International Orthopaedics (SICOT) (2010) 34:511–515
DOI 10.1007/s00264-009-0812-3

ORIGINAL PAPER

The outcome of Morton's neurectomy in the treatment of metatarsalgia

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Received: 2 April 2009 / Revised: 8 May 2009 / Accepted: 11 May 2009 / Published online: 30 May 2009

Abstract Morton's neuroma is a common cause of metatarsalgia caused by intermetarsal digital nerve thickening. This study reviews the pathology, presentation, symptoms and signs, and patient satisfaction with surgical treatment. Seventy-eight patients (82 feet) were treated for Morton's metatarsalgia by excision of the interdigital nerve. The patients were followed-up for a mean of 4.6 years (range 0.8–8.1 years) and scored using the Foot Functional Index and the American Orthopedic Foot Ankle Society scoring system. In 74 patients the Foot Functional Index was more than 85 (maximum score 100). Seventy-one patients scored more than 90 on the American Orthopedic Foot Ankle Society scoring system with two patients scoring 100 (maximum score). Postoperatively, 82% reported excellent or good results, 10% had a fair result with restriction of activities or pain and 8% had no improvement at all after surgery while 71% had restrictions with footwear.

Introduction

Morton's neuroma is a painful enlargement of the plantar digital nerve between the metatarsal heads. The cause of Morton's neuroma remains unclear. It is probably a form of entrapment neuropathy and may be related to overuse of inappropriate footwear. A chronic traumatic factor is thought to play an important role. However, the condition does not appear to be more common in individuals who undertake sporting activities that involve high stresses on the forefoot. The nerve is probably repetitively squeezed between the anterior edge of the deep transverse ligament and the plantar soft tissue as well as the intermetarsal bursa causing an inflammatory process. It may occasionally represent a local manifestation of a generalised disease such as rheumatoid arthritis [10].

The symptoms in Morton's metatarsalgia include a burning pain or ache between a pair of metatarsal heads with radiation into the corresponding toes. The pain is aggravated by walking or standing, while rest and removal of shoes brings relief. Clinically there may be tenderness and a dorsal bulging lump may be found. The tumour may cause deviation of adjacent toes. When pressure is applied axially to the intermetarsal space acute pain is induced. This may be associated with a painful and palpable clicking sensation (Mulder's sign) [1, 20].

Magnetic resonance imaging and ultrasonography may be used to confirm the diagnosis in equivocal cases. Both are equally effective in demonstrating the enlargement of the nerve. However, small lesions, which can be just as painful as larger lesions, may be missed. Ultrasonography however is the most convenient and the least expensive method to determine the shape and size of Morton's neuroma under investigation. A high sensitivity and specificity for diagnosis of an interdigital neuroma by MRI has been demonstrated [15, 25]. The term 'neuroma' for the tumour found between the metatarsal heads is misleading. The lesion consists of perineural fibrosis, local vascular proliferation, oedema of the endoneurium and axonal degeneration. Macroscopically it has a typically fusiform configuration, a glistening and white to yellowish white appearance and a relatively soft consistency. Histologically, this condition is characterised by fibrous degeneration of the soft tissues around the nerve and demyelination and endoneurial fibrosis of the nerve [18, 24].

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There are various conservative and surgical methods of treatment for interdigital neuromas. Conservative methods include footwear modifications, orthoses and local anaesthesia and corticosteroid injections. Surgery is probably the most efficient method of treatment of Morton's metatarsalgia and involves the resection of the nerve "neuroma" and its branches. Conservative treatment is recommended in cases which are unfit for surgery or in need of relief while awaiting surgery.

There are only a few studies that reveal the functional outcome and satisfaction of patients after Morton's neurectomy and these studies involve a small cohort of patients [1, 13, 21].

Methods and materials

Between 1999 and 2007, 78 patients (82 feet) were treated surgically for suspected Morton's neuroma. They consisted of 69 women and nine men, with an average age of 59 years (range 22–73 years). Six patients were insulin-dependant diabetics and three patients had underlying rheumatoid arthritis.The average duration of clinical follow-up was 4.6 years (range 0.8–8.1 years) (see Table 1).

The patients were all operated upon by the two senior authors using a similar technique. All of the procedures were carried out at the Nottingham University hospitals. Conservative treatments included well-fitting, metatarsal pads and bars, nonsteroidal antiinflammatory medication and injections of a mixture of corticosteroid and local anaesthetic into the involved webspace were tried in all patients prior to surgery. The average period of conservative treatment ranged from 3.5 months to 3.2 years (average 1.2 years). Injections into the webspace were the most successful of the conservative modalities used in the 43 neuromas injected. Relief ranged from less than one day to 3.1 months, with an average time of relief of symptoms of 1.6 months (Table 1).

Duration of symptoms prior to referral ranged from 6.3 months to 86.5 months, with a mean of 32.6 months. Clinical localisation of the interdigital nerve was supported in 36 patients by a positive injection test using a local anaesthetic in the suspected intermetarsal space.

All operations were performed under general anaesthetic under tourniquet control using a 2-cm dorsal approach in the appropriate interspace(s). The dorsal sensory branch of the superficial peroneal nerve was retracted and the dorsal interosseous fascia incised. The interosseous muscle was partially detached from the distal portion of the metatarsal to gain a wider surgical exposure where required. A laminar spreader helped to separate the metatarsal shafts to further improve exposure. The common digital nerve was identified after dividing the deep transverse ligament. The nerve was resected for 1 cm distal and for 3 cm proximal to the ligament including the neuroma. Haemostasis was performed after release of the tourniquet. The operative procedure time varied from 22 minutes to 56 minutes (average 31 minutes).

Soft dressing was applied after wound closure and the neuroma submitted for histological diagnosis. The patients were mobilised in a wooden sole shoe for two weeks and were instructed to stay inactive for the first week. All patients were followed-up at two weeks and six months postoperatively.

The medical notes for the patients were retrieved and the patients followed-up by personal interview. This was carried out independently by the first author (AP) who did not operate on the cohort of patients. The patients were asked whether they had pre and postoperative pain on performing specific activities and if they experienced pain at night. They were asked to grade their pre and postoperative pain intensity as mild, moderate or severe (Table 2). At follow-up, patients were asked to score the pain they had prior to surgery, and this may have introduced recollection bias in the results. Any sensory

Table 1 Study overview

Characteristic	Value
Number of patients	78
Number of operated feet	82
Mean age	59 years (range 22–73 years)
Gender (female:male)	69:9
Mean symptom duration	32.6 months (range 6.3–86.5 months)
Treatment prior to surgery	
Shoe modification	62
Orthoses	49
Lignocaine injection into webspace	43
Preoperative investigations	
MRI	8 feet
Ultrasound	19 feet

Table 2 Pain levels and intensity

Activity	Preoperative	Postoperative
Pain on standing	78	12
Pain on walking	78	14
Pain on running	78	13
Pain made worse by shoe wear	32	23
Night pain	9	0
Rest pain	9	0
Pain on pressure	60	15
Severe (8–10)	37	9
Moderate (5–7)	22	11
Mild (<5)	19	15

disturbances prior to and after the operation were reported as none, mild, moderate or severe (Table 3).

The patients were also scored using the validated Functional Foot Index scoring system (Fig.1) [2] and the American Orthopedic Foot Ankle Society scoring system (Fig. 1) [14], which score patients out of a total of 100. Patients were asked to score ten various activities including walking in the house, walking outside, standing on tip-toes, etc. Each activity is scored from 0, indicating no difficulty, to 10, indicating the inability to perform the activity. The American Orthopedic Foot Ankle Society scoring system individually scores the ankle-hind foot, midfoot and forefoot as well as hallux and lesser metatarsopharyngeal–interpharyngeal regions. Each part of the foot is scored in terms of pain (40 points), function (45 points) and alignment (15 points).

The best score which can be achieved is 100. The patients in this study were scored with the forefoot system. Finally patients were asked to grade the result of their operation as being excellent, very good, good, fair or bad, as well as their overall satisfaction as being completely satisfied, satisfied with minor reservations, satisfied with major reservations or dissatisfied.

Results

There were 78 patients in the study, 62 of whom were females. Fourteen patients had a neurectomy performed in more than one webspace. Preoperative interview and examination identified the frequency of presenting symptoms as shown in Table 3. Sixty-one out of 78 patients (78%) complained of numbness, 66 out of 78 patients (85%) complained of pain radiating to the forefoot and in 40 patients this was relieved by rubbing the foot. The mean follow-up was 4.6 years (range 0.8–8.1 years).

Forty-two patients (53.5%) were completely satisfied with the procedure, 16 (21.4%) were satisfied with minor reservations, 12 (14%) were satisfied with major reservations and eight (10.7%) were unsatisfied. There were 18 complications: eight had a superficial wound infection treated successfully with antibiotics, five had persistent hypersensitive scars and four developed local keloid formations. Forty-six patients (60%) reported excellent results, 16 patients (21%) reported very good results, eight (10.7%) fair, and six (7%) poor results. Eight patients required revision due to recurrence of the neuroma at a mean 2.1 years after index surgery.

Table 3 Frequency of presenting symptoms in Morton's neuroma

Symptoms	No. of patients	Yes	No
Numbness	78	61	17
Radiation pain	78	66	12
Pain relieved by rubbing	78	40	38
Sensory disturbances	Preoperative	Postoperative	
None	16	21	
Mild	24	35	
Moderate	26	13	
Severe	16	13	

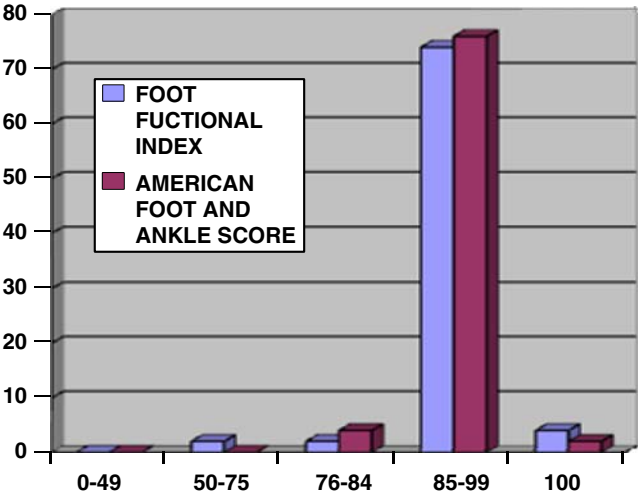

Fig. 1 Patient scoring

In 64 feet, only one intermetarsal space was affected and in 18 feet, two spaces were involved. The second intermetarsal interspace was involved in 20 cases (25%), the third in 43 cases (53%) and the fourth in 18 cases (22%). Sixty-two webs were operated on in the left foot and 20 in the right. Multiple neuromas were found in nine (12%) patients. Seventy-four patients underwent unilateral operation. Six of these patients had multiple neuromas in the same foot. Only four patients had bilateral operations, two during the same sitting.

Histological results revealed macroscopically visible interdigital neuromas in 64 cases (78%), which were microscopically confirmed to be primary interdigital neuromas. Thirteen cases (16%) revealed no evidence of a Morton's neuroma but did show the characteristic histological findings of a primary interdigital neuroma. In five specimens (6%) histology revealed a section of a normal nerve and in two cases a lipoma rather than a Morton's neuroma.

Discussion

Extensive literature has been published on the aetiology and pathophysiology of Morton's neuroma, but very few studies have been carried out on long-term follow-up of the surgical outcome using validated scoring systems.

Thomas G. Morton described "a peculiar and painful affection of the fourth metatarsophalangeal articulation" in 1876 [19]. Morton attributed the pain to the fourth metatarsopharyngeal joint. It was Hoadley who first actually excised an interdigital neuroma from the third web space of a foot in 1883 [11].

Morton's neuroma or interdigital neuroma is one of the most common disorders encountered in the foot. Viladot's study [23] found intermetatarsal neuroma as the cause of metatarsalgia in 33% of patients.

Most neuromas are located in the third intermetatarsal space, i.e. between the third and fourth metatarsal heads where the branches of the medial and lateral plantar nerves anastomose. This anatomosis is thought to predispose to the development of the neuroma [6]. However, in our series, a neuroma was found in the second interspace in 25%, in the third interspace in 53% and in 22% in the fourth, findings which may question the anatomical hypothesis claimed by some authors as the aetiology.

In up to 80% of patients, intermetarsal neuroma may be associated with some other pathological findings of the forefoot [6]. In our study 50% had an associated foot pathology. Surgical excision of the interdigital nerve provides satisfactory relief of symptoms in over 80% of patients [4, 17]. Incisions may be dorsal or plantar. Mann and Reynolds preferred the dorsal approach as this not only avoids painful sole scars associated with the plantar approach but also provides adequate visualisation and prevents painful scars [16]. However, a retrospective study in the *Journal of Foot and Ankle Surgery* found that there are several advantages in using the plantar transverse incision such as improved exposure and access to the neuroma [8].

In our series only 18 (22%) revealed no evidence of Morton's neuroma at histological diagnosis. This contrasts with other reported series such as that of Vachon et al. who reported 33% negative histological findings [22]. Proper history taking, examination and diagnostic injections are vital for diagnosing the condition and result in a high hit rate. MRI and ultrasound are not routinely essential but may be useful in selected equivocal cases.

Our study revealed a postoperative success rate of 82% which correlates well with published reports such as that of Keh et al. who reported a 93% long-term subjective relief from neurectomy [13]. However, the authors report that many patients complain of some residual discomfort in the region of the surgery and 70% still have some degree of footwear restriction [21]. Numbness in the webspace postoperatively is very common but most patients are unaware of the sensory loss. Footwear problems in patients may effect the outcome of surgery in spite of providing good pain relief. In our series, the majority (71%) had problems wearing fashionable shoes even though they were happy with the surgery. Only 29% of patients had no footwear restriction.

The excision of plantar neuromas is not always successful. Publications show failures as high as 14–21%. Johnson et al. [12], who operated on 33 recurrences, found eight patients had not improved through surgery. Coughlin [3] pointed out that occasionally when excision is performed and the nerve is resected, a true bulb neuroma may then be produced, which can be painful if it is in the weight bearing area. Gauthier [7] reported 83% good long-term results in a series of 206 feet with Morton's neuroma by dividing the deep transverse intermetarsal ligament and decompressing the involved interdigital nerve. Neurolysis also produces good results. Diebold et al. [5] reported 37 out of 40 patients had excellent results, with 35 patients reporting normal toe sensitivity. Long-term follow-up of neurectomy in this series showed that there was no long-term relief in 82% of the patients. Nonoperative treatment however offered only short-term relief of symptoms. Injections provided pain relief for only short periods of time but the relief of pain correlated well with the subsequent diagnosis so that injections are more useful as a diagnostic rather than a therapeutic measure. Greenfield [9] reported that injections provided complete pain relief in 30% of patients and partial relief of pain in 50%. After two years nearly 95% of those patients with initial complete pain relief remained asymptomatic. This high success rate using this modality of treatment may be related to the fact that the interspace pain in the cohort of patients reviewed were inflammatory in origin. In our series there were no patients suffering from an inflammatory source of interspace pain which reflects the low success of injection therapy obtained in our series and in other published reports.

References

1. Biasca N, Zanetti M, Zollinger H (1999) Outcomes after partial neurectomy of Morton's neuroma related to preoperative case histories, clinical findings, and findings on magnetic resonance imaging scans. Foot Ankle Int 20(9):568–575
2. Budiman-mak E, Conrad KJ, Roach KE (1991) The foot function index: a measure of foot pain and disability. J Clin Epidemiol 44:561–570
3. Coughlin MJ, Pinsonneault T (2001) Operative treatment of interdigital neuroma. A long-term follow-up study. J Bone Joint Surg Am 83-A(9):1321–1328
4. Dereymaeker G, Schroven I, Steenwerckx A, Stuer P (1996) Results of excision of the interdigital nerve in the treatment of Morton's metatarsalgia. Acta Orthop Belg 62(1):22–25
5. Diebold PF, Daum B, Dang-Vu V, Litchinko M (1996) True epineural neurolysis in Morton's neuroma: a 5-year follow up. Orthopedics 19(5):397–400
6. Diez EM, Mas SM (2004) Comparative results of two different techniques in the treatment of the Morton's neuroma. The Foot 15:14–16

7. Gauthier G (1979) Thomas Morton's disease: a nerve entrapment syndrome. A new surgical technique. Clin Orthop Relat Res (142):90-92
8. Glasoe WM, Coughlin MJ (2006) A critical analysis of Dudley Morton's concept of disordered foot function. J Foot Ankle Surg 45(3):147–155
9. Greenfield J, Rea J Jr, Ilfeld FW (1984) Morton's interdigital neuroma. Indications for treatment by local injections versus surgery. Clin Orthop Relat Res (185):142–144
10. Hassouna H, Singh D (2005) Morton's metatarsalgia: pathogenesis, aetiology and current management. Acta Orthop Belg 71 (6):646–655
11. Hoadley A (1893) Six cases of metatarsalgia. Chicago Med Rec 5:32
12. Johnson JE, Johnson KA, Unni KK (1988) Persistent pain after excision of an interdigital neuroma. Results of reoperation. J Bone Joint Surg Am 70(5):651–657
13. Keh R, Ballew K (1992) Long term follow-up of Morton's neuroma. J Foot Surg 31(1):93–95
14. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M (1994) Clinical rating systems for the ankle-hindfoot, midfoot, hallux and lesser toes. Foot Ankle Int 15(7):349-353
15. Lee MJ, Kim S, Huh YM, Song HT, Lee SA, Lee JW, et al. (2007) Morton neuroma: evaluated with ultrasonography and MR imaging. Korean J Radiol 8(2):148–155
16. Mann RA, Reynolds JC (1983) Interdigital neuroma—a critical clinical analysis. Foot Ankle Int 3(4):238–243
17. Mann RA (1999) Diseases of the nerve. In: Coughlin MJ, Mann RA (eds) Surgery of the foot and ankle. Mosby, St. Louis, pp 502–524
18. Morscher E, Dick W (2000) Morton's intermetarsal neuroma: morphology and histological substrate. Foot Ankle Int 21(7):558–562
19. Morton TG (1876) A peculiar and painful affection of the fourth metatarsophalangeal articulation. Am J Med Sci 71:37–45
20. Mulder JD (1951) The causative mechanism in Morton's metatarsalgia. J Bone Joint Surg Br 33:94–95
21. Schroven I, Geutjens G (2003) Results of excision of the interdigital nerve in the treatment of Morton's metatarsalgia. The Foot 5:196–198
22. Vachon P, Lemay M, Bouchard HL (1991) Pathologic study of Morton's neuroma. Can J Surg 34(4):356–358
23. Viladot A (1973) Metatarsalgia due to biomechanical alterations of the forefoot. Orthop Clin North Am 4(1):165–178
24. Weinfeld S, Myerson M (1996) Interdigital neuritis: diagnosis and treatment. J Am Acad Orthop Surg 4:328–335
25. Zanetti M, Strehle JK, Kundert HP, Zollinger H, Hodler J (1999) Morton's neuroma: effect of MR imaging findings on diagnostic thinking and therapeutic decisions. Radiol 213(2):583–588