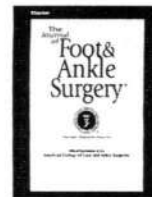


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## Tips, Quips, and Pearls

"Tips, Quips, and Pearls" is a special section in The Journal of Foot & Ankle Surgery<sup>®</sup>, which is devoted to the sharing of ideas to make the practice of foot and ankle surgery easier. We invite our readers to share ideas with us in the form of special tips regarding diagnostic or surgical procedures, new devices or modifications of devices for making a surgical procedure a little bit easier, or virtually any other "pearl" that the reader believes will assist the foot and ankle surgeon in providing better care.

## Schwannomas of the Foot and Ankle: A Technical Report



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### ABSTRACT

The present technical report provides a detailed description of open surgical resection of peripheral nerve sheath tumors in the foot and ankle. We present 3 cases to illustrate important differences in the technique based on the presentation, anatomic location, and intraoperative neurophysiologic monitoring findings. It is important for surgeons to understand that surgical excision of many peripheral nerve sheath tumors can be undertaken without en bloc resection of the entire nerve trunk.

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Schwannomas are benign encapsulated tumors that originate from Schwann cells in the peripheral nervous system (1) and, compared with neurofibromas, are the more common of these 2 principal subtypes of benign peripheral nerve sheath tumors (PNSTs) (2,3). Although classically associated with neurofibromatosis types 1 and 2, PNSTs can also occur as solitary lesions in the general population. The location of PNSTs can be quite diverse (3,4), with the head and neck being the most common sites (5) and the foot and ankle relatively less common (6,7). In 1 single-center retrospective review, only 14 of 137 identified PNSTs (10.2%) were located in the foot and/or ankle (4). In another series, 12 of 104 (11.5%) solitary benign PNSTs identified in a single hospital during a 32-year period were located in the foot and/or ankle (8).

The clinical presentation of a patient with a PNST in the foot or ankle will depend on the precise location and size of the lesion. The signs and symptoms will typically result from the mass effect and/or direct involvement of the nerve and surrounding tissues (9). Owing to the slow growth of these tumors and the nonspecific nature of the associated signs and symptoms, PNSTs often go undiagnosed for many years, until the tumor has become large enough to produce an easily palpable lump or grossly evident mass effect (5,10). Furthermore, the signs and symptoms of PNST can be incorrectly attributed to some

other, more common clinical entity. For instance, PNSTs are a rare cause of tarsal tunnel syndrome when they occur in a location that allows for impingement of the posterior tibial nerve. Thus, PNSTs in this location are often misdiagnosed initially as entrapment neuropathy or lumbosacral radiculopathy (5,10).

Importantly, surgical resection of PNSTs in the foot and ankle is associated with minimal postoperative morbidity and rare recurrence, if resected properly (4,11). Therefore, it is necessary to consider PNST in any patient with nonspecific signs and symptoms of a foot or ankle mass lesion or nerve injury of unknown etiology and to be familiar with the proper technique of surgical resection for when such lesions are identified. We have reviewed a single surgeon's technique of surgical resection of such lesions by reviewing 3 cases of World Health Organization grade 1 schwannomas located in the foot and ankle.

### Surgical Technique

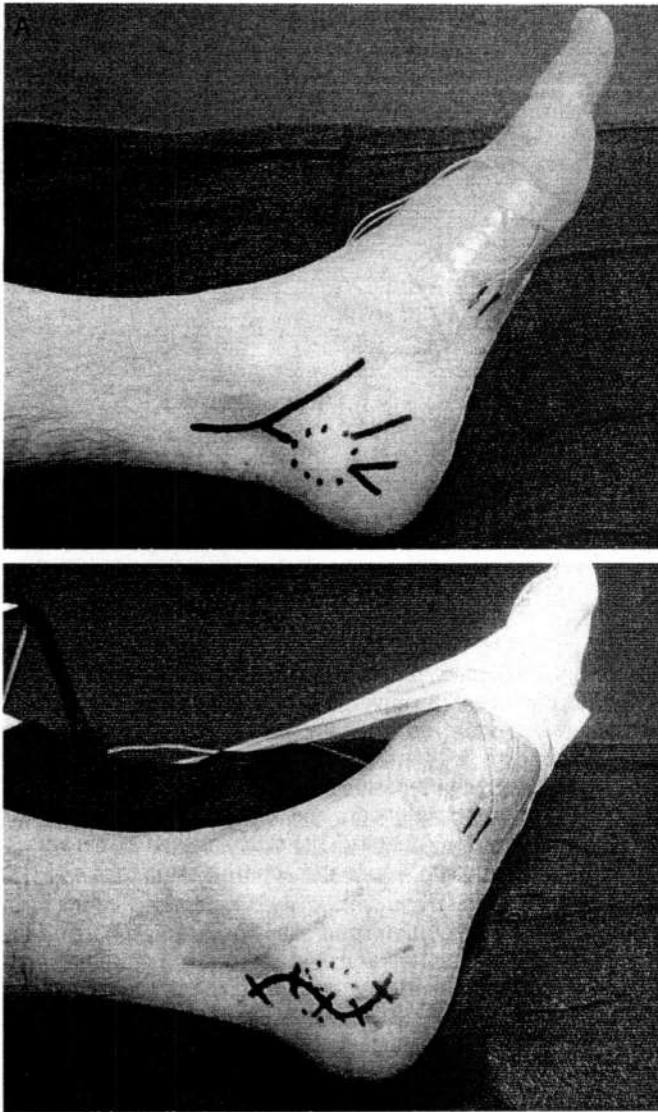
Each of the 3 cases of foot and/or ankle schwannoma has been discussed separately. The clinical presentation and diagnostic workup have been reviewed only briefly, followed by a description of the open surgical resection of the tumor, the focus of the present report. Although each of the cases discussed pertains to a pathologically confirmed schwannoma of the foot and/or ankle, the particular nerve affected was different in each patient, and, therefore, the nuances of the surgical resection varied among the cases. The operative technique has been reviewed in detail for patient 1, and the relevant discussion for the subsequent cases highlighted the distinguishing features of each particular case.

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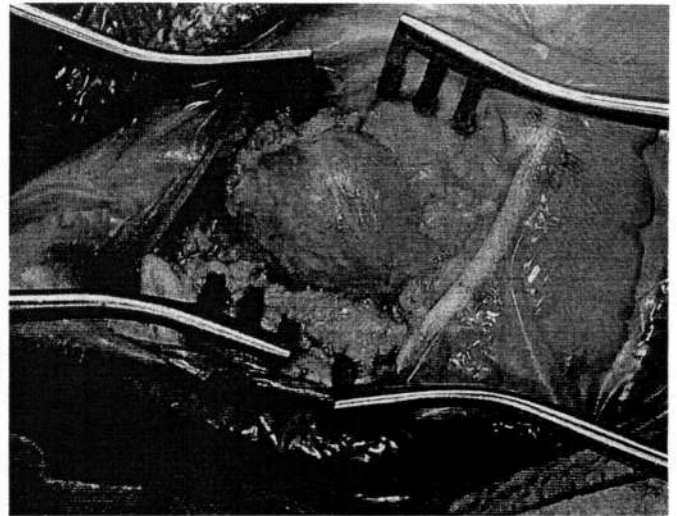
**Fig. 6.** Intraoperative photograph showing surgical approach for patient in the supine position. (A) Tibial nerve and its lateral calcaneal branches indicated by solid lines. Dotted line indicates the tumor, arising from the lateral calcaneal branch of the tibial nerve. (B) A lazy-s incision (solid line) was used to provide adequate exposure of both nerve and tumor while avoiding an incision onto the glabrous skin of the heel.

distally to the lesion and to facilitate external neurolysis of the tumor (Fig. 7).

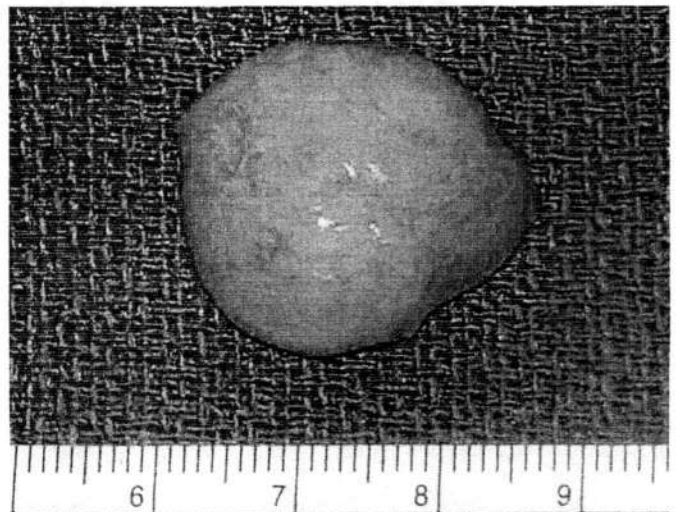
Intraoperative nerve stimulation was conducted, and the absence of an electromyographic response after stimulation of the affected nerve confirmed that this was a sensory branch. A longitudinal incision was then made along the direction of the nerve fibers, and the dissection was carried down into the potential space between the tumor and the parent nerve. The tumor was able to be easily dissected free from the parent nerve and removed in 1 piece (Fig. 8), leaving the parent nerve anatomically intact. Hemostasis was achieved with electrocautery and FloSeal® (Baxter, Healthcare), the wound was copiously irrigated and then closed with 4-0 multifilament absorbable sutures and 5-0 nylon sutures in the skin, and dressings were applied.

### Patient 3

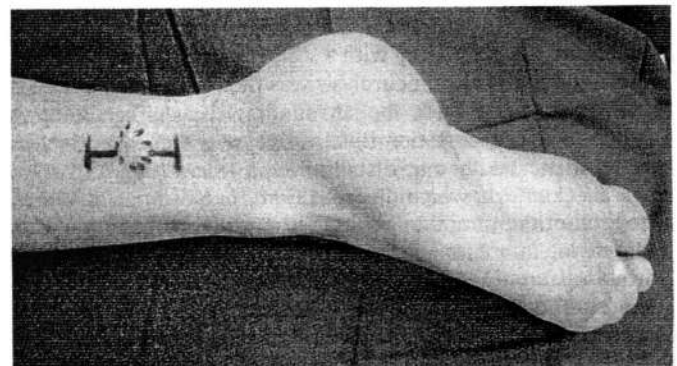
Patient 3 presented with a 20-year history of a mass along the left lateral ankle that had slowly enlarged and eventually became



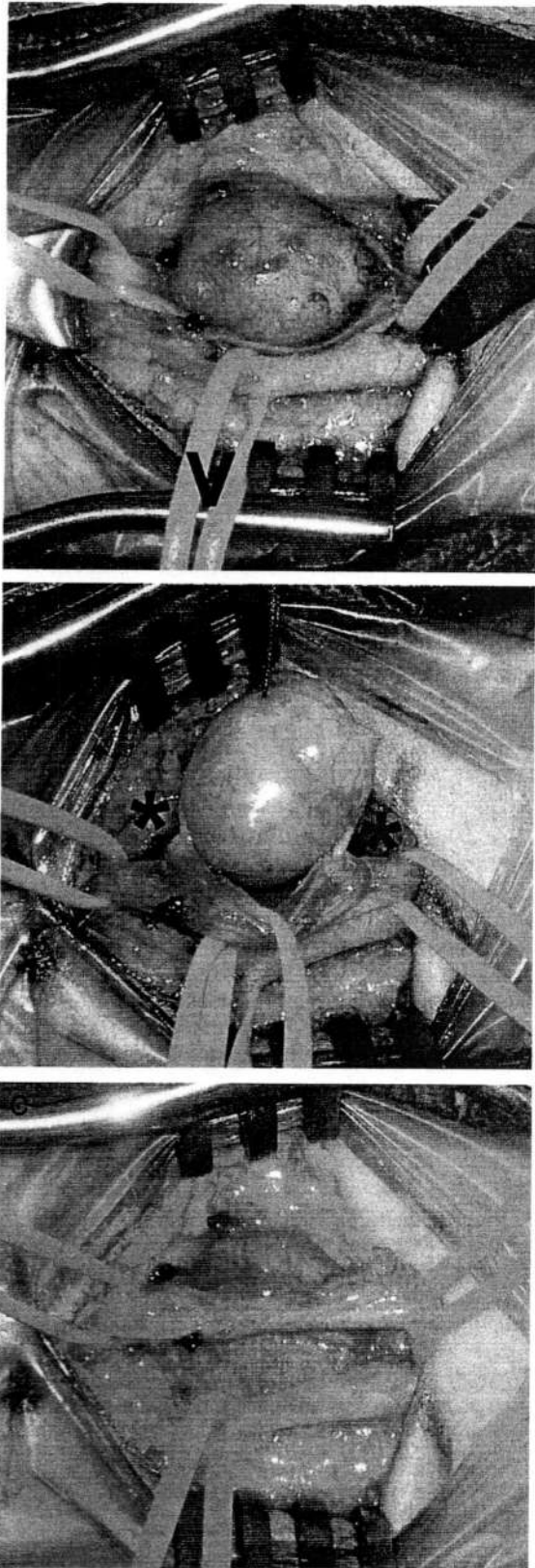
**Fig. 7.** Intraoperative photograph after dissection of the tumor. The tumor was located within the lateral calcaneal branch of the tibial nerve and was adequately exposed with the lazy-s incision.



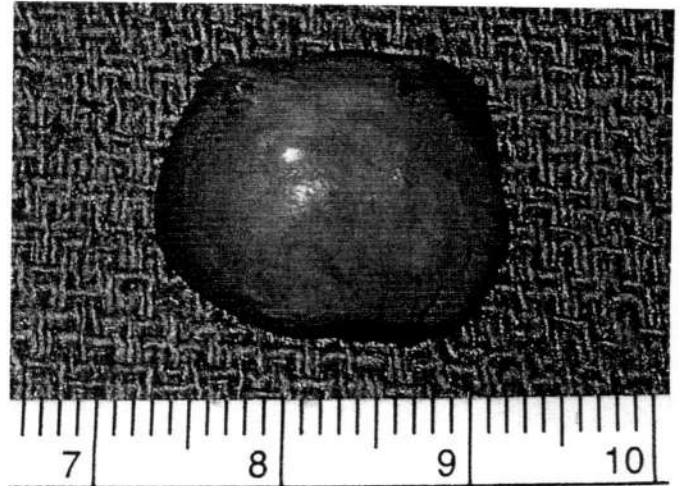
**Fig. 8.** Intraoperative photograph showing lateral calcaneal nerve schwannoma after gross total excision.



**Fig. 9.** Intraoperative photograph showing the surgical approach with the patient in the prone position. The incision (solid line) is directly over the sural nerve; dotted line indicates the nerve sheath tumor.



**Fig. 10.** Intraoperative photograph showing exposure, dissection, and removal of the tumor. (A) The sural nerve and tumor have been subjected to external neurolysis. The proximal and distal nerve segments and lesser saphenous vein (V) have all been tagged with vessel loops. (B) The tumor has been dissected free from the sural nerve after a longitudinal incision over the thinnest portion of the nerve. The tumor remains attached to the sural nerve by 2 small fascicles (asterisks). (C) The tumor has been removed, and the sural nerve remains functionally and anatomically intact.



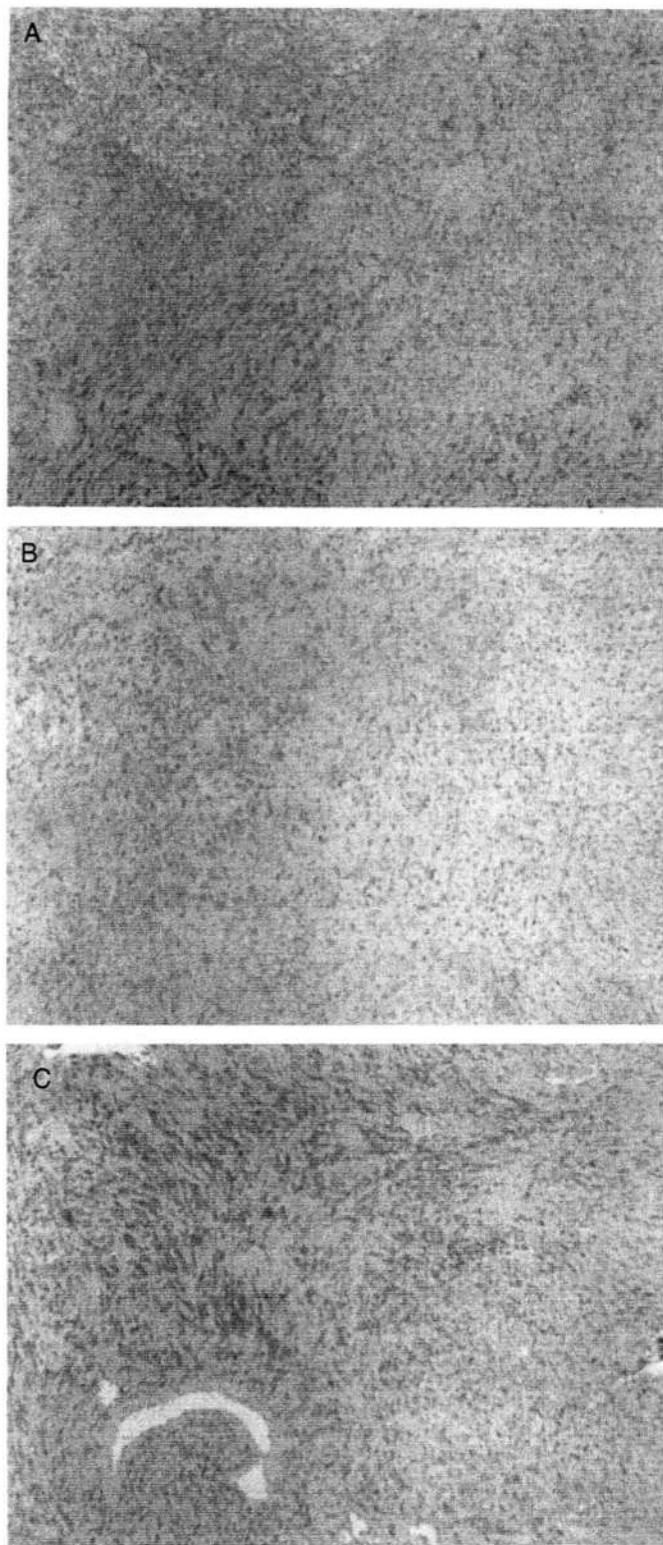
**Fig. 11.** Intraoperative photograph showing sural nerve schwannoma after gross total excision.

associated with an electric shock-like sensation radiating into the lateral aspect of the foot. On examination at presentation, a mobile mass about 1.5 cm in diameter was palpated along the course of the sural nerve between the left lateral malleolus and the Achilles' tendon. The mass was noted to be exquisitely sensitive, and Tinel's sign was elicited with radiation into the sural distribution. The patient elected surgical resection, because the pain was beginning to interfere with his activities of daily living.

In the operating room, preoperative antibiotics and general anesthesia were administered, and the patient was then placed in the prone position to facilitate access to the lesion on the posteriorly located left sural nerve (Fig. 9). The patient was prepared and draped in the usual sterile fashion, local anesthetic was injected along the course of the intended surgical site, and a 2.5-in. incision was made along the course of the sural nerve just above the left ankle. After dissecting down to the subcutaneous tissues and placing a self-retaining retractor, the sural nerve was identified, and external neurolysis was achieved, including dissection of the lesser saphenous vein off of the nerve. Vessel loops were then placed both proximally and distally to the tumor and on the lesser saphenous vein (Fig. 10A), and intraoperative nerve stimulation was used to identify the optimal site of incision into the tumor for internal neurolysis. A longitudinal incision was made parallel to the nerve fibers at a quiescent site, the tumor was dissected apart from the parent nerve along the subepineural plane (Fig. 10B), and the tumor was removed in 1 piece (Fig. 11), leaving the parent nerve anatomically intact (Fig. 10C). Final hemostasis was achieved with bipolar electrocautery, and the wound was irrigated and closed with 3-0 multifilament absorbable suture and adhesive skin strips.

## Discussion

The clinical presentation of each of these 3 patients was typical for benign PNST of the foot and/or ankle. Pain and/or numbness were the primary complaints in each case, and the precise distribution of these symptoms allowed accurate localization of the tumor to a particular peripheral nerve. Furthermore, a mass was palpable at the symptomatic site in each of these patients, further facilitating the diagnosis. The correct diagnosis was made in all 3 cases without a significant delay or an initial misdiagnosis (Fig. 12), notable given that correct diagnosis was delayed by a mean of 86.5 months in



**Fig. 12.** (A and B) Micrographs of hematoxylin and eosin-stained tumor sample from patient 2, illustrating characteristic Antoni A and B areas of schwannomas (original magnification  $\times 100$ ). (C) Another hematoxylin and eosin-stained sample obtained from patient 2, demonstrating Verocay bodies and hyalinized vessels also characteristic of schwannomas (original magnification  $\times 100$ ).

a previous cohort of 25 patients with schwannoma of the posterior tibial nerve (5).

With regard to the surgical resection, a number of key aspects of the operative technique are worthy of additional discussion and emphasis. It is critical to expose the affected nerve with sufficient margins, both proximally and distally to the lesion. Adequate exposure will allow for proper visualization of the anatomy and will also facilitate intraoperative nerve stimulation and unobstructed dissection of the tumor from the parent nerve. To achieve adequate exposure for lesions located in the foot and/or ankle, it could be necessary to sharply dissect the fibrous flexor retinaculum overlying the tarsal tunnel, such as in patients 1 and 2. For distal lesions, we prefer to keep the incision off the glabrous skin whenever possible to minimize the risk of wound healing complications on weightbearing skin surfaces. We used intraoperative nerve stimulation and monitoring in each of these cases. The reasons for this were threefold. First, it allowed confirmation of the visualized anatomy. This was demonstrated in patient 2, for whom the preoperative diagnosis was a mass lesion on the calcaneal branch of the tibial nerve, which provides cutaneous innervation to the skin of the heel and medial side of the sole of the foot. Intraoperative nerve stimulation allowed confirmation that the affected nerve was, in fact, an exclusively sensory nerve, reaffirming the preoperative diagnosis. Second, intraoperative nerve stimulation is critical for identifying the optimal location for the incision into the lesion and internal neurolysis. From the results of the neurophysiologic testing, a quiescent area of nerve fibers can be selected and a longitudinal incision made along the direction of the epineurial fibers to minimize disruption of the anatomic and functional integrity of the parent nerve.

In conclusion, we have reviewed 3 cases of schwannoma of the foot and/or ankle and provided a technical report of the surgical resection of these lesions. The use of microsurgical techniques, such as was described for these cases, allows for the safe removal of these lesions in the overwhelming majority of cases without causing neurologic deficits. Thus, the technique of cross clamping the nerve and excising the tumor by sacrificing the nerve should be avoided. Adequate surgical exposure, careful identification of the essential anatomy, and intraoperative nerve monitoring are simple steps that can be taken to minimize the complications of this procedure.

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