Morton's neuroma (also called intermetatarsal neuroma, interdigital neuroma, and Morton's metatarsalgia) is a frequent finding thought to be caused by an entrapment of the intermetatarsal nerve (the plantar proper digital nerve) under the deep transverse intermetatarsal ligament, or by a mechanical foot imbalance causing repetitive trauma that results in degenerative neuropathy. This condition is frequently found in the third intermetatarsal space, between the third and fourth metatarsals, and is more common in women than in men. Intermetatarsal neuromas are usually found in the excessively pronated foot but have been reported in both the rectus foot and cavus foot as well. I have successfully treated intermetatarsal neuromas with a series of dilute ethyl alcohol injections; the results have been well received by patients and compare favorably to other conservative treatments or surgery for neuromas.

**Symptoms and diagnosis**

Most patients present with similar complaints, which range from numbness in the digital web space to intense pain in the ball of the foot or into the toes with activity. When asked to describe these complaints, patients use terms such as pins and needles, burning pain, tingling, or a sense of fullness or cramping in the toes, especially with activity. Additionally, they may describe the pain as moving from the plantar ball of the foot to the toes, or radiating into the arch or up the leg. Walking in dress shoes or running in athletic shoes tends to increase the severity of symptoms and removing the shoes or resting tends to decrease the severity of symptoms after activity. Many patients report that removing the shoes and massaging the ball of the foot and toes provides immediate relief of symptoms; however, walking barefoot on hard surfaces may also be uncomfortable for patients with more advanced conditions.

The diagnosis of Morton’s neuroma is made using several different techniques; however, clinical history and physical examination of the foot are the most reliable. Direct examination usually locates the point of maximum tenderness by reproducing symptoms during a
pinch test involving dorsal and plantar compression of the intermetatarsal space (Figure 1) or with the lateral squeeze test using medial and lateral compression of the forefoot area (Figure 2). Also, direct pressure at the plantar distal intermetatarsal space may reproduce the patient's symptoms and identify increased thickness or an enlarged nerve (Figure 3). A combination of the lateral squeeze test and the pinch test may reproduce an audible and/or palpable click in the involved intermetatarsal space, often referred to as a positive Mulder's sign.3

Additional studies may include a diagnostic anesthetic nerve block injection performed proximal to the suspected neuroma site, weight-bearing x-rays of the involved foot area, computed tomography, magnetic resonance imaging, ultrasonography, or sensory nerve conduction testing. These diagnostic studies are not very standard or popular because of cost, operator inexperience, and equipment unavailability. Clinical examination and review of the patient's history of symptoms are still the most common techniques for diagnosis of intermetatarsal neuroma. Morton's neuroma may be mimicked by several different clinical findings including any condition that causes forefoot pain, numbness, nerve-like pain, metatarsalgia symptoms, or discomfort into the toes. Specific conditions can be found in the list of differential diagnoses (see table, page 60). Most of the conditions listed can be identified by careful history and physical examination, as well as with the more sophisticated diagnostic studies already mentioned.

Treatment options
There are numerous treatment options available for Morton's neuroma, ranging from no treatment to conservative methods to surgical care. The conservative alternatives include tape strapping of the foot to provide additional support, application of intermetatarsal pads to help separate the metatarsal heads on weight-bearing, and the use of functional orthotic devices to help stabilize the feet. Most of these approaches are less than successful. Other conservative
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treatments involve vitamins B12, injections, corticosteroid injections, and dilute alcohol injections.

Among the several surgical options is the most obvious: surgical excision of the involved nerve. Variations include transection of the intermetatarsal ligament with or without neuroectomy, external or internal neurolysis, translocation of the involved nerve, endoscopic decompression, and other destructive measures such as laser ablation or cryogenic denervation.

The surgical techniques all have the potential for failure and complications. The major problems following surgery include recurrence of the condition, worsening of the pain, creation of traumatic or stump neuromas, excessive deep or superficial scar formation, damage to adjacent soft tissue structures, wound dehiscence, and infection. Less serious complications include numbness in the toes or around the ball of the foot, a feeling of fullness or swelling, and persistent paresthesias.

**Chemical neurolysis of Morton’s neuroma**

In an unpublished study performed from 1977 through 1985, I evaluated more than 150 patients who underwent weekly injections of 1/2 ml of a 4% alcohol solution for clinical symptoms of intermetatarsal neuromas. The results showed that more than 80% experienced resolution of their neuroma symptoms after three or more weekly injections. Unfortunately, the collection of data and efforts to control for additional therapeutic measures in each case was flawed. There were so many variables and other treatments provided that the results were not publishable. Many patients had multiple interspace complaints, had undergone previous cortisone...
Figure 4. The injection technique. In this case, the area of maximum point of tenderness (MPT) is marked with a small spot for identification. The injection of a small amount (0.5 to 1 ml) of the 4% ethyl alcohol solution is placed proximal to the MPT (deep into the intermetatarsal space below and proximal to the intermetatarsal ligament). It is important on the first few injections to manipulate the needle in the deep tissues until the involved nerve is stimulated before injecting the solution. This allows for close proximity of the injected alcohol solution to the nerve tissue for more rapid absorption.

Injections, were wearing functional orthotic devices or had received some other forms of treatment before or during the study time.

In 1986, the technique for mixing the solution and the different clinical conditions responsive to sclerosing injections were published. The mixture was initially composed of 48 ml of 2% lidocaine with epinephrine (1:100,000) and 2 ml of dehydrated ethyl alcohol, which resulted in a 4% dilute solution. However, during this time I began to note that using 0.5% bupivacaine HCl with epinephrine (1:200,000) combined with the dehydrated ethyl alcohol at the same 4% concentration provided more consistent results and longer lasting anesthesia after injection, and this became the mixture of choice. Based on this experience, I then developed further studies to help control many of the problems and variables noted in the earlier study design.

From 1986 through 1996, I performed a detailed prospective study to evaluate the treatment results of a conservative technique involving the chemical neurolysis of isolated intermetatarsal space neuromas. The 100 patients chosen for the study had clinical symptoms of a single intermetatarsal space neuroma on one foot only. None of the patients had undergone previous therapy for the neuromas and all agreed to refrain from receiving additional alternative treatments while in the study program. The patients all had a minimum of three to a maximum of seven weekly 1/2-ml injections of the 4% ethyl alcohol solution proximal to the point of maximal tenderness. The results were published in 1999.9

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The 4% alcohol solution used for chemical neurolysis in this study and in all subsequent treatment of neuromas in my practice is prepared by mixing 48 ml of 0.5% bupivacaine HCl with epinephrine (1:200,000) with 2 ml (two 1-ml vials) of dehydrated ethyl alcohol for injection, for a total volume of 50 ml. The new mixture is kept in the original bupivacaine bottle, dated and relabeled to identify the solution as 4% sclerosing rather than local anesthetic to prevent inadvertent misuse.

The use of epinephrine appears to aid in the results of neuroma injections, probably because it potentiates the local anesthetic agent, confines the sclerosing solution to a smaller area, prevents the rapid absorption of the solution into the adjacent tissues, and may have some neurolytic action on the nerve tissue itself. However, I also make a bottle of the 4% solution using bupivacaine HCl without epinephrine for use on those patients who have reactions to the epinephrine.

In the prospective study, the injection was made to the dorsal aspect of the foot with a 1 1/4-inch, 27-gauge needle penetrating deep into the intermetatarsal space below and proximal to the intermetatarsal ligament (Figure 4). To position the needle tip close to the nerve tissue proximal to the actual neuroma, the needle was then gently and slowly manipulated within the deep tissue layers until the patient responded with a sensation of tingling, pins and needles, radiating pain into the toes, or burning into the ball of the foot. Once the sensation was felt by the patient, then the injection was completed. It was my hypothesis that the nerve in this location would be smaller, without surrounding perineural fibrosis or adjacent thickened tissues, making it easier to destroy with the chemical solution at this level than it would be at the actual neuroma site. Additionally, it is not necessary or recommended to perform a local anesthetic nerve block prior to injection of the 4% ethyl alcohol solution since the anesthesia will make it very difficult to locate the involved nerve and could potentially dilute the alcohol solution even further.

**Results and complications**

Of the 100 patients included in the study, the 73 females and 27 males ranged in age from 20 to 75 years (average 51 years). Sixty-two left feet and 38 right feet were involved. Fifty percent of the patients had six or seven injections. The third intermetatarsal space was involved in 81 cases. Follow-up evaluation was performed for each patient at six months to two years (average 13 months) following completion of treatment. Final results showed that 82 patients reported 100% improvement of their symptoms and seven patients reported from 60% to 85% improvement. This resulted in an overall patient satisfaction rate of excellent or good of 89%. Eleven patients had continued pain or other symptoms at the end of the study and elected to proceed with surgical neuroectomy. The long-term results of this prospective study appear to be superior to most reported forms of treatment, including surgical care.15
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Discussion

The complications with this injection technique appear to be minimal and include failure to relieve the original symptoms, recurrence of symptoms, increased symptoms after the first and possibly the second injection (postinjection neuritis), and a postinjection lymphatic reaction. The increase in symptoms following the first or second injection appeared to be relatively common and occurred in the first 48 hours after the injection, after which the intensity decreased rapidly. By the subsequent clinical visit all patients reported that the “new” pain had decreased significantly and in most patients had subsided completely. Very few patients had similar increased pain after the third or subsequent injections due to the increasing neurolytic effect of the previous injections.

Although I have never actually seen the perilymphatic irritation, a few podiatric physicians have contacted me to report that the symptoms include increased pain, intense redness with streaking from the injection point proximally up the foot, and blistering in a few cases. The irritation is seen soon after the injection. It is my opinion that in these cases the 4% ethyl alcohol solution was picked up by the dorsal superficial lymphatic system. Deep injections of the solution do not appear to have this secondary effect. This reaction is probably similar to the condition reported following cortisone injections, termed perilymphatic atrophy.16

For more information, circle #50

For more information, circle #51