

Reconstruction of a Spinal Accessory Nerve Defect Using Vascularized Vastus Lateralis Motor Nerve Graft

Shiori Yanagishita, MD*†
Naoya Otani, MD*
Shien Seike, MD*
Koichi Tomita, MD, PhD*†
Tateki Kubo, MD, PhD*

Summary: Massive resection of a malignant tumor of the head and neck region often requires loss of critical nerves, including the spinal accessory nerve. Recently, vascularized nerve grafts (VNGs) have been used to repair facial and other nerve defects with successful outcomes, even in cases involving factors that can inhibit nerve regeneration, such as radiotherapy. However, the effectiveness of these nerve grafts against postoperative radiotherapy has yet to be explored. We report the first successful case in reconstructing a spinal accessory nerve defect after total left parotidectomy with radical neck dissection, using a vascularized vastus lateralis motor nerve graft and an anterolateral thigh flap based on the lateral circumflex femoral system, with great shoulder function outcomes even after postoperative radiotherapy. A branch of vastus lateralis motor nerve perfused by the accompanying descending branch of lateral femoral circumflex vessel was used as a nerve graft, and was repaired in an end-to-end manner. The patient underwent postoperative radiotherapy to the area of operation. At 6-months follow-up, the patient was capable of 90 degrees lateral shoulder abduction, and at 18 months, achieved full-range shoulder abduction and reported neither functional limitations of the shoulder nor complaints of any shoulder pain (Disabilities of Arm, Shoulder, and Hand score 0). Although further study is necessary to fully understand the superiority of VNGs over postoperative radiotherapy, immediate nerve reconstruction using VNG for accessory nerve defects in patients scheduled for radiotherapy post-operation may be extremely beneficial for preserving shoulder motor function and sustaining the patient's quality of life. (*Plast Reconstr Surg Glob Open* 2023; 11:e5174; doi: 10.1097/GOX.0000000000005174; Published online 23 August 2023.)

In treating surgically resectable malignant tumors of the head and neck, adequate tumor resection often requires the loss of critical nerves, such as the spinal accessory nerve (SAN). Injuries to this nerve can lead to problems with shoulder abduction, shoulder drooping, and scapular winging, and immediate reconstruction is recommended. However, head and neck reconstructions can often be complicated by factors that negatively affect the vascular wound bed, such as postoperative radiotherapy.

Recently, strong evidence suggesting the superiority of vascularized nerve grafts (VNGs) over non-VNG has been reported, with VNG offering immediate blood supply, avoiding fibrosis due to ischemia and promoting axonal regeneration.^{1,2} For this reason, reports using VNGs such as lateral femoral cutaneous nerve, vastus lateralis motor nerve (VLMN), and latissimus dorsi motor nerve in many different oncological and other tissue defect reconstructions have been on the rise.²⁻⁵ However, although the adverse effects of postoperative radiotherapy to nerve regeneration have been reported,⁶ its effects on reconstructed VNGs have not been well documented. Here, we report a successful SAN reconstruction using a VLMN with great shoulder function outcome, even after postoperative radiotherapy.

From the *Department of Plastic Surgery, Osaka University Graduate School of Medicine, Osaka, Japan; †Department of Plastic and Reconstructive Surgery, Osaka Rosai Hospital, Osaka, Japan; and ‡Department of Plastic and Reconstructive Surgery, Kindai University Faculty of Medicine, Osaka, Japan.

Received for publication March 15, 2023; accepted June 23, 2023.

Copyright © 2023 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000005174

Disclosure statements are at the end of this article, following the correspondence information.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

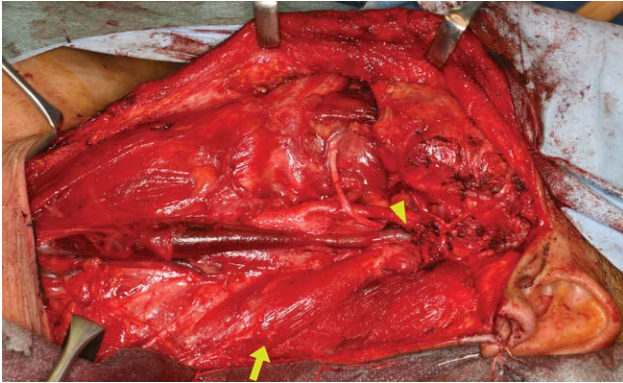


Fig. 1. After total left parotidectomy with radical neck dissection on the left side, with the proximal cut end of the accessory nerve (arrowhead) and distal cut end of the nerve (arrow).

CASE DESCRIPTION

This study was approved by the ethical review board of Osaka University Hospital (approval no.: 17124), and informed consent was obtained from the patient.

A 53-year-old man diagnosed with adenocarcinoma of the left parotid gland was referred to the department of otolaryngology at Osaka University Hospital. He was prepared for total parotidectomy and radical neck dissection (I-V) on the left side. Tumor resection required the removal of sternocleidomastoids muscle and its surrounding soft tissues, and the SAN running from the carotid triangle to the posterior triangle of the neck was resected, leaving a 5-cm gap from the proximal end to the distal end of the SAN (Fig. 1).

An anterolateral thigh (ALT) flap with a maximum skin paddle area of 6.5×21.5 cm with perforating vessel arising from the descending branch of the lateral circumflex femoral system was elevated as a perforator flap. The VLMN accompanying the descending branch of lateral femoral circumflex vessel showed a “normal” anatomical pattern, as described by Casey et al, and 6 cm of a branch of the VLMN was included in the flap⁷ (Fig. 2). [See figure, Supplemental Digital Content 1, which displays the schematic drawing of the vastus lateralis motor nerve (VLMN) anatomy in relation to the ALT flap and the descending branch of lateral femoral circumflex vessels. Vascular

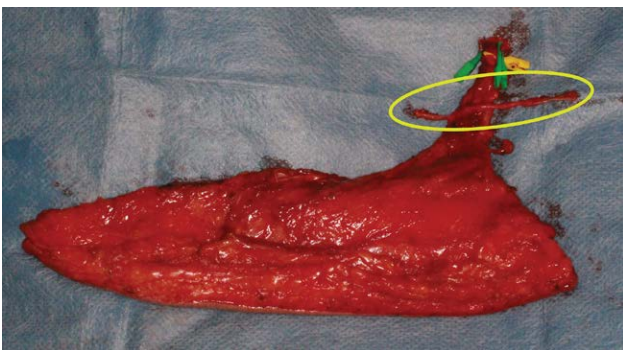


Fig. 2. Vascularized vastus lateralis muscle motor nerve graft (circled) with a free anterolateral thigh flap.

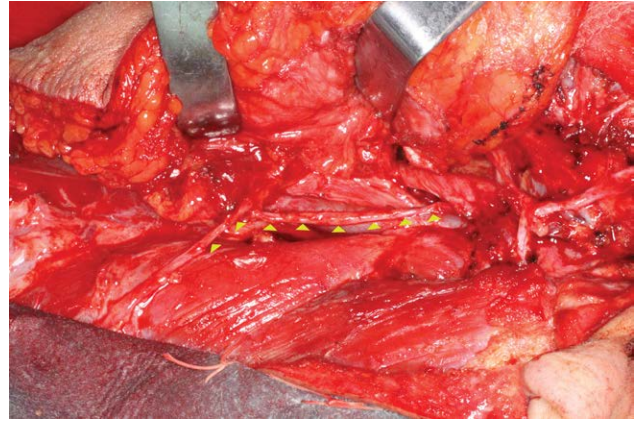


Fig. 3. Accessory nerve was reconstructed with a vascularized VLMN graft (arrowheads), and soft tissue was reconstructed with a free anterolateral thigh flap.

supply to the nerve graft is obtained, as the VLMN branch is in close contact with the perforator vessels. <http://links.lww.com/PRSGO/C706>.] The main stem of the VLMN was preserved. After microvascular anastomosis of the transferred flap and observing visible bleeding from the cut ends of the nerve graft, VNG was interposed into the SAN gap and was repaired end-to-end with epineurial sutures using 10-0 nylon (Fig. 3). The donor site was closed primarily.

The patient was discharged 18 days postoperatively. After discharge, the patient received six courses of docetaxel and cisplatin combination chemotherapy, and a total dose of 60 Gy was applied to the area of operation, including the nerve graft. At 6-months postoperation, the patient was capable of 90 degrees lateral shoulder abduction, and at 18 months, achieved full-range shoulder abduction and a Disabilities of Arm, Shoulder, and Hand (DASH) score of 0 (Fig. 4). (See figure, Supplemental Digital Content 2, which shows that 6 months after surgery, the patient was able to achieve 90 degrees in shoulder abduction. <http://links.lww.com/PRSGO/C707>.) Although slight atrophy of



Fig. 4. Twenty-four months after surgery, the patient showed no signs of shoulder drooping and achieved full range of motion in shoulder abduction.

the trapezius muscle was observed, winging of the scapula and drooping of the shoulder were not seen. (See Video [online], which displays the patient's shoulder abduction motion at 24-months after surgery.) For donor-site, the patient showed no apparent motor function deficits, and overall observed no significant complications.

DISCUSSION

In the past few decades, the number of cases using VNGs in nerve reconstructions has been on the rise, including a successful case of SAN reconstruction using a vascularized long thoracic nerve graft with postoperative radiotherapy.⁵ To our knowledge, however, the number of reported cases involving postoperative radiotherapy is limited.

Compared with non-VNGs, VNGs have increased density and diameter of regenerating axons.¹ As such, Kimata et al included a history of previous irradiation at the wound as one of the five indications for using VNGs in facial nerve reconstruction.³ Preoperative radiotherapy can lead to a poor wound bed, which could benefit from using VNGs, whereas the adverse effects of radiation have caused many to hesitate in proceeding with immediate nerve reconstruction when postoperative radiotherapy is scheduled. However, Zhu et al revealed that even though adjuvant radiotherapy reduced the total number of nerve bundles in both VNGs and non-VNGs, VNGs still had a greater number of nerve bundles, richer capillaries, and tighter nerve bundles than those observed in non-VNGs.⁶ Immediate reconstruction using VNGs may be beneficial in restoring motor function of muscles even if postoperative radiotherapy is scheduled, as even after radiation, VNGs are superior in functional recovery.

In addition, the ALT flap is an extremely versatile flap that can be harvested together with the VLMN or femoral cutaneous nerve, making it suitable for highly complex head and neck reconstructions.⁷ Although both nerves can be used as VNGs, there are no reports investigating the superiority of either nerve graft. However, in a study evaluating blood perfusion to nerves in the ALT flap using indocyanine green fluorescence angiography, the intensity of the fluorescence was slow and weak in the cutaneous nerve, whereas it was consistently rapid and strong in the VLMN, indicating richer and more stable blood flow to the VLMN.⁸ Studies have also demonstrated that when recipient and the donor nerves are of the same modality, as in cases where motor nerve defects are reconstructed using a motor nerve graft, the nerve graft shows significant increases in nerve density and total fiber numbers,⁹ enabling minimization of the muscle denervation period. Therefore, when using an ALT flap, the VLMN may be a better choice for motor nerve reconstruction when postoperative radiotherapy is planned, considering its superior vascularization and its modality.

The ALT flap is also reported to have low rates of donor site complications; even when cutaneous nerve or VLMN

is harvested simultaneously with the flap, patients showed no signs of functional morbidity and were able to return to the preoperative level of function.¹⁰ Although Schultes et al reported on using a free latissimus dorsi myocutaneous flap with a vascularized long thoracic nerve graft for SAN reconstruction,⁵ we believe that using an ALT flap with a vascularized VLMN graft is an equally effective method, especially when postoperative radiotherapy is scheduled, with fewer donor site complications.

Tateki Kubo, MD, PhD

Department of Plastic Surgery
Osaka University Graduate School of Medicine
2-2-C11 Yamadaoka, Suita-shi
Osaka 565-0871, Japan
E-mail: tateki@psurg.med.osaka-u.ac.jp

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. Koshima I, Harii K. Experimental study of vascularized nerve grafts: morphometric study of axonal regeneration of nerves transplanted into silicone tubes. *Ann Plast Surg.* 1985;14:235–243.
2. Li SS, Mangialardi ML, Nguyen QT, et al. The chimeric scapulo-dorsal vascularized latissimus dorsi nerve flap for immediate reconstruction of total parotidectomy defects with facial nerve sacrifice: building a new program and preliminary results from 25 cases. *Ann Plast Surg.* 2021;86:S379–S383.
3. Kimata Y, Sakuraba M, Hishinuma S, et al. Free vascularized nerve grafting for immediate facial nerve reconstruction. *Laryngoscope.* 2005;115:331–336.
4. Yamamoto T, Narushima M, Yoshimatsu H, et al. Free anterolateral thigh flap with vascularized lateral femoral cutaneous nerve for the treatment of neuroma-in-continuity and recurrent carpal tunnel syndrome after carpal tunnel release. *Microsurgery.* 2014;34:145–148.
5. Schultes G, Gaggi A, Karcher H. Reconstruction of accessory nerve defects with vascularized long thoracic vs. non-vascularized thoracodorsal nerve. *J Reconstr Microsurg.* 1999;15:265–270; discussion 270–261.
6. Zhu Y, Zhou S, Xu W, et al. Effects of postoperative radiotherapy on vascularized nerve graft for facial nerve repair in a rabbit model. *J Oral Maxillofac Surg.* 2019;77:2339–2346.
7. Casey WJ III, Rebecca AM, Smith AA, et al. Vastus lateralis motor nerve can adversely affect anterolateral thigh flap harvest. *Plast Reconstr Surg.* 2007;120:196–201.
8. Tanaka K, Okazaki M, Yano T, et al. Quantitative evaluation of blood perfusion to nerves included in the anterolateral thigh flap using indocyanine green fluorescence angiography: a different contrast pattern between the vastus lateralis motor nerve and femoral cutaneous nerve. *J Reconstr Microsurg.* 2015;31:163–170.
9. Brenner MJ, Hess JR, Myckatyn TM, et al. Repair of motor nerve gaps with sensory nerve inhibits regeneration in rats. *Laryngoscope.* 2006;116:1685–1692.
10. Hanasono MM, Skoracki RJ, Yu P. A prospective study of donor-site morbidity after anterolateral thigh fasciocutaneous and myocutaneous free flap harvest in 220 patients. *Plast Reconstr Surg.* 2010;125:209–214.