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Improved Injection Technique of Ethanol for Morton's Neuroma

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Abstract

Background: Morton's neuroma is a common cause of forefoot pain. Various conservative methods (injections of various pharmacologic agents) have been published with an outcome of 6%-75% success rate (free of pain in daily life) per injection. The aim of the present study was to assess the outcome of an improved localization technique, a higher dosage, and a higher percentage of ethanol.

Methods: Using fluoroscopic and electroneurographic guidance, 2.5 mL of 70% ethanol were injected into 33 feet with a magnetic resonance imaging (MRI)–verified neuroma. We evaluated patients at up to 5-year follow-up.

Results: A "success rate" of more than 82% per single injection (defined as free of pain in daily life) was achieved and no recurrence was seen over 5 years. All scores (visual analog scale; Short Form–36 subscales, American Orthopaedic Foot & Ankle Society ankle-hindfoot score) showed significant improvement ($P < .0001$). Mean 1.2 injections were necessary. No significant side effects were seen. However, some mild pain persisted in some patients who participated in sports.

Conclusion: The injection of 2.5 mL of 70% ethanol under fluoroscopic and electroneurographic guidance was a safe method for the treatment of MRI-verified Morton's neuromas. Combining the effect of a higher percentage of alcohol and a higher dosage and an improved localization technique resulted in a high rate of patients without pain.

Level of Evidence: Level IV, cases series, prospective.

Keywords: interdigital neuroma, sclerosant injection, alcohol ablation, Morton's neuroma, metatarsalgia

Background

Morton's neuroma is a common cause of forefoot pain.[33] Operative treatment with surgical excision of an interdigital neuroma leads to 51% to 87% good and excellent long-term results.[1,3,5,9,10,16,24,36] But neurectomy may be associated with adverse effects such as vascular lesions, wound infection, hypertrophic scarring, phantom pain, stump neuroma, or revision surgery.[5,17,35] Therefore, conservative treatment with orthotic devices and injections of various agents (steroids,[32] botulinum toxin,[4] phenol,[19] and alcohol[14]) is usually tried first. Good and excellent results of alcohol injections range from 6% to 75% of all patients treated, according to the study regimen and to the definition of "success." One might assume that better results might be achieved with a higher concentration of alcohol; however, this was not assessed in detail in the past.* Often, 3 to 10 injections per patient are given (4% to 50%).[6-8,14,15,21,26,28,30] A recent review presented results of outcomes and all percentages of alcohol used; however, all the studies reviewed consisted of a research design offering a low level of evidence that could have had methodologic biases and interpretation.[30] Furthermore, in all the conservative studies above, the diagnosis was not magnetic resonance imaging (MRI)–confirmed on a regular basis, either none or a single diagnostic regimen was used in order to localize the Morton's neuroma during the injection (ultrasonography or fluoroscopy), the maximum

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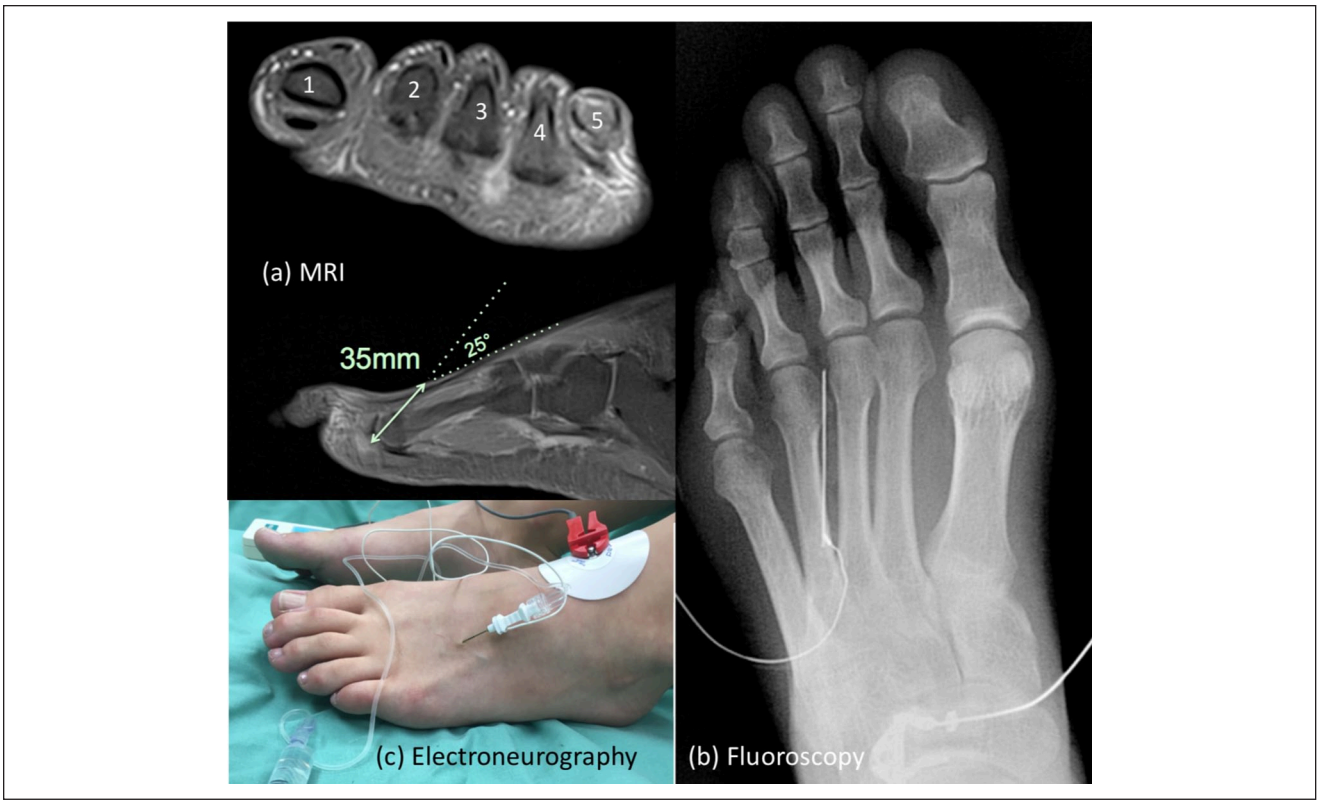

Figure 1. Localization technique, injection of 2.5 mL ethanol 70% with 3-fold localization using (A) magnetic resonance imaging, (B) fluoroscopy, and (C) electroneurography. After 10 seconds, 2.5 mL of lidocaine hydrochloride (Xylocaine) 2% was applied.

concentration of alcohol used was 50% or less, and the maximum volume of alcohol was 2 mL.

The aim of the current prospective study was to assess the outcome of an alcohol injection using an improved localization technique in each patient (MRI first and then fluoroscopy and electroneurography during the injection) and a higher quantity of alcohol (2.5 mL and 70% of ethanol) as compared to previous studies. Our hypothesis was that this would result in a better outcome (defined as free of pain in daily life) and less injections per neuroma.

Method

Inclusion criteria were MRI-verified Morton's neuromas, refractory to treatment with insoles and shoe modification for more than 3 months and reproducible pain or numbness in the specific toes on mediolateral compression of the forefoot (squeeze test), pain during sport, and temporary symptom relief after the infiltration of 5 mL of local anesthetic 1 week before the alcohol injection in order to exclude radicular pain. Exclusion criteria were previous operation(s), bursitis on MRI, diabetes, rheumatoid arthritis, and foot deformity (flatfoot, pes equinus, cavus foot, dropfoot, intermetatarsal angle of >13 degrees, previous fractures of the metatarsal bones), or anticoagulation therapy. Thirty patients (33 feet) were prospectively enrolled beginning in 2012 with institutional review board approval, and a 5-year follow-up was completed. We used the following therapeutic regimen (Figure 1):

1. Measuring: Using MRI, the dorsoplantar and the mediolateral distance of the neuroma in relation to the adjacent metatarsal heads was measured. The depth of the desired infiltration was measured using a 25-degree oblique approach from dorsoproximal to plantar-distal.
2. Localization: Using fluoroscopic guidance, the needle was positioned according to the measured distances at a 25-degree angle and according to the measured depth.
3. Confirmation: Electroneurographic confirmation was done using a 1.5-mA current with 100 Hz onto the needle. Consecutively, the patient was asked if the typical pain was reproduced in the respective toes. The amperage was then incrementally reduced. If the pain could still be felt below 0.5 mA, the correct positioning of the needle was confirmed. If necessary, the needle was repositioned with micromovements.
4. Alcohol injection: After the correct needle placement, 2.5 mL of 70% ethanol was administered over 2 seconds and after a pause of 5 seconds (time to

reconnect), 2.5 mL of a local anesthetic (2% lidocaine hydrochloride [Xylocaine]) was injected subsequently slowly.

5. Postoperative: the regimen consisted of elevation for 1 hour and cooling with ice packs for 10 minutes 3 times a day for 3 consecutive days and a single dose of 500 mg mefenamic acid or another nonsteroidal anti-inflammatory drug.
6. Assessment: visual analog scale (VAS), AOFAS, and SF-36 subscales for pain and impairment were assessed by a blinded independent observer prior and at 1, 3, and 12 months afterward and then yearly up to 5 years. They were compared using analyses of variance with repeated measures. Friedman tests were conducted in addition and confirmed the results of analyses of variance.

Results

Thirty patients with 33 consecutive feet (24 female and 9 male), mean body mass index 23 (17-35), 16 right and 17 left, with a mean age of 53 years (range 34-73) were included. Mean follow-up time was 5 years (31-91 months), with a follow-up rate of 100%. In 66% cases, the third web-space and in 34% the second web-space was affected. Thirty-nine injections in 33 feet were given. In 4 patients (4 feet), a second injection was given 6 weeks later, and 1 further patient (1 foot) received 2 further injections because of an insufficient reduction in pain. The mean number of injections therefore was 1.2 per neuroma (39/33). Ninety percent of all patients performed sports on a regular basis (Table 1).

A significant improvement was seen clinically (pain at rest, in tight shoes, during exercise, in daily life; Table 2) and in all scores over time ($P < .0001$; Figures 2–4): VAS decreased from 7.8 ± .8 to 0.7 ± 0.8 at 5 years. The AOFAS score increased from 72 ± 4.5 to 92 ± 10.0. SF-36 questions regarding pain and impairment decreased from 8.9 ± 0.8 to 2.5 ± 0.4.

Twenty-three of 28 feet were free of pain (at rest, in tight shoes, and in daily life) after a single injection (82% success rate per injection), and 28 of 33 patients (85%) were free of pain in daily life after repeated injections. The remaining 5 patients (15%) were counted as failures in our study; however, all of them showed an increase in AOFAS from mean 63 (56-72) to 89 (56-85) and a decrease in VAS pain score from 7.2 (4-9) to 2.8 (2-5). In 1 patient, an MRI was done and it showed a reduction of the neuroma from 8 to 4 mm. All 5 failed patients had mild pain in daily life and during exercise, but 3 of them nevertheless performed sports without restrictions, 1 did not perform sports previously, and only 1 of these patients still had pain at rest (he received 3 injections, and 2 open operations without success).

All patients reported pain during exercise initially. Nine patients (27%) still had pain during exercise at the end of the study; however, their mean VAS score improved from 8 (4-10) to 2.1 (2-5) at the latest follow-up. The remaining 63% (patients without pain during exercise at the latest follow-up) had an improvement from VAS score 7.6 (4-10) to 0.13 (0-2).

Every patient was able to work without restrictions on the first postoperative day. In 79% of all cases, a

Table 1. Activity Level.

Sport Activities of Our Patients	Percentage
No sports	10
Perform sport at least	90
1 or 2 times per week	33
3 times per week	43
More per week	24
Running	27
Tennis	17
Bike	13
Dancing	7
Other	36

Table 2. Clinical Outcome.

	Patients Reporting Pain . . .				
Months	at Rest, %	in Tight Shoes, %	in Daily Life, %	during Exercise, %	Mean VAS Score
Pre	42	88	97	100	7.8 ± 1.56
1	12	24	24	40	1.7 ± 2.46
3	3	12	15	27	0.7 ± 1.79
6	3	12	30	30	0.7 ± 1.79
12	3	12	18	27	0.7 ± 1.79
24	3	12	15	27	0.7 ± 1.79
36	3	12	15	27	0.7 ± 1.79
48	3	12	15	27	0.7 ± 1.79
60	3	12	15	27	0.7 ± 1.79

Abbreviation: VAS, visual analog scale.

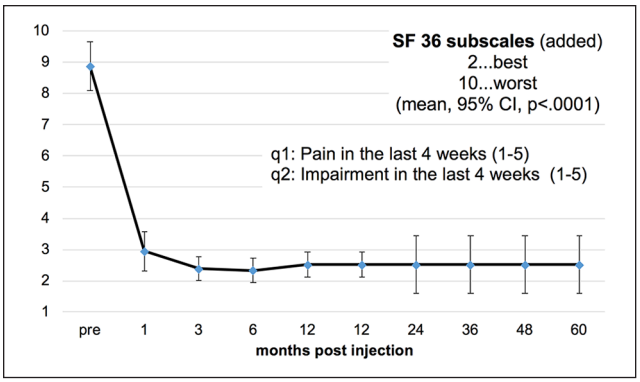

Figure 2. Short Form–36 (SF-36) score subscales.

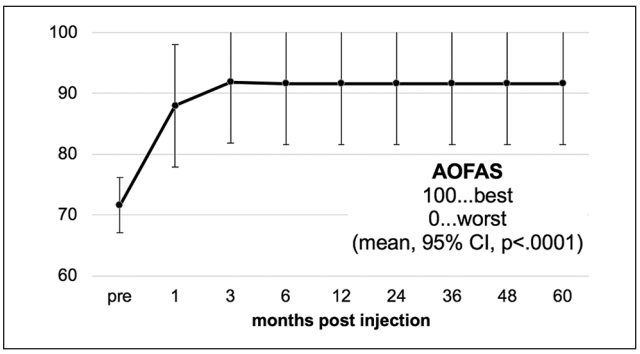

Figure 3. American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot score.

temporary numbness for 4-6 weeks of the respective toes occurred after the injection, which confirmed the correct localization. A mild swelling for 2 weeks was seen in 76% of all cases. Although 27% of patients still reported some mild pain during running, all of them could perform sports without restrictions and were not willing to undertake further treatment (reinjection, or open surgery; Table 2).

Discussion

Because operative treatment of Morton's neuroma can have major disadvantages (infection, scarring, swelling, time off from work), a minimally invasive therapy is desirable. Most of the previously published papers regarding nonoperative methods demonstrate a high number of injections (3-10) per patient and some disadvantages (poor localization, recurrence, skin irritation, insufficient long-term effect, etc).[†] Furthermore, most studies are short-term, with significant limitations.

First, with regard to localization, in most studies no MRI was done initially, and the diagnosis was based on clinical findings only, which might result in an inclusion of bursitis and metatarsalgia. If radiologic support was used, all authors used only 1 technique to localize the neuroma, mainly, ultrasonography. It is well known that the diagnostic accuracy of ultrasonography (56%) regarding Morton's neuroma is inferior compared with MRI (83%) or electroneurography (sensitivity 82%-93%, specificity 80%-85%).[25,34] Also, different electroneurographic methods are available to localize a Morton's neuroma.[2,25] Therefore, a combination of MRI, fluoroscopy, and electroneurography—as used in this study—should enhance the localization. Nevertheless, MRI remains an expensive diagnostic tool, with limited access in some areas compared with sonography.

The alcohol used in other studies had concentrations between 4% and 50% (Figure 4).[6-8,14,15,21,26,28] The application of alcohol below 30% has no histologic evidence of necrosis or inflammation to the nerve or surrounding tissue and leads to no observable histologic change in apoptosis, or cell number, in response to the alcohol injection.[22] Furthermore, in previous studies,[6-8,14,15,21] less than 2 mL alcohol was used or no quantity was given. Use of less than 0.3 mL ethanol in a tibial nerve of a rabbit leads to full recovery.[18] In lumbar sympathetic neurolysis, 2 mL of ethanol 96% is used successfully.[27] Bruno Magnan published the use of 2.5 mL of phenol, and he as well used 2.5 mL of ethanol 70% in his department for years with similar effect.[19] The positive effect of alcohol injections is seen in other neural pathologies, such as trigeminal neuralgia, celiac plexus neurolysis, tibial nerves, or lumbar nerves. Therefore, we used a comparable quantity of 2.5 mL 70% ethanol.

A mean number of 3 to 10 injections has been used in previous publications,[‡] which has a success rate of 15% to 50% (defined as freedom of pain) per single injection in those articles (Figure 4). The use of local anesthetics, botulinum, or cortisone alone[3,4,11,13,20,29,31] does not seem to be beneficial in peripheral nerves in the long term. We assume that the lower mean number of injections per patient in this study was due to the greater quantity of alcohol, the 3-fold localization technique—MRI, fluoroscopy, and electroneurography.

Limitations of our study include that it was impossible to determine whether the localization process or the higher alcohol volume and concentration were the main determinants for improved outcomes. We used MRI, an electroneurographic device, and a fluoroscope in all cases, which may not be available in all outpatient units. Also, no control group (placebo or operative) was used. Regarding patients who participated in sports 27% still felt mild pain, but not limiting their sports activity.

Conclusion

In conclusion, the injection of 2.5 mL of ethanol 70% under fluoroscopic and electroneurographic guidance was

[†]References: 3-8, 11, 13-15, 17, 20, 21, 29, 31.

[‡]References: 3, 4, 6-8, 11, 13-15, 20, 21, 29, 31.

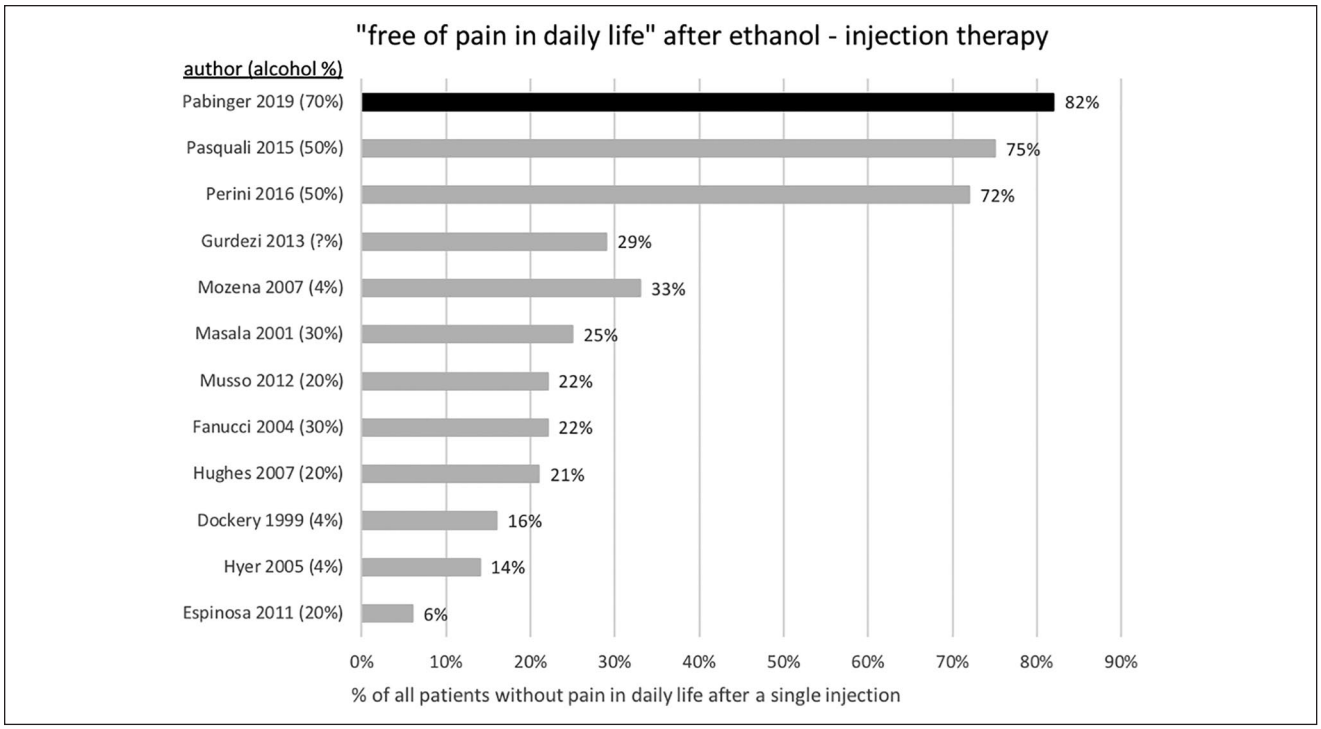

Figure 4. Outcome per injection compared to literature. The top-most bar indicates the results of the current study with the improved localization technique and the higher percentage and higher volume of ethanol.

a safe and easy method for the treatment of MRI-verified Morton's neuromas. In contrast to previously published studies, a higher percentage of alcohol, a higher dosage, and better localization lead to an improved "success rate" of 82% per single injection, but some mild pain persisted in some patients who participated in sports.

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