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Neurolysis, neurectomy, and grafting for chronic lower extremity pain following major rearfoot reconstruction

by Nathan Blanton[1*], DPM, Phuoc Bui, DPM, Dominic Rizzo, DPM, FACFAS

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Chronic pain is something that any provider will see throughout their career, and it is very common following trauma and/or reconstructive surgery. Up until recently, there hasn't seemed to be too many advances in treatment options for patients with chronic nerve pain, and who have had all other potential sources of pain ruled out. Unfortunately, a good number of patients either choose to deal with their pain day to day, or get passed onto pain clinics. Presented is a case report of a patient who had previous hindfoot reconstructive surgery and chronic lower extremity pain since surgery. The patient had diagnostic, in office, local anesthetic blocks applied around specific nerve courses. He reported improvement in his symptoms with these blocks. He then underwent surgical neurolysis and neurectomy of his superficial peroneal nerve and sural nerve, with significant subjective pain reduction post-operatively.

Keywords: nerve decompression, neurolysis, neurectomy, nerve cap, nerve allograft

Pain following acute trauma or major reconstruction is prevalent. A 2008 study found that 62.7% of patients still complained of pain up to one year following trauma or injury. Seventy-three percent of patients with lower extremity trauma complained of continued ongoing pain up to 7 years following the incident [1].

Incidents of trauma, and equally traumatic major reconstructive surgery, are events that are common enough to the foot and ankle surgeon that the complications of such events cannot be ignored. Being able to handle these patients with efforts other than chronic pain medication is becoming equally important in our modern society. According to the CDC, in 2017 the number of overdose deaths involving opioids (including prescription and illegal opioids) was six times higher than it was in 1999 [2]. Opioid prescribing has quadrupled since 1999, and according to a 2016 study, most opioid related deaths involved prescribed medications such as oxycodone and hydrocodone [3].

Not only is chronic pain a threat to a patient's quality of life, but there is data to suggest that it also has severe detrimental effects on the patient's social and family environment, and well as on the health care services. Employing proper peripheral nerve surgical techniques may be beneficial to the patient, when other, more conservative methods have failed to reduce pain. Presented is a case review of one patient undergoing microscopic peripheral nerve surgery for the treatment of chronic lower extremity pain, following previous reconstructive rearfoot surgery.

1 - TriHealth Residency – Director of Research, American Microsurgical Orthoplastic Society Chairman, Cincinnati, Ohio
* - Corresponding author: nathan_blanton@trihealth.com

Figure 1 The superficial peroneal nerve (SPN) emerging through the fascia to become superficial.

Figure 2 The nerve allograft sutured to the connector. 8-0 nylon suture was utilized; one on each side of the connector.

Methods

The patient was a 45-year-old male with a history of trauma to the right lower leg and ankle. He is now multiple years removed from tibiotalocalcaneal (TTC) fusion (via a strict lateral approach), with hindfoot rigidity and compensatory discomfort in the midfoot.

Figure 3 Allograft with nerve connector sutured to the proximal stump of the SPN.

Figure 4 The multiple branches of the sural nerve course.

He was also still having pain in the region of his previous TTC surgery. Imaging modalities confirmed that the structural integrity of the bone and fusion site were fine, with an arthrodesis of the ankle and subtalar joint appreciated. In the office setting, the patient underwent regional blocks of the superficial peroneal nerve (SPN) and the sural nerve (SN), with subjective improvement in pain of more than 75%. The blocks were performed in the lower 1/3rd of the leg. Due to this improvement, and the chronicity of his pain, neurolytic and neurectomy procedures were decided upon for the SPN and SN.

The patient was cleared for surgery by his primary care physician. Once in the operating room, he was placed on the table in the supine position with a bump placed under his right hip. After anesthesia was obtained, the left shoulder was tilted down some in order to better visualize the anterolateral and posterolateral lower leg. An anterolateral leg incision was created approximately 10 cm proximal to the ankle joint line. This incision was approximately 5 cm in length and it was further and carefully carried down to the level of the fascia. At approximately 10 cm to the ankle joint, the SPN was located piercing through the fascia where it becomes superficial (Figure 1). The SPN was carefully dissected away from surrounding soft tissue. At a level just distal to the SPN becoming superficial, a fresh 15 blade was used to transect the nerve completely and cleanly. Literature indicates that at this level, the SPN is entirely sensory with motor branches having come off much more proximal [4]. Meanwhile, on the back table, an Axoguard nerve connector (Axogen, Inc. Alachua, Fl) was half way placed around and covered one end of an Avance allogenic nerve graft (Axogen, Inc.). The nerve graft and connector were sutured together with 8-0 nylon, while using 2.5x loupe magnification (Figure 2). This connector/graft structure was brought over to the operating table, and the other end of the nerve connector was attached in similar fashion as before to the freshly severed end of the proximal SPN stump; again using 8-0 nylon (Figure 3).

The nerve allograft was allowed to lie in the normal plane of the SPN. The distal stump of the SPN had axonal degeneration performed via the "double crush" technique, which is discussed later.

The original incision was continued distally, and posteriorly, another few centimeters in a "lazy S" configuration to reach the approximate anatomical location of the distal sural nerve (SN). The incision was carefully deepened until the SN came into view. At this level, we identified two branches of the SN (Figure 4). These branches were traced proximally a few centimeters until one main branch of the SN was identified. Once the main SN branch was identified, a fresh 15 blade was used to transect the nerve cleanly. Again, the distal nerve stumps underwent a "double crush" technique. The proximal nerve end was covered with another nerve connector, and held in place with 8-0 nylon. The distal end of the connector was capped with a vascular clip and the nerve was allowed to lie in its normal plane. Neither the SPN nor SN was buried into muscle or bone.

The surgical area was irrigated. The adipose layer and the skin were closed. The deep fascial layer was not re-approximated with suture. 20 mL of bupivacaine plain was injected around the surgical site and the patient was placed in a soft but compressive dressing.

Results

The patient has been followed for 12 months at the time of this writing. At his first postoperative visit week one, he relates that his subjective pain to lower leg and lateral ankle was already 50% better. At his most recent follow-up visit, he relates that his musculoskeletal pain overall is significantly reduced by about 70%. In some areas of the leg and ankle, he feels his pain is reduced by up to 90%. He does not relate having any irregular sensitivities or paresthesias. Most of his relief is located around the distal lateral leg, lateral foot and ankle, with some elements of the dorsolateral foot. Overall, he relates that he is very happy and pleased with his progress. He states that he has actually been much more physically active in light of the denervation procedure.

Discussion

Described here is a case of one patient with intractable lower leg and ankle pain following trauma with subsequent hindfoot reconstruction. The patient's pain was subjectively improved with surgical intervention to the SN and SPN. This is an important subject matter for those patients with post-traumatic/surgical pain. A 2008 study indicated that nearly 63% of patients still have pain averaging 5.5 on a 10 point scale at one year following the trauma [1].

The concept of neurolysis of peripheral nerves received very little attention in the literature until 1970 [5]. In regards to the foot and ankle, a common and historically accepted treatment of peripheral neuromas was complete transaction of the nerve with possible implantation into surrounding tissue. This treatment does not address the terminal end of the nerve. More recent techniques for the management of neuromas have been developed over the past several years. The decision as to which technique may be best is often decided by how available the terminal nerve end is for reconstruction. These techniques include:

centro-central connector assisted neurorrhaphy, nerve capping, nerve graft relocation, hollow tube reconstruction, "end-to-side" neurorrhaphy [6] and some others. The ones presented in this case are nerve capping and nerve graft relocation. Both of these techniques are passive in nature, in that we did not directly reconstruct the nerve end.

The nerve graft relocation technique, for the SPN, is designed to provide a runway for any regenerating nerve. The intent is for the allograft to become a less painful destination for the axons to grow into. The regenerating axons will work their way into the organized graft, which is size matched (in diameter) to the nerve of interest. The allograft nerve also will need to be several centimeters in length to allow for any axonal growth to dissipate. This technique allows for regeneration but does not necessarily restore function [6]. The hollow nerve connector keeps any regenerating axons in their path to the nerve allograft. Leaving a gap of a couple millimeters between the proximal nerve end and the allograft nerve end is recommended to prevent a "mushroom" effect of new axons directly up against the allograft, which could ultimately produce a new stump neuroma. Also of note, the allograft nerve end was not implanted into muscle or bone. It was left in line along the course of the SPN. In the lower third of the leg, there are more tendons than large muscle bellies, so it would be difficult to bury it effectively. But, the other thought is to limit motion of the nerve end as much as possible anyways, to prevent the likelihood of a stump neuroma reforming.

In regard to the SN, the nerve capping technique has been shown to have some promising results [7]. Again, the capping technique is passive and does not reconstruct the nerve, but rather reigns in the terminal end of the nerve [6]. As of now, there is not enough data to suggest one technique over another. More studies need to be done comparing the results of each technique. In this case, multiple methods were chosen. It is possible that if one procedure was performed at each nerve site, maybe the patient would have more or less pain resolution. However, for now this is difficult to determine.

Passive techniques were decided upon for this patient, due to the location of his pain symptoms. Since the neurectomy for the SPN and SN were performed so low on the leg, it would have been difficult to reconstruct the nerve distally after resection of the neuromas. Any further distal, and the nerves become too thin and wispy to handle with care. Also, it becomes more difficult to suture the connector, or end cap, through just the epineurium, which is the recommended layer for peripheral nerve repair [8].

The "double axonal crush" technique is one that was described by Bridge, et al., 1994. The technique involves using two hemostats and placing them at the stump of the transected nerve, approximately 1 cm apart. The nerve is crushed when each hemostat is closed down to one "click" and held in that position for approximately 30-60 seconds. This crush technique causes impairment of the fascicles of the axon, causing axonotmesis. From this, sensory function should be lost over time due to Wallerian degeneration [9,10].

In the procedure, the SPN and SN were strategically located and transected. First, it has been shown that the motor branches of the SPN have already separated off at a much more proximal level than where this procedure took place [4]. Also, it has been shown that in over 70% of patients, the SPN will pierce the crural fascia and become superficial at approximately 10-12 cm proximal to the ankle joint. At approximately 4.4 cm proximal to the ankle joint, the medial and intermediate dorsal cutaneous nerves (MDCN and IDCN) will divide the SPN. One must be careful however, because there can be instances where the MDCN and IDCN are separated much higher [11]. It is important to look out for this, and possibly identify both branches if necessary.

In regards to the SN, it was interesting to see multiple branches at this level. Historical variations have been described by Huelke in 1958. In his original paper, he dissected out the SN and its components on 198 limbs. From this he deduced eight different possible configurations for SN development. One of these variations involved the medial sural cutaneous nerve (MSCN) and lateral sural cutaneous nerve (LSCN) coursing distally and independently of one another. The MSCN continues onto the posterior heel, while the LSCN will continue on as the lateral dorsal cutaneous nerve of the foot. Just proximal to the posterior ankle joint, there is a peroneal communicating nerve, connecting the MSCN and LSCN [12]. It is possible that in the case presented here, we found one cutaneous branch, the communicating branch, but not the other cutaneous branch. Unfortunately, as of now, there is no method, which we have found, to identify which SN variation a patient will have prior to surgery. Also, while in surgery, you want to minimize as much exploration and dissection as much as possible. A possible reason as to why this patient is still having some residual pain (although subjectively much less) is that the SN had another branch that was not located, cleanly transected, and capped.

There are several limitations here. The first limitation being that this is only one case performed by one surgeon. A higher patient population would be better to see if these subjective results are reproducible. Also, there is no statistical analysis performed. If more patients are studied in the future, it would be beneficial to perform Visual Analog Scores pre-operatively, and at standardized time intervals post-operatively. Finally, the purpose of the surgical technique is to limit possible generation of stump neuromas. Post-operative EMG and NCV tests may be beneficial in that determination. More studies about these peripheral nerve techniques, and a comparison of the outcomes following each technique are needed.

Conclusion

This was one case where a patient undergoing peripheral nerve surgery had subjective improvement in his chronic lower extremity pain. More research needs to be performed on the long term outcomes of these patients, as well as understanding if any one technique has better outcomes than the others. There seems to be an increased interest in microscopic nerve surgery in recent years. With this spike in interest, there should also hopefully be an increase in our understanding of chronic pain in the extremities and what we can do surgically to improve the quality of life for these patients.

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