Treatment of Drop Foot Via Nerve Anastomosis of the Motor Branch of Lateral Hemi-Soleus to Deep Peroneal Nerve Branches

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Statement of Purpose

This consisted of targeting a patient with weak and/or absent extrinsic dorsiflexory power (i.e., etiology of drop foot). Not only did this patient have abnormal peripheral nerve etiology, but it was also linked to a musculoskeletal pathology [1-3,9]. Associated literature suggests consistent treatment modalities, whereas this case study represents a new methodology for the reversal and treatment of peripheral nerve-induced drop Foot [9-11,14].

The purpose of this case study is two fold: 1) To demonstrate the use of distal motor branches of the tibial nerve (i.e., motor branches of the lateral hemi-soleus muscle) to reverse drop foot via nerve anastomosis to the injured deep peroneal motor nerve branches, and 2) To demonstrate salvage of the superficial peroneal nerve branches to further preserve eversion functionality.

Literature Review

Drop foot is a common condition and can cause significant gait abnormalities. The most frequent cause is a common peroneal neuropathy at the neck of the fibula, but other known causes can include: acute trauma, casting too high, braces, soft tissue masses, entrapment at the fibular tunnel, vasculitis and L5 radiculopathy [1-3]. Affected patients typically will have a steppage or abnormal gait, which is awkward, energy consuming and physically demanding [4]. Historically, the surgical solution to drop foot is a Bridle procedure, which consisted of a Posterior Tibial tendon that is transferred through the interosseous membrane and anastomosed to the Anterior Tibial tendon and a rerouted Peroneus Longus tendon [5-8]. Although this can be a successful and effective procedure, and patients typically do not require a brace to walk afterwards, thus increasing one's activity of daily living and lifestyle [4-5].

Since the most frequent cause of drop foot can be associated to a peripheral nerve issue (i.e., the common peroneal nerve), nerve transfer is a potential treatment option in correcting this condition. In the upper extremity, nerve transfers have been well documented with consistent and good success, but that is not so much the case for lower extremity nerve damage [9]. Nerve repair via grafting is the gold standard of treatment, however, it has variable results as the axon must regenerate at either end of the graft [10-11]. Nerve transfer offers the following benefits over nerve repair: provides a direct link for coaptation from the donor nerve stump to the recipient nerve, it minimizes the number of coaptation, there is only one axon regeneration instead of two, and the muscular anatomy remains relatively uninterrupted [9-10]. The tibial nerve branches provide the most feasibility due to the following reasons: it has been assessed in cadaver studies, it provides sufficient length for tensionless coaptation, and it has more than one approach for harvesting and transferring either around the fibular head or through the interosseous membrane [11-13].

Timely surgical correction appears to favor nerve recovery (i.e., the donor nerve recovers while the harvested motor fibers grow into the previously deinnervated muscle, thus shortening your period of denervation) [9-10, 14]. Nerve transfer is a good option as it does not burn any bridges, because if it fails, you are still able to perform other procedures, whether they be osseous reconstruction or tendon transfers (i.e., Bridle procedure).

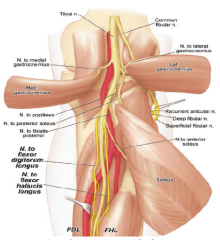

Figure 1. Photo from Bodily et al.[11] showing neurovascular anatomy of popliteal fossa.

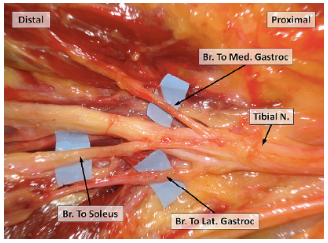

Figure 2. Intra-op photo from Strazar R et al.[14] that shows the dissected out Tibial nerve branches.

Case Study

This 48-year-old female with a past medical history of right lower extremity peroneal nerve complex injury presented to the clinic with an 18 month history of peroneal nerve injury secondary to motor vehicle accident. Patient subsequently developed dorsiflexory power weakness of her right lower extremity over the 18 month course. Treatments consisted of physical therapy and bracing, which did not provide adequate restoration of her dorsiflexory power. Patient wanted to pursue surgical intervention to correct this problem.

Physical Exam

Neurological: Negative Tinel's or Valleix's sign. EMG/NCV demonstrated significant decrease in velocity of distal branches of the deep peroneal nerve (DPN). Conductivity of the superficial peroneal nerve (SPN) branches were normal.

Musculoskeletal: 0-1/5 for dorsiflexion muscle strength R foot (pre-op), 4-5/5 for eversion muscle strength R foot, 5/5 for all other lower extremity muscle groups.

Dermatological: Within normal limits and non-contributory.

Vascular: Within normal limits and non-contributory.

The rationale for the following procedural selection was an attempt to restore dorsiflexory power back to the patient's right lower extremity, while preserving her eversion power with the utilization of the distal tibial motor branches of the hemi-soleus nerve via nerve transfer and anastomosis.

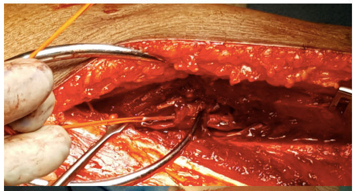

Figure 3. Microsurgical dissection of the deep common peroneal and tibial nerve branches.

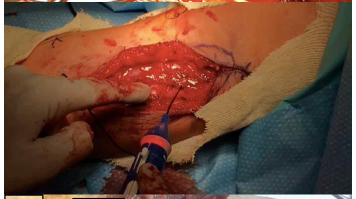

Figure 4. Using a handheld intra-operative nerve stimulator for accurate nerve transfer and anastomosis.

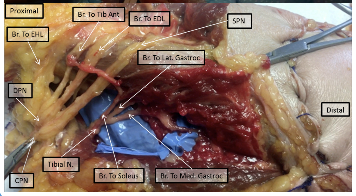

Figure 5. Nerve transfer of the lateral hemi-soleus nerve branch to the Tibialis Anterior nerve branch with utilization of a single layer collagen to prevent adipose fascial postoperative adhesions.

Case Study

Figure 6. Utilization of a partial lateral gastrocnemius muscle flap for coverage of the common peroneal nerve complex for adequate padding and healing.

The branches of the DPN and tibial nerves were carefully dissected out in the popliteal fossa (Figure 3). Once the intra-operative nerve stimulator was utilized to identify the correct nerve branches (Figure 4), the nerve to the branch of the soleus was dissected free from its distal attachment and transferred to the branch of the DPN that was innervating the Tibialis Anterior (Figure 5). Under loop vessel magnification, the two motor nerve branches were coapted using 7-0 nylon and wrapped with a single layer collagen to prevent adipose fascial adhesions. To confirm successful transfer, the nerve stimulator device was utilized and the patient had about 2/5 dorsiflexory muscle strength intra-operative. The whole common peroneal nerve complex was then covered with a partial lateral gastrocnemius muscle flap (Figure 6). The patient was closed up and splinted.

The patient was followed post-operatively for 14 months and at the 1 year mark had strengthened and maintained 4/5 dorsiflexory muscle strength. Everters are at 5/5 muscle strength.

Analysis and Discussion

The primary purpose of this study was to restore dorsiflexory power while at the same time preserving everting forces for the lower extremity. In this case study example, we were able to show efficacious results for drop foot reversal via nerve transfer of the distal tibial motor branch of the lateral hemi-soleus muscle while at the same time preserving eversion forces of the lower extremity.

The analysis of this study demonstrated that there are additional anatomic structures that allow for this adequate and positive result as compared to historic literature, which would result in restoration of dorsiflexory power, but at the same time significantly weaken everting forces of the lower extremity [4,11]. Patients that underwent a Bridle procedure, not only would lose and/or weaken their everters, physical retraining and rehabilitation of the out-of-phase transfer muscle-tendon units would take several months.

Most cases of drop foot can be associated to peripheral nerve injuries (i.e., CPN), it only makes sense to offer patients a treatment plan that attempts to reverse and restore their muscle functionality via nerve transfer, as it has been well documented in the literature [9-10]. In the correct patient, this nerve transfer can provide sufficient post-op outcomes for patients not wanting to sacrifice eversion abilities [9-10,14].

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