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TECHNICAL NOTE - PERIPHERAL NERVES

The medial safe zone for treating intraneural ganglion cysts in the tarsal tunnel: a technical note

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Abstract

Introduction Intraneural ganglion cysts in the tarsal tunnel are rare but are being increasingly reported. The cysts involve the tibial or plantar nerves and are most commonly derived from a neighboring (degenerative) joint, (i.e., the tibiotalar or subtalar) via an articular branch arising from the medial aspect of the nerve. We describe a safe zone for approaching these cysts in the tarsal tunnel that allows for identification of the joint connection without injury to important distal branches.

Methods We present a case of an intraneural ganglion cyst within the tarsal tunnel in a patient with symptoms consistent with tarsal tunnel syndrome. Using intraoperative photographs and artist rendering, we describe a technique to safely disconnect the abnormal joint connection while preserving the important distal branches of the tibial nerve.

Conclusion The safe zone for the tibial nerve in the tarsal tunnel can be exposed by mobilization and gentle retraction of the vascular bundle. In cases of intraneural ganglion cysts, all apparent connections between the nerve and degenerative joints within this safe zone can be resected without injury to important distal nerve branches.

Keywords Intraneural · Ganglion · Cyst · Tibial · Tarsal · Tunnel

Introduction

The unifying articular theory has expanded the understanding of the pathophysiologic mechanism underlying the formation and treatment of intraneural ganglion cysts [7, 10, 11]. Recent reviews have demonstrated that intraneural cysts can occur throughout the body, and with detailed review of preoperative imaging, even in a retrospective fashion, an enlarged articular branch from the involved nerve has been discovered [2]. These cysts are most commonly encountered in the peroneal nerve at the fibular neck, typically occurring due to degeneration of the superior tibiofibular joint causing joint fluid (cyst) to propagate along the articular branch to the parent nerve, often to a significant extent [9]. It has been demonstrated that disconnection of the articular branch can lead to complete resolution of the cyst and symptoms without intraneural dissection and/or direct cyst excision from within the nerve [8].

Intraneural ganglion cysts in the tarsal tunnel are rare but are being increasingly reported. The cysts involve the tibial or plantar nerves and are most commonly derived from a neighboring (degenerative) joint, (i.e., the tibiotalar or subtalar) via an articular branch arising from the medial aspect of the nerve [1, 3–6]. The cyst may propagate proximally to the tibial nerve proper, before crossing over and descending down the lateral and medial plantar or calcaneal nerves [4, 5]. Expansion of the nerve within the confines of the tarsal tunnel can lead to symptoms of painful paresthesias of the plantar aspect of the foot, as well as evidence of denervation of the abductor hallucis muscle on EMG, consistent with a diagnosis of tarsal tunnel syndrome. High-resolution imaging of the tarsal tunnel with MRI or ultrasound can identify cystic expansion of the nerve, as well as the joint connection. Decompression of the tarsal and/or plantar tunnels along with disconnection of the cystic articular branch is the recommended treatment; however surgery can be difficult, owing to the anatomy of the tibial nerve and its branching pattern in this area and the associated vascular bundle (posterior tibial artery and vein), not to mention the pathology of the intraneural cyst complex, especially in revision cases [4, 5]. We present a case of an intraneural ganglion cyst of the tibial nerve arising from the subtalar joint and highlight a technique to uncover a "safe zone" along the medial border of the nerve

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allowing for safe disconnection of the joint connection without causing injury to the distal branches of the tibial nerve. While intraneural cysts in this location are rare, we have used this technique in several cases leading to adequate disconnection of the articular branch, cyst decompression, and resolution of symptoms without injury to the tibial nerve.

Case illustration

A 52-year-old man presented with a several months history of medial plantar painful paresthesias that developed spontaneously and worsened with activity. Physical examination demonstrated decreased sensation in the medial plantar nerve distribution without appreciable motor weakness in the foot. There was tenderness with percussion over the tarsal tunnel. Prior to our evaluation, an ultrasound-guided steroid injection into the tarsal tunnel gave him no relief. Repeat high-resolution ultrasound and MRI of the ankle (Fig. 1) demonstrated a complex, cystic dilation of the medial plantar nerve with a connection to the degenerated subtalar joint. The cyst had propagated proximally along the medial plantar nerve to involve the origin of the tibial nerve and descended along the medial and lateral plantar nerves. There was denervation edema within the abductor hallucis muscle. The patient underwent surgery for decompression of the tarsal tunnel and disconnection of the articular branch (Fig. 1); the distal cyst was not explored or decompressed. At 3-month post-op, the patient had relief of preoperative symptoms and follow-up

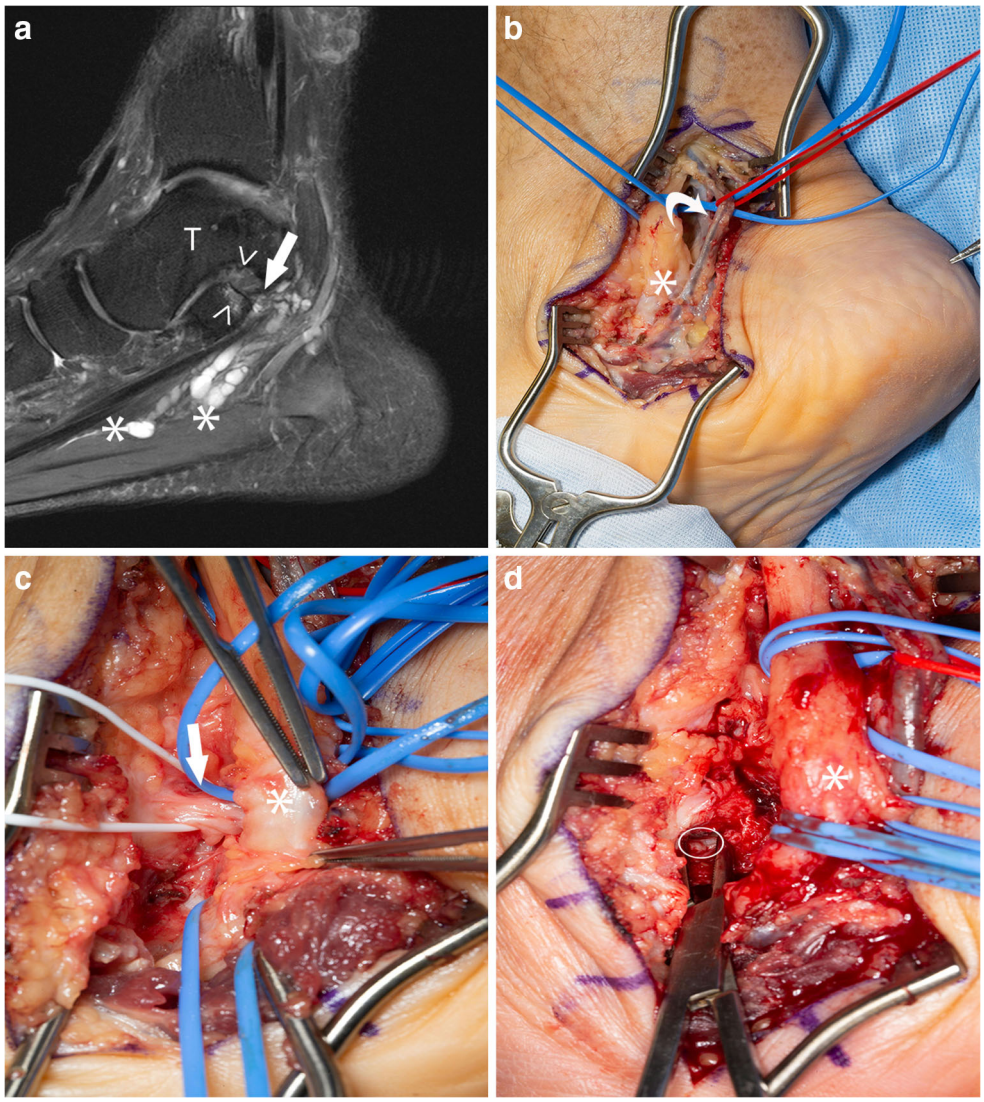

Fig. 1 A 52-year old man with symptoms of tarsal tunnel syndrome. **a** Sagittal T2-weighted MRI of the ankle demonstrates cystic dilation of the medial plantar nerve at the junction of the distal tibial nerve with a connection (arrow) to the degenerative subtalar joint (arrowheads). Cystic dilation has progressed in the medial and lateral plantar nerves distally (asterisks). T, talus. **b** Intraoperative picture demonstrating lateral mobilization (curved arrow) of the vessels uncovering the intraneural cyst in the medial plantar nerve (asterisk). **c** The joint connection (arrow) is seen arising from the medial aspect of the medial plantar nerve (asterisk). **d** The defect within the subtalar joint (circle) is seen after capsulotomy of the subtalar joint and disconnection of the articular branch at the end of the case (when the tourniquet is delfated)

MRI-demonstrated resolution of the intraneural cyst within the medial and lateral plantar nerves and improvement in the denervation changes within the abductor hallucis.

Technical note

The unifying articular theory suggests that disconnecting the articular branch can lead to resolution of the cystic dilation within the involved nerve. Within the tarsal tunnel, identifying the joint connection and distinguishing it from involved distal branches of the tibial nerve which should be preserved can be challenging. In some cases, the articular branch is small and difficult to identify. Making this approach more difficult is inadvertent decompression of the intraneural cyst, which can deflate it, as well as the possibility of injury to the neighboring posterior tibial artery and vein. If the procedure is performed with a tourniquet in place, injury to the vessels may not be readily apparent until the end of the case. We present a technique of uncovering a "safe zone" along the medial aspect of the tibial nerve, which provides for disconnection of even a difficult to identify articular branch without risking injury to the vascular bundle or important distal branches of the tibial nerve (Fig. 2).

During the initial exposure, the normal tibial nerve should be identified proximally within the tarsal tunnel and placed in a vessel loop. At this level, the vascular bundle (posterior tibial artery and vein) can also be identified and controlled in a vessel loop. The vascular bundle is often superficial and anterior to the medial and lateral plantar nerves, and complex branching patterns can make identification of tibial nerve difficult. Distal dissection through the tarsal tunnel can allow lateral mobilization of the vascular bundle (i.e., so that the vessels are away from the ankle/subtalar joints and posterior to the nerves). Within the tarsal tunnel, all important branches of the tibial nerve (calcaneal, lateral plantar) arise from the lateral aspect of the nerve. In nearly every case, the articular branch arises from the medial aspect of the tibial/medial plantar nerve. After control of the vascular bundle is achieved, the tibial nerve and its branches can then be identified and traced through the tarsal and/or plantar tunnels. By mobilizing the vascular bundle laterally, the surgeon uncovers the medial "safe zone" along which there are no important branches, and the articular branch almost certainly arises. Any apparent connections from the nerve to the joint medially can be coagulated and dissected. In the field of orthopedic surgery, there is a maxim that "bone is home" suggesting that dissection directly along bone provide a mostly safe corridor where surrounding structures can be avoided. In the case of intraneural ganglion cysts of the tibial nerve in the tarsal tunnel, bone is again home, as it not only provides a safe zone along the nerve but harbors the abnormal connection from joint to the nerve. If direct cyst decompression is thought necessary, a small epineural window can be created allowing for some direct cyst decompression. This can be considered for more immediate symptom relief, although this is not required and may risk injury to the nerve fascicles. After this is complete, the degenerated joint and associated capsular defect can often be identified. We recommend incising the joint capsule and debriding it. We believe this technique decreases the risk to both the vessels and nerves incurred by attempting to operate between small corridors between the nerve and vascular branches, which are many, along the lateral aspect of the nerve.

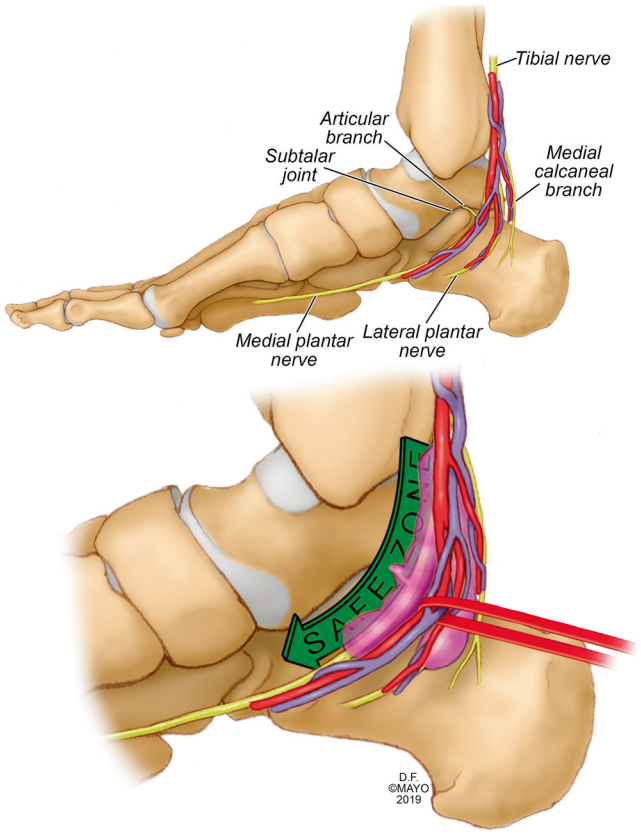

Fig. 2 Anatomical depiction of the neurovascular anatomy within the tarsal tunnel. Lateral mobilization of the posterior tibial artery and vein uncovers the medial "safe zone" along the distal tibial and medial plantar nerves. There are no important distal branches of the tibial nerve along this safe medial border, and any apparent connections from the medial plantar nerve to the subtalar joint can be coagulated and disconnected (reproduced with permission from Mayo Clinic, 2019)

Conclusion

Uncovering the safe zone along the medial border of the tibial/medial plantar nerve in cases of intraneural cysts can facilitatearticular branch recognition and disconnection with a lower risk of injury to the important neurovascular structures within the tarsal tunnel.

Compliance with ethical standards IRB approval was obtained for this study.

All patients included signed consent forms for the use of non-identifying medical information in medical research, including this study.

Conflict of interest The authors declare that they have no conflict of interest.

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Comments

Excellent article describing how to deal with a surgically challenging ganglion cyst involving the tibial nerve and it's distal branches with excellent intraoperative photographs and schematic illustrations.

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