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CLINICAL ARTICLE

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Free anterolateral thigh flap and masseter nerve transfer for reconstruction of extensive periauricular defects: Surgical technique and clinical outcomes

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Abstract

Background: Radical tumor ablation in the periauricular area often results in extensive soft tissue defects, including facial nerve sacrifice, bone and/or dura defects. Reconstruction of these defects should aim at restoring facial reanimation, wound closure, and facial and neck contours. We present our experience using free anterolateral thigh flap (ALT) in combination with masseter nerve to facial nerve transfer in managing complex defects in the periauricular area.

Methods: Between 2011 and 2015 six patients underwent a combined procedure of ALT flap reconstruction and masseter nerve transfer, to reconstruct extensive, post tumor resection, periauricular defects. The ALT flap was customized according to the defect. For smile restoration, the masseter nerve was transferred to the buccal branch of the facial nerve. If the facial nerve stump was preserved, interposition of nerve grafts to the zygomatic and frontal branches was performed to provide separate eye closure. The outcomes were analyzed by assessing wound closure, contour deformity, symmetry of the face, and facial nerve function.

Results: There were no partial or total flap losses. Stable wound closure and adequate volume replacement in the neck was achieved in all cases, as well as good facial tonus and symmetry. The mean follow-up time of clinical outcomes was 16.8 months. Smile restoration was graded as good or excellent in four cases, moderate in one and fair in one.

Conclusion: Extensive periauricular defects following oncologic resection could be adequately reconstructed in a combined procedure of free ALT flap and masseter nerve transfer to the facial nerve for smile restoration.

KEYWORDS
masseter nerve transfer, free anterolateral thigh flap, periauricular defects, facial reanimation

1 | INTRODUCTION

Resection of locally advanced tumors located in the periauricular area often results in extensive soft-tissue defects in combination with facial nerve sacrifice. Surgical resection of malignancies in this area may involve different structures, such as skin, parotid gland, lymphatic nodes, temporomandibular joint (TMJ), sternocleidomastoid muscle, lateral temporal bone or/and dura. These composite defects lead to facial contour deformities and functional deficits. In addition, postoperative radiation therapy is highly likely in this patient group affecting both wound healing and nerve regeneration (Elliott, Weinstein, Low, & Wu, 2011; Fritz & Rolfes, 2015; Pusic, Chen, Patel, Cordeiro, & Shah, 2007; Revenaugh, Knott, Scharpf, & Fritz, 2012).

Free flaps provide reliable and well-vascularized tissue, and are widely accepted in head and neck reconstruction (Neligan, 2013; Rosenthal et al., 2008). The anterolateral thigh (ALT) flap has become one of the most popular flaps in head and neck reconstructions due to its reliability and minimal donor site morbidity (Ali, Bluebond-Langner,

TABLE 1 Patients' Demographics, Surgical Techniques, and Clinical Outcomes

Patient	Age (years)	Gender	Tumor	Surgical Resection	ALT design	Facial Nerve Reconstruction	Complications	Terzis's Functional and Aesthetic Grading System	Secondary Procedures	Follow-up
1	78	Male	BCC	External ear, parotid, SCM, MRN, extratemporal facial nerve, mastoid, TMJ	Chimeric: fasciocutaneos and VLm	Masseter nerve to bucca branch	Malocclusion	Grade 3, Moderate	Gold weight implant for eye closure	28 months
						Nerve graft (VLMN) for zygomatic and frontal branches			Flap debulking	
2	68	Male	SCC	External ear, parotid, SCM, MRN, extratemporal facial nerve, mastoid, medial ear, TMJ	Chimeric: Fasciocutaneous and VLMN	Masseter[a] nerve to buccal branch	Malocclusion	Grade 5, Excellent	Scar correction	13 months. Deceased 14 months after surgery due to distant metastasis
						Vascularized Nerve graft (VLMN) for orbicularis oris and marginal branches				
3	63	Female	SCC	Parotid, SCM, MRN, dura, facial nerve intratemporal, mastoid, medial-internal ear, TMJ	Chimeric: Adipofascial ALT and VLm	Masseter nerve to buccal branch	Malocclusion. Stroke. Neuroma of the Great Auricular Nerve. Partial facial skin necrosis	Grade 4, Good	Gold weight implant for eye closure	38 months
									Flap debulking	
									Neuroma Revision	
4	37	Male	Terato carcinoma	External skin, parotid, SCM, MRN, extratemporal facial nerve	Fasciocutaneos ALT	Masseter nerve to buccal branch	No	Grade 5, Excellent	No	13 months. Deceased 27 months after surgery due to distant metastasis
						Nerve graft (LFCN) for zygomatic and frontal branches				
5	29	Female	MM	External skin, parotid, MRN, extratemporal facial nerve	Adipofascial ALT	Masseter nerve to buccal branch	No	Grade 4, Good	No	4 months. Deceased 9 months after surgery due to distant metastasis
						Nerve graft (VLMN) for zygomatic and frontal branches				

TABLE 1 (*Continued*)

Patient	Age (years)	Gender	Tumor	Surgical Resection	ALT design	Facial Nerve Reconstruction	Complications	Terzis's Functional and Aesthetic Grading System	Secondary Procedures	Follow-up
6	61	Female	BCC	External skin, parotid, MRN, extratemporal facial nerve, mastoid, medial ear	Chimeric: Fasciocutaneos ALT with VLm and VLMN	Masseter nerve to buccal branch Vascularized Nerve graft (VLMN) for zygomatic and frontal branches	No	Grade 2, Fair	No	5 months

BCC: basal cell carcinoma; SCC: squamous cell carcinoma; MM: malignant melanoma; SCM: sternocleidomastoid muscle; MRN: Modified radical neck dissection; TMJ: temporomandibular joint; RT: radiotherapy; ALT: anterolateral thigh flap. VLm: vastus lateralis muscle; VLMN: Vastus Lateralis Motor Nerve; LFCN: Lateral femoral cutaneous Nerve.
[a]The patient number 2 sustained a previous enucleation of the left eye due to a traumatism therefore no effort was made to reinnervate the orbicularis oculi muscle.

Rodriguez, & Cheng, 2009; Demirkan et al., 2000). The ALT flap can be tailored to the needs of the defect and designed as fasciocutaneous, adipofascial, or quimeric flap, being a very versatile option in reconstruction of complex total parotidectomy defects (Elliott et al., 2011).

For tumors located close to the facial nerve, partial or complete facial nerve sacrifice is often inevitable. The subsequent facial palsy affects facial function, psychological health, and aesthetic outcomes (Bianchi, Ferri, & Sesenna, 2012; Manktelow, Tomat, Zuker, & Chang, 2006). A large number of surgical techniques and modifications have been published for the rehabilitation of the face after nerve transection including nerve grafting, nerve transfers, regional muscle transposition, and free muscle transfers (Coombs, Ek, Wu, Cleland, & Leung, 2009; Garcia et al., 2015; Klebuc, 2011; Labbé & Huault, 2000; Terzis & Konofaos, 2012; Terzis & Tzafetta, 2009). Nerve transfers provide a healthy source of axons close to the target muscles and allows for direct coaptation. Among all potential donor nerves for reconstruction of the facial nerve, the masseter nerve has recently increased its popularity due to its constant nerve anatomy, strength of the motor impulses, fast recovery of tonus and motion, ease of cerebral adaptation, and low donor-site morbidity (Coombs et al., 2009; Klebuc, 2011; Manktelow et al., 2006).

The aim of the current report is to describe the combined procedure of free ALT flap and masseter to facial nerve transfer for reconstruction of extensive post cancer defects in the periauricular area.

2 | PATIENTS AND METHODS

Between 2011 and 2015 six patients (three men and three women) with mean age of 56 years (range 29–78 years) with extensive post-oncological periauricular defects including total resection of the facial nerve were reconstructed with a combined free ALT flap and masseter nerve to facial nerve transfer. A two-team approach was carried out in every case where the oncological resection was performed by the head and neck surgery team and the reconstruction by the plastic surgery team. All patients received postoperative radiation therapy. Demographic characteristics of the patients are summarized in Table 1.

2.1 | Surgical technique

The ALT flap harvesting was performed simultaneously with the tumor resection, using a two-team approach to minimize total operative time. Perforators were located using a hand-held Doppler and the flap was harvested subfascial in a standard fashion as described elsewhere (Wei et al., 2002). Once the tumor was resected, the flap was tailored to the defect and redesigned using foam templates to match the defect as a chimeric, adipofascial, or fasciocutaneous flap. Vascular anastomoses were performed after partial insetting of the flap. For smile restoration, the masseter nerve was anastomosed to the facial nerve branch of the zygomaticus mayor muscle identified by using a nerve stimulator. The masseter nerve was located at the mandible notch as we have previously described (Cheng, Audolfsson, Rodriguez-Lorenzo, Wong, & Rozen, 2013). The nerve was transected distally and the nerve stump

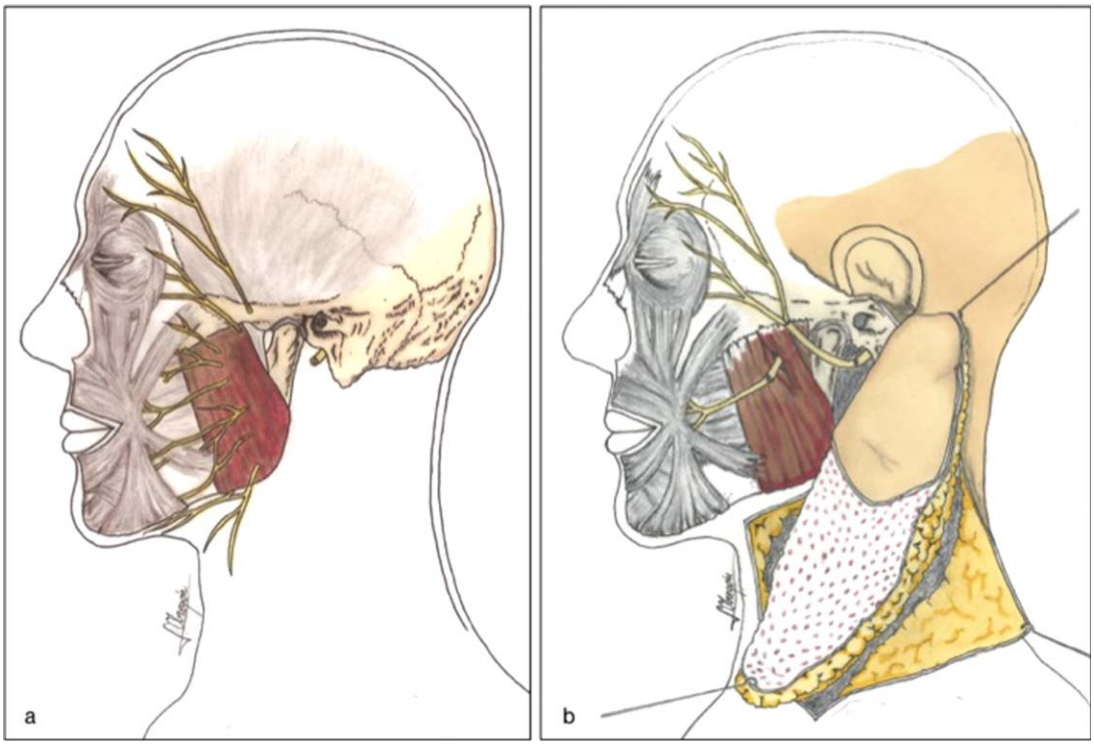

FIGURE 1 Drawing of the surgical technique showing the insetting of the ALT flap to provide volume in the neck and skin closure and facial nerve reconstruction with masseter nerve transfer for smile restoration and separate eye neurotization using the facial nerve stump with nerve grafts

transposed to the surface of the muscle for neurorraphy to the facial nerve. In case of availability of the extratemporal facial nerve stump, a nerve graft interposition to the zygomatic and the frontal branches was performed in order to isolate the action of blinking from smiling. Finally, the skin island of the flap was partially de-epithelialized and buried in order to provide volume in the depleted neck (Figure 1).

The reconstruction outcomes were reported in a descriptive manner by flap outcomes, postoperative complications, and smile restoration based on postoperative photographies and video recording of the patients using the Terzis' Functional and Aesthetic Grading System (Terzis & Tzafetta, 2009). Written consent was obtained to use patient's images for publication and patient's data was handled in accordance with our institution's research ethics board policies (ethical approval number Dnr 2016/031).

3 | RESULTS

Four ALT flaps were designed and harvested as chimeric flaps with combinations of a fasciocutaneous, adipofascial, vastus lateralis muscle, and/or vastus lateralis vascularized motor nerve components, one ALT as adipofascial and one as fasciocutaneous (Table 1). In all cases but one, the proximal stump of the facial nerve was available and was used for neurotization of the orbicularis oculi muscle via nerve grafts or vascularized vastus lateralis nerve. All flaps healed without major complications. One case required surgical revision of skin necrosis of the recipient auricular skin.

Resection of the TMJ was performed in three patients, resulting in mandibular deviation and malocclusion. One patient suffered a stroke on postoperative day 2. Three patients developed distant metastasis and died from the disease. There were no donor site complications.

Stable wound closure and adequate volume restoration in the neck was achieved in all cases with a mean follow-up time of clinical outcomes of 16.8 months (range 4–38 months). Commissural contraction due to masseter nerve activation was restored in all cases and all patients except one were able to smile voluntarily when biting. One case achieved spontaneous smile and independency from biting. According to Terzis' Functional and Aesthetic Grading System, four patients were scored as good or excellent, one as moderate and one as fair result. Both patients graded as moderate or fair were above 60 years old and the follow-up for patient number 6 was only 5 months. No synkinesis was noticed. None of the patients experienced oral incompetence at the last follow-up visit. The resection of the TMJ resulted in mandibular deviation and difficulties in initial training of facial reanimation (three out of six patients).

Eye closure was achieved by nerve reconstruction using nerve grafts in only one of six cases. Two patients needed subsequently gold weight implants to correct lagophtalmus. One patient had previously eye enucleation due to a previous traumatism therefore no nerve reconstruction for eye closure was performed. One patient died of distant metastasis 9 months after surgery with still not ability for eye

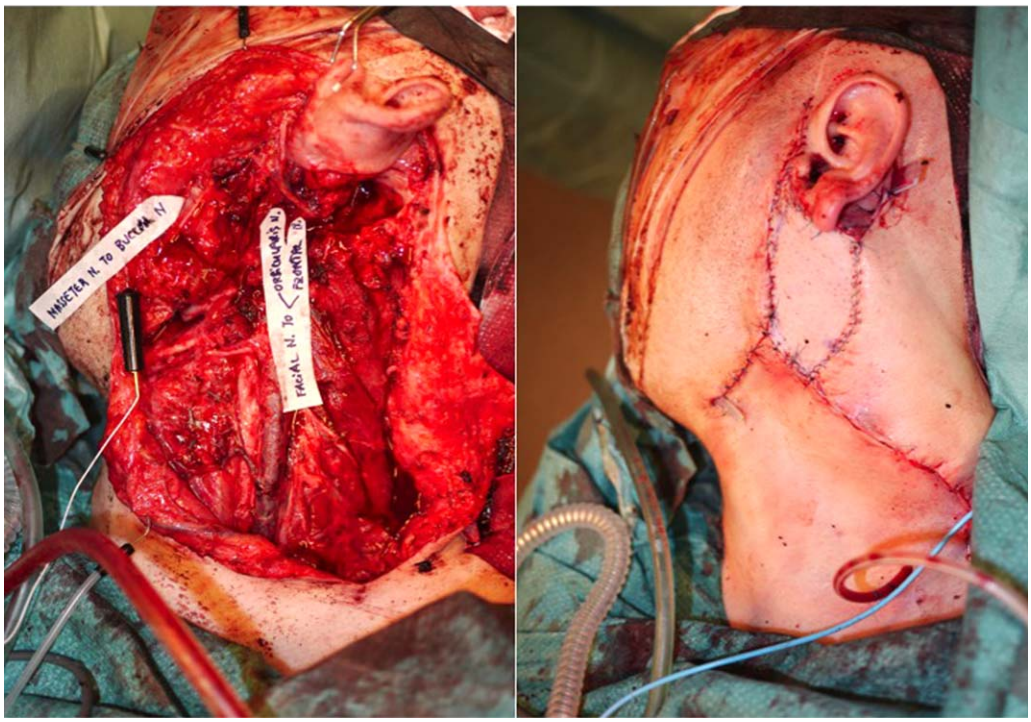

FIGURE 2 Intraoperative photograph of patient 4. On the left, resulting defect after tumor resection and nerve reconstruction with masseter nerve transfer to the buccal branch of the facial nerve and nerve graft from the facial nerve stump to the zygomatic and frontal branches. On the right, ALF flap after partial desepidermization for wound closure and restoration of volume in the neck.

closure. The patient with the shorter follow-up was not able to close the eye at the time of the visit 6 months after surgery.

3.1 | Case Report

A 37-year-old man with a previously treated teratocarcinoma in the ethmoidal sinus with ingrowth into the right frontal lobe presented with a metastasis in the parotid gland three years after initial treatment. Combination therapy with surgical excision and radiotherapy was planned and the resection included total parotidectomy, facial nerve nerve sacrifice, mastoidectomy, and radical neck dissection. The defect was reconstructed using a free fasciocutaneous ALT flap, masseter nerve transfer to buccal branch, and interposition of lateral femoral cutaneous nerve graft from the facial nerve stump to zygomatic and frontalis branches for separate eye closure. Vascular anastomosis was performed to the superior thyroid artery and vein. The distal portion was de-epithelialized and placed into the neck to provide volume, while the skin paddle was used to resurface the external defect (Figure 2).

FIGURE 3 Left, immediate postoperative photo showing complete left facial paralysis; on the middle; Middle, 13 months follow-up showing excellent smile restoration and on the right, eye closure at 13 months follow-up in patient 4

FIGURE 4 Satisfactory wound closure and volume restoration in the neck with the ALT flap

Thirteen months postoperatively the patient showed good symmetry at rest as well as during dynamic movements. The smile was comparable in both sides of the face and became effortless without the need of biting. The functional result was graded as excellent according to Terzis' Grading Scale (Figure 3). An aesthetically acceptable contour was achieved and the result remained stable without any need for further correction (Figure 4). The patient died of distant metastasis 27 months after surgery.

4 | DISCUSSION

Head and neck defects are among the most challenging for the reconstructive surgeon because of the intimate relationship between form and function in this anatomical area (Hanasono, Matros, & Disa, 2014). In the particular case of malignant tumors in the periauricular area, the defect encountered may involve several structures, ranging from skin and subcutaneous soft-tissue, to extensive defects including parotid gland, facial nerve, temporal bone, skull base, dura, and variable neck structures such as the lymph nodes, sternocleidomastoid muscle, etc. All these structures have a key role in providing support and protection, function, and three-dimensional appearance, and their absence can be devastating from a cosmetic and functional perspective (Elliott et al., 2011; Hanasono, Skoracki, Silva, & Yu, 2010; Pusic et al., 2007; Revenaugh et al., 2012; Rosenthal et al., 2008).

In our six cases, using ALT perforator flap for periauricular defects, we achieved stable wound closure and adequate volume restoration, with a long-lasting result, even after radiation therapy. Although several flaps can be used to cover these defects, those with muscle go to atrophy, especially after radiotherapy (Haubner, Ohmann, Pohl, Strutz, & Gassner, 2012). We observed that the final aesthetic result was influenced, not only by volume restoration, but also by the presence or absence of the ear. Patients who underwent ear resection had noticeable deformity, compared to those who did not. Defects of the auricular framework caused an unbalanced facial contour and we think that its reconstruction is essential to achieve an optimal aesthetic result. However, reconstruction of the ear is out of the scope of our article.

As previously mentioned, one of the goals of reconstruction in extensive periauricular defects is facial nerve reconstruction. Simultaneous facial nerve repair is associated with a more favorable outcome (Bascom, Schaitkin, May, & Klein, 2000) even if postoperative radiation therapy is planned (Brown, Eshleman, Foote, & Strome, 2000; Gidley et al., 2010), therefore we intended to reanimate the face in a single-stage procedure at the same time of oncological resection. Different surgical techniques have been described to reconstruct the facial nerve function after oncological resections in combination with free flap surgery. Elliot et al. (2011) reported their experience using ALT flap with adjacent nerve and fascia, for immediate reconstruction of complex parotidectomy defects in 22 patients. This approach offers a single donor site procedure, with minimal morbidity, and results in favorable functional outcomes and high degrees of patient satisfaction. Similarly, Hanasono et al. (2012) reported the use of nerve graft along with free flap for immediate reconstruction after oncological resection of temporal bone and facial nerve. They observed facial nerve recovery in 71.4% of patients occurring at a mean time of 7.9 months postoperatively. Ch'ng, Ashford, Gao, McGuinness, and Clark (2012) performed ALT flap and repair of the facial nerve with graft from vastus lateralis motor nerve, gold weight, and temporalis transfer for dynamic reanimation of the face in 21 patients undergoing radical parotidectomy.

Nerve transfers represent a valid alternative to reconstruct the facial nerve. It allows for a fasted nerve recovery since it may allow direct nerve coaptation close to the target muscle. Selection of donor nerves in facial reanimation include the hypoglossal, masseter, contralateral facial with cross-face nerve grafts, spinal accessory, and phrenic nerves (Garcia et al., 2015; Klebuc & Shenaq, 2004). Spira (1978) proposed the use of masseteric nerve as a viable alternative to facial nerve reconstruction. This alternative has been advocated and supported by several authors (Bianchi et al., 20014; Biglioli et al., 2012; Coombs et al., 2009; Hontanilla, Marre, & Cabello, 2014; Klebuc, 2011; Klebuc & Shenaq, 2004; Manktelow et al., 2006). In our cases, a combined approach consisting of masseter to facial nerve transfer to buccal branch, and nerve grafting to zygomatic and frontal branches were performed. We reconstructed these branches separately, in order to prevent synkinesis and maximize the speed of nerve regeneration by using nerve transfers in the setting of advanced cancers. Only in one case the combined approach was not possible due to the lack of facial nerve stump, therefore eye closure was restored in second stage using a gold weight implant. We transferred the masseter nerve to the buccal branch because a fast and reliable functional outcome was desirable in a single operative procedure. The motor nerve to the masseter muscle is close to the recipient site, which allows direct anastomosis without the need for grafting, and ensures fast reinnervation time. The anatomy is constant, and it provides powerful and reliable reinnervation of the muscles because of the abundant supply of axons (Coombs et al., 2009). Donor site morbidity is low, and there is no interference with masticatory function: masseteric nerve can be transected distal to some of the arborising branches and so it denervates the muscle only

partially (Coombs et al., 2009; Klebuc & Shenaq, 2004). Patients usually learn quickly to smile without biting, as reported by Kebluc and Shenaq (2004), however we found difficulties for initial training in patients undergoing resection of the TMJ. This was probably related to the mandible deviation and problems with clenching teeth.

We use the facial nerve stump if available to neurotize the eye with nerve grafts. In all cases, nerve grafts were obtained from the lateral femoral cutaneous or vastus lateralis motor nerve, in order to use the same donor site as the ALT flap. Vastus lateralis motor nerve presents adequate anatomic features to be used as a vascularized nerve graft for facial nerve reconstruction in terms of length, pedicle, and caliber (Agrogiannis, Rozen, Reddy, Audolfsson, & Rodriguez-Lorenzo, 2015). This nerve runs closely to the ALT pedicle, and sacrifice of one branch can be performed without impairing postoperative ambulation. In our patients, differently from smile reanimation, only one obtained satisfactory eye closure by nerve reconstruction. Our explanation for this is that several factors in these patients affects negatively nerve regeneration when using nerve grafts such as long nerve gaps, age, or association with radiotherapy.

Masseter nerve transfer maybe more favorable technique to reconstruct facial nerve gaps than nerve grafting in patients with advance head and neck cancer and presumably shorter life expectancy. It provides a quicker facial reanimation in comparison to nerve grafts, especially when bridging long nerve gaps as it is in the case or our patients' series where three of the six patients passed away within 13 months postoperatively. These patients presented facial reanimation that was graded as good or excellent by using the masseter nerve transfer, which would be very unlikely to achieve in such a short time using conventional nerve grafts.

Although a limited number of patients were included in the current report, we conclude that extensive periauricular defects following oncologic resection could be adequately reconstructed in a combined procedure of free ALT flap and masseter nerve transfer to the facial nerve for smile restoration.

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