Case Study: The Utilization of Centrocentral Anastomosis for Forefoot Stump Neuromas

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Purpose

The aim of surgical treatment in this case study was to alleviate pain using centrocentral anastomosis with a collagen nerve conduit for the treatment of adjacent plantar intermetatarsal stump neuromas. We hypothesized that the intervention would result in guided nerve regeneration without axonal sprouting into adjacent unconstrained soft tissues.

Literature Review

A symptomatic stump neuroma displays histologic evidence of unorganized connective tissue intermingled with nerve fibers, Schwann cells, macrophages, fibroblasts, and myofibroblasts (**Fig. 1**). Myofibroblasts play an integral role in persistent pain because they contract in the perineural fibrous tissues, and this is associated with abnormal impulse conduction, potentiation of neighboring nerve fibers, and heightened nociception wherein minor stimuli generate painful responses.[1] Sectioned peripheral nerves have the capacity to regenerate axons from the proximal stump, which can initiate a number of neuropathophysiologic mechanisms that magnify pain if the sprouting neurites expand in a misguided fashion. Surgical efforts to minimize exuberant neurite regeneration, unconstrained neuronal sprouting, and perineural fibrosis are indicated in the treatment of symptomatic stump neuroma.[2] Fundamental surgical elements of neuroma management include excision of the lesion with placement of the sectioned terminal in a well vascularized and mechanically protected area, such as skeletal muscle or bone.[3] Unfortunately, the incidence of symptomatic stump neuroma formation has been reported to be as high as 65% following plantar neurectomy.[4] If the stump neuroma fails to satisfactorily respond to supportive measures, then neuromyodesis, neuroosteodesis, or centrocentral anastomosis may be beneficial. The decision as to which maneuver is indicated hinges on the availability of nearby muscle, bone, and nerve. When adjacent intermetatarsal stump neuromas are present, centrocentral anastomosis is a particularly useful option, as long as the anastomosis can be shielded deep to intact skeletal muscle. Centrocentral anastomosis was first described in hand literature in 1984 by Gorkisch et al,[5] and aims to unite two nerves of similar origin together within an epineural repair. Histologically, centrocentral anastomosis promotes organized, regular nerve formation with a balance between myelinated and unmyelinated fibers.[3] Placement of a collagen conduit about the anastomosis minimized adjacent fibrosis.[2]

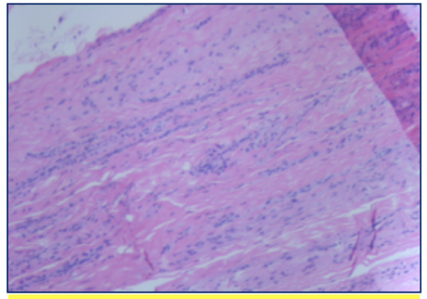
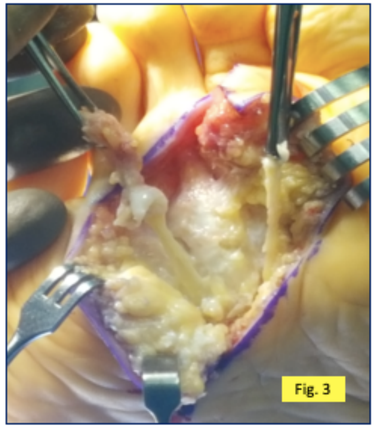


Fig. 1 Histologic appearance of stump neuroma with collagenation and myofibroblasts, H&E, 100x

Case Study

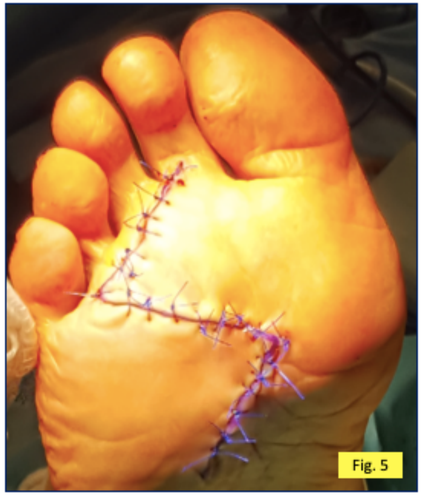
A 53-year-old male with past medical history of hypertension presented with right foot shooting and "electric shock" pain that he rated as 8/10 on a VAS pain scale, aggravated by weight bearing, and localized to the plantar aspect of his second and third intermetatarsal spaces. Objectively, the patient experienced hyperesthesisas, proximal and distal radiation of pain along the course of the medial plantar nerve, and Mulder's sign, when either intermetatarsal space was palpated plantarly. He related a history of having undergone intermetatarsal neurectomy via dorsal incisions in the second and third intermetatarsal spaces 10 years earlier. A diagnosis of symptomatic stump neuroma in each intermetatarsal space. Our initial intervention involved shoe modification, physical therapy, local corticosteroid injection, and oral antiepileptic medication, all of which failed to adequately alleviate his pain. Thereafter, a surgical course involving centrocentral anastomosis was pursued.

A plantar Z incision (**Fig. 2**), loupe magnification, and fine-tipped instruments were used to identify and isolate the respective hypertrophied medial plantar common digital nerve branches in the second and third intermetatarsal spaces, terminating in stump neuromas incarcerated in cicatrix. External neurolysis of each common plantar nerve trunk was carried proximally to grossly normal nerve, after which each neuroma was excised (**Fig. 3**) and the separate specimens were sent to pathology (**Fig. 1**). Thereafter, the two nerve ends were anastomosed end-to-end at their resected margins using simple interrupted epineural sutures of 7-0 polypropylene. A 4-mm diameter bovine collagen conduit was then used to entubulate the anastomosis (**Fig. 4**), again using the polypropylene suture. Finally, we secured the anastomosis to the superior aspect of the flexor digitorum brevis muscle belly without tension. Layered wound closure was then performed without reapproximation of the deep fascia (**Fig. 5**). A soft bandage without immobilization, ankle and digital range of motion exercises, and non-weight bearing ambulation, were used for the first 3 postoperative weeks. The patient experienced an unremarkable course of rehabilitation with periodic follow up visits. He resumed weight bearing in a regular shoe at 3.5 weeks postoperative and his VAS pain score was 2 at 12 months, and 0 at 14 months (Fig. 6), and his activities were unrestricted.



Discussion

Recurrent forefoot stump neuromas treated with centrocentral anastomosis and a concomitant nerve conduit appears to effectively limit unconstrained neurite budding and is a particularly useful method for the treatment of symptomatic, adjacent plantar intermetatarsal neuromas. The concept of embedding the terminal nerve in an appropriate area devoid of excessive pressure or exposure to moving joint structures that could reignite symptomatology, is important. The adjunct use of the conduit xenograft may provide an environment which decreases inflammation and pain generating molecules, thus limiting cicatrix.[4,6] Based on our experience with the case described in this report, we believe that centrocentral anastomosis reinforced with a collagen conduit is a potentially useful option for surgeons treating patients with adjacent plantar intermetatarsal stump neuromas.



References

1. Wagner E, et al. The painful neuroma and the use of conduits. *Foot and Ankle Clinics* 16(2):295-304, 2011.
2. Lidor C, et al. Centrocentral anastomosis with autologous nerve graft treatment of foot and ankle neuromas. *Foot Ankle Int.* 17(2):85-8, 1996.
3. Gould JS, et al. Use of collagen conduits in management of painful neuromas of the foot and ankle. *Foot Ankle Int* 34(7):932-40, 2013.
4. Bibbo C, et al. Nerve transfer with entubulated nerve allograft transfers to treat recalcitrant lower extremity neuromas. *J Foot Ankle Surg* 56(1):82-6, 2017.
5. Gorkisch K, Boese-Landgraft J, Vaubel E: Treatment and prevention of amputation neuromas in hand surgery. Plast Reconstr Surg 73: 293–296, 1984.
6. Rodriguez E, Repair of stump neuroma using Axoguard nerve protector and Avance nerve graft in the lower extremity. *J Orthop Rheumatol* 1:555-66, 2015.