TIBIAL NERVE DECOMPRESSION: RELIABLE EXPOSURE USING SHORTER INCISIONS

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Background: Patients and surgeons recognize the value of procedures that minimize scarring and tissue dissection, but technical standards do not exist with regards to incision lengths needed for tibial nerve decompression. This article introduces reproducible techniques that reliably provide exposure for release of known anatomical compression points of the tibial nerve, while minimizing the length of required skin incisions. Methods: The senior author’s approach to decompression of the tibial nerve at the soleus arch and the tarsal tunnel is presented. Typical incision lengths and surgical exposure are demonstrated photographically. The safety of using this technique is examined by review of the medical records of all patients undergoing this procedure from 2003 to 2011, looking for technical complications such as unintentional damage to nerves or adjacent structures. Results: 224 consecutive patients undergoing 252 total procedures underwent release of known anatomical compression points of the tibial nerve at either the tarsal tunnel, inner ankle, or the soleus arch. Typical incision lengths used for these procedures were 5 cm for the proximal calf and 4.5 cm for the tarsal tunnel. Review of medical records revealed no incidences of unintentional injury to nerves or adjacent important structures. Functional and neurological outcomes were not assessed. Conclusions: Tibial nerve decompression by release of known anatomical compression points can be accomplished safely and effectively via minimized skin incisions using the presented techniques. With appropriate knowledge of anatomy, this can be performed without additional risk of injury to the patient, making classically-described longer incisions unnecessarily morbid. © 2012 Wiley Periodicals, Inc. Microsurgery 32:533–538, 2012.

Compression neuropathy of the tibial nerve results mainly from entrapment at two major anatomical compression sites: the soleus arch in the proximal calf, and distally in the tarsal tunnel at the medial ankle. Sequences of tibial neuropathy range from early symptoms of plantar foot and calf paresthesias and pain to plantar numbness, weakness of plantar flexion, and a propensity towards the formation of pressure ulcers in advanced disease. When unexplained symptoms of tibial compression neuropathy persist beyond 3–6 months despite conservative management and optimization of medical comorbidities, and a Tinel’s sign or tenderness is elicited over compression sites on physical exam, surgical decompression may be warranted to prevent further deterioration and encourage neural repair. If these symptoms occur immediately following surgery or trauma, decompression may be indicated more urgently.

The governing principal of surgical therapy for nerve compression syndromes is exposure and release of known anatomical compressive structures about the nerve, along with examination of the nerve itself and decompression of any non-anatomical or unexpected compressive tissue bands. Techniques for access to the nerve and manipulation of the surrounding tissues will vary between surgeons, but all should share this same objective of exposure and decompression.

As a surgeon performs increasing volumes of decompression surgeries, the question of how best to technically achieve this objective while causing minimal morbidity to the patient becomes increasingly important. Given that both sites of tibial nerve entrapment occur near joint creases, the potential for scar contractures affecting joint function exists. Additionally, several case series studying the use of tarsal tunnel decompression in diabetics have noted a tendency for dehiscence or infection to occur at this incision. Bearing in mind the already high risk of limb loss in these patients, minimizing incision length in this area seems prudent.

Reviewing the literature, it is evident that despite a large amount of literature on tarsal tunnel decompression, relatively little attention has been paid to developing minimally invasive approaches that are simple and reproducible (Fig. 1). Where novel approaches are described, crucial safety data in a large volume of patients may be missing. In a previous report, we described the general concept and advantages of using shorter incisions for peripheral nerve decompressions. The purpose of this article is to introduce specific techniques for tibial nerve decompression both at the soleus arch (in the proximal calf) and at the tarsal tunnel (inner ankle, including decompression of the tibial, medial plantar, lateral plantar and calcaneal nerves) that reliably allow exposure of the relevant nerves and their known anatomical compression points while using minimized skin incisions and simple equipment. The techniques are described and illustrated photographically, with an emphasis on skin incision placement and incision length. The question of whether

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or not using minimal access incisions presents any greater operative risk to the patient is answered by chart review of our consecutive case series of tibial nerve decompressions using the described techniques to determine the incidence of technique-dependent intraoperative complications such as unintended injury to nerves or important adjacent structures.

**METHODS**

After institutional review board approval, retrospective review of the senior surgeon’s case logs was undertaken to identify patients who presented between 2003 and 2011 and underwent decompression of the tibial nerve, either at the tarsal tunnel or the soleus arch. Operative reports were reviewed for incidences of unintentional nerve injury or injury to nearby critical structures. The senior author was the single surgeon performing the described technique. The relevant anatomy and technical details for both areas of the tibial nerve are outlined below.

**Soleus Arch**

Compression of the tibial nerve in the proximal calf may occur at the anatomical tight point where the soleus muscle forms a tendinous arch across the tibial nerve and vessels, typically about 9 cm distal to the medial tibial plateau. To access the soleus arch and proximal tibial nerve, patients were positioned prone and a 5 cm longitudinal incision was made over the midline of the posterior calf, 8–10 cm distal to the knee flexion crease, overlying the origin of the soleus muscle (Figs. 2A and 2B). Skin and subcutaneous tissues were dissected with a combination of bipolar cautery, dissecting scissors, and small retractors. The heads of the gastrocnemius muscle were separated as needed to expose the tendinous arch of the proximal soleus muscle beneath (Fig. 2C). The fascia of the soleus was identified at the entry point of the tibial nerve and vessels, and bipolar cautery used to decompress constricting bands of fascia (Fig. 2D). At this point, a small, lighted retractor was inserted to create an illuminated tunnel along the proximal, then distal courses of the nerve. The lighted retractor can be used to illuminate an area up to 4 cm beyond the corners of the skin incision in each direction, essentially adding 8 cm of exposure directly along the course of the nerve, allowing decompression of up to a 13 cm segment through a 5 cm skin incision. This wide exposure not only ensures that the soleus arch itself can be identified and released, but also allows exploration along the relevant length of the nerve for any potential non-anatomic or aberrant compressive bands.

In cases where prone positioning was not feasible, patients were positioned supine and the soleus arch was approached using similar technique through a 5 cm medial calf incision overlying the sulcus between the tibia and posterior compartment (Figs. 3A–3D).

**Tarsal Tunnel**

Known anatomic compression points predisposing the tibial nerve and its branches (the medial plantar, lateral plantar, and calcaneal nerves) to compression at the medial ankle are the flexor retinaculum, the septum between the tunnels of the medial and lateral plantar nerves, and the overlying fascia of the abductor hallucis brevis muscle. To access these nerves and structures, a 4.5 cm curvilinear incision was placed centered between the medial malleolus and the calcaneus (Fig. 4A). Subcutaneous tissues were dissected using a combination of bipolar cautery, scissors, and small retractors. Upon incising the flexor retinaculum, a lighted retractor was inserted to create an illuminated tunnel that could be extended along the course of the nerve(s) for at least 3.5 cm past either end of the incision (Figs. 4B–4D). First, the lighted retractor was used to create a tunnel proximally, and the tibial nerve was decompressed of all fascial impingements as it was traced proximally. Subsequently, using this technique, the tunnels of the medial and lateral plantar nerves were exposed and unroofed from the abductor hallucis brevis fascia, decompressing these nerves. The septum between them was next excised. Following this, the calcaneal tunnel was decompressed. Care was taken to identify and protect the medial cutaneous branches coursing near the inferior pole of the incision.

All procedures were performed under tourniquet (unless contraindicated), utilizing microsurgical techniques, instruments and 4.0× loupe magnification. A bulky Jones cotton dressing and light ACE wrap were applied, and immediate ambulation was encouraged to prevent postoperative adhesions of the nerve to the surgical bed.
RESULTS

A 224 consecutive patients operated upon by a single surgeon from 2003 to 2011 were identified, who underwent a total of 252 decompression procedures (218 tarsal tunnel, 34 soleus arch). Typical incision lengths used for these procedures were 5 cm at the dorsal calf and 4.5 cm at the medial ankle, although incisions were sometimes extended in patients with obese body habitus or in cases of re-do decompression. Using the minimal incision lengths and technique described above, known anatomical compression points were reliably exposed, accessed, and released in all cases. Review of medical records revealed no incidences of unintentional injury to nerves or adjacent important structures. Peri-operative complications included no neurovascular injuries and were limited to only eight instances of tarsal tunnel wound infection or dehiscence (3%), all healed with antibiotics and local wound care. Functional and neurological recovery outcomes were not assessed, as those would be the topic of future studies.

DISCUSSION

The increasing adoption of endoscopic techniques across surgery serves as evidence of a general trend towards minimizing unnecessary incision lengths. In keeping with this trend, we have sought to improve standard, open technique for tibial nerve decompressions by creating reliable exposure of known anatomical compression points through skin incisions that are much shorter than those described in standard reference texts or technical articles. In this article, we present a detailed description of our techniques for doing so and demonstrate the safety of these techniques by a review of medical records of our case series demonstrating no major intraoperative technical complications such as inadvertent injury to critical nerves or nearby critical anatomic structures.

The clinical relevance of these short-incision techniques is best appreciated when they are considered as an easily adoptable alternative that bridges the gap between traditional “open” techniques that often use incisions of
10 cm or greater,\textsuperscript{2,17} and “endoscopic” nerve release techniques, which offer shorter incision lengths, but require adoption of specialized equipment and training.\textsuperscript{14,15,18} Our approach requires only a simple, lighted retractor for exposure, and allows direct manipulation of the indicated structures in the manner familiar to most surgeons. It should be noted, however, that the short incisions described in this article may need to be extended when dealing with very obese patients or in cases of re-do decompression surgery.

The question of whether shorter incisions for tibial nerve decompression have any real medical benefit to the patient will require prospective, comparative studies to be reliably answered. However, reviewing comparable published studies yields a reassuring safety profile for the short-incision tarsal tunnel decompression technique. Wieman and Patel,\textsuperscript{9} in a cohort of only 26 patients undergoing tarsal tunnel decompression, report a dehiscence or infection rate of 15% (4/26 patients) using an incision length of nearly 10 cm. Wood and Wood\textsuperscript{11} report a dehiscence or infection rate of 12% (4/33 patients) using an unreported incision length. Given the many differences in study designs, inferences regarding the reason for a difference in infection rates between ours’ and others’ series would be purely speculative; nonetheless, our dehiscence or infection rate of 3% in much larger study population appears, at least empirically, to be better than rates published using longer-incision techniques. Although proper surgical and sterile technique certainly decreases the risk of surgical site infection, the above-referenced studies and our own results do reveal a propensity for some level of wound-healing difficulty and infection at the tarsal tunnel incision site. Bearing in mind that many patients undergoing these surgeries will be medically compromised by diabetes as well as other comorbidities, it would be optimistic to hope that none of these postoperative infections could lead to serious sequelae, such as ascending infection and amputation. Therefore,
efforts to minimize the rate of wound healing complications at the tarsal tunnel, such as by minimizing incision lengths, seem worthwhile pursuing and investigating.

This study is limited in that we did not examine functional outcomes with our technique, either neurologic or cosmetic. Rather, we demonstrate reliable exposure and release of known compression structures for the proximal and distal tibial nerve, and use this as a measure of equivalency with longer-incision open techniques that target the same structures, assuming that the length of the skin incision itself has no positive or negative effect on the neurologic outcome of surgery so long as cutaneous sensory branches are identified and protected in both instances. We did not feel a formal evaluation of cosmetic outcome was necessary, as all patients simply preferred shorter scars; a fact to which the rise of endoscopic nerve releases attests.

Despite the limitations described above, this article demonstrates that known anatomical compression points can be safely and reliably decompressed for the treatment of tibial nerve compression syndromes using minimized skin incisions. Because these techniques accomplish the same objective as longer-incision approaches with simple, commonly available equipment, they may represent a new technical standard for minimizing potential incisional morbidity using open techniques for nerve decompression. With the feasibility and safety of short incision decompression techniques established, future studies should compare outcomes and complication rates of long and short incision approaches.

REFERENCES

Figure 4. Minimally invasive approach to tarsal tunnel release. A: A 4.5 cm curvilinear incision was marked between the medial malleolus and the calcaneus. B: The total length of surgical exposure along the nerve was 11.5 cm, with 3.5 cm of subcutaneous dissection at either end of the 4.5 cm incision. C: The lighted retractor was used to extend dissection proximally for 3.5 cm, dividing constricting fascia along the length of the tibial nerve proper. D: Distal dissection was extended 3.5 cm with the lighted retractor. Complete decompression involves division of the flexor retinaculum, neurolysis of the medial and lateral plantar nerves with release of the abductor hallucis brevis fascia and excision of the septum, and release of the calcaneal branch within the calcaneal tunnel. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]