ORIGINAL ARTICLE

Direct Facial-to-Hypoglossal Neurorrhaphy with Parotid Release

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ABSTRACT

Objective: Facial nerve paralysis or compromise can be caused by lesions of the temporal bone and cerebellopontine angle and their treatment. When the facial nerve is transected or severely compromised and primary end-to-end repair is not possible, hypoglossal-facial nerve anastomosis remains the most popular method for accomplishing three main goals: restoring facial tone, restoring facial symmetry, and facilitating return of voluntary facial movement. Our objectives are to evaluate the surgical feasibility and long-term outcomes of our technique of direct facial-to-hypoglossal neurorrhaphy with a parotid-release maneuver. Design: Prospective cohort. Setting: Academic tertiary care referral center. Patients: Ten patients with facial paralysis from proximal nerve injury underwent the facial-hypoglossal neurorrhaphy with a parotid-release maneuver. Main outcome measures: The Repaired Facial Nerve Recovery Scale, questionnaires, and photographs. Results: Facial-hypoglossal neurorrhaphy with parotid release was technically feasible in all cases, and anastomosis was performed distal to the origin of the ansa hypoglossi. All patients had good return of facial nerve function. Nine patients had scores of C or better, indicating strong eyelid and oral sphincter closure and mass motion. There was no hemilingual atrophy and no subjective tongue dysfunction. Conclusions: The parotid-release maneuver mobilizes additional length to the facial nerve, facilitating a tensionless communication distal to the ansa hypoglossi. The technique is a viable option for facial reanimation, and our patients achieved good clinical outcomes with continual improvement.

KEYWORDS: Facial paralysis, facial reanimation, hypoglossal-to-facial anastomosis

Hypoglossal-facial nerve anastomosis is a popular reanimation technique for managing facial paralysis resulting from temporal bone and cerebellopontine angle surgery, trauma, and

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Skull Base 2006;16:101–108.

Received: July 5, 2005. Accepted after revision: November 11, 2005.
Published online: April 1, 2006.
DOI 10.1055/s-2006-934111. ISSN 1531-5010.

neoplasms.[1,2] However, hemiglossal paralysis associated with the classic technique has resulted in morbidity in mastication and speech. Consequently, modifications to the original hypoglossal-facial nerve anastomosis technique have been developed to improve preservation of glossal function. These modifications include anastomosis of a descending hypoglossal branch to the facial nerve,[3] anastomosis of a descending hypoglossal branch to the distal stump of the hypoglossal nerve after classic hypoglossal-facial nerve anastomosis,[4] hemihypoglossal-facial nerve anastomosis,[3,5] split hypoglossal nerve anastomosis,[1,3,6] and interpositional-jump graft.[7,8]

Most authors agree that the most important prognostic factor in facial reanimation is a tensionless anastomosis.[9] More recently, several techniques have been developed that both preserve hypoglossal function and lengthen the mobilized facial nerve. In 1979, Hitselberger initially described mobilization of the intratemporal facial nerve to improve the connection between the hypoglossal nerve and facial nerve remnant in an end-to-end anastomosis.[10] To gain further length, an additional step to retroposition the parotid gland and pes anserinus was proposed.[11] In a cadaveric study, Yarbrough and colleagues rerouted the intratemporal facial nerve and retropositioned the parotid to gain an extra 17 mm for facial nerve anastomosis.[9] In 1997, Atlas and Lowinger[12] and Sawamura and Abe[13] introduced a technique that both lengthened the facial nerve by mobilizing the intratemporal segment and preserved glossal function by using a partial transection of the hypoglossal nerve for a side-to-end anastomosis.

We introduce a new technique for hypoglossal-to-facial nerve reanimation. It differs from that described by Atlas and Lowinger[12] and by Sawamura and Abe[13] by the addition of a parotid-release maneuver. Our goals were to evaluate the surgical feasibility and long-term outcomes of this direct facial-to-hypoglossal neurorrhaphy with a parotid-release maneuver in 10 patients with House-Brackmann (HB)[14] grade V to VI facial nerve paralysis. Adjunctive reanimation techniques included gold weights, tarsorrhaphy, endoscopic browlift, and facial sling.

METHODS

From December 1999 to July 2002, 10 patients (5 men, 5 women; age range, 13 to 58 years)

Table 1 Clinical Summary of Direct Facial-to-Hypoglossal Neurorrhaphy Technique Using the Parotid Release Maneuver

Patient Number	Location	Etiology	Duration of Paralysis	Grade of CN VII (HB)	Iatrogenic Paralysis	Time to Reinnervation (mos)	RFNRS Score	Duration of Follow-Up (mos)
1	Posterior	Acoustic neuroma	22 months	VI	yes	12	B	33
2	Fossa	Acoustic neuroma	15 months	VI	yes	11	C	11
3		Acoustic neuroma	6 months	VI	yes	7	B	41
4		Acoustic neuroma	7 days	VI	yes	12	C	12
5		Facial neuroma	0 days	VI	no	N/A	N/A	N/A
6		Malignant medulloblastoma	36 months	VI	yes	16	C	24
7		Meningioma	23 months	VI	yes	8	B	32
8	Temporal	Hemangioma	9 months	V	no	6	B	19
9	Bone	Cholesteatoma	12 months	VI	yes	6	B	48
10		Cholesteatoma	0 days	VI	no	6	B	14

HB, House-Brackmann; RFNRS, repaired facial nerve recovery scale.

Table 2 Repaired Facial Nerve Recovery Scale (RFNRS)

Score	Function
A	Normal facial function
B	Independent movement of eyelids and mouth Slight mass motion Slight movement of forehead
C	Strong closure of eyelids and oral sphincter Some mass motion No forehead movement
D	Incomplete closure of eyelids Significant mass motion Good tone
E	Minimal movement of any branch Poor tone
F	No movement

From Gidley et al.[2]

underwent direct facial-to-hypoglossal neurorrhaphy using the parotid-release maneuver performed by the senior author (J.T.R.). In all patients a gold weight was placed in the ipsilateral upper eyelid and lower tarsorrhaphy was performed (P.J.M.).

In seven cases, the cause of facial nerve paralysis was iatrogenic: one occurred at our institution and six occurred at outside institutions. In three cases, facial nerve paralysis was the result of a primary disease (Table 1). Preoperatively, facial nerve function was evaluated using the HB grading system. Nine patients were graded VI, and one was graded V. The duration between injury and facial nerve repair ranged from immediately to 36 months. A patient with a cholesteatoma and a patient with a facial nerve neuroma underwent reanimation at the time of tumor resection. Postoperatively, facial nerve function was assessed by the senior surgeons (J.T.R. and P.J.M). Outcomes were evaluated using the Repaired Facial Nerve Recovery Scale (RFNRS)[2] (Table 2) by incorporating follow-up examinations, photographs, and a patient satisfaction questionnaire. Patients underwent rehabilitation to encourage the development of voluntary facial movements and expression.

This study was approved by the Institutional Review Board.

SURGICAL TECHNIQUE

An incision is made in the temporalis region curving posteriorly and inferiorly behind the mastoid to a crease 3 cm inferior to the angle of the mandible. At the superior extent of the incision, the temporalis fascia is exposed. At the level of the mastoid, the incision proceeds deeper to expose the periosteum. In the neck, dissection is performed in the subplatysmal plane anterior to the parotid gland; the external auditory canal remains intact. Efforts are made to include prior postauricular incisions. The facial nerve is skeletonized via the mastoidectomy approach from the immediate postgeniculate area to the stylomastoid foramen. If the patient has serviceable hearing, the incus is removed via a facial recess exposure to facilitate dissection of the tympanic segment of the facial nerve. The incus is replaced as an interposition at the conclusion of the case. The facial nerve is transected distal to the geniculate ganglion. It is elevated from the fallopian canal and completely mobilized from the stylomastoid foramen for positioning into the neck. Care is taken to avoid cerebrospinal fluid leakage, especially in a patient who has undergone a prior translabyrinthine surgery.

The superficial lobe of the parotid, the facial nerve, and a cuff of deep parotid tissue are elevated (Fig. 1) and rotated inferiorly to provide additional length of mobilized facial nerve (Fig. 2). This maneuver is performed by separating the parotid gland from the cartilaginous external auditory canal and by undercutting the parotid tail, medial to the facial nerve, using a Shaw Hemostatic Scalpel (Hemostatix Medical Devices, Cherry Hill, NJ, USA) or a Colorado Micro Dissection Needle® (Colorado Biomedical Inc., Evergreen, CO, USA) on the electrocautery setting. The parotid-release maneuver provides an additional 3 to 5 cm of inferior extension to the mobilized facial nerve. This addition provides a tension-free anastomosis to the hypoglossal nerve distal to the origin of the ansa hypoglossi. The mobilized parotid tail is secured in an inferior rotation position with absorbable sutures.

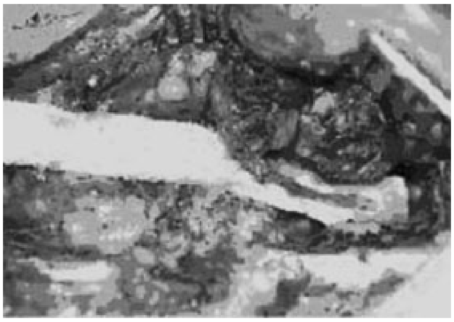

Figure 1 The facial nerve is mobilized from the stylomastoid foramen and the parotid is retracted anteriorly.

With the sternocleidomastoid muscle retracted posteriorly, the denervated posterior belly of the digastric is reflected inferiorly. Dissection proceeds medially until the hypoglossal nerve is located. The hypoglossal nerve is followed antegrade to a point where the facial nerve can be transposed to rest on the hypoglossal nerve without tension.

Under the operating microscope, a wedge incision no more than half the diameter of the hypoglossal nerve is made distal to the ansa hypoglossi. The distal end of the facial nerve is revised with a fine knife. Three or four interrupted 9–0 monofilament nylon sutures are used to approximate the epineurium of the facial nerve stump to the wedge incision on the proximal aspect of the hypoglossal nerve. The nerve endings should be approximated without any tension. The wound is closed in two layers. A nonsuction drain is placed at the end of the procedure and removed after 24 hours. All patients should receive perioperative antibiotics.

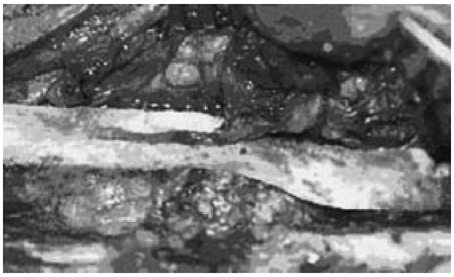

Figure 2 The facial nerve and a cuff of parotid tissue are rotated inferiorly into the neck, gaining an additional 3 to 5 cm of length for anastomosis to the hypoglossal nerve.

RESULTS

The duration of follow-up for nine patients ranged from 11 months to 48 months. One patient died of an undetermined cause about 36 hours after excision of a facial neuroma and facial nerve repair. Six patients were assigned an RFNRS score of B, and three patients were assigned an RFNRS score of C (Table 2). Median time to reinnervation was 8 months. Two patients with facial nerve paralysis of 12 and 23 months' duration recovered sufficient facial movement to allow removal of the gold weight. Two patients underwent ipsilateral facial sling procedures, and one patient underwent an ipsilateral browlift (Fig. 3). No complications were associated with our procedure.

Personal satisfaction scores recorded on a questionnaire distributed to five patients ranged from 7 to 9 on an ascending scale of 0 to 10. Patients were most satisfied with the return of symmetry and movement. They were most concerned with facial stiffness and eye dryness. Three patients denied problems eating. One patient reported a slight eye twitch while eating and one reported crocodile tears. Three patients denied dysphagia and three patients denied difficulty speaking; no patients complained of dysphagia or difficulty speaking. All patients denied changes in the appearance of their tongue. Three patients reported facial symmetry at rest, and two patients reported a symmetric smile with use of their tongue.

Figure 3 Preoperative (left) and postoperative views (right) of patient who underwent facial reanimation 9 months after acoustic neuroma resection. A left endoscopic browlift was performed. Photos printed with permission.

DISCUSSION

Hypoglossal-to-facial nerve repair is indicated when the facial nerve has been transected or permanently paralyzed at the brain stem, and the proximal facial nerve segment is therefore unavailable for primary anastomosis or interposition grafting.[12] Our direct facial-to-hypoglossal neurorrhaphy using the parotid-release maneuver is a reliable method for facial reanimation in patients with intact mimetic musculature and a viable distal facial nerve. Donor site morbidity is minimized. The additional length of facial nerve gained from its harvest just distal to the geniculate ganglion and from parotid release facilitates a tensionless anastomosis to the partially transected hypoglossal nerve distal to the ansa hypoglossi. This location provides greater hypoglossal motor axonal supply for innervation of facial musculature.[7] All patients experienced good to excellent functional outcomes with rapid return of facial tone, symmetry, and movement and no hemilingual atrophy.

The primary advantage of the parotid-release maneuver is the gain of mobilized facial nerve to facilitate a tensionless anastomosis. Mobilization of the intratemporal nerve provides 30 to 50 mm of facial nerve length, and the parotid tail provides an additional 30 to 50 mm. Tension at the anastomosis in addition to local tissue forces that determine nerve survival, host-bed neovascularization, and graft position significantly affect clinical outcomes.[11] Suture anastomosis may result in fibrosis, foreign-body reactions, axonal mismatch, neuromas, and wound separation.[2,11] Thus, a single anastomosis, unlike the jump graft technique, enhances neural regeneration and optimizes results.

To improve preservation of glossal function, techniques have been developed to minimize disruption to the hypoglossal nerve. Conley and Baker reported disappointing results in tongue dexterity after using a split nerve or a descending hypoglossal branch.[3] Because the hypoglossal nerve is not polyfasciculated, it cannot be subdivided into fascicles; nerve splitting may cause various degrees of hemiglossal atrophy.[1,6] All of our patients maintained excellent glossal function using the side-to-end anastomosis that sacrificed only half of the hypoglossal nerve.

The goals of facial reanimation are restoration of facial tone, symmetry, and coordinated, voluntary facial function. Nine of our patients achieved good facial tone and mobility. Atlas and Lowinger also reported return of facial tone, symmetry, and voluntary facial expression in their three patients after 6 to 11 months of follow-up; no grading scale was applied to characterize their results.[12] Sawamura and Abe reported that three of four patients recovered facial tone, symmetry, and some voluntary movement.[13] In comparison, it is recognized that the classic technique restores the paralyzed face with excellent results.[3] Conley and Baker reported that 95% of their patients attained good resting tone and some mass movement; however, variations of the classic anastomosis using the descendens hypoglossi and hypoglossal nerve splitting failed to restore useful facial function.[3] Overall, the outcomes associated with long cable grafts, multiple anastomoses, and extensive perineural dissection have been variable.[2,7,11]

The duration of paralysis likely affects facial reanimation outcomes. Conley and Baker reviewed their experience with 137 cases of hypoglossal-facial nerve anastomosis over 30 years. Reanimation was most effective when performed immediately or within 2 years of paralysis.[3] Our results in patients who had facial nerve paralysis for as long as 3 years before repair have been excellent. We observed that facial function returned more gradually in patients with a longer duration of paralysis.

The incorporation of adjunctive reanimation techniques augments the results of facial-to-hypoglossal neurorrhaphy. These include placement of eyelid gold weights, tarsorrhaphy, endoscopic browlift, and facial sling. Our patients had no significant eye problems, including eye dryness, visual problems, eye irritation, ocular pain, and excessive tearing. These techniques enhance both cosmetic and functional outcomes.

In summary, our modified technique for hypoglossal-to-facial neurorrhaphy with a parotid-release maneuver facilitates a tensionless anastomosis and achieves facial tone and function without hemilingual atrophy. Our results may be appreciated on several levels. First, mobilizing the intratemporal facial nerve is not technically difficult. The mastoid is frequently exposed during the initial approach for tumor removal, and a mastoidectomy is easily performed. Second, a tensionless anastomosis of the facial nerve to the hypoglossal nerve distal to the ansa hypoglossi is feasible with the parotid release. Third, procedural time is saved because only one anastomosis is created. Fourth, no hemilingual atrophy was observed. Finally, the technique is a viable option for patients who have experienced prolonged facial nerve paralysis and who seek facial reanimation.

CONCLUSIONS

The parotid-release maneuver mobilizes additional length to the distal facial nerve, creating a tensionless communication distal to the ansa hypoglossi. Our study demonstrates that this maneuver is a viable option for facial reanimation and that patients achieve good clinical outcomes associated with continual improvement.

PAPER PRESENTED

Presented at the 16th Annual North American Skull Base Society Meeting, Toronto, Ontario, Canada, April 8, 2005.

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Commentary

Dr. Roland and his colleagues have done an excellent job of describing a procedure that improves facial animation and tone without sacrificing tongue mobility. Their article certainly answers the question of whether a partial anastomosis has enough "horsepower" to rehabilitate facial palsy, even years after the event. Because the procedure does not appear to affect glossal function, it may be a good option for patients with other lower cranial nerve palsies.

It may be argued that a unilateral 12th cranial nerve deficit is rapidly rehabilitated in an otherwise normal patient. In patients who have mastoid cavities that are potentially exposed to cerebrospinal fluid (CSF), it will be important to balance the relative disability of the 12th cranial nerve palsy against the longer operating time and risk of CSF leakage in the procedure described here compared to a traditional end-to-end anastomosis, which may not require reopening the mastoid.

Peter A. Weisskopf, M.D., F.A.C.S.[1]

Commentary

Dr. Roland and his colleagues present a modification of the hypoglossal-facial nerve graft procedure for facial paralysis. Multiple variations of the technique have been performed with the goal of obtaining a tensionless anastomosis between the hypoglossal and facial nerves. The current modification offers a novel technique of mobilizing the facial nerve to the hypoglossal nerve. In most techniques, both nerves are mobilized to meet each other. The advantage of their technique is preservation of hypoglossal function while obtaining equivalent reanimation outcomes. In the armamentarium of facial nerve reanimation, this technique, with good reanimation results and preservation of the hypoglossal nerve, should be considered.

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Published online: April 1, 2006.
DOI 10.1055/s-2006-934107. ISSN 1531-5010.

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Skull Base 2006;16:107. Copyright © 2006 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.
Published online: April 1, 2006.
DOI 10.1055/s-2006-934108. ISSN 1531-5010.