

The Reset Neurotomy within a Nonidentifiable Zone of Injury after Trauma

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Summary: Recent reconstructive approaches to peripheral nerve surgery have been directed toward active approaches; one such approach is nerve grafting the injured nerve segment. Addressing a nerve injury proximal to the zone of injury has demonstrated reproducible results in preventing symptomatic neuroma formation. A 53-year-old woman with a history of an ankle fracture presented with neuritic symptoms that interfered with her activities of daily living. Her intractable pain was significantly but temporarily relieved with in-office nerve blocks to the superficial peroneal nerve and sural nerve. There were no identifiable zones of injury in the nerve conduction study. Orthopedic etiology was ruled out. Nerve allografts, each 3 cm in length, were utilized with conduits and placed at the location proximal to the zone of maximum tenderness. Once the neurotomy was performed, the nerve allografts and conduits were coapted to each nerve. The patient's intractable neuritic pain was relieved even 15 months postoperatively. The visual analog scale went from eight of 10 preoperatively to two of 10 postoperatively. Additional nerve conduction studies were not needed, and the patient returned to daily activities once the skin incisions healed. The reset neurotomy is an option for the microsurgical surgeon to have for patients with a nonidentifiable zone of injury or no identifiable neuroma but presents with intractable nerve pain relieved by local anesthetic nerve blocks. (*Plast Reconstr Surg Glob Open* 2023; 11:e5316; doi: 10.1097/GOX.0000000000005316; Published online 12 October 2023.)

Sensory nerve injuries caused by a nontransected injury are challenging to address.¹ A painful neuroma will be symptomatic in at least 3%–5% of patients with nerve injuries.² Ablative techniques such as nerve capping, excision and implantation into muscle or bone, and traction neurectomies have been utilized.^{3–5} Recent techniques aim to satisfy the distal nerve using active or reconstructive interventions.³ After identification of the location and type of neuroma, autograft or allograft nerve reconstruction can be considered if the distal healthy nerve end is available.⁶ Reconstructive procedures allow for nerve regeneration to be more organized to prevent

symptomatic neuromas.^{3,6–12} Eberlin et al¹ presented the reset neurectomy involving transection of a nerve segment proximal to the zone of injury using a nerve allograft in Sunderland grade II, III, and IV injuries.¹

CASE

History and Physical

A 53-year-old woman presented with intractable neuropathic pain in her right leg and right dorsal-lateral foot. She had a history of a right ankle fracture and a right ankle arthroscopy with gastrocnemius recession. Postoperatively, the patient experienced continued pain at night, loss of sleep, and difficulty walking. There was maximum tenderness, burning, and tingling pain along the superficial peroneal nerve at the middle one-third of the leg and along the sural nerve 3 cm proximal to the ankle joint with decreased light touch sensation to the right dorsal-lateral foot. Decreased joint space at the subtalar joint and ankle joint were noted on radiographs.

Nerve Conduction Velocity Study and Electromyography

The nerve conduction velocity study and electromyography (NCV/EMG) was unremarkable with normal distal

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latencies. The needle electromyography revealed no alterations at rest or during voluntary control. There was no evidence of focal entrapment neuropathy nor polyneuropathy in the lower limbs.

Nerve Blocks

Ultrasound-guided peripheral nerve blocks were administered proximal to the point of maximal tenderness to the right sural and superficial peroneal nerves. For each nerve block, 1 mL of 0.5% bupivacaine plain was used. The patient reported 50% pain reduction, lasting several days. Posttraumatic arthritic pain was evaluated and ruled out. A discussion was conducted that the intractable pain may decrease after the surgery, but numbness may be present postoperatively.

Surgical Technique

The assessment included right sural neuritis and right superficial peroneal nerve neuritis. The surgical plan included right superficial peroneal nerve and sural nerve external neurolysis, reset neurotomy with conduit-allograft assisted repair (3 cm × 4 mm allografts with 4 mm conduits; Axogen, Inc., Alachua, Fla.), platelet-rich plasma, and bone marrow aspirate from the proximal tibia. The allograft was used as a trajectory for nerve growth to reduce pain symptoms without removing the nerve itself due to no identifiable zone of injury.

The procedure was performed under loupe magnification. Tourniquet and long-acting paralytics were avoided. A biphasic nerve stimulator was used to differentiate between the motor and sensory components of the superficial peroneal nerve.¹³ Platelet-rich plasma and bone marrow aspirate from the proximal ipsilateral tibia were administered.

The lateral compartment orthoplastic approach was utilized for exposure of the superficial peroneal nerve.

The superficial peroneal nerve was identified. An external neurolysis was performed. Next, a neurotomy was performed of the superficial peroneal nerve proximal to the zone of maximum provocation. The conduit-allograft-conduit construct was sutured with 9-0 nylon (Fig. 1). The porcine submucosa conduit provides a structure similar to neural tissue and was selected to avoid adhesions. An additional branch nerve variation of the superficial peroneal nerve was identified within the intercompartment septum and addressed with a regenerative peripheral nerve interface.

Next, attention was directed to the sural nerve. The anterior lateral aspect of the achilles tendon was identified, 3 cm proximal to the ankle joint, to expose the sural nerve proximal to the most painful provocation point. External neurolysis was performed, neurotomy, and then a conduit-allograft-conduit construct was sutured with 9-0 nylon (Fig. 2).

No nerve resections were performed on the superficial peroneal nerve or the sural nerve, only neurotomies with the superimposition of the conduit-allograft-conduit constructs proximal to the zone of injury due to no identifiable neuroma. The patient was put in a non-weight-bearing posterior splint for 2 weeks.

The pain on postoperative day 9 decreased from eight of 10 to one to two of 10. At 2.5 months, the patient noted significant improvement in neuritic symptoms, and she returned to her daily activities. At 15 months postoperatively, the patient rated her nerve pain symptoms a two of 10.

DISCUSSION

This neurotomy proximal to injury gives the nerve a “runway” to regenerate and is facilitated with the nerve allograft.¹ The allograft allows for regeneration or asymptomatic neuroma formation. The authors’

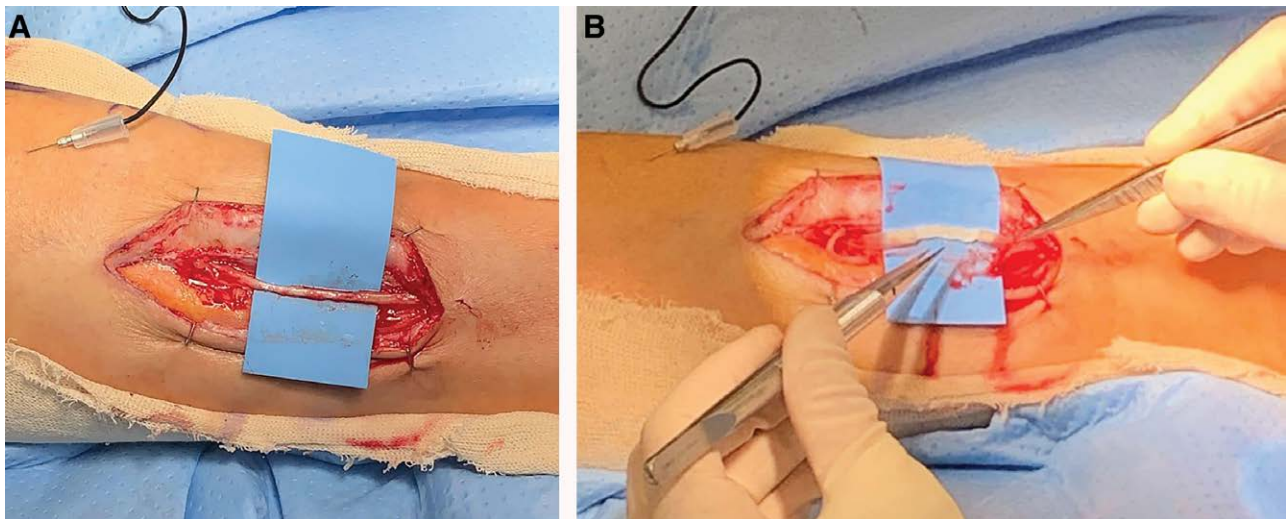


Fig. 1. The superficial peroneal nerve reset neurotomy. A, An external neurolysis was performed on the superficial peroneal nerve through the lateral orthoplastic surgical exposure. B, The neurotomy was performed with a tongue depressor and #10 blade, then coaptation took place with the conduit-allograft-conduit construct. The construct was sutured with 9-0 nylon under loupe magnification.

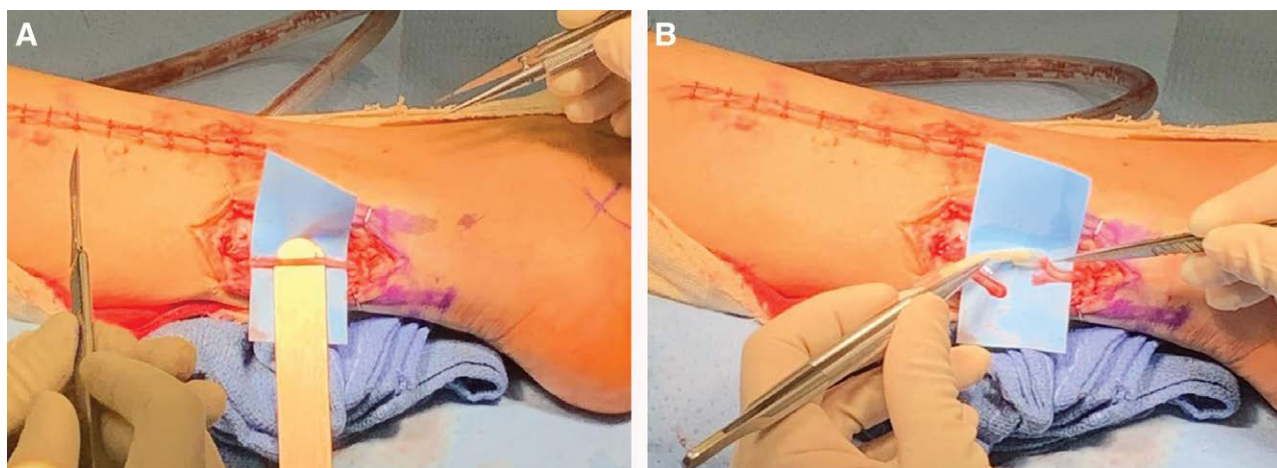


Fig. 2. The sural nerve reset neurotomy. A, An external neurolysis was performed on the sural nerve which was exposed anterior to the achilles tendon 3cm proximal to the ankle joint. B, The neurotomy was performed with a tongue depressor and #10 blade, then coaptation with the conduit-allograft-conduit construct like the superficial peroneal nerve reconstruction. The construct was sutured with 9-0 nylon under loupe magnification.

preferred method is an allograft with porcine submucosa conduits, although a conduit may also be utilized alone with a distance of less than 5 mm between nerve segments. Bone marrow aspirate and platelet-rich plasma are utilized adjunctively to promote active regeneration into the nerve allograft of the distal transected nerve.¹⁴

It should be noted that a reset neurectomy or reset neurotomy (depending if there is a nerve resection or nerve division without segmental resection) has been performed only in sensory nerve injuries. Because there was no identifiable neuroma or injury, no nerve segment was resected. There are several variations of nerves, especially the superficial peroneal nerve and sural nerve.¹⁵⁻¹⁸ No sural nerve variations were identified in this case.

The importance of nerve variations is to be able to ensure all branches/variations are identified and addressed. If neuritic symptoms persist at three months postoperatively, repeat NCV/EMG to ensure there is no neuroma formation or nerve entrapment.

CONCLUSIONS

The reset neurotomy is an option for patients with chronic intractable nerve pain with a history of trauma who do not have an identifiable zone of injury on NCV/EMG and respond well to nerve blocks. This is the first documented case with over a 1-year follow-up in which a neurotomy was performed in a nonidentifiable zone of injury after trauma, without resection of a nerve segment.

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DISCLOSURES

Dr. Rodriguez-Collazo is a consultant for Integra, Orthofix, and IstoBiologics. Dr. Oexeman is a consultant for Integra and Orthofix. The other authors have no financial interest to declare.

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