The sentinel vein

AN ANATOMICAL GUIDE TO LOCALISATION OF THE DORSOMEDIAL CUTANEOUS NERVE IN HALLUX SURGERY

N. Makwana, M. Hossain, A. Kumar, A. Mbako

From Wrexham Maelor Hospital, Wrexham, United Kingdom

Damage to the dorsomedial branch of the medial dorsal cutaneous nerve is not uncommon in surgery of the hallux. The resultant morbidity can be disabling. In the light of the senior author's operative observation of a sentinel vein, we undertook a cadaver study to investigate the anatomical relationships of the dorsomedial branch of the medial dorsal cutaneous nerve. This established that in 14 of 16 cadaver great toes exposed via a modified medial incision, there is an easily identified vein which runs transversely superficial and proximal to the nerve. In a prospective clinical study of 171 operations on the great toe using this approach, we confirmed this anatomical relationship in 142 procedures (83%), with no complaint of numbness or pain in the scar at follow-up. We attribute this to careful identification of the ‘sentinel’ vein and the subjacent sensory nerve, which had been successfully protected from damage. We recommend this technique when operating on the great toe.

The main sensory supply to the dorsum of the foot comes from the superficial peroneal nerve, which ends in the medial and intermediate dorsal cutaneous nerves. The medial dorsal cutaneous nerve (MDCN) itself divides into two dorsal sensory branches, of which the dorsomedial cutaneous nerve (DMCN) supplies the medial side of the hallux and is at risk during operations on the great toe. The incidence of nerve damage can be as high as 45% after surgery on the great toe, and can lead to sensory loss and a painful scar, which can make it difficult to find comfortable shoes. The most serious complication of injury to the nerve is the formation of a neuroma, which can be severely disabling and difficult to treat. Different authors have described a number of approaches to reduce the risk of damaging the nerve, the course of which and relationship to different surgical incisions has been studied in some detail. Previous researchers have described the position of the DMCN in relation to the nailbed, the extensor hallucis longus tendon and the metatarsophalangeal (MTP) joint. However, damage to the DMCN remains a common complication of hallux surgery.

During routine surgery on the great toe the senior author (NM) noted a consistent anatomical relationship between a sentinel superficial vein and the DMCN, which facilitated identification and protection of the nerve during the procedure. The purpose of this study was twofold: to describe a cadaver investigation of the anatomical relationships between the DMCN and this sentinel vein to help surgeons reduce the risk of damaging the nerve during surgery, and to report on a prospective clinical study of surgery on the great toe using a modified medial skin incision incorporating this anatomical knowledge.

Materials and Methods

Cadaver study. A total of 16 cadaver feet were dissected by three authors (MH, AK, AM) in order to study the relationship between the DMCN and the dorsoplantar venous network and to further elucidate our in vivo findings (Fig. 1). All the specimens were preserved in formalin. We exposed the dorsum of the foot using our usual modified version of the mid-medial incision described by Solan, Lemon and Bendall. This incision is made midway between the plantar and dorsal margins of the first metatarsal. As we developed wide skin flaps to expose the entire superficial venous network this revealed a transversely placed vein. We identified the main trunk of the superficial peroneal nerve proximally and followed the nerve distally to its terminal branches, noting the relationship with the superficial venous network.

Clinical study. We prospectively reviewed 171 consecutive operations (in 136 patients) on the great toe to assess the presence of the sentinel vein and DMCN, and the presence or
absence of pain or numbness in and around the scar. These patients were prospectively reviewed in the clinic initially by clinical staff and later by an advanced podiatric practitioner who is not part of the study. All patients were followed at two, six and 12 weeks post-operatively and any wound-related complications were examined and recorded.

All operations were performed by the senior author (NM) or under his supervision. Each operation was performed under tourniquet control after exsanguination of the limb. The medial border of the hallux metatarsal was palpated and a longitudinal incision was made midway between the plantar and dorsal margins of the metatarsal shaft. The incision begins just distal to the MTP joint. The proximal extent of the incision depends on the proposed procedure. We extend it to the whole length of the metatarsal shaft for a Scarf osteotomy. This incision was somewhat more dorsal than the traditional mid-medial incision, where the skin is incised at the junction of the plantar and dorsal skin. During the subsequent dissection we consistently noted a transversely placed vessel about 2 cm proximal to the distal margin of the MTP joint, even while operating with a tourniquet, due to identification of the vein as a result of residual blood in the vessel. On deeper dissection a pearly-white structure was found lying immediately deep and distal to the vessel. This was the DMCN.

Results

Cadaver study. We found a single vessel a mean of 2.13 cm (1.9 to 2.4) proximal to the MTP joint in 14 of 16 of the dissected specimens. The vein was positioned transversely across the wound and communicated with both the dorsal and the plantar venous arches (Fig. 2). On deeper dissection the DMCN was found immediately deep to the venous network and distal to the communicating vein (Fig. 3). It was orientated obliquely and was found dorsal to the skin incision. The nerve usually crossed under the dorsal venous network at the point where the communicating vein entered the dorsal venous arch.

In the remaining two specimens where the communicating vein was absent, the plantar and dorsal venous arches joined together more proximally (3.2 cm to 3.4 cm). The DMCN was still visible lying obliquely immediately deep to the venous arch (Fig. 4).

Clinical study. Out of the initial group of 171 operations (in 136 patients), we located the DMCN in 142 (83%) (116 patients) through identification of the sentinel vein. These included 108 operations for hallux valgus (including chevron, scarf and proximal metatarsal osteotomies), 25 for MTP joint arthrodesis and nine dorsal cheliotomies.

The vein was identified in all 108 operations for hallux valgus, but only in 34 out of 63 cases of hallux rigidus. In vivo we found the sentinel vein to be situated at a mean of 2.38 cm (2.1 to 3.0) from the MTP joint, which was similar
to the findings of the cadaver dissection with a mean distance of 2.13 cm (1.9 to 2.4).

Post-operatively none of these patients complained of numbness or pain around the scar (including those remaining 29 operations in which the sentinel vein was not identified, but the DMCN was nevertheless still identifiable).

Discussion
Anatomical studies have confirmed that incisions for surgery on the great toe invariably place branches of medial dorsal cutaneous nerve at risk.3,4,5 Neuroma formation is the most troublesome complication of injury to this nerve. Its true incidence is not known, though it is more common than anticipated and can lead to failed foot surgery.3,8 Meier and Kenzora10 reported a 5% incidence of painful scars following hallux valgus surgery which can detract from the surgical outcome. Kenzora11 reported a rate of 45% poor or fair results from surgical treatment of neuromas, which moved the author to suggested that it was easier to prevent a neuroma than to treat one.12 Most surgeons agree on the need to visualise and protect the DMCN and thus reduce the possibility of neuroma formation.4-7

Surgical approaches have been described based on the anatomy and distribution of the nerves around the great toe and designed to identify and protect the DMCN. Campbell,4 after a series of cadaver dissections, described an incision along a line from the corner of the nailbed extending along the axis of the first metatarsal. He advised that the DMCN would lie lateral to this incision and hence injury to the nerve could be avoided. Using this technique, he was able to reduce the incidence of DMCN injury to 20%. Solan et al5 after cadaveric dissections suggested that the dorsomedial incision was likely to injure the DMCN, whereas the mid-medial incision is safer because it lies midway between the dorsal and plantar digital branches.

Whether the use of the mid-medial incision actually reduces the incidence of injury to the DMCN is not known. Standard textbooks on anatomical approaches do not agree on the best approach and describe the dorsal, dorsomedial and mid-medial incisions for surgery of the great toe.13-16 Nevertheless the importance of careful dissection and exposure and protection of the DMCN is emphasised but without citing its exact anatomical location. There is variability in the size and position of the DMCN and the nerve is at risk in all incisions made in this area.7 With experience careful dissection and visualisation of the DMCN becomes easier.

There are a number of limitations to our study. We have not provided any histological proof of the presence of the nerve nor was a control group included in the study. Although compared with historical controls our results appear superior,4 we did not directly compare our incision with the other incisions proposed by various authors in the past. Researchers may wish to conduct further studies in future directly comparing different incisions.

Our study showed that in the majority of cases there is an easily identifiable anatomical landmark to help the surgeon to identify protect and preserve the DMCN. In this regard we wish to introduce the concept of the ‘zone of caution’. We have found that visualisation of the sentinel vein warns the surgeon that the nerve is nearby. We advise careful and slow dissection at this stage until the nerve is adequately visualised and avoided. The purpose of our study was to accurately document the anatomical relationship of the DMCN with the sentinel vein and guide the surgeon safely through this relationship. We have found the sentinel vein to be an important and consistent landmark in our clinical practice which helps to identify and preserve the DMCN.

The authors are indebted to Keele University Medical School and the Robert Jones and Agnes Hunt Orthopaedic and District Hospital NHS Trust for providing facilities for the cadaveric dissections.

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.

References


