital nerve rises up between the metatarsal heads where they can be compressed and, thereby, traumatized.[51] Abnormal metatarsal mobility that results from such weakened ligaments inflames the bursa (cushioning sac) between the heads, creating a space into which tissue from the plantar side of the foot can enter and is subsequently pinched by the metatarsal heads.[52] A fibrous build-up can occur when the weak ligaments allow tissue between bones to be rubbed and irritated. Because Prolotherapy strengthens weakened ligaments and connective tissues, it is a viable treatment option.

For Prolotherapists, Morton's "neuroma" is most likely mechanically-induced from excessive motion between the metatarsals, combined with excessive weight-bearing stress on the forefoot.[53] Hypermobility of the forefoot predisposes a person to this condition, and Prolotherapy injections at the plantar and dorsal structures of the affected metatarsals will benefit the patient.[54]

Prolotherapy has a long history of being utilized for unresolved foot and toe pain.[55] In a study of 19 patients with unresolved foot and toe pain, 63% of patients noted 75% pain relief from Prolotherapy.[56] In a study undertaken precisely to evaluate the effectiveness of Dextrose Prolotherapy on Morton's neuroma pain, 16 of the 20 patients with chronic plantar fasciitis who had failed previous conservative treatment reported good to excellent results from the Prolotherapy.[57]

As a treatment, Prolotherapy has been utilized for approximately 100 years, with its modern injection protocols being formalized by George S. Hackett, MD in the 1950s.[58, 59] Increasingly popular in the US, Prolotherapy is used nationally and internationally in both alternative (integrative) and allopathic (orthodox) medical practice.[60] The treatment is simple. When therapeutic solutions are injected into painful and tender ligaments, tendons, and joints—an inflammation develops, which causes healing cells to proliferate and strengthen damaged ligament, tendon, and joint structures,[61] These injections improve both joint stability and biomechanics, ultimately decreasing pain.[62] In this way, Prolotherapy is a safe and practical option for hypermobile joints of the foot that cause persistent pain.[63]

## Conclusion

While the exact cause of Morton's neuroma (MN) is still debated, this study confirms that the Hackett-Hemwall technique of Dextrose Prolotherapy not only reduces levels of pain for patients with MN, but also enhances other quality of life concerns. Conventional therapies, on the other hand—rest, weight loss, exercises for muscle strengthening, orthotics, massage therapy, physiotherapy, manipulation, analgesics, non-steroidal anti-inflammatory drugs, anti-depressant medications, trigger point and steroid injections, and various surgical treatments—often result in residual pain for the patients.[64-66] Patients with MN, therefore, are searching for alternative treatments to relieve the pain.[67] Patients unable to find relief with traditional treatments are also hesitant to use options like surgery. Surgery for Morton's neuroma, for instance, presents these significant risks: numbness of the affected toe, postoperative infection, incisional soreness, scarring, and recurring stump neuromas.[68, 69] Instead of these traditional options, patients dealing with Morton's neuroma are now trying Prolotherapy.[70]

As a promising option, Prolotherapy—using injections of an irritant—tightens, shortens, and strengthens ligaments, tendons, and joints. Prolotherapy works by stimulating the body to repair these soft tissues. The solution starts and accelerates healing through inflammation, triggering a healing cascade of effects. Initially, fibroblasts—immature cells capable of producing collagen fibers—proliferate. Hence, the term Prolotherapy arose from this observable process. Once collagen forms, it is woven (reticulated) into ligament and tendon tissue. In this manner, Prolotherapy has the potential to stop the disease process.

In some cases, preliminary, anecdotal evidence suggests that Prolotherapy can reverse Morton's neuroma. In one double-blind animal study over a six-week period, for instance, Prolotherapy was shown to increase ligament mass by 44%, ligament thickness by 27%, and ligament-bone attachment by 28%.[71] In human studies on Prolotherapy, biopsies performed after the completion of Prolotherapy showed significant increases in collagen fiber and ligament diameter of 60%.[72, 73] These finding are especially significant since a potential cause of Morton's neuroma is weakened ligaments.[74, 75]

In this prospective study, the Hackett-Hemwall technique of Dextrose Prolotherapy used on patients averaging 1.5 years of unresolved pain with Morton's neuroma was shown to improve their quality of life, which continued 13.3 months after their last session. The 17 patients treated with Prolotherapy reported significantly *less* pain, stiffness, disability, or use of other pain therapies, as well as *improvements* in walking, range of motion, ability to exercise, and performing activities of daily living.

Patients told that there were no other treatments for pain or that surgery was their only option achieved the same positive results. This study justifies the desirability and use of Prolotherapy for Morton's neuroma pain. Future studies need to further substantiate these findings, especially if Prolotherapy enables Morton's neuroma sufferers to avoid surgery and its possible adverse effects. Although a study with more patients in a controlled empirical setting is needed to document the efficacy of Hackett-Hemwall Dextrose Prolotherapy, this treatment should be considered, based on the substantial advantages and minimal drawbacks (e.g., aversion to needles), as well as the reduced risks and increased rewards of Prolotherapy over conventional treatments.

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