ORIGINAL ARTICLE

The Risk of Adjacent Nerve Recruitment During Posterior Tibial Nerve Stimulation

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ABSTRACT

Purpose: This report describes the recruitment of an adjacent nerve during attempted stimulation of the posterior tibial nerve intraoperatively.

Methods: During sciatic nerve exploration surgery, somatosensory evoked potentials (SSEPs) and other modalities were recorded. Electrodes for eliciting the lower extremity SSEPs were placed at the typical site on the medial aspects of the ankles for posterior tibial nerve (PTN) stimulation. Transcranial motor evoked potential (TcMEP) and compound muscle action potential (CMAP) recording sites were in the gastrocnemius, tibialis anterior, and biceps femoris muscles.

Results: The posterior tibial nerve stimulation yielded no SSEP response at an intensity of 30 mA. Stimulation was then increased to 50mA, producing a morphologically abnormal but reproducible SSEP response. It remained reproducible throughout the remainder of the surgical procedure. A distal segment of the sciatic nerve was exposed and mobilized, and an attempt was made to record a CMAP from the typically innervated muscles using direct-nerve concentric bipolar probe stimulation. However, no CMAP could be recorded. Further exposure of the sciatic nerve revealed a complete transection proximal to the initial site of nerve stimulation.

Conclusion: The posterior tibial nerve courses superiorly, joined by the common fibular nerve at the level of the popliteal fossa, forming the sciatic nerve. Given the proximal transection of the sciatic nerve, it was concluded that the SSEP, as recorded, could not have resulted from PTN stimulation but rather from the saphenous nerve. The phenomenon of adjacent nerve depolarization has been previously described in other nerves, particularly the wrist. To our knowledge, this is the first recruitment report between the posterior tibial and saphenous nerves.

INTRODUCTION

It is well-known that hip surgery can lead to injury of the sciatic nerve, with accidental iatrogenic trauma during the procedure being responsible for 21% of all sciatic nerve injuries, as reported by Robinson et al. in 2000. In cases where the nerve has been completely transected, the prognosis is particularly poor. Therefore, in patients with iatrogenic transection, immediate surgical exploration and repair via nerve graft is crucial to prevent permanent loss of motor function, which can occur if motor units are not reinnervated within 12-24 months.

Intraoperative neurophysiologic monitoring (IONM) has been used to identify sciatic nerve injury's presence, severity, and location. This report describes a case in which an ostensibly intact somatosensory evoked potential (SSEP) initially led us to conclude that the sciatic nerve was at least partially intact. However, upon subsequent exploration, it was determined that the nerve was, in fact, completely transected.

CASE DESCRIPTION

The patient is a 50-year-old woman who was evaluated by a multidisciplinary team at the Dartmouth-Hitchcock Peripheral Nerve clinic for evaluation of right foot drop. Approximately thirteen months before her presentation to our service, the patient underwent emergent right hip debridement for septic arthritis at an outside hospital. Post-operatively, the patient had a profound, diffuse weakness, as well as hypoesthesia of all sensory modalities in her right foot. Her symptoms were initially managed conservatively with physical therapy and an ankle/foot orthosis. Eight months following her hip debridement, the patient experienced no improvement in her symptoms and was subsequently referred to our peripheral nerve service.

MRI of the pelvis demonstrated an asymmetric increased T2 signal and mild enlargement of the right sciatic nerve at the level of the ischial tuberosity. The nerve demonstrated a small surrounding area of T2 signal change at this location, possibly indicating edema or scarring. However, no definite nerve transaction was identified on imaging.

Electromyography (EMG)/nerve conduction velocity (NCV) studies were normal in the bilateral upper extremities. The right peroneal and posterior tibial nerve responses were absent in the lower extremities. Additionally, bilateral sural nerve responses were also absent. These findings were consistent with sensory polyneuropathy, as well as a severe right sciatic nerve injury.

The patient demonstrated mild atrophy of the right calf and intrinsic foot muscles on physical exam. Tinel's sign was negative when tapping over the right fibular neck. There was 3/5 strength of right knee flexion (compared to 5/5 on the left) and 0/5 strength with right foot dorsiflexion, right great toe extension, right foot eversion, right plantar flexion, and right toe flexion, compared to 5/5 for the corresponding muscle groups on the left. The sensation was diminished on the right foot's dorsum, right first interweb space, plantar surface, and lateral aspect. A diagnosis of right foot drop was made, with motor and sensory deficits consistent with severe injury to the sciatic nerve.

The patient was scheduled for a surgical neurolysis of the right sciatic nerve with intraoperative neurophysiologic monitoring (IONM). The IONM plan was to record SSEPs with bilateral posterior tibial nerve stimulation, transcranial electrical motor evoked potentials (TcMEPs) from lower extremity muscles, and compound muscle action potentials (CMAPs) with direct sciatic nerve stimulation. The surgeon sterilely placed the needle recording electrodes into the following muscles: gastrocnemius, tibialis anterior, and biceps femoris. The anesthetic regimen provided was total intravenous anesthesia (TIVA) with short-acting neuromuscular blockade at induction, with no further administered paralytics. Train-of-four testing was confirmed to be 4:4 before any nerve or muscle stimulation.

At the initiation of IONM, no reproducible SSEP response could be obtained with the right PTN stimulation at 30 mA intensity. When the stimulation current was increased to 50 mA, a small but reproducible response was recorded at a latency of approximately 43 msec (Fig. 1). Of note. However, TOF was 4:4, and no toe twitch was appreciated during the delivery of electrical stimulation to the right PTN. The left toe twitched when the current was delivered to the left PTN.

Figure 1. Curve stack of cortical SSEP responses (43 msec latency) to stimulation delivered at the right PTN. The current was increased until cortical SSEP responses were obtained, with positive peaks indicated by the dashed lines.

The sciatic nerve was exposed in the right posterior thigh, and it was stimulated directly using a concentric bipolar probe to record CMAPs from the distal lower extremity muscles. Stimulation intensity was initially set at 1.0 mA, then gradually increased at the surgeon's request in increments of 1.0 mA until a maximum intensity of 20 mA was reached. No CMAP responses were seen at any stimulation intensity in the ipsilateral gastrocnemius, tibialis anterior, and biceps femoris muscles. To confirm the integrity of the circuit, the surgeon stimulated an exposed muscle in the field and observed a focal contraction, verifying that the bipolar probe was delivering current.

The nerve was dissected further and exposed proximally as planned since the initial stimulation attempt was distal to the area targeted for surgical exploration. As the nerve exposure reached the right hip, it was discovered that the sciatic nerve was entirely transected within a few centimeters distal to the sciatic notch. (Fig. 2)

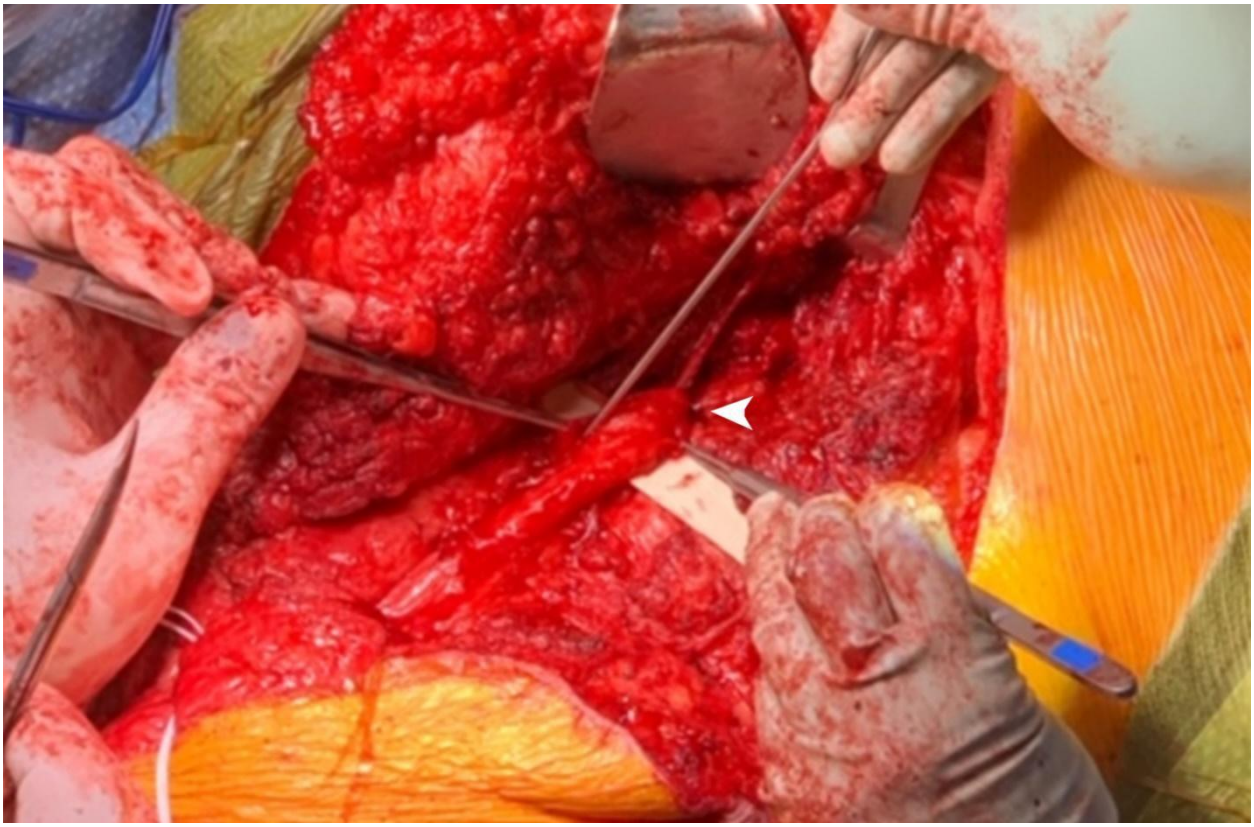

Figure 2. The truncated end of the distal sciatic nerve (white arrow). The retractor at the top of the image is lifting the gluteus muscles. The stump neuroma is visible at the end of the nerve and was trimmed using the tongue depressor seen underlying the nerve.

After these findings, the planned neurolysis was abandoned. The proximal and distal trunks of the sciatic nerve were identified and trimmed until healthy fascicles were observed. The two free ends of the sciatic nerve were then cable grafted using bilateral sural nerve grafts. With high current stimulation, the right lower extremity SSEP remained stable compared to baseline until IONM was discontinued.

DISCUSSION

The posterior tibial nerve is a mixed motor and sensory nerve that courses posteriorly to the medial malleolus and joins the peroneal nerve at the knee to become the sciatic nerve, inserted into the spine through the L4-S3 nerve roots.

The saphenous nerve is a pure sensory nerve with no motor component. It courses anteriorly to the medial malleolus (Fig. 3) and ascends to join the femoral nerve inferior to the head of the femur. Branches of the femoral nerve insert into the spine at the L3 and L4 levels.

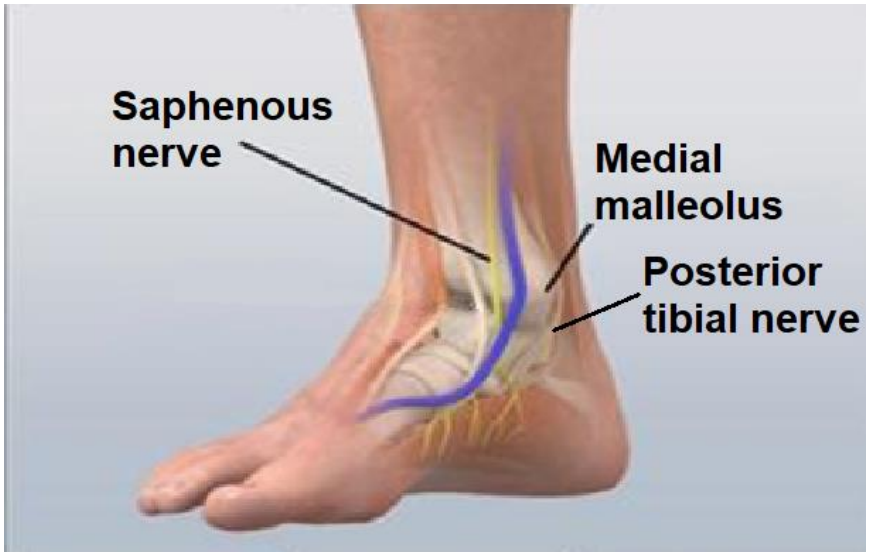

Figure 3. The complete transection of the sciatic nerve at the level of the lower buttock resulted in Wallerian degeneration distal to the injury. For this reason, we could not obtain CMAP responses from any muscle with direct stimulation of the sciatic nerve. It also explained our initial inability to record SSEPs with PTN stimulation at lower stimulation intensities.

We hypothesize that increased stimulation current from 30 mA to 50 mA created a large enough electrical field to depolarize the saphenous nerve. This resulted in a falsely reassuring SSEP when the nerve we intended to stimulate was, in fact, transected.

Adjacent nerve recruitment from supramaximal stimulation is a well-known phenomenon in generating SSEPs at the wrist [3] but is less frequently encountered at the ankle. This case report demonstrates that care must also be taken when stimulating the ankle to avoid the recruitment of other adjacent nerves. Inadvertent stimulation of non-targeted nerves could lead to misinterpretation of the IONM recordings, resulting in an inappropriate surgical procedure.

CONCLUSION

The phenomenon of adjacent nerve recruitment through supramaximal stimulation has been a well-established method of generating SSEPs at the wrist. However, its application at the ankle is not as often observed. It is crucial to exercise extreme caution when stimulating nerves in the ankle region to avoid the inadvertent recruitment of adjacent nerves. Failure to do so can lead to misinterpretation of IONM recordings, resulting in inappropriate surgical intervention.

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REFERENCES

1. Robinson LR. Traumatic injury to peripheral nerves. *Muscle Nerve Off J Am Assoc Electrodiagn Med*. 2000;23(6):863-873.
2. Yuen EC, Olney RK, So YT. Sciatic neuropathy: clinical and prognostic features in 73 patients. *Neurology*. 1994;44(9):1669
3. Shah, A., Nguyen, V., Lee, L. H., Le, S., Cho, S. C., & Lopez, Isolating C8 nerve root technique with focal digital stimulation, *Clinical Neurophysiology*, Volume 129, Supplement 1, May 2018, Page e108