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How I Do It

Single-Incision Sural Nerve Harvest: Technical Considerations for Cross-Facial Nerve Grafting

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B.A. is the senior author and performed all of the procedures described, and conceptualized and edited the article. L.E.I. was responsible for data collection and analysis, editing the manuscript, and compiling the figures. D.B.Y. performed the first single-incision nerve harvest with B.A. and is responsible for B.A. adopting the practice. B.L. is B.A.'s partner and assisted with the majority of surgeries and proofread the manuscript. G.G.M. was cosurgeon on many of the described cases and is partly responsible for conceptualizing the article. G.L.P. was responsible for data collection and writing of the original manuscript and compiling the illustrations.

Key Words: Facial nerve, facial reanimation, facial paralysis, sural nerve.

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INTRODUCTION

Dynamic facial reanimation with free functional muscle transfer innervated by a cross-facial nerve graft has become a preferred method for the treatment of developmental and long-standing flaccid facial paralysis.[1,2] Utilizing the sural nerve as the cross-facial nerve graft is ideal given its accessibility and potential length. Morbidity associated with the sural nerve harvest is low and stems from the approach used. Historically, the sural nerve has been harvested using a long continuous lower-leg incision extending from just posterior to the lateral malleolus to the midcalf region. Over time, this has evolved into a series of stair-step incisions, which is the current preferred method for most reconstructive surgeons.[3]

Minimally invasive techniques have been described in the literature.[4,5] In 1978, a single-incision sural nerve harvest technique using a tendon stripper was described in the plastic surgery literature. This technique was effective, with no premature transection of the nerve, in a series of six patients undergoing a total of seven nerve harvests.[6] Subsequently, in 1985, the orthopedic surgery literature described a series of 20 patients who underwent sural nerve harvest with the tendon stripper using two incisions.[5] Hadlock and Cheney in 2008 and Lin and colleagues in 2007 described a single-incision endoscopic approach for sural nerve harvest similar to that of harvesting coronary artery bypass grafts.[4,7]

From 1985 to the present, most of the published articles on this topic have outlined long incisions or stair-step incisions.[3,8–17] These larger and multiple incision techniques take longer to perform and may require more recovery time.

The senior author (B.A.) revisited the use of a tendon stripper several years ago for the purpose of obtaining sural nerve grafts utilizing a simplified single-incision method.[2] In this article, the authors present technical considerations and results of this preferred technique for sural nerve harvest.

STUDY METHODS

All patients who underwent cross-facial nerve grafting using the sural nerve performed by the senior author (B.A.) between June 2012 and February 2017 were evaluated retrospectively. Demographic and surgical data were collected from chart review and the senior author's surgical log. Data for the first group of 22 patients were compared with the second group of 23 patients to determine the learning curve of the procedure. Significance was determined using the Student paired two-tailed *t* test.

All patients in this review were from the private practice of the senior author. No patients or patient records included in this report were obtained from an academic institution at the time of the retrospective review, and so institutional

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review board approval was not obtained. Written informed consent for the surgery was obtained for each procedure, and the present review adheres to the standards of the Declaration of Helsinki and complies with the Health Insurance Portability and Accountability Act.

SURGICAL TECHNIQUE

The leg is propped in a flexed position to allow for maximal exposure of the lateral malleolus and the entire lower leg. A two-team approach is used to save operating room time. A 1.5- to 2.5-cm incision is marked approximately 2.0 to 5.0 cm superior and 1.5 to 2.5 cm posterior to the lateral malleolus (Fig. 1).

The sural nerve is easily identified in close proximity to the saphenous vein (Fig. 1). The nerve is dissected inferiorly for 3 to 5 cm and transected sharply. A 2-0 silk suture is tied around the free distal end placed through a 7.4-mm × 342.9-mm Acufex tendon stripper (Smith & Nephew PLC, London, United Kingdom) (Fig. 2).

The Acuflex tendon stripper's circular leading edge is not so sharp that it would indiscreetly tear through tissue, yet it can be used to carefully dissect in the trajectory of the sural nerve superiorly toward the popliteal fossa (Fig. 2). The length of dissection is determined by the amount of nerve that is required for the particular patient. Younger patients generally require shorter nerves. Patients who are scheduled to have dual innervation with the masseteric nerve require longer nerves. When the superior dissection is completed, the tendon stripper can be angled slightly against the skin and rotated to cut the nerve proximally within the calf without the need for an additional incision. Once the nerve is transected proximally, it is extracted from the incision by pulling on the distal suture (Fig. 2). The wound is copiously irrigated and closed in layers. Following the sural nerve harvest, the cross-facial nerve graft is performed (Fig. 3).[1]

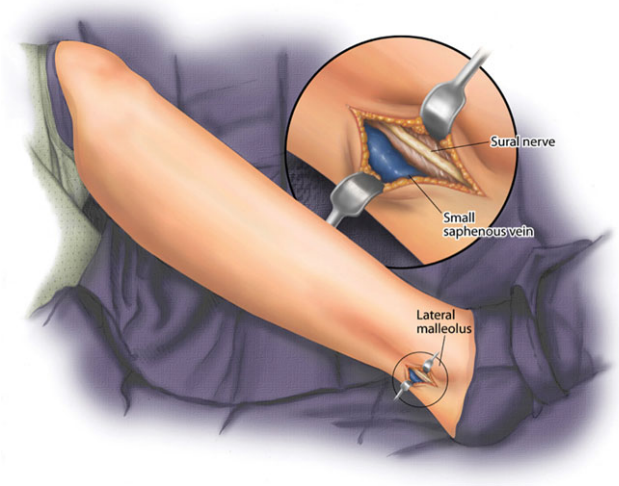

Fig. 1. A 1.5- to 2.5-cm incision is marked lateral to the lateral malleolus. The small saphenous vein is used as a landmark to identify the distal sural nerve. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

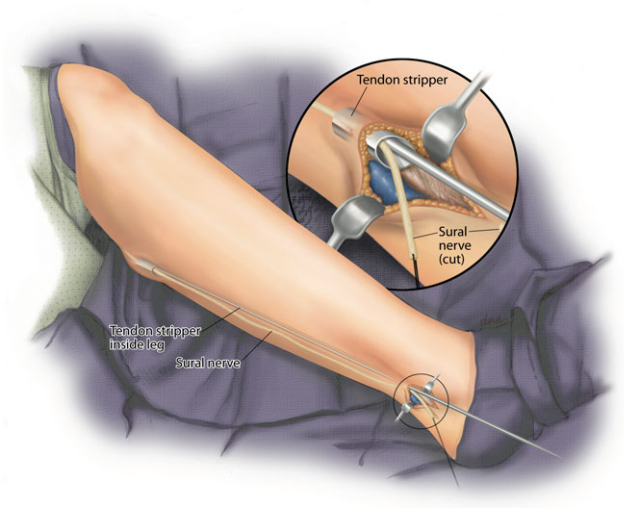

Fig. 2. The nerve is dissected distally, transected several centimeters distal to the incision, and tagged with a silk suture. The tendon stripper is passed over the sural nerve and used as a dissecting as well as a transecting instrument. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

All patients are encouraged to immediately ambulate and are fully weight bearing on postoperative day 1. Patients are allowed to shower on postoperative day 2.

RESULTS

Forty-five sural nerve harvests were performed by the senior author from June 2012 to February 2017. This included 12 males and 33 females. All sural nerve harvests were performed using the outlined single-incision technique. The ages ranged from 6 years to 67 years, with a mean age of 35 years. The mean length of nerve harvested was 18.1 cm (10 to 31 cm). There was no instance in which a second incision or the contralateral side was needed for nerve harvest due to inadequate length.

Operative time was clearly documented by nurses and anesthesiologists for 14 of the patients and ranged from 12 to 38 minutes; the average time was 21 minutes. There was no

Fig. 3. Photos before (left) and 1 year after (right) of a patient who underwent cross-facial nerve grafting with the sural nerve followed by gracilis free muscle flap for facial reanimation. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

intraoperative damage to the sural nerves, surrounding tissues, or vasculature requiring additional interventions.

The average follow-up time was 532 days (range, 8–1548 days). All patients recovered well with return to normal ambulation postoperatively. There were no cases of wound infection, dehiscence, neuromas, or hematomas.

The first 22 nerves harvested averaged 15.6 cm in length, whereas the last 23 nerves averaged 20.5 cm. There was a statistically significant increase in nerve length between the first and second half of the cases ($P < .001$), whereas the patient demographics did not change significantly. The average age was 33.6 years in the first half and 36.9 years in the second half ($P = .6$). The complication rate was zero in both sets of patients.

DISCUSSION

As the popularity of the cross-facial nerve grafting with free gracilis transfer for rehabilitation of the paralyzed face increases, more efficient methods of sural nerve harvest are desired to decrease surgery cost and intraoperative time and hasten postoperative recovery.

Although the goal a single small incision has been achieved with the use of endoscopic harvest, the disposable costs of the endoscopic harvesting system can range from $1,200 to $1,600 per use in addition to the cost of endoscopic equipment. These increased expenses and the learning curve to master the equipment have limited its feasibility for many surgeons and institutions.

Over the years, the senior author has tried several approaches to sural nerve harvest and found that a single-incision technique with a tendon stripper to dissect and transect the nerve proximally is an efficient and cost-effective technique.

In our series of 45 patients, the incision is similar in size to those made for the endoscopic sural nerve harvest. Operative times are short. Without additional endoscopic equipment, the costs for the harvest are contained to a minimum. A single surgeon performed all cases. The second half of patients studied had a significantly longer length of nerve than the first half. Although the senior author has begun using dual innervation more commonly in the last few years, necessitating longer sural nerve grafts, there does appear to be a learning curve when using the single-incision technique. Nevertheless, the complication rate was zero in both cohorts and the length of nerve was adequate in all cases.

There are four configurations of the sural nerve, depending on the branching patterns of the medial and lateral sural cutaneous nerves and a peroneal communicating branch.[18] This variability in branching pattern may potentially impact a closed sural harvest technique using a short incision. This study, however, demonstrated that the technique can be successfully utilized for most patients with minor limitations because the overall direction of the main branch of the sural nerve is consistent.[19]

The possibility of neuroma formation from the proximal end of the transected sural nerve should also be considered. Dellon et al. reported that nerve fascicles remain organized and neuroma formation does not occur when nerve endings are adjacent to or implanted in muscles rather than in subcutaneous tissue.[19] Preservation of perineurium reduced histologic signs of neuroma at 4 weeks.[19] In the senior author's technique, the direction of the nerve transection is toward the skin, which may potentially lead to increased risk of neuroma formation based on Dellon et al.'s research. However, no patients in our study reported symptoms of neuroma formation. Although we cannot eliminate the possibility of asymptomatic neuroma formation because we do not have histologic data, our average follow-up is significantly longer than 4 weeks. Our hypothesis for lack of neuroma formation is that the proximal nerve has intact perineum and retracts back into the calf muscles.

Limitations of this study are its retrospective nature and lack of direct comparison to other techniques.

CONCLUSION

The short scar, single-incision technique for sural nerve harvesting has low morbidity and is cost-effective with excellent results.

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