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CLINICAL ARTICLE

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Facial nerve transfer for facial reanimation with parotidoplasty approach

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Abstract

Background: Facial paralysis has a profound impact on quality of life in affected individuals, primarily through loss of verbal and nonverbal communication. Common facial nerve reanimation techniques include coaptation to the masseteric or hypoglossal nerve. Most techniques require nerve grafts to achieve a tension-free neurorrhaphy. Our report aims to show a surgical adaption to current facial reanimation procedures using a partial parotidoplasty approach in order to avoid challenges caused by interpositional nerve grafts through primary neurorrhaphy.

Patients and Methods: The modified surgical approach was performed on four patients, aged 30–67. Length of paralysis ranged from 6 to 13 months. Cause of paralysis included one patient with Bell's palsy in one patient, prior surgery in two patients, and traumatic fracture in the remaining patient. A modified Blair approach is used to expose the parotid capsule. The facial nerve is dissected proximally toward the stylomastoid foramen and distally toward the masseter. The parotid gland substance is sectioned overlying each branch of the facial nerve using ultrasonic dissection or hemostatic scalpel, allowing mobilization of the proximal segment and upper and lower divisions of the facial nerve. The superficial lobe of the parotid is preserved in most cases. The House–Brackmann (H–B) functional scale was used to assess facial nerve function pre- and post-operatively.

Results: All patients showed H–B score V or greater prior to reanimation. Follow-up was conducted at 3-, 6-, and 12-months in all patients with resultant improvement of H–B scores of I in three patients and II in the remaining patient. Only one complication was noted, with one patient developing a right postauricular hematoma that was adequately managed without sequelae. All remaining patients experienced an uncomplicated post-operative course.

Conclusion: Our modified approach to facial nerve reanimation works well with a planned parotidoplasty allowing for successful reanimation outcomes without the need for interpositional grafting. This technique may be considered in masseteric and hemi-hypoglossal nerve transfers for the reinnervation of facial muscles.

1 | INTRODUCTION

Facial palsies due to facial nerve injury are well documented in medical literature. Common causes include idiopathic or Bell's palsy, iatrogenic,

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tumors, Ramsay Hunt syndrome, Lyme disease, otic infection, and trauma (Jowett & Hadlock, 2015). Iatrogenic injuries to the facial nerve occur commonly following ablative surgeries of the parotid gland, temporal bone, and lateral face (Gordin, Lee, Ducic, & Arnaoutakis, 2015). Facial nerve paralysis has a significant impact on quality of life. A variety of modalities to restore facial function and esthetics have been devised and instituted with varying degrees of success. Paralysis affecting the upper portion of the face can be treated using browpexy, blepharoplasty, myectomies, gold weights, springs, muscle transfers, and botulinum toxin for cocontractures (Guerreschi & Labbé, 2019). Treatments of the lower face include facial nerve repair with and without grafting, facial nerve transfer to a recipient nerve, reanimation, static suspension, regional muscle transfers, and myoplasty (Guerreschi & Labbé, 2019). The ideal facial nerve reanimation technique restores both upper and lower function via preservation of the temporal and zygomatic branches of the facial nerve.

Dynamic reanimation of the facial nerve has been achieved by various means including regional muscle transfer, free muscle with nerve transfer, and nerve transfer. Donor nerves for a nerve transfer approach include hypoglossal, masseteric, deep temporal branches of the trigeminal, or cross facial grafting with a sural nerve graft (Jowett & Hadlock, 2015). Of these two, the hypoglossal nerve and the masseteric nerve have gained the most widespread use.

The first description of the use of the masseteric nerve in facial reanimation was by Spira (1978). Since that time, several authors have described the use of masseteric-facial transfer for reanimation in flaccid facial paralysis (Henstrom, 2014; Murphey, Clinkscales, & Oyer, 2018). Facial reanimation is traditionally performed using the masseteric nerve or hypoglossal nerve. The masseteric nerve is a worthwhile donor nerve for facial nerve reanimation due to its favorable size match, length, predictable anatomic location, rich density of axons, and minimal impact on masticatory functions (Gordin et al., 2015). The masseteric nerve has gained in popularity due to higher rates of efficacy and avoidance of morbidity including synkinesis and impairment of tongue function when the hypoglossal nerve is used (Jowett & Hadlock, 2015). While the hypoglossal nerve must typically be partially divided to prevent synkinesias, this is not required in the masseteric transfer. These approaches both commonly require an interpositional graft in order to perform the neurorrhaphy.

The surgical approach to facial nerve reanimation via neurorrhaphy with either of these donor nerves is complex. The approach to both procedures is similar, involving locating both the donor nerve and facial (recipient) nerve, followed by approximation and neurorrhaphy of the two nerves. One of the most important principles of neurorrhaphy procedures is the need to perform the neurorrhaphy without tension. If a neurorrhaphy is performed under tension, it can compromise blood flow and lead to intrafascicular vessel damage compromising nerve regeneration (Miyamoto, 1979). Therefore, the presence of tension when the nerves are approximated is one of the most common findings necessitating the use of a nerve graft (Jones, 2010). Nerve grafting can ensure that the neurorrhaphy is performed without tension but has significant downsides including additional cost of the surgery, the need for a staged second surgical procedure and risk of donor site morbidity. Autologous grafts avoid the potential of rejection but carry the risk of deficit at the donor site (Wolford & Stevao, 2003). Allografts can be used to avoid deficits at the donor nerve site, but there is an increased cost of the procedure, the possibility of an inferior result, and the chance of allograft rejection. Inherent in the use of a nerve graft is the creation of two neurorrhaphy sites, the second of which proves an additional obstacle to axonal growth and return of function. These limitations make it ideal to avoid the use of an interpositional graft if the coaptation can be performed without tension. Both the masseteric and hypoglossal nerve transfer procedures routinely require interpositional grafting due to insufficient donor and recipient length or mobility.

A modification to the standard approach to facial reanimation could be of great benefit due to the common need for interpositional nerve grafting. The modification we recommend is to routinely release the proximal facial nerve and its upper and lower division by performing a parotidoplasty. This will allow for increased mobility of the recipient nerve, which will allow for a tension-free coaptation of the donor and recipient nerves without the need for a nerve graft. The purpose of this report is to describe the surgical approach and outcomes of the facial reanimation with the parotidoplasty procedure in a small number of patients.

2 | PATIENTS AND METHODS

Four patients are included in this report who received facial reanimation using the parotidoplasty approach to donor nerve transfer. Three patients received a masseteric nerve to facial nerve transfer while one received a hemi-hypoglossal to facial nerve transfer. Facial palsy in the four patients occurred due to factors including Bell's palsy in one patient, prior neurosurgical procedure in two patients, and traumatic rupture secondary to basilar skull fracture in the remaining patients. Patients ranged in age from 30 to 67 years. The length of time from paralysis to reanimation ranged from 6 to 13 months. Three patients had complete paralysis on pre-operative EMG while the remaining patient had near-complete paralysis. All patients demonstrated a complete loss of muscle tone (H–B VI) on clinical examination (Table 1). The four operations were performed by two surgeons.

2.1 | Surgical technique

A modified Blair or modified face-lift incision was utilized. After incisions were made, skin-SMAS flaps were elevated exposing the entire parotid capsule. The tragus of the ear was identified and the tragal cartilage ("tragal pointer") dissected to its inferior end. The facial nerve is most commonly found within 1 cm anterior, inferior, and medial to the "tragal pointer." The facial nerve trunk is initially dissected proximally toward the stylomastoid foramen. The facial nerve was then dissected distally toward the masseter muscle, freeing the superficial lobe of the parotid gland above and releasing the nerve from its deep

TABLE 1 Patient characteristics

Patient	Surgery received	Age at time of surgery	Gender	Indication for procedure	Type of neurorrhaphy	Denervation period	Pre-operative EMG findings	Time of last follow-up	Final outcome (H–B score)
1	Nerve to masseter to facial nerve	33	Female	Bell's palsy	End-to-end	13 months	Near-complete paralysis of CN VII	2 years	I
2	Nerve to masseter to facial nerve	67	Female	Prior neurosurgical procedure	End-to-end	6 months	Complete paralysis of CN VII	1.7 years	I
3	Nerve to masseter to facial nerve	30	Male	Basilar skull fracture	End-to-end	12 months	Complete paralysis of CN VII	1 year	I
4	Hemi-hypoglossal to facial nerve	37	Female	Prior neurosurgical procedure	End-to-side	8 months	Complete paralysis of CN V + VII	1 year	II

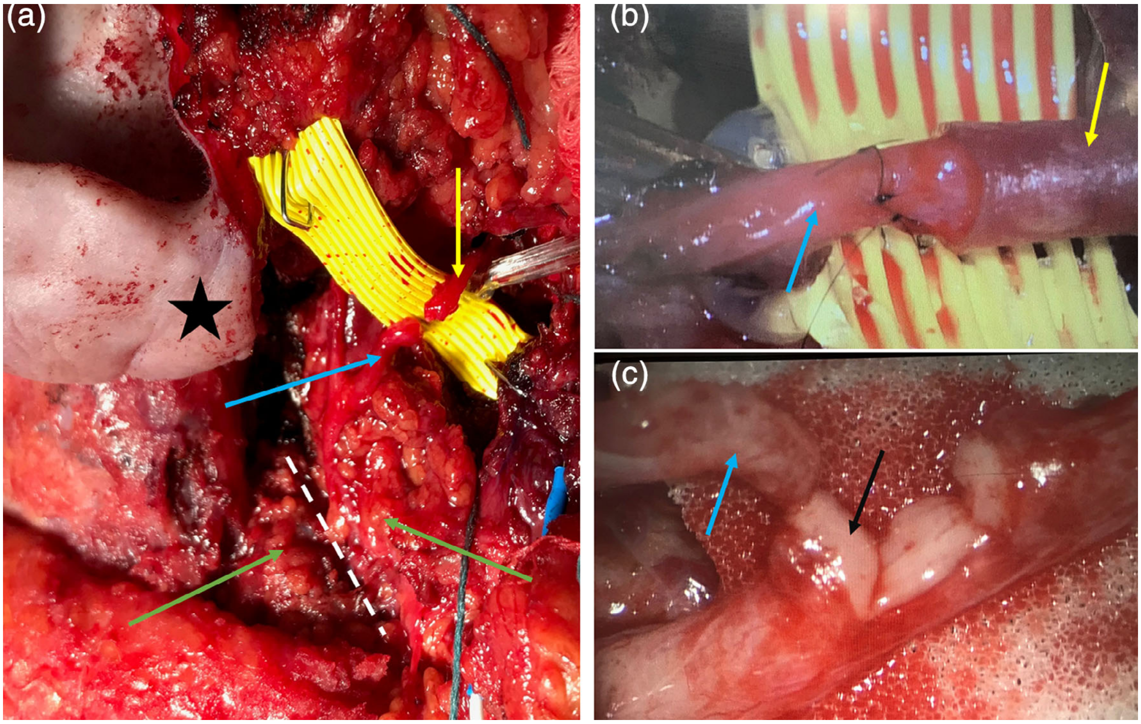

FIGURE 1 (a) Mobilization of the facial nerve following parotidoplasty allowing tension-free coaptation of the facial nerve and nerve to the masseter. (b) Nerve to the masseter and facial nerve neurorrhaphy once completed. (c) End-to-side neurorrhaphy of the facial nerve to the partially divided hypoglossal nerve following parotidoplasty technique. Yellow arrow denotes nerve to the masseter. Blue arrow denotes the facial nerve. Green arrow denotes the parotid substance and the white dotted line marks the path of the division of the parotid. The black star overlies the ear lobule and the black arrow marks the hypoglossal nerve

lobe attachments. This was achieved by sequentially sectioning the substance of the parotid gland overlying each branch of the facial nerve (Figure 1b), thus ensuring independent movement of the branches of the nerve. Complete mobilization of the proximal segment and its upper and lower divisions were accomplished. In most cases, the majority of the superficial lobe of the parotid gland was preserved and the incisions made into the parotid gland were loosely approximated to preserve the esthetic fullness of the cheek. All dissection of the parotid was performed with ultrasonic dissection or a hemostatic scalpel. These devices avoid electrocautery depolarization of the nerve during the dissection, a harbinger of slower recovery. The deep lobe of the parotid is left intact.

FIGURE 2 (a) Pre-operative imaging prior to facial reanimation demonstrating House–Brackmann score of VI. (b) Post-operative imaging taken at 6-month follow-up with patient at rest. (c) Post-operative imaging taken at 6-month follow-up with patient smiling

The masseteric muscle was then identified, and its fibers separated bluntly in a vertical direction from the zygomatic arch to the sigmoid notch of the mandible. The masseteric nerve was then identified between the superficial and deep muscle plain of the masseter muscle. The identity of the masseteric nerve was confirmed with intraoperative EMG. The descending branch of the masseteric nerve was isolated, divided, and rotated to approximate it to the facial nerve. A connector assisted neurorrhaphy was created using 10-0 nylon sutures.

For patients who received hypoglossal to facial nerve transfer, the approach to the facial nerve is similar to the procedure detailed above. An identical parotidoplasty is performed for mobilization of the facial nerve in both procedures. The hypoglossal nerve is then located underneath the posterior belly of the digastric, before distally turning anteriorly toward the tongue. The hypoglossal nerve is partially transected to preserve the function of the hypoglossal nerve. The hemi-hypoglossal nerve is then isolated and rotated to approximate to the facial nerve, and a neurorrhaphy created using 10-0 nylon sutures.

The House–Brackmann (H–B) scale was used to assess facial nerve function preoperatively and during recovery from facial surgery. The scale has levels I–VI, based on clinical evaluation of the patients' facial function. Grade I indicates full nerve function, while Grade VI denotes complete loss of function (Kochhar et al., 2016). Each patient received a pre-operative and 12-month post-operative H–B score.

3 | RESULTS

Of these, three patients received direct coaptation using the masseteric nerve as the donor, while one patient received copatation using a hemi-hypoglossal nerve transfer. A parotidoplasty was performed in all four patients which released the facial nerve from its parotid attachments thus allowing dorect coaptation without tension in all patients. None of our patients required nerve grafts. The patient with a hemi-hypoglossal transfer received an end-to-side coaptation, while the other three patients received end-to-end coaptation.

All patients had pre-operative H–B score for facial nerve function of V or VI, indicating barely detectable movements of the facial nerve distribution and loss of muscle tone. Follow-up was conducted at 3-, 6-, and 12-months post-operatively. Three patients had post-operative H–B score of I at the 6-month follow-up, indicating full facial nerve function. The remaining one patient had a H–B score of II at the 6-month follow-up. The average time to first facial movement was 3.5 months. Three of patients regained some movement by 3 months, while one regained movement at 5 months post-operatively. All improvements seen at the 6-month follow-up were still present at the 12-month follow-up. The patient who regained movement at 5 months was the same patient who had post-operative H–B of II. One patient developed a post-operative hematoma in the right postauricular area which was adequately managed without sequelae. The remaining patients had a routine post-operative course with no sequelae, infections, or abscess formation. No synkinesis were noted.

4 | CASE REPORT

We present the case of a 30-year-old male patient who had a prior neurosurgical procedure after sustaining a basilar skull fracture. He underwent a facial nerve to masseteric nerve neurorrhaphy for total functional facial paralysis (Figure 2a). The total length of paralysis was 12 months. Pre-operative EMG showed complete paralysis of cranial nerve VII. Prior to surgery, the patient had an H–B score of V. Following surgery, he demonstrated an H–B score of I at the 6-month follow-up, demonstrating improved facial symmetry while at rest (Figure 2b) and smiling (Figure 2c). The patient was pleased with his result, with stable total functional recovery.

5 | DISCUSSION

The technique for coaptation of the masseteric nerve or the hypoglossal nerve to the facial nerve involves dissection and division of the facial nerve as it exits the stylomastoid foramen. We propose routine division of the parotid substance encasing the nerve (Kochhar et al., 2016) This permits direct coaptation of the facial nerve stump to the nerve to the masseter avoiding the need for an interpositional graft, which was previously necessary due to lack of available nerve length and limited mobility (Murphey et al., 2018; Yetiser, 2007). The use of an interpositional graft has been shown to increase time to initial facial movement by 2.18 months compared to direct nerve to nerve neurorrhaphy (Murphey et al., 2018). The use of interpositional nerve grafts has also been linked to incomplete regeneration of both motor and sensory axons (Bertelli et al., 2004). Interpositional nerve grafts also introduce additional site/s of neurorrhaphy, thereby providing potentially additional site/s of axonal impedance to growth progression. Finally, facial reanimation procedures that can avoid a nerve graft often require sacrifice of the zygomatic branches of the facial nerve to perform the coaptation without tension (Klebuc, 2011). This decreases the upper facial reanimation achieved by the procedure, which we believe is unwarranted.

We propose a relatively straightforward surgical modification to the traditional approaches of managing the facial nerve within the parotid substance, specific to this nerve transfer technique. By performing an intraprocedural parotidoplasty, increased mobility of the facial nerve can be achieved. This allows a direct neurorrhaphy without the need for an intervening nerve graft and without tension, yet still preserving the temporal and zygomatic branches of the facial nerve. All four patients in the series received facial reanimation without the need for nerve grafting. This was made possible by the modified parotidoplasty technique allowing the facial nerve to be released and reflected over a range of 1.5–2.0 cm additional length. Patient outcomes in our report were excellent, with three of patients reaching post-operative H–B of I, indicating normal function. The average time to onset of movement was 3.5 months.

These results are noteworthy when compared with the current literature. Patients receiving the masseter to facial approach have an average time to first facial movement of 4.95 months (Murphey et al., 2018) and that the majority of these patients regain moderate (31.3%) or good–excellent function (56.3%) (Wang et al., 2014). Function similar to the contralateral side is regained at a median of 5.6 months (Wang et al., 2014). Patients receiving reanimation via a hemi-hypoglossal to facial approach reported regained of first facial movement 4–6 months post-operatively. In the same study, 62% of patients regained an H–B grade of at least II, post-operatively (Yetiser, 2007). Our modified procedure demonstrated reduced time to first facial movement, comparable, if not better functional outcomes when compared to the literature, as measured by the H–B scale.

The literature supports early intervention with respect to the timing of the reanimation (Yetiser, 2007). Patients receiving reanimation within 1–6 months of onset of paralysis regained significantly more function than those receiving repair after 12 months (Yetiser, 2007). Additional literature supports the need for early transfer in both hemi-hypoglossal and masseter approaches (Zhang, Hembd, Ching, Tolley, & Rozen, 2018). Patients in our report had excellent outcomes and received transfer at an average of 9.75 months, which is later than the ideal 1–6 months identified in the literature. We can then infer that our technique allowing for direct neurorrhaphy ensures successful reanimation at longer time periods after paralysis, which would increase the patient population that are candidates for facial reanimation.

The superficial lobe of the parotid gland was sequentially divided and mobilized to permit free rotation of the facial nerve for direct neurorrhaphy without tension (parotidoplasty technique). This technique is not described in any literature that the authors were able to find at the time of the report. The parotid tissue is not routinely divided as part of a facial reanimation technique. The partial parotidoplasty technique also prevents a sunken appearance to the cheek by preserving the majority of parotid tissue. None of the patients in our report experienced major complications from the nerve transfer or the parotidoplasty technique. One patient developed a surgical site superficial hematoma, which was managed in clinic setting without sequelae. A potential limitation of this procedures include the risk of salivary fistulization, though this was not found in our cohort of patients. This technique is contraindicated in patients with malignancy of the parotid gland.

Limitations to the report include the small cohort of patients. A larger-scale study should be conducted to validate the results discussed in this report. Additionally, the H–B scale used to evaluate the success of the facial reanimation is a subjective method of evaluating facial function. This scale is, therefore, dependent on the observer. Additional objective methods could be used to remove observer bias in grading pre- and post-operative facial nerve function. Finally, all patients in the report received operations conducted by one surgeon. Studies should be conducted comparing other surgeons' outcomes while utilizing the same parotidoplasty approach.

6 | CONCLUSION

Our modified approach to facial nerve reanimation utilizing hemi-hypoglossal or masseteric nerve transfers works well with a planned parotidoplasty or superficial parotidectomy. The parotidoplasty preserved parotid tissue thus avoiding a “sunken” appearance to the cheek when the parotid removed. Our approach allows for successful reanimation outcomes without the need for an interpositional nerve graft. This technique has not shown any additional side effects. This technique may be considered in masseteric and hemi-hypoglossal nerve transfers for the reinnervation of facial muscles.

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