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End-to-side intrapetrous hypoglossal–facial anastomosis for reanimation of the face

Technical note

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The aim of this paper was to report on further experience with a new technique for reanimation of the facial nerve. This procedure allows a straight end-to-side hypoglossal–facial anastomosis without interruption of the 12th cranial nerve or the need for graft interposition. It is technically demanding and time-consuming but offers an effective, reliable, and extraordinarily quick means of reinnervating the facial muscles, including the orbicularis oculi muscle, thus avoiding the need for a gold weight in the eyelid or a fascial sling.

Key Words • **facial paralysis** • **vestibular schwannoma** • **facial nerve** • **hypoglossal–facial anastomosis** • **end-to-side nerve repair** • **translabyrinthine approach**

Reanimation of a recently injured facial nerve when the proximal stump is unavailable is generally performed using the seventh–12th cranial nerve jump graft, which utilizes only one half of the hypoglossal nerve joined to the extracranial facial nerve by a single cable graft. The importance of sparing part of the hypoglossal nerve was originally emphasized by Zehm and Hartenau[11] in 1981, but in 1991 May, et al.,[8] definitively refined, popularized, and actually named the jump graft technique. This procedure uses only a portion of the hypoglossal nerve and has the enormous advantage of avoiding the tongue dysfunction that results from resection of the entire hypoglossal nerve. It is technically safe and the results are consistent and durable.[5] Recovery starts approximately 7 to 8 months postoperatively, depending on the age of the patient, and the final functional result is generally good when the face is at rest but requires active, prolonged, and motivated training to mimic voluntary and involuntary movements. Closure of the eye generally requires separate treatment involving the insertion of either a gold weight or a fascial sling in the upper eyelid.[6]

A limitation of the jump graft technique is the necessity of a graft together with its obvious double line of suture to be crossed by the regenerating axons as well as the resultant scarring and morbidity at the donor site (usually the sural nerve or, more rarely, the great auricular nerve). These factors have prompted us to develop an alternative method of facial nerve reanimation, although similar procedures have been previously reported by Darrouzet, et al.,[2] in 1999 and Atlas and Lowinger[1] in 1997. Independent of us and on a different basis, the same technique was described by Donzelli, et al.,[3] in 2003 as a one-stage process for repeated treatment of three residual vestibular schwannomas via the translabyrinthine route.

Materials and Methods

Patient Population

Two young women (31 and 34 years old) underwent removal of a large (4-cm) vestibular schwannoma via the suboccipital retrosigmoid approach. Despite anatomical preservation of the nerve, complete facial paralysis (House–Brackmann Grade VI) ensued postoperatively (Fig. 1). At 1 year postresection, electromyography and clinical examination results showed evidence of irreversible damage and surgery was undertaken.

Surgical Technique

Via a transmastoid fossa approach, the intratemporal facial nerve is exposed from the vertical third portion up to the external genu. The nerve is traced medially into the facial recess and cut. The fallopian canal is then carefully opened using a diamond bur under continuous suction and irrigation, and the distal facial nerve is extracted and rerouted outside the stylomastoid foramen. Use of this procedure gains an additional length of 3.5 cm, compared with the length exposed during isolation of the nerve at the tragal pointer.

The hypoglossal nerve is prepared in the retromandibular space distal to the origin of the descending ansa, to enhance the possibility of recruiting powerful motor axons (Fig. 1). The main trunk of the nerve is progressively gently pulled using multiple No. 7-0 epineurial stay sutures and is anchored to the surrounding connective tissue in an upward and lateral position (Fig. 2 *left*) to join the facial nerve stump. Ensuring accuracy of this maneuver is of paramount importance to avoid tension at the level of the suture. At very high magnification, through a small epineurial window, the endoneuria of two descending fascicles are opened (Fig. 2 *center*) and connected end-to-side with the stump of

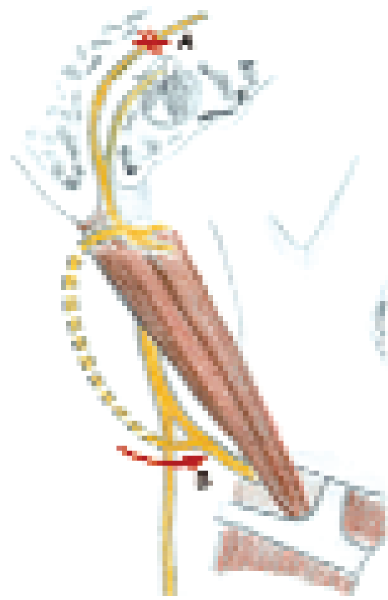

FIG. 1. Drawing illustrating the surgical procedure. The facial nerve is extracted from the fallopian canal, rerouted, and neurotized end-to-side to the hypoglossal nerve distal to the descending ansa. A = section of the intrapetrosal facial nerve at the level of the second genu; B = attachment of the facial nerve to the hypoglossal nerve after downward rerouting of the distal stump.

the facial nerve. One or two No. 10-0 stitches and fibrin glue are applied (Fig. 2 *right*). No branch coming off the facial nerve is interrupted during this procedure.

Results

Accurate evaluation of the results is hindered by two important factors. First, regardless of the scale used, data somehow depend on the personal evaluation of the surgeon or the team. Second, and much more importantly, the House–Brackmann[7] grading system can only be perfectly adapted for facial nerve recovery when a lesion in continuity is present (Bell or delayed posttraumatic palsy) or a nerve-to-nerve repair is performed. Additional problems are encountered when the results are evaluated in light of a repair with a different nerve. In reporting the results of an extrafacial neurotization technique, one inevitably underestimates the quality of even the best results: the presence of obvious synkinesis, in fact, automatically classifies the upper limit as a House–Brackmann Grade III, regardless of the degree of motor activity present. Therefore, we currently use the system proposed by House and Brackmann and later adopted by the Facial Nerve Disorders Committee of the American Academy of Otolaryngology–Head and Neck Surgery (Table 1).

TABLE 1

House–Brackmann scale for grading facial nerve function

Degree of Function	Grade	Definition
normal	I	normal & symmetrical function in all areas
mild dysfunction	II	slight weakness noticeable only on close inspection; complete eye closure with minimal effort; slight asymmetry of smile with maximal effort; synkinesis barely noticeable; contracture or spasm absent
moderate dysfunction	III	obvious weakness, but not disfiguring; may not be able to lift eyebrow; complete eye closure & strong but asymmetrical mouth movement with maximal effort; obvious, but not disfiguring, synkinesis, mass movement, or spasm
moderately severe dysfunction	IV	obvious disfiguring weakness; inability to lift eyebrow; incomplete eye closure & asymmetry of mouth with maximal effort; severe synkinesis, mass movement, & spasm
severe dysfunction	V	motion barely perceptible; incomplete eye closure, slight movement in corner of mouth; synkinesis, contracture, & spasm usually absent
total paralysis	VI	no movement; loss of tone; no synkinesis, contracture, or spasm

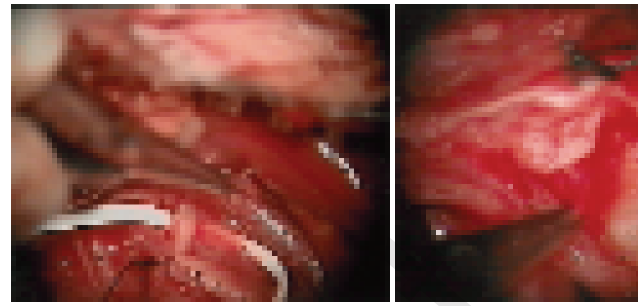

FIG. 2. Photographs depicting the procedure. *Left:* A stay suture mobilizes the hypoglossal nerve upward and laterally. *Center:* Epiendoneurial opening—note the herniating fascicles still in continuity. *Right:* Suture with fibrin glue.

At 2 months postoperatively reinnervation starts and constantly improves during the 1st year. At only 3 months muscle tone is excellent at rest, and at 6 months facial muscle function is very good on controlled speaking or laughing. When the patient is emotionally upset (sudden burst of crying or laughing), the responses are uncoordinated and the sequelae of the palsy are clearly visible.

The ability to mimic such voluntary and involuntary movements is highly dependent on prolonged exercise at the mirror. Noticeable, however, is the fact that the orbicularis oculi muscle is also reinnervated. Very soon the lower part of the muscle is perfectly active and lagophthalmos is no longer visible. At approximately 7 to 8 months postoperatively the upper orbicularis oculi muscle is also functioning, and a good symmetric blinking reflex is present. The gold weight in the upper eyelid was removed without consequence. Follow-up evaluations were performed between 18 and 24 months posttreatment. The tongue was normal at this time.

Discussion

Based on our experience, this procedure is quick and reliable, and recovery has an overall better quality than that with the seventh–12th cranial nerve jump graft (26 cases in our previous series, unpublished data). The results are unquestionably dependent on the precision of the suture, and therefore microsurgical skill in nerve repair is obviously welcome. Of particular interest are the normalization of the sagging face as early as 2 months after nerve repair and the definitive resolution of the eye problem. Given the speedy

TABLE 2

*Literature review of intratemporal direct hypoglossal–facial anastomosis**

Authors & Year	No. of Patients	Donor Nerve	Tongue Function (no./total no.)	House–Brackmann Grade (no. of patients)
Atlas & Lowinger, 1997	3	section of half CN XII	normal	III (3)
Darrouzet, et al., 1999	6	section of half CN XII	normal (4/6), min dysfunction (2/6)	III (5), IV (1)
Donzelli, et al., 2003	3	section of half CN XII	min dysfunction (3/3)	III (1), IV (2)
present study	2	endoneurial contact w/ CN XII fascicles	normal	II (2)

* CN = cranial nerve; min = minimal.

results the technique could be applied in cases referred late, probably even 2 years after nerve damage. Finally, no scarring or morbidity due to graft harvesting is part of the process.

Compared with other previously described techniques, we used a true end-to-side suture in that no nerve fascicle was interrupted. Both the jump graft technique and the intratemporal hemihypoglossal–facial attachment described by other authors (Table 2) entail the interruption of approximately one half of the hypoglossal nerve to attach the recipient facial nerve. This interruption is proven by the observation that either the graft or the facial nerve stump has a square section, which is exactly one half of the hypoglossal nerve. Note, however, that this nerve suture must be considered an end-to-end type of union, although it may macroscopically appear as an end-to-side type.

In contrast, the true end-to-side technique that we describe has two main advantages: tongue function is completely undisturbed and the quality of recovery is optimal because an exceedingly vigorous and disfiguring reinnervation is avoided, particularly in the nasogenual fold. Synkinesis is barely noticeable, and contracture or spasm is totally absent. These factors place our results at or near a House–Brackmann Grade II.

For the same reason, during this procedure we do not voluntarily interrupt the distal tiny lower branches coming off the facial nerve, as described by Darrouzet, et al.,[2] to avoid excess reinnervation of the lower face. A reduced rate of synkinesis after a true end-to-side coaptation has also been confirmed by the observations of Yoleri, et al.,[10] in 2000, although, on the whole, their approach is radically different, being totally outside the skull base.

A very important issue is still to be ascertained: the safety of the procedure must be established in terms of possible infection and cerebrospinal fluid leak in a larger series of patients, with special attention to repeated operations via a translabyrinthine approach during which the intradural space had been left open and the cleft filled with fat.

Conclusions

In light of the results obtained and the absolute lack of any morbidity associated with our procedure, one wonders whether the technique may be even better than a direct intracranial repair of the seventh cranial nerve when a wear and tear interruption of the proximal facial nerve occurs, as might happen in the course of removing large acoustic tumors.

Depending on its condition, a ruptured proximal stump might not always be considered the best choice for reinnervation. As originally demonstrated by Oberlin and colleagues,[9] and confirmed by our recent experience[4] in microsurgical repair of peripheral nerves, a perfectly functioning secondary nerve has extraordinary power of regeneration, sometimes preferable to a damaged proximal stump of the proper nerve.

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