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Corticosteroid injection for Morton's neuroma with or without ultrasound guidance

A RANDOMISED CONTROLLED TRIAL

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Aims

The objective of this double-blind randomised controlled trial was to assess whether ultrasound guidance improved the efficacy of corticosteroid injections for Morton's neuroma (MN).

Patients and Methods

In all, 50 feet (40 patients) were recruited for this study but five feet were excluded due to the patients declining further participation. The mean age of the remaining 36 patients (45 feet) was 57.8 years (standard deviation (SD) 12.9) with a female preponderance (33F:12M). All patients were followed-up for 12 months. Treatment was randomised to an ultrasound guided (Group A) or non-ultrasound guided (Group B) injection of 40 mg triamcinolone acetonide and 2 ml 1% lignocaine, following ultrasound confirmation of the diagnosis.

Results

The mean visual analogue score for pain improved significantly in both groups (Group A – from 64 mm, SD 25 mm to 29 mm, SD 27; Group B – from 69 mm, SD 23 mm to 37 mm, SD 25) with no statistical difference between them at all time-points. The failure rate within 12 months of treatment was 11/23 (48%) and 12/22 (55%) in Groups A and B, respectively (p = 0.458). The improvement in Manchester Oxford Foot Questionnaire Index and patient satisfaction favoured Group A in the short-term (three months) that almost reached statistical significance (p = 0.059 and 0.066 respectively). However, this difference was not observed beyond three months.

Conclusion

This study has shown that ultrasound guidance did not demonstrably improve the efficacy of corticosteroid injections in patients with MN.

Take home message: In the presence of a clear diagnosis of MN, a trained clinician who understands the forefoot anatomy may perform an injection without ultrasound guidance with good and safe results.

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Morton's neuroma (MN), also known as plantar interdigital neuroma, is a common cause of forefoot pain.[1,2] It is characterised as a benign peri-neural fibrotic lesion of the common interdigital nerve underlying the transverse metatarsal ligament, with the highest prevalence at the third intermetatarsal space.[3,4] The diagnosis can be established through accurate history and examination,[5,6] and may be confirmed by ultrasound (US)[7,8] or MRI[9,10] in equivocal cases.

Non-operative treatment provides relief in most patients with MN, which may include adjustment to footwear, use of insoles and corticosteroid injections.[11-13] The clinical benefit of using US guidance to facilitate steroid injections for MN is unclear in the literature. US guided injections are labour intensive, increase the overall cost, and delay the delivery of treatment due to lengthy waiting times in most units. However, they possibly allow better targeting of injections. A recent systematic review provided an argument that US guidance improved the efficacy of steroid injections in treating MN but this was based on a narrative synthesis of case series and retrospective studies.[14] To date, there have been no randomised controlled trials comparing the efficacy of US- and non-US guided corticosteroid injections in managing symptoms of MN.

The objective of this study was to evaluate whether US guidance improved the efficacy of corticosteroid injections in patients with MN.

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Table I. Johnson satisfaction scale[17]

Satisfaction score	
1	Completely satisfied – essentially pain free, no restrictions in activity, and only minor restriction in footwear
2	Satisfied with minor reservation – occasional mild pain, minor restrictions in activity and minor restrictions in footwear
3	Satisfied with major reservation – mild or moderate pain, moderate restrictions in activity and major restrictions in footwear, but overall improvement
4	Dissatisfied – no improvement in pain or worse pain, major restrictions in activity and footwear, no improvement or worse symptoms

Patients and Methods

Study design. This was a double-blind randomised controlled trial undertaken on patients referred to a single foot and ankle surgeon in a tertiary unit. The study was approved by the regional ethics committee and patients gave their written informed consent to participate. Patients were recruited between September 2012 and February 2014.

Patients with a clinical diagnosis of MN (intermetatarsal space pain that was worse with certain shoe-wear or weight-bearing and with a positive thumb-index-finger web space squeeze test[5] at the corresponding site of symptoms) and those who met the inclusion criteria were enrolled into the study. The inclusion criteria were: symptom duration of more than six months and US confirmation of MN at the site of symptoms. Patients with bilateral lesions were also included and each foot was analysed separately.

The exclusion criteria were: patients who had previously received a corticosteroid injection for MN (within 12 months of recruitment), concomitant symptoms from other foot pathologies including metatarsophalangeal joint synovitis and tenosynovitis, peripheral neuropathy, allergy, intolerance or contraindications to the drugs and, incapacity to provide informed consent.

Once a clinical diagnosis of MN was made, patients were referred for US to confirm the diagnosis. All US scans were performed by a single musculoskeletal radiologist (RB) using a LOGIQ Ultrasound machine (GE Healthcare, Chalfont St Giles, United Kingdom) with a 9 MHz to 15 MHz linear transducer. Intermetatarsal spaces were scanned in the sagittal plane from the plantar surface whilst applying manual digital pressure on the dorsal aspect of the scanned interspace. The presence of a non-compressible hypoechoic lesion in the intermetatarsal space just proximal to the metatarsal heads was used to confirm the diagnosis of MN.[4,15] All four intermetatarsal spaces were scanned and the presence of symptomatic and asymptomatic neuromas was recorded. The neuroma was defined as symptomatic if pain was produced on squeezing the corresponding intermetatarsal space. The coronal and sagittal diameters of the lesion were recorded and the largest dimension in either plane was used for analysis.

Following confirmation of diagnosis, patients were randomly assigned to two treatment subgroups:

- Group A – corticosteroid injection with US guidance;
- Group B – corticosteroid injection without US guidance.

The local research and development department performed block randomisation with block sizes of six using Microsoft Excel 2010 (Microsoft Corporation, Redmond, Washington) and generated allocation cards that were placed in opaque sealed envelopes. Allocation concealment was achieved using these envelopes that were sequentially opened at the time of injection. In patients with bilateral neuromas, allocation to treatment was done for each foot separately. The investigators were kept blind to the block randomisation.

The same radiologist (RB) performed all of the injections using a 23 G needle. In all cases, the US transducer was repositioned on the plantar surface of the corresponding neuroma interspace. In Group A, the transducer was switched on and the needle was advanced from the dorsal surface into the neuroma under US guidance. In Group B, the transducer was kept off (sham ultrasound) and the needle was advanced to the region of the neuroma without US visualisation. The patients were kept blind to treatment allocation as the US monitor was concealed from their view. A mixture of 1 ml triamcinolone acetonide (40 mg) and 2 ml 1% lignocaine was used to inject each symptomatic neuroma.

Outcome measures. The primary outcome measure was the change in visual analogue scale (VAS) pain score when walking (0 to 100 mm scale: best to worst). Secondary outcomes included the Manchester-Oxford Foot Questionnaire Index (MOxFQ-Index)[16] (0 to 100, with higher scores indicating greater severity), patient satisfaction with treatment (Johnson scale)[17] (Table I) and failure of treatment. Failure was defined as patients requesting further treatment (repeat injection or surgical excision). Patients were reviewed at three, six and 12 months following injection. When a patient requested further treatment (failure), outcome measures at that point were recorded and analysed but subsequent VAS and MOxFQ-Index scores were not undertaken. Their final satisfaction score (Johnson scale) was carried forward for subsequent analysis and failure rates were recorded as a cumulative outcome over the 12 months.

Statistical analysis. The sample size was calculated to detect a minimal clinically important difference (MCID) of 15 mm in the VAS pain score between the groups. Power calculations indicated that 42 cases would be needed to achieve 80% power with an alpha error of 0.05; equivalent to an effect size of 0.8. We aimed to enrol 50 cases to allow for a 15% drop-out through withdrawals or loss to follow-

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Table II. Characteristics of the study population (Group A with ultrasound guidance and Group B without ultrasound)

	Group A (n = 23)	Group B (n = 22)	p-value
Mean age (yrs)	57.1 (SD 11.7)	58.6 (SD 14.3)	0.691
Median size of MN (mm)	10 (IQR 9.5 to 14)	11 (IQR 9 to 12)	0.967
Pre-injection mean VAS pain score	64 (SD 25)	69 (SD 23)	0.484
Pre-injection median MOxFQ-Index	53 (IQR 45 to 67)	60 (IQR 42 to 80)	0.964

Mean age and VAS pain scores were analysed using Student's *t*-test. MN size and MOxFQ-Index were compared using the Mann-Whitney U test

Statistical significance was defined as a p-value < 0.05. VAS, visual analogue scale; MN, Morton's neuroma; MOxFQ-Index, Manchester Oxford Foot Questionnaire-Index; SD, standard deviation; IQR, interquartile range

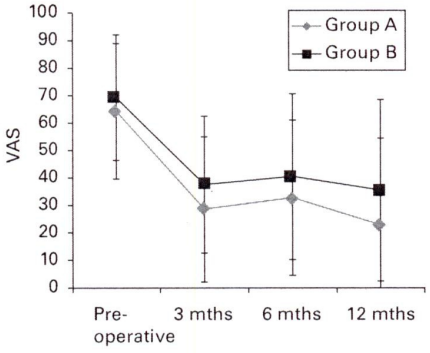


Fig. 1

Mean visual analogue score (VAS) for pain before and after receiving corticosteroid injection in Group A under ultrasound guidance and Group B without guidance. The error bars represent the standard deviations.

Table III. Median MOxFQ-Index scores (with interquartile ranges (IRQ) before and after receiving corticosteroid injection (Group A with ultrasound guidance and Group B without ultrasound). Data analysed using Mann-Whitney U test

MOxFQ-Index	Group A (n = 23)	Group B (n = 22)	p-value
Pre-injection	53 (IQR 45 to 67)	60 (IQR 41.8 to 80)	0.964
3 mths	23 (IQR 11 to 44)	37 (IQR 23 to 50)	0.059
6 mths	34 (IQR 17 to 64)	54 (IQR 11 to 74)	0.722
12 mths	17 (IQR 9 to 36)	21 (IQR 4 to 76)	0.631

Statistical significance was defined as a p-value < 0.05. MOxFQ-Index, Manchester Oxford Foot Questionnaire-Index; IQR, interquartile range

up. Statistical analysis was undertaken using IBM SPSS Statistics 19 (IBM Inc., Armonk, New York) software. The Shapiro-Wilk test was used to assess normality of data. Parametric data were presented as mean (standard deviation (SD)) and analysed using Student's *t*-test. Mann-Whitney U test was used to analyse non-parametric data, which were presented as medians (interquartile range, IQR). Comparisons of nominal and ordinal data were performed using Pearson's chi-squared test. Statistical significance was defined as a p-value < 0.05.

Results

Demographics. In all 40 patients (50 feet) with MN were recruited but there were five study withdrawals involving four patients. Following recruitment, three patients (four feet) subsequently declined the injection and chose to continue managing symptoms conservatively. One patient (one foot) declined follow-up assessments following injection.

The analysis was undertaken on the remaining 36 patients (45 feet). In total 23 feet received US guided corticosteroid injections (Group A) and 22 feet received non-US guided corticosteroid injections (Group B). Both groups were matched (Table II).

The mean age was 57.8 years (SD 12.9) with a female preponderance (feet: 33 female, 12 male). The median neuroma size was 11 mm (interquartile range (IQR) 9.25 to 12) and the mean VAS for pain was 67 mm (SD 24). All neuromas were confined to the third and second interspaces. A single concurrent ipsilateral neuroma was detected in 12 feet (27%), of which only two were symptomatic (one in each group). The symptomatic ipsilateral neuromas were also injected and included in the analysis. None of the feet included in this study had associated pathology such as metatarsophalangeal joint synovitis or tenosynovitis revealed by US.

VAS pain score. A significant reduction in VAS was seen in both groups following corticosteroid injection (Student's *t*-test, $p < 0.001$) (Fig. 1). The difference in VAS scores between the groups were not statistically significant at all time-points (three months ($p = 0.257$); six months ($p = 0.463$); 12 months ($p = 0.329$)).

Manchester Oxford Foot Questionnaire-Index. A significant improvement in the MOxFQ-Index was observed following the corticosteroid injection (Group A (Mann-Whitney U test, $p < 0.001$); Group B (Mann-Whitney U test, $p = 0.007$)) (Table III). At three months following treatment, there was a trend favouring Group A that almost reached statistical significance. However, no demonstrable difference was noted at six and 12 months between the groups.

Patient satisfaction with treatment (Johnson scale). The overall satisfaction with treatment at three months appeared to be better in Group A, though it did not reach statistical significance (Pearson chi-squared test, $p = 0.066$) (Table IV).

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Table IV. Patient satisfaction at three months following corticosteroid injection (Group with ultrasound guidance and Group B without ultrasound)

Johnson scale	Group A (n = 23; %)	Group B (n = 22; %)
Completely satisfied	7 *(30.5)*	1 *(5)*
Satisfied with minor reservation	9 *(39)*	10 *(45)*
Satisfied with major reservation	1 *(4.5)*	5 *(23)*
Dissatisfied	6 *(26)*	6 *(27)*

Table V. Characteristics of cases that did not respond to corticosteroid injection compared to the rest of the study population

	No response (n = 6)	Responded to injection (n = 39)	p-value
Age (yrs)	52.2 (SD 11.9)	58.7 (SD 12.9)	0.887
Size of MN (mm)	12.5 (IQR 9 to 15.5)	11 (IQR 9.75 to 12)	0.306
Ipsilateral MN (n)	2 *(33)*	10 *(26)*	0.514
Pre-injection mean VAS pain score	6.5 (SD 2.0)	6.7 (SD 2.4)	0.490
Pre-injection median MOxFQ-Index	52.5 (IQR 34 to 71)	56 (IQR 45 to 80)	0.568

Age and VAS pain scores analysed using Student's *t*-test; Size of MN and MOxFQ-Index analysed using Mann-Whitney U test and presence of ipsilateral MN compared using Pearson Chi-squared test. Statistical significance was defined as a p-value < 0.05 MN, Morton's neuroma; VAS, visual analogue scale; MOxFQ-Index, Manchester Oxford Foot Questionnaire-Index; SD, standard deviation; IQR, interquartile range

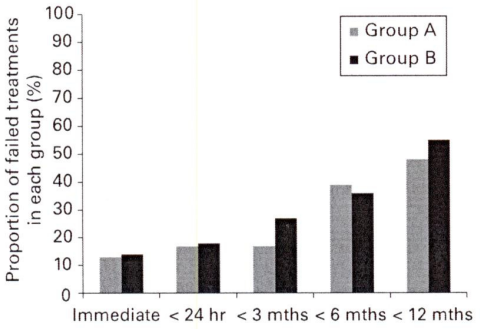


Fig. 2

A graph showing cumulative failure over 12 months following corticosteroid injection in Group A under ultrasound guidance and Group B without guidance.

By 12 months however, the overall satisfaction in the two groups was similar (Pearson chi-squared test, p = 0.873): 10/23 (44%) of feet in Group A were dissatisfied with treatment compared with 12/22 (55%) in Group B (Pearson chi-squared test, p = 0.458).

Failure of injection therapy

No response to treatment. There were three feet from each group (13.3% of study population) that did not have any response to the corticosteroid injection. The characteristics of these affected patients were not significantly different to the rest of the study population (Table V). In five of these feet, the symptoms subsequently improved through surgical excision of the symptomatic neuroma only. In the remaining foot, the symptoms improved approximately four months after the injection and further intervention was declined by the patient whilst on the surgical waiting list.

Failure over time. The therapeutic effect of the corticosteroid injection gradually decreased with time, with failure rates similar between the groups at all time-points (three months (Pearson chi-squared test, p = 0.425); six months (Pearson chi-squared test, p = 0.848); 12 months (Pearson chi-squared test, p = 0.652)) (Fig. 2). Within 12 months of treatment, 11/23 (48%) *versus* 12/22 (55%) of feet failed treatment in Groups A and B, respectively.

The demographics of cases that failed treatment within 12 months were not dissimilar to the rest of the study population (Table VI). There were a higher proportion of patients with ipsilateral neuromas in the group that failed treatment but this did not reach statistical significance (Pearson chi-squared test, p = 0.208).

Two feet (one in each group) had concurrent symptomatic ipsilateral neuromas which were simultaneously injected and both feet failed treatment at six months.

Only two of the recruited feet had received a corticosteroid injection for MN in the past (> 12 months prior to recruitment); both of which were successfully treated when reviewed at 12 months following their current study intervention.

Of the feet that failed to improve with treatment, a request for a further injection was made for nine (39%) and 14 (61%) requested surgical excision.

Complications. Localised depigmentation occurred in one patient who had received an injection without US guidance. There were no cases of intrinsic ligament or tendon damage, or fat atrophy.

Discussion

Corticosteroid injections are routinely administered as first-line treatment for MN and recent randomised controlled trials have supported its efficacy, showing better outcomes compared with shoe-wear modification[18] and the use of local anaesthetic injections.[12] Our results reinforced these findings, having shown that the reduction in VAS pain score following corticosteroid injection was significant. At three months, there was a 55% and 46% reduction in mean

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Table VI. Characteristics of cases that failed treatment within 12 mths of corticosteroid injection compared to cases that remained therapeutic

	Remained therapeutic (n = 22)	Failed treatment (n = 23)	p-value
Age (yrs)	56.6 (SD 11.9)	59.0 (SD 14.0)	0.542
Size of MN (mm)	10.5 (IQR 10 to 12)	11.5 (IQR 9 to 13)	0.741
Gender (M:F)	6:16	6:17	0.928
Ipsilateral MN	4/22 *(18)*	8/23 *(35)*	0.208

Age was analysed using Student's *t*-test; Size of MN analysed using Mann-Whitney U test; Gender distribution and presence of ipsilateral MN compared using Pearson chi-squared test. Statistical significance was defined as a p-value < 0.05 MN, Morton's neuroma; M, male; F, female; SD, standard deviation; IQR, interquartile range

VAS in the US-guided and non-US guided injection groups respectively; well beyond the therapeutic effect of the local anaesthetic used in the injection.

By the end of follow-up, 23/45 (51%) of the feet required further intervention for persistent/recurrent symptoms (31% surgery, 20% further injection). The failure rates were not statistically different whether US guidance was used or not. Likewise, Markovic et al[11] reported that 12/39 (31%) of their patients subsequently underwent surgical treatment within nine months of receiving US guided corticosteroid injection (5.7 mg/ml betamethasone sodium phosphate/ betamethasone acetate with 0.5 ml of 1% lidocaine). In contrast, Makki et al[13] reported a poorer response to US guided corticosteroid injection (40 mg methylprednisolone with 1 ml of 1% lidocaine), having found that 29/39 (74%) of cases had requested further intervention within 12 months of treatment but had a lower surgical rate (15%). The variability in the results seen in these studies may be attributed to the experience of the clinicians performing these injections, and the type and volume of injection used.

We had expected all patients with a symptomatic MN to have gained immediate relief of pain following the injection, considering that local anaesthetic had been used. However, 13% (three feet in each group) of our study population did not respond to the combined local anaesthetic and corticosteroid injection. Further analysis on this subgroup failed to identify any factors that may have contributed to this. We do not believe that the failed response was due to a case of misdiagnosis as symptoms improved after surgical excision of the neuroma. Likewise, Markovic et al[11] found that 20.5% of patients with MN in their study had no pain relief at all following an US guided corticosteroid and local anaesthetic injection. These findings also question the practice of using diagnostic local anaesthetic blocks in the management of patients with MN. A patient with a negative response to the diagnostic injection may still have a symptomatic MN. Younger and Claridge[19] have also shown that a positive response to diagnostic blocks may not necessarily improve patient selection for surgical excision. Their results of surgical excision of MN following a positive diagnostic block were similar, if not slightly worse than that published in the literature. Further research is needed to identify why a subgroup of patients do not have any response to injection therapy.

The use of US guidance facilitated accurate placement of the injection needle into the MN complex. However, the improvement in pain scores seen in the group that received US guided corticosteroid injections were neither statistically nor clinically different to patients who had received their injections without US guidance. Failure rates were also similar. There was some indication that patients who had received US guided corticosteroid injections had better short-term functional scores and satisfaction ratings, but this did not reach statistical significance. Schiffer et al[20] presented their retrospective review and concluded that US guided corticosteroid injections did not confer any advantage to the palpation guided injections in patients with MN. These findings possibly suggest that perineural injections of MN may not be necessary in order to gain therapeutic benefits from corticosteroid injections.

The assumption that US guidance would reduce the risk of adverse reactions was also not substantiated in this study. Fat atrophy, intrinsic ligament or tendon damage did not occur to any foot. Only one out of 22 feet (4.5%) in the non-US guided injection group developed skin hypopigmentation at the site of treatment. This minor complication is recognised in the literature[12,21] and had been reported to occur in 5% of patients who had received US guided corticosteroid injections.[12]

There are two main limitations of this study. Firstly, all of the injections were performed by a single musculoskeletal radiologist. Nevertheless, the use of a single operator in this study allowed for improved consistency and patient blinding.

Secondly, the sample size of this study was small and may have introduced a type II error in some of the secondary outcome measures. This study was principally powered to detect a large effect size in the primary outcome measure which was the VAS pain scores. The relatively small sample size may have been underpowered to detect differences in the secondary outcomes. As there was a trend favouring the US guided corticosteroid injection group in patient satisfaction and the MOxFQ-Index, which a larger study may have detected with a statistically significant difference in these outcomes.

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Significant improvement in pain and function were observed following a corticosteroid injection for MN, whether performed with or without ultrasound guidance. There was no significant difference in terms of pain relief or failure between the two techniques. Functional scores and patient satisfaction appeared to be better in the short-term in the ultrasound guided group but this difference was not statistically significant.

In the presence of a clear diagnosis, established either clinically or following imaging, a trained clinician who understands the forefoot anatomy may perform an injection without ultrasound guidance with good and safe results. We believe that imaging continues to have a place in the assessment and treatment of patients where the diagnosis is not clear, when there has been failure to respond to a previous corticosteroid injection and where other pathologies may be present.

Author contributions:
D. Mahadevan: Study design, Data collection and analysis, Writing the manuscript.
M. Attwal: Data collection, Writing the manuscript.
R Bhatt: Study design, Performed ultrasounds and injections, Writing the manuscript.
M. Bhatia: Study design, Data analysis, Writing the manuscript.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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References

1. **Morton TG.** A peculiar and painful affection of the Fourth Metatarso-Phalangeal Articulation. *Am J Med Sci* 1970;71:37–45.
2. **Durlacher L.** *Treatise on corns, bunions, diseases of nails, and the general management of the feet.* London: UK: Simpkin, Marshall and Co, 1845.
3. **Wu KK.** Morton's interdigital neuroma: a clinical review of its etiology, treatment, and results. *J Foot Ankle Surg* 1996;35:112–119.
4. **Kaminsky S, Griffin L, Milsap J, Page D.** Is ultrasonography a reliable way to confirm the diagnosis of Morton's neuroma? *Orthopedics* 1997;20:37–39.
5. **Mahadevan D, Venkatesan M, Bhatt R, Bhatia M.** Diagnostic Accuracy of Clinical Tests for Morton's Neuroma Compared With Ultrasonography. *J Foot Ankle Surg* 2015;54:549–553.
6. **Owens R, Gougoulias N, Guthrie H, Sakellariou A.** Morton's neuroma: clinical testing and imaging in 76 feet, compared to a control group. *Foot Ankle Surg* 2011;17:197–200.
7. **Pollak RA, Bellacosa RA, Dornbluth NC, Strash WW, Devall JM.** Sonographic analysis of Morton's neuroma. *J Foot Surg* 1992;31:534–537.
8. **Redd RA, Peters VJ, Emery SF, Branch HM, Rifkin MD.** Morton neuroma: sonographic evaluation. *Radiology* 1989;171:415–417.
9. **Erickson SJ, Canale PB, Carrera GF, et al.** Interdigital (Morton) neuroma: high-resolution MR imaging with a solenoid coil. *Radiology* 1991;181:833–836.
10. **Sartoris DJ, Brozinsky S, Resnick D.** Magnetic resonance images. Interdigital or Morton's neuroma. *J Foot Surg* 1989;28:78–82.
11. **Markovic M, Crichton K, Read JW, Lam P, Slater HK.** Effectiveness of ultrasound-guided corticosteroid injection in the treatment of Morton's neuroma. *Foot Ankle Int* 2008;29:483–487.
12. **Thomson CE, Beggs I, Martin DJ, et al.** Methylprednisolone injections for the treatment of Morton neuroma: a patient-blinded randomized trial. *J Bone Joint Surg [Am]* 2013;95-A:790–798.
13. **Makki D, Haddad BZ, Mahmood Z, et al.** Efficacy of corticosteroid injection versus size of plantar interdigital neuroma. *Foot Ankle Int* 2012;33:722–726.
14. **Morgan P, Monaghan W, Richards S.** A systematic review of ultrasound-guided and non-ultrasound-guided therapeutic injections to treat Morton's neuroma. *J Am Podiatr Med Assoc* 2014;104:337–348.
15. **Okafor B, Shergill G, Angel J.** Treatment of Morton's neuroma by neurolysis. *Foot Ankle Int* 1997;18:284–287.
16. **Morley D, Jenkinson C, Doll H, et al.** The Manchester-Oxford Foot Questionnaire (MOXFQ): development and validation of a summary index score. *Bone Joint Res* 2013;2:66–69.
17. **Johnson JE, Johnson KA, Unni KK.** Persistent pain after excision of an interdigital neuroma. Results of reoperation. *J Bone Joint Surg [Am]* 1988;70-A:651–657.
18. **Saygi B, Yildirim Y, Saygi EK, Kara H, Esemenli T.** Morton neuroma: comparative results of two conservative methods. *Foot Ankle Int* 2005;26:556–559.
19. **Younger AS, Claridge RJ.** The role of diagnostic block in the management of Morton's neuroma. *Can J Surg* 1998;41:127–130.
20. **Schiffer G, Chan O, Jalan R, Padhiar N.** Retrospective review of injection therapy in Morton's neuroma [abstract]. *Br J Sports Med* 2013;47:3.
21. **Reddy PD, Zelicof SB, Ruotolo C, Holder J.** Interdigital neuroma. Local cutaneous changes after corticosteroid injection. *Clin Orthop Relat Res* 1995;317:185–187.

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