Evaluating CNVII Recovery after Reconstruction with Vascularized Nerve Grafts: A Retrospective Case Series

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Summary: Few studies have evaluated vascularized nerve grafts (VNGs) for facial nerve (CNVII) reconstruction. We sought to evaluate long-term outcomes for CNVII recovery following reconstruction with VNGs. A retrospective review of all patients at a tertiary centre who underwent radical parotidectomy and immediate CNVII reconstruction with VNGs was performed (January 2009–December 2019). Preoperative demographics, perioperative factors (flap type, source of VNGs), and postoperative factors [complications, adjuvant therapy, revisionary procedures, length of follow-up, and CNVII function via the House-Brackmann scale (HB)] were collected. Data were summarized qualitatively. Twelve patients (M = 53 ± 18 years) with a mean follow-up of 33 (± 23) months were included. Six patients underwent reconstruction with a radial forearm flap and dorsal sensory branches of the radial nerve. Six patients underwent reconstruction with an anterolateral thigh flap and only deep motor branches of the femoral nerve to the vastus lateralis (n = 4) or combined with the lateral femoral cutaneous nerve (n = 2). Two patients regained nearly normal function (HB = 2). Eight patients regained at least resting symmetry (HB = 3 for n = 7; HB = 4 for n = 1). One patient regained a flicker of movement (HB = 5). One patient did not regain function (HB = 6). Six patients had static revision procedures to improve symmetry. Five patients had disease recurrence; 3 died from their disease. VNGs offer a practical and viable addition to the CNVII reconstruction strategy, and result in good functional recovery with acceptable donor site deficits. The associated adipofascial component of these flaps can also augment the soft tissue defect left after tumor ablation. (Plast Reconstr Surg Glob Open 2021;9:e3374; doi: 10.1097/GOX.0000000000003374; Published online 22 January 2021.)

INTRODUCTION

The facial nerve (CNVII) is a mixed nerve with many anatomical complexities. Thorough knowledge of CNVII anatomy is crucial to adequately plan for reconstruction. CNVII reconstruction following radical parotidectomy

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is important to restore patients’ eye protection, nasal patency, oral competence, and social interactions. Few studies have evaluated the effectiveness of vascularized nerve grafts (VNGs) for CNVII reconstruction. Superiority of VNGs versus non-VNGs has been demonstrated. Small case series describe immediate CNVII reconstruction with VNGs, including the anterolateral thigh flap (ALT) with the lateral femoral cutaneous nerve (LFCN) and deep motor branch of the femoral nerve to vastus lateralis (DMBVL). The radial forearm flap (RFF) with dorsal sensory branches of the radial nerve (DSBRN) has not been described as a VNG source.

Given the lack of literature, we performed a retrospective review of our patients who underwent immediate CNVII reconstruction with VNGs following...
radical parotidectomy. We sought to identify the amount of regained CNVII function following immediate reconstruction using VNGs.

METHODS
Consecutive patients who underwent radical parotidectomy with immediate CNVII reconstruction via VNGs were retrospectively reviewed (January 1, 2009–December 31, 2019). Preoperative (eg, demographics and pathology), perioperative (eg, operative details and VNG source), and postoperative (eg, complications, hospital stay, follow-up, adjuvant therapy, revision procedures, and oncologic outcomes) variables were collected. The primary outcome of postoperative CNVII function, measured by the House-Brackmann (HB) scale, was recorded. Data were abstracted and summarized qualitatively.

Technique (Figs. 1 and 2)
We harvest VNGs with a RFF or ALT flap. Care is taken to prevent separation of the donor nerves (eg, DSBRN, LFCN, and/or DMBVL) from the adipofascial components of the flap to maintain vascularity. Proximal and distal nerve branches are dissected to adequate lengths to bridge the CNVII defect.

The flap is inset (Fig. 1) to obliterate dead space and achieve the desired contour. Flap vessels are anastomosed to recipient neck vessels. Neurorrhaphies are performed between the proximal end(s) of the severed CNVII and the donor nerve(s), and between the distal end(s) of the donor nerve(s) and distal severed CNVII branches.

If CNVII is severed at the main trunk, a massester to buccal branch transfer (MBBT) is used to reinnervate midface and lip musculature. VNGs then bridge the gap between the main trunk and upper division to drive eye musculature and a second buccal branch, if applicable.

RESULTS
Twelve patients were included (3 women, 9 men; mean age = 53 (± 18.6) years; Table 1). Patients underwent reconstruction using RFF with DSBRN (n = 6) or an ALT flap with either DMBVL and LFCN (n = 2) or DMBVL only (n = 4). CNVII reconstruction was augmented with MBBT in 7 patients.

One patient returned to the OR for venous thrombosis with successful salvage. One patient had delayed donor site healing. No patients had subjective concerns regarding their donor sites. Average hospital stay was 6.5 (± 2.4) days. All patients received adjuvant radiotherapy; 2 patients received adjuvant chemotherapy. Six patients underwent additional static revision procedures. Five patients had disease recurrence; 3 patients died from their disease.

Average follow-up was 33 (± 23.7) months. Ninety-two percent (n = 11) of patients regained some facial nerve function (HB ≤ 5) and 75% (n = 9) regained at least resting symmetry (HB ≥ 3). Two patients achieved nearly normal function (HB = 2). The patient with no recovery died 9 months postoperatively from local recurrence. (See Video 1 [online], which displays the appearance of an 18-year-old woman [Patient 12 in Table 1] 87 months following immediate CNVII reconstruction with vascularized nerve grafts, masseter to buccal branch transfer, and adjuvant radiotherapy. The patient also received a revisionary procedure of autologous fat grafting to the preauricular area. The sequence of movements, from start to finish, includes closing the eyes at rest, smile with bite, and smile with no bite.) (See Video 2 [online], which displays the appearance of a 50-year-old man [Patient 6 in Table 1] 40 months following immediate CNVII reconstruction with vascularized nerve grafts, massester to buccal branch transfer, and adjuvant radiotherapy. The patient received no further revisionary procedures to address the affected eye. The sequence of movements, from start to finish, includes smile with no bite and smile with bite.)

DISCUSSION
CNVII reconstruction is crucial to restore facial functioning. Case reports of VNGs are few. No case series with RFFs or long-term follow-up exist. Our series demonstrates VNGs are a successful method of CNVII reconstruction, where the majority of patients achieve at least resting symmetry with good movement profiles. This is important, as many individuals with CNVII palsy suffer anxiety, depression, and social isolation. The restoration of resting symmetry and movement can reduce stigma and improve quality of life.
Compared with a published series of non-VNGs, our series of VNGs appears to offer superior outcomes regarding restoration of at least partial CNVII function, with fewer patients requiring secondary procedures for symmetry and eye function. The associated adipofascial component of these flaps helps augment the soft tissue contour defect after tumor ablation. Only 1 donor site is required with VNGs, offering the advantage of reconstructing both the contour and neuromuscular deficits. This contrasts with non-VNGs, which are typically harvested from sites remote to the free flap. Free vascularized tissue and VNGs may be more resistant to damage incurred by adjuvant radiation. Both donor sites used by our group were well tolerated. We believe these advantages make VNGs superior to conventional reconstruction techniques using non-VNGs.

Tailoring CNVII reconstruction to the level of sacrifice is an important consideration. The use of MBBT with VNGs can improve outcomes where CNVII has been severed at the main trunk. This concept has been described with non-VNGs. This technique permits reinnervation of separate facial subunits with distinct motor nerve sources, potentially decreasing synkinesis. However, the masseteric nerve is a strong power source that may contribute to voluntary movement beyond the targeted subunit(s) and influence final outcomes in patients with MBBT.

We acknowledge the limitations of our retrospective series. We used the HB scale despite its shortcomings to evaluate CNVII recovery. We encourage the use of improved measures to better capture the intricacies of CNVII recovery (eg, Facial Nerve Grading System 2.0 and Sunnybrook Facial Grading System) and patient-reported outcomes (eg, FACE-Q). Future investigations of VNGs would benefit from technologies (eg, indocyanine green angiography) to confirm vascularity following reconstruction. Vascularity to the VNGs was assumed to be maintained if evidence of flap vascularity was present, but we recognize this pitfall as nutrient vessels to VNGs were not directly monitored. We also acknowledge that many factors (eg, pathology, adjuvant radiotherapy and chemotherapy, and patients’ commitment to postoperative CNVII retraining) may affect outcomes beyond the reconstructive technique used.

VNGs are an underutilized and viable method for CNVII reconstruction resulting in good functional recovery with acceptable donor site deficits. Due to advantages beyond conventional non-VNGs, we recommend VNGs for CNVII reconstruction to improve long-term recovery for patients with large hostile ablative surgical fields, especially those subjected to adjuvant radiotherapy.
Table 1. Patient and Oncologic Characteristics, Details of Reconstructions and Adjunct Treatments, and Facial Nerve Function Outcomes

| No | Age at Surgery (y) | Sex | Masseter to Facial Nerve Surgery Source | Buccal Branch Nerve Transfer? | Adjuvant Therapy | Facial Flap | Adjuvant Surgical Techniques | Revisionary Surgery? | Followup (mo) | Disease Outcome | Disease-Free Followup (mo) | Function Outcome (HB Scale) | Diagnosis |
|----|--------------------|-----|---------------------------------------|------------------------------|--------------------------|-------------|-----------------------------|---------------------|--------------|----------------|--------------------------|---------------------------|------------|
| 1  | 43                 | F   | ALT                                   | No                           | Yes                      | RT          | RT                          | No                  | 7            | Metastatic recurrence | Disease-free              | 5                        | Ex-pleomorphic adenoma (high grade) |
| 2  | 40                 | M   | RFF                                   | Yes                          | No                       | RT          | RT                          | No                  | 9            | Local recurrence and deceased | Disease-free              | 6                        | Mucoepidermoid carcinoma |
| 3  | 58                 | M   | RFF                                   | No                           | Yes                      | CT + RT     | RT                          | Yes                 | 54           | Metastatic recurrence | Disease-free              | 5                        | Recurrent pleomorphic adenoma |
| 4  | 54                 | M   | RFF                                   | No                           | Yes                      | CT + RT     | RT                          | Yes                 | 19           | Metastatic recurrence | Disease-free              | 5                        | Acinic cell carcinoma |
| 5  | 67                 | M   | ALT                                   | No                           | Yes                      | No          | No                          | No                  | 11           | Metastatic recurrence | Disease-free              | 5                        | Salivary duct carcinoma |
| 6  | 46                 | M   | RFF                                   | Yes                          | No                       | RT          | CT + RT                     | Yes                 | 40           | Metastatic recurrence | Disease-free              | 2                        | Recurrent acinic cell carcinoma |
| 7  | 59                 | M   | DSBRN                                 | No                           | Yes                      | CT + RT     | Yes (UL gold weight; LL lateral canthopexy) | No                  | 30           | Metastatic recurrence | Disease-free              | 3                        | Salivary duct carcinoma |
| 8  | 76                 | F   | RFF                                   | Yes                          | No                       | RT          | RT                          | Yes                 | 87           | Metastatic recurrence | Disease-free              | 3                        | Cystic adenocarcinoma |
| 9  | 68                 | M   | DSBRN                                 | No                           | Yes                      | RT          | CT + RT                     | Yes                 | 30           | Metastatic recurrence | Disease-free              | 4                        | Metastatic SCC to parotid gland |
| 10 | 74                 | M   | DSBRN                                 | No                           | No                       | RT          | CT + RT                     | Yes                 | 42           | Metastatic recurrence | Disease-free              | 3                        | Metastatic SCC to parotid gland |
| 11 | 79                 | M   | DSBRN                                 | No                           | Yes                      | CT + RT     | Yes (UL gold weight; LL lateral canthopexy) | No                  | 30           | Metastatic recurrence | Disease-free              | 4                        | Metastatic SCC to parotid gland |
| 12 | 11                 | F   | DSBRN                                 | No                           | Yes                      | RT          | CT + RT                     | Yes                 | 87           | Metastatic recurrence | Disease-free              | 3                        | Cystic adenocarcinoma |

CT, chemotherapy; DFBVL, deep femoral motor branch to vastus lateralis; HB, House-Brackmann Scale; LL, lower lid; RT, radiotherapy; SCC, squamous cell carcinoma; UL, upper lid; VNG, vascularized nerve graft.

REFERENCES

1. Myckatyn TM, Mackinnon SE. A review of facial nerve anatomy. Semin Plast Surg. 2004;18:5–12.
2. Yang SH, Park H, Yoo DS, et al. Microsurgical anatomy of the facial nerve. Clin Anat. 2021;34:90–102.
3. Zhu Y, Liu S, Zhou S, et al. Vascularized versus nonvascularized facial nerve grafts using a new rabbit model. Plast Reconstr Surg. 2015;135:331e–339e.
4. Schultes G, Gaggl A, Kleinert R, et al. Vascularized versus nonvascularized nerve transfers: histologic study in rats. J Reconstr Microsurg. 2001;17:637–642.
5. Taylor GI, Ham FJ. The free vascularized nerve graft. A further experimental and clinical application of microvascular techniques. Plast Reconstr Surg. 1976;57:413–426.
6. Klein HJ, Guedes T, Tzou CJ, et al. Contemporary concepts of primary dynamic facial nerve reconstruction in the oncologic patient. J Craniofac Surg. 2019;30:2578–2581.
7. Cristóbal L, Linder S, Lopez B, et al. Free anterolateral thigh flap and masseter nerve transfer for reconstruction of extensive periauricular defects: surgical technique and clinical outcomes. Microsurgery. 2017;37:479–486.
8. Kimata Y, Sakuraba M, Hishinuma S, et al. Free vascularized nerve grafting for immediate facial nerve reconstruction. Laryngoscope. 2005;115:331–336.
9. Iida T, Nakagawa M, Asano T, et al. Free vascularized lateral femoral cutaneous nerve graft with anterolateral thigh flap for reconstruction of facial nerve defects. J Reconstr Microsurg. 2006;22:343–348.
10. Villarreal IM, Rodríguez-Valiente A, Castelló JR, et al. Promising technique for facial nerve reconstruction in extended parotidectomy. Iran J Otolarngol. 2015;27:475–479.
11. Xu ZE, Duan YW, Tan XX, et al. Reconstruction of complex total parotidectomy defect with a chimeric anterolateral thigh perforator flap and vascularized motor branch of femoral nerve grafting. J Oral Maxillofac Surg. 2015;73:2448.e1–2448.e7.
12. House JW, Brackmann DE. Facial nerve grading system. Otolaryngol Head Neck Surg. 1985;93:146–147.
13. Bogart KR. Socioemotional functioning with facial paralgesia: is there a congenital or acquired advantage? Health Psychol. 2020;39:345–354.
14. Bogart KR, Tickle-Degnen L, Joffe MS. Social interaction experiences of adults with Moebius syndrome: a focus group. J Health Psychol. 2012;17:1212–1222.
15. Bogart KR. “People are all about appearances”: a focus group of teenagers with Moebius syndrome. J Health Psychol. 2015;20:1579–1588.
16. Renkonen S, Sayed F, Keski-Säntti H, et al. Reconstruction of facial nerve after radical parotidectomy. Acta Otolaryngol. 2015;135:1065–1069.
17. 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.
18. Sahowaler A, Yeh D, Yao J. Primary facial reanimation in head and neck cancer. Oral Oncol. 2017;74:171–180.
19. Vrabec JT, Backous DD, Djalilian HR, et al; Facial Nerve Disorders Module. Cancer staging of facial nerve defects. J Oral Maxillofac Surg. 2009;67:445–450.
20. Neely JG, Cherian NG, Dickerson CB, et al. Sunnybrook facial grading system: reliability and criteria for grading. Laryngoscope. 2010;120:1038–1045.
21. Cracchiolo JR, Klassen AF, Young-Afat DA, et al. Leveraging patient-reported outcomes data to inform oncology clinical decision making: introducing the FACE-Q Head and Neck Cancer Module. Cancer. 2019;125:863–872.

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