A Systematic Review of the Management of Multiple Adjacent Morton's Neuromas in the Same Foot
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Introduction/Purpose: The most common presentation of Morton's neuroma is that of a single neuroma in a single interdigital space. However, the occurrence of multiple neuromas in adjacent interdigital spaces of the same foot is not uncommon, with this scenario reported in 3-4% of all cases. Treatment of Morton's neuroma has been studied extensively, with most authors recommending surgical intervention only after failure of non-operative approaches such as steroid injection orthoses or shockwave therapy. Whilst systematic reviews on the management of Morton's neuroma have been performed previously, these focus on the treatment of a single neuroma in a single foot. This review aims to address this gap in the literature by systematically reviewing studies reporting treatment of multiple neuromas in adjacent intermetatarsal spaces of the same foot.

Methods: A systematic review was performed according to PRISMA guidelines. A thorough computer-based search was performed by two reviewers independently in Pubmed, Embase, Cinahl, Emcare, Web of Science and Scopus databases using relevant terms such as ‘interdigital’, ‘Morton’s’, ‘intermetatarsal’, ‘neuroma’, ‘neuralgia’, ‘adjacent’ and ‘multiple’. Title/abstract and full text screening was performed independently by the same two reviewers, using a-priori selection criteria. All original research articles (randomised control trails, cohort studies and observational studies) reporting any management strategy for multiple adjacent Morton's neuromas in the same foot were included. Studies describing treatment of both single and multiple adjacent neuromas in the same article were included if results were clearly separated according to these distinct presentations. The methodological index for non-randomized studies (MINORS) was used to assess risk of bias and methodological quality of included studies.

Results: A total of 253 unique articles were identified, with seven studies, including 383 patients included in the final review. Of these seven studies, four describe treatment of both single and multiple neuromas in the same article, whilst three include only patients with multiple adjacent neuromas in the same foot. Simultaneous excision using a single incision was the most common strategy, reported in three studies. Whilst two studies each reported use of simultaneous excision with two distinct incisions and delayed excision respectively. Of the four studies reporting treatment of both single and multiple neuromas, the pooled proportion of patients with the later presentation was 51/354 (14.4%). Only two studies, both describing simultaneous excision with a single incision, used scoring scales to assess treatment outcomes. These articles find significant increases in Manchester Oxford Foot questionnaire (MOXFQ), 12 item short form health survey (SF-12) and American Orthopaedic Foot & Ankle Society (AOFAS) scores.

Conclusion: There is currently no evidence favouring use of a delayed excision or multiple incision approach in the treatment of multiple adjacent neuromas. However, there is a paucity of literature describing this presentation, with a number of studies failing to separate outcomes of single and multiple neuroma treatment. Given that the presentation of multiple adjacent neuromas may not be as rare as previously thought, it is important that further high-quality comparative research is performed to enable clinicians to draw firm, evidence-based conclusions to guide clinical practice. Future research should also investigate the role of alternative strategies such as non-operative treatment.

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| Author      | Year | Type of study | Number of patients | Number with multiple neuromas | Mean Age | M: F | Mean Follow up (months) |
|-------------|------|---------------|-------------------|-----------------------------|----------|-----|------------------------|
| Benedetti  | 1996 | Case Series   | 15                | 15                          | 54.4     | 4:11| 68.6 (32-113)          |
| Bucknall    | 2016 | Case Series   | 99                | 26                          | 56       | 21:78| 6                      |
| Coughlin    | 2001 | Case Series   | 66                | 6                           | 55       | 14:52| 69.6                   |
| Kasparek    | 2013 | Case series   | 81                | 13                          | 50.6     | 12:69| 183.6 (120-240)        |
| Lee         | 2009 | Case Series   | 11                | 11                          | 50       | 0:11 | 25                     |
| Thompson    | 1993 | Case Series   | 3                 | 3                           | 52       | 0:3  | 17 (6-20)              |
| Yanez-Arauz | 2020 | Case Series   | 108               | 6                           | 49.4     | 11:97| 121 (96-168)           |