ORIGINAL ARTICLE

# Outcomes of Direct Facial-to-Hypoglossal Neurorrhaphy with Parotid Release

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## ABSTRACT

Lesions of the temporal bone and cerebellopontine angle and their management can result in facial nerve paralysis. When the nerve deficit is not amenable to primary end-to-end repair or interpositional grafting, nerve transposition can be used to accomplish the goals of restoring facial tone, symmetry, and voluntary movement. The most widely used nerve transposition is the hypoglossal-facial nerve anastamosis, of which there are several technical variations. Previously we described a technique of single end-to-side anastamosis using intratemporal facial nerve mobilization and parotid release. This study further characterizes the results of this technique with a larger patient cohort and longer-term follow-up. The design of this study is a retrospective chart review and the setting is an academic tertiary care referral center. Twenty-one patients with facial nerve paralysis from proximal nerve injury at the cerebellopontine angle underwent facial-hypoglossal neurorraphy with parotid release. Outcomes were assessed using the Repaired Facial Nerve Recovery Scale, questionnaires, and patient photographs. Of the 21 patients, 18 were successfully reinnervated to a score of a B or C on the recovery scale, which equates to good oral and ocular sphincter closure with minimal mass movement. The mean duration of paralysis between injury and repair was 12.1 months (range 0 to 36 months) with a mean follow-up of 55 months. There were no cases of hemiglossal atrophy, paralysis, or subjective dysfunction. Direct facial-hypoglossal neurorrhaphy with parotid release achieved a functional reinnervation and good clinical outcome in the majority of patients, with minimal lingual morbidity. This technique is a viable option for facial reanimation and should be strongly considered as a surgical option for the paralyzed face.


**KEYWORDS:** Facial paralysis, facial reanimation, facial-to-hypoglossal anastomosis, parotid release

Facial nerve paralysis can be a devastating sequelae of temporal bone and cerebellopontine angle lesions. Although primary anastomosis or interpositional nerve grafting is generally preferred for reinnervation, the site of injury frequently precludes this type of repair.[1,2] In these cases, the hypoglossal-facial anastomosis is a popular and accepted reanimation option. The operation relies on a rerouted neuronal pathway traveling from the donor hypoglossal nerve to the distal trunk of the facial nerve. The technique in its classic form is an end-to-end anastomosis, which has been proven to restore facial tone, symmetry, and volitional muscle contraction to the

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reinnervated hemiface.[3–5] However, these results are achieved at the expense of tongue function—resulting in hemiglossal atrophy, tongue deviation, and impaired mastication.[6] These deficits are not insignificant, especially when multiple lower cranial nerve deficits or contralateral deficits are present, as is the case with the management of many skull base lesions. Consequently, several modifications have been proposed including ansa cervicalis coaptation, split hypoglossal anastomosis, and hemihypoglossal anastomosis with interpositional jump graft.[3,6–8]

One promising technique, developed and first described by Atlas and Lowinger, and Sawamura and Abe, provides for a rerouted intratemporal portion of the facial nerve to produce a single anastomosis.[9,10] To date, only limited series of patients undergoing this procedure have been published.[9–15] Previously, we reported on our technique, which is an expansion on the technique described by Atlas and Sawamura and their colleagues, using a parotid release maneuver with the contained facial nerve to provide additional length. This facilitates a single, tensionless anastomosis to the hypoglossal nerve distal to the ansa hypoglossi. No other series has evaluated the results of parotid release and anastomosis distal to the ansa hypoglossi. Herein, we report on the results of this technique in 21 patients treated at our institution.

## PATIENTS AND METHODS

This study was approved by the New York University Institutional Review Board, study No. H08-540. From the years 1999 to 2008, a total of 22 patients underwent direct facial-to-hypoglossal neurorrhaphy with parotid release at our institution. Inclusion criteria for the study were patients who underwent the procedure and who had follow-up of more than 1 year. One patient who underwent the procedure was excluded due to mortality of undetermined cause in the postoperative period. Patients previously reported in the senior author's original publication of this technique were included to provide longer-term follow-up.[16]

Data assessed included patient age, sex, etiology, and duration of facial nerve paralysis, preoperative House-Brackmann score, use of adjunctive reanimation procedures, and use of facial rehabilitation. Onset of first visible innervation was assessed during postoperative visits. Tongue mobility and degree of atrophy were recorded. Evaluation of facial function was made on the last available clinic visit by the senior surgeon. For those who were graded with a gold weight in place, critical attention was focused on the function of the orbicularis oculi, allowing the differentiation of passive versus active closure, and accurate scoring. A patient satisfaction questionnaire was used to assess subjective results.

**Table 1 Gidley-Ganz Repaired Facial Nerve Recovery Scale[2]**

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

Outcomes were assessed using the Repaired Facial Nerve Recovery Scale (RFNRS), which was first developed by Gidley and colleagues as a method of specifically evaluating those patients who have undergone reanastomosis of the facial nerve.[2] These patients, a unique group, often develop strong eye closure and possess some degree of mass motion while possessing little forehead movement. The RFNRS differs from the House-Brackmann scale by altering the emphasis on mass motion and forehead movement, resulting in a more representative measurement of outcomes (Table 1).

## SURGICAL TECHNIQUE

As previously described, 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.[16] At the superior extent of the incision, the temporalis fascia is exposed. The facial nerve is skeletonized via the mastoidectomy approach from the immediate postgeniculate area to the stylomastoid foramen. This has often already been performed on previous translabyrinthine approaches. Facial recess exposure facilitates dissection of the tympanic segment of the facial nerve. In some cases of difficult exposure, the incus is removed via facial recess exposure, to facilitate dissection of the tympanic segment of the facial nerve, and is subsequently 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 inferiorly. The nerve to the stapedius, chorda tympani, and sensory branch to the external auditory canal are sacrificed during this transposition. In the neck, dissection proceeds in a subplatysmal plane anterior to the parotid. The superficial lobe of the parotid, the facial nerve, and a cuff of deep parotid tissue are

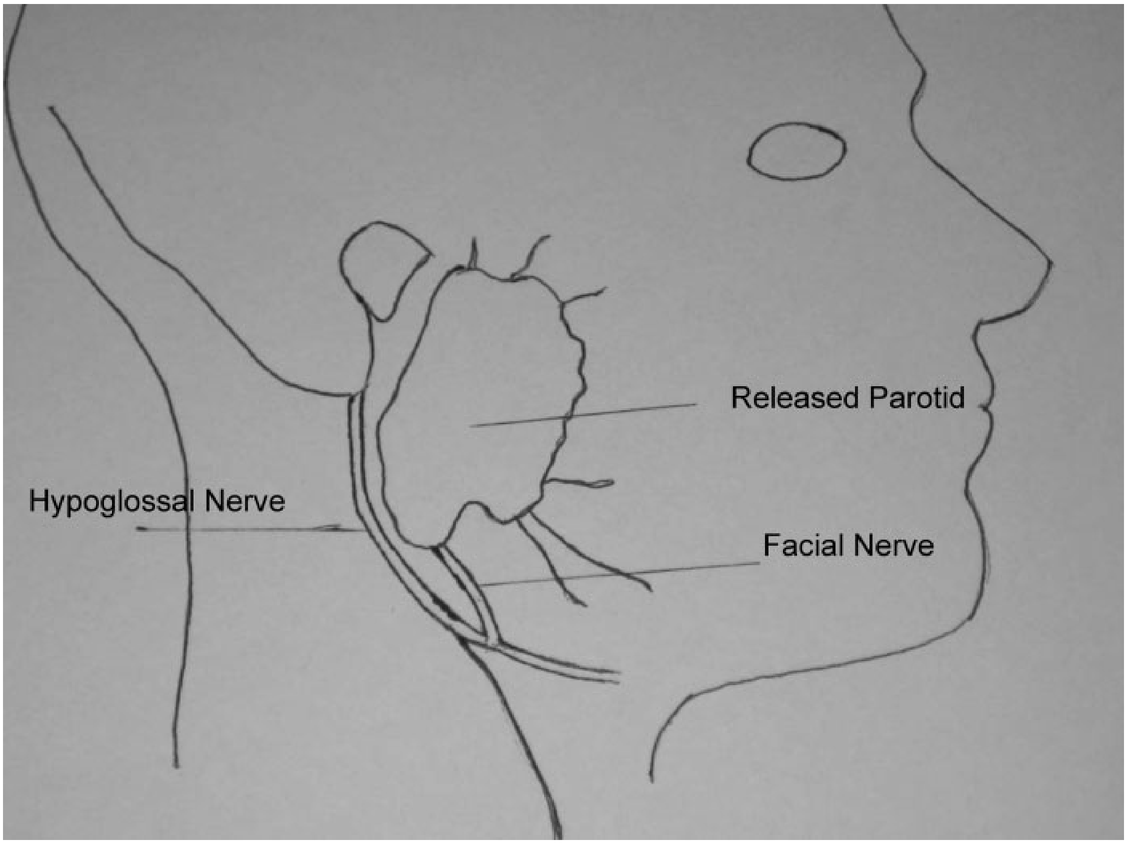


**Figure 1** Schematic of direct facial-to-hypoglossal neurorrhaphy with parotid release.

elevated and rotated inferiorly to provide additional length of mobilized facial nerve. 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. The parotid-release maneuver provides an additional 3 to 5 cm of inferior extension to the mobilized facial nerve. The mobilized parotid tail is secured in an inferior rotation position with absorbable sutures. With the sternocleidomastoid muscle retracted posteriorly, the posterior belly of the digastric is reflected inferiorly off of the mastoid tip, and 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 distal to the ansa hypoglossi. 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. 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 layers. A nonsuction drain is placed at the end of the procedure and removed after 24 hours. All patients receive perioperative antibiotics (Figs. 1, 2, and 3).

## RESULTS

Twenty-one patients were included in the study. Average patient age at the time of surgery was 42 (range 13 to 73) years. Acoustic neuroma was the most common pathology, seen in 10 of the 21 patients. Preoperative facial nerve function was a House-Brackmann (H-B) grade 6 in all but three patients, two of whom were H-B grade 5 and one a grade 4. All patients had lesions or tumors that involved portions of the facial nerve. Patients who were H-B 4 or 5 had not yet undergone primary tumor excision, and the operation would render them H-B 6. For these patients, neurorrhaphy was done at the time of tumor excision. Mean duration of facial paralysis before undergoing neurorrhaphy was 12.1 (range of 0 to 36) months.

Follow-up times ranged from 1 to 9 years with an average of over 4 years. Postoperative recovery was assessed at regular postoperative visits using the RFNRS. Of the 21 patients, 14 progressed to RFNRS class B (67%), indicating independent movement of eyelids and mouth, slight mass motion, and slight forehead movement. Four patients progressed to RFNRS class

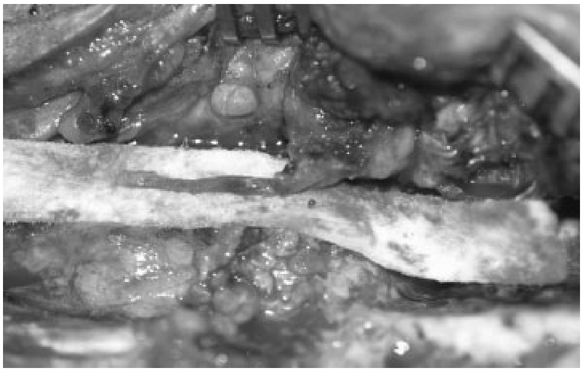

**Figure 2** Intratemporal portion of facial nerve mobilized with cuff of parotid tissue.

C (19%), and three to class D (14%). One patient who was a class D suffered from a severe Ramsey-Hunt syndrome postoperatively, and another was a patient with squamous cell carcinoma of the cerebellopontine angle and a history of external beam radiation and chemotherapy. No patients were observed to have hemilingual atrophy. First signs of reinnervation were seen between 4 and 6 months and progressed through the first 2 years.

Adjunctive reanimation procedures were done on nearly all patients. Gold weight eyelid implants were often performed at the time of surgery, and 17 of 21 received gold weight implants to assist with eye closure. Seven of these patients also received a lower-lid tarsal-strip procedure simultaneously to compensate for lid laxity. Four patients elected to undergo a brow-lift and midfacial-lift at a later date. The majority of patients underwent facial rehabilitative physical therapy. Gold weights were selectively removed in patients with sufficient eye closure, if complications developed or according to patient preference. In 15 patients, the gold weight was still in place at the time of last evaluation, including

**Figure 3** Hypoglossal nerve (solid white arrow and arrowhead) identified distal to the ansa hypoglossi (solid black arrow and solid white arrowhead) takeoff. Facial nerve (*) transposed with parotid tissue (open white arrow).

9 of 14 patients with class B, three of four patients graded as class C, and all three class D patients.

Patient satisfaction questionnaires were completed by 16 of 21 patients. The average satisfaction rating on a scale from 1 to 10 was 7. None reported loss of tongue function. All had return of eye closure. However, eye dryness was the most common complaint, in over half of responders. These patients used either eye drops or ointment on a regular basis (Table 2).

## DISCUSSION

Facial reanimation with hypoglossal-to-facial nerve transposition has been used for over 100 years to address the debilitating morbidity of facial nerve paralysis. The technique has continued to evolve to meet the challenges of restoring facial tone, symmetry, and coordinated facial movement with minimal donor site morbidity.

May et al made a major advance with the hemitransection of the hypoglossal nerve and interpositional jump graft, which forms the basis for sparing hypoglossal nerve function while providing sufficient axonal regrowth for reinnervation of the facial musculature.[7] Although outcomes are generally positive with the jump graft, drawbacks include the potential loss of axonal regrowth across two anastomoses and the need for peripheral nerve harvest.[17] This provides the impetus for the technique developed by Atlas and Lowinger and Sawamura and Abe, which offers several advantages by providing a single anastomosis and hypoglossal nerve preservation.[9,10] From the case series published, it clearly gives comparable results to the jump graft and classic technique.[9–15] However, because of slight variations in technique, different grading scales, and small series, it is difficult to directly compare results.

Our technique of facial-to-hypoglossal neurorrhaphy takes into account several important principles: the preservation of tongue function and a single, tension-free anastomosis distal to the ansa hypoglossi. The hemitransection of May et al did not completely eliminate hypoglossal nerve morbidity, and in 3 of 20 patients, there was postoperative hemiglossal dysfunction.[7] Other series also noted some hemiglossal dysfunction, albeit minimal when the nerve was hemitransected for the single anastomosis.[12,13,15] We propose that by anastomosing distal to the ansa, we can more reliably preserve hypoglossal integrity. Because fascicles are not linearly arranged, the location of the cervical motor roots is not predictable; sectioning may counterproductively preserve cervical roots and sacrifice excess hypoglossal fibers. Anastomosis distal to the ansa bifurcation allows a more reliable preservation of half to two-thirds of the hypoglossal nerve. None of our neurorrhaphies produced hemitongue atrophy or paralysis.

The parotid release maneuver offers the main advantage of gaining length for the mobilized facial

**Table 2 Long-Term Outcomes of Direct Facial-to-Hypoglossal Neurorrhaphy with Parotid Release**

| Age | Tumor | Time of Paralysis | Preoperative HB | Recovery Period (mo) | Facial Nerve Recovery Scale |
|---|---|---|---|---|---|
| 58 | AN | 22* | 6 | 93 | B |
| 50 | AN | 15* | 6 | 71 | C |
| 50 | AN | 6* | 6 | 101 | B |
| 20 | AN | 0.25* | 6 | 72 | C |
| 73 | AN | 6 | 6 | 23 | B |
| 60 | AN | 0.25 | 6 | 39 | B |
| 19 | AN | 10 | 6 | 21 | B |
| 67 | AN | 12 | 6 | 23 | B |
| 48 | AN | 9 | 6 | 25 | B |
| 27 | AN | 0 | 4 | 39 | B |
| 28 | FNN | 6 | 5 | 12 | B |
| 13 | MM | 36* | 6 | 84 | B |
| 43 | Men | 23* | 6 | 92 | B |
| 47 | Men | 18 | 6 | 37 | C |
| 60 | Men | 8 | 6 | 75 | D |
| 17 | LGM | 13 | 6 | 39 | D |
| 51 | GGH | 9* | 5 | 79 | B |
| 17 | VA | 13 | 6 | 12 | C |
| 67 | SCC | 36 | 6 | 51 | D |
| 29 | Chol | 12* | 6 | 108 | B |
| 33 | Chol | 0* | 6 | 74 | B |

*Indicates previous study patients.
AN, acoustic neuroma; Chol, cholesteatoma; FNN, facial nerve neuroma; GGH, geniculate ganglion hemangioma; HB, House-Brackmann; LGM, low grade malignancy of brainstem; Men, meningioma; MM, malignant medulloblastoma; SCC, squamous cell carcinoma; VA, venous angioma.

nerve. Hitselberger was among the first to described rerouting of the intratemporal facial nerve for additional length, which he used for the classic hypoglossal-to-facial anastomosis and which forms the basis for the single anastomosis.[18,19] Anatomic studies by Asaoka et al showed that mobilizing the facial nerve from the second genu to the pes can free from 22 to 42 mm, which was sufficient to reach the closest point on the hypoglossal nerve.[20] This was also the case with Campero and Socolovsky, who determined that on average 35 mm of mobilized nerve or graft is needed.[21] However, this does not take into account the extra length to reach beyond the ansa hypoglossi bifurcation, and in our experience, additional release is needed from the parotid. This allows for decreased tension on the anastomosis, optimizing the local tissue environment and host-bed neovascularization for improved clinical outcomes.[1,17] Thus reinnervation can be more consistent and predictable.

Duration of paralysis has been implicated in the outcomes of reanimation, and it is generally recommended that reanimation be performed before fibrosis and permanent atrophy of the facial musculature; however, the maximum length of time for which reinnervation can succeed is debated.[6] Our patients who progressed to a Gidley-Ganz score of B had a mean time of paralysis of 10.8 months, although among our patients with poor outcomes, five of the seven were reinnervated after more than 1 year of paralysis, with a mean of 20.6 months. On the other hand, there were several patients who achieved good reinnervation even after 3 years of paralysis. From our study, the effect of paralysis duration on outcomes is unclear, but it suggests that earlier repair is beneficial.

The majority of our patients achieved the goal of facial mimetic function, restored tone, and minimal synkinesis. There were no direct surgical complications, and theoretical risks, such as parotid seromas or cerebrospinal fluid leaks, were not seen. This compares favorably with other series of facial-hypoglossal transposition studies. Although facial assessment was made by the senior surgeon in a nonblinded manner, the RFNS scores were critically evaluated and accurate over time and between patients. This is one area that could be addressed in the future in a prospective manner with video-recorded examinations and multiple surgeon evaluations.

Adjunctive techniques such as eyelid gold weight, tarsorrhaphy, brow-lifts, and facial slings aided both cosmetic and functional outcomes. Despite successful rehabilitation and strong eye closure, many of these patients still commonly complained of eye dryness. The authors believe that even minor assistance from the gold weight may still be beneficial, and these were surgically removed only for patient concerns or complications from the weight. Electromyographic exam (EMG) was used selectively to expedite the neurorrhaphy in cases with uncertain prognosis or postoperatively when patients failed to progress to a strong reinnervation. The prognostic value with systematic EMG use is one area that can be addressed in future studies.

## CONCLUSION

The facial-to-hypoglossal neurorrhaphy with parotid release produced good functional results in the majority of patients. The rerouted intratemporal facial nerve in addition to the parotid release allows for a single, tensionless anastomosis distal to the ansa hypoglossi, thereby optimizing reinnervation and clinical outcomes. Given these advantages, we propose that this technique should be strongly considered for facial nerve reanimation.

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