Cross-facial nerve graft and masseteric nerve cooptation for one-stage facial reanimation: Principles, indications, and surgical procedure

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ABSTRACT: *Background.* The use of facial cross-grafting in acquired recent unilateral facial palsy provides spontaneity and emotional activation. Masseteric nerve for facial animation has mainly been described for reinnervation of neuromuscular transplants, babysitter procedures, or direct facial nerve cooptation. The simultaneous use in a single procedure of cross-facial nerve grafting and masseteric cooptation has not been described.

Methods. Eight patients underwent facial animation using single stage cross-facial nerve grafting and masseteric nerve cooptation. The mean duration of facial palsy was 10.2 months (range, 1–23 months).

Results. Voluntary contraction in response to masseteric nerve activation was observed after 2 to 4 months. All patients underwent postoperative rehabilitation and spontaneous contraction was achieved in 7 to 13 months postoperatively. Cosmetic outcomes were evaluated as moderate in 1 patient, good in 5 patients, and excellent in the remaining 2 patients.

Conclusion. This new technique could provide good results with fast, reliable, and powerful reinnervation, spontaneity, and low morbidity. © 2013 Wiley Periodicals, Inc. *Head Neck* **36:** 235–240, 2014

KEY WORDS: masseteric nerve cooptation, cross facial nerve grafting, facial nerve, facial animation, facial palsy

INTRODUCTION

Facial nerve paralysis is a functionally, esthetically, and psychologically disabling condition. Although several attempts have been made to find the ideal surgical procedure for reanimating the face, no ideal treatment has been developed; the surgical approach depends on the etiology and timing of palsy, the patient's age, and general condition, and the surgeon's experience.[1]

In 1971, Scaramella[2] first described cross-facial nerve grafting for reanimating the face after an acquired unilateral facial palsy. Since then, several modifications and improvements of the procedure have been proposed in the international literature.[3,4] The advantage of cross-facial nerve grafting is that it uses the healthy contralateral facial nerve to reanimate the paralyzed side, ensuring the spontaneity and synchronicity of facial expression.

The main disadvantage of this technique is the long time required for axon regeneration, which results in prolonged facial muscle denervation and atrophy. To overcome this issue, Terzis et al[5] introduced the 2-stage babysitter procedure in 1988, in which the hypoglossal nerve is used as a temporary, powerful donor nerve to innervate and maintain the tone of the facial muscles, preventing denervation and atrophy.

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Although satisfactory results can be achieved with this technique, the use of the hypoglossal nerve often yields unpredictable, unsatisfactory results because of the mild impulse provided by the XII cranial nerve and the patient's difficulty controlling facial movement. Furthermore, tongue morbidity should not be underestimated and care must be taken during preparation of the hypoglossal nerve to prevent tongue atrophy and impairment.[6]

The use of the masseteric nerve for facial animation has mainly been described for reinnervation of neuromuscular transplants, especially in patients with Moebius syndrome.[7,8] This nerve ensures fast, strong reinnervation with predictable, reliable results. Furthermore, patients usually learn to control its activation, achieving the release of facial contractions from biting and, in some cases, spontaneous and emotional activation have been hypothesized and reported.[9]

The masseteric nerve has been used successfully by other authors for babysitter procedures or for direct facial nerve cooptation[10,11]; however, its simultaneous use in a single procedure involving cross-facial nerve grafting and masseteric cooptation has not been described.

The rationale of using this technique is represented by the possibility to obtain a fast and predictable reanimation of the inferior third of the face (the most important for cosmesis) and to complete the facial rehabilitation once the cross-facial nerve grafting provides reinnervation of the facial middle and upper third without needing secondary procedures. Furthermore, the powerful impulse ensured by the masseteric cooptation allows an adequate contraction and excursion of the oral commissure,

TABLE 1. Patients.

Sex/age	Side	Etiology	Duration, mo	Platinum weight
M/34 y	Right	Acoustic neuroma	1	No
M/45 y	Left	Acoustic neuroma	11	No
M/38 y	Right	Acoustic neuroma	7	No
M/68 y	Left	Acoustic neuroma	23	Yes
M/59 y	Left	Acoustic neuroma	4	No
F/61 y	Right	Acoustic neuroma	18	Yes
M/44 y	Left	CPA tumor	15	No
M/67 y	Right	Acoustic neuroma	3	No

Abbreviation: CPA, cerebellopontine angle.

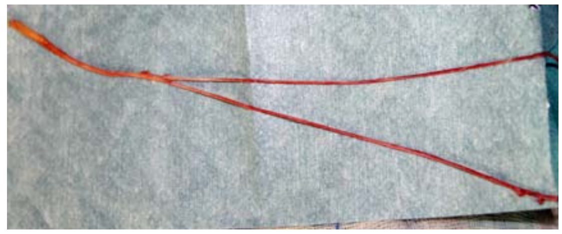

FIGURE 1. The sural nerve graft has been harvested and split. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

increasing symmetry with the healthy side that could hardly be achieved with classic cross-grafting techniques.

This article presents our experience with the 1-stage cross-facial nerve grafting and masseteric cooptation technique, discussing its indications, advantages, and disadvantages.

PATIENTS AND METHODS

Between January 1, 2006, and June 30, 2011, 8 patients (7 men, 1 woman; mean age, 52 years [range, 34–68 years]) affected by a complete unilateral facial paralysis underwent facial animation using cross-facial nerve grafting and masseteric nerve cooptation, according to the surgical protocol described below. The patient data are summarized in Table 1. The left and right side were equally involved in 4 cases. The etiology of the facial palsy was facial nerve sacrifice in acoustic neuroma resection in 7 cases and resection of a cerebellopontine angle astrocytoma in the remaining case. The mean duration of facial palsy was 10.2 months (range, 1–23 months). A platinum eyelid weight was used to improve upper eyelid closure in 2 patients who had eye discomfort at the time of diagnosis.

Surgical technique

The procedure is carried out by 2 teams working simultaneously. One team works on the leg, harvesting the sural nerve that is split under a microscope to obtain 2 or 3 monofascicular nerve grafts (Figure 1).[12]

The primary team works on the head, starting from the healthy side. Through a preauricular incision and dissection over the parotid fascia, the terminal branches of the healthy facial nerve are reached, mapped, and dissected. Facial branch selection is key to the procedure: a zygomatic-buccal branch is needed for middle contralateral face animation, whereas a zygomatic-ocular branch is usually used for eyelid animation (Figure 2A). At this stage, to prevent denervation and weakness of the healthy side, using a neurostimulator, it is very important to select only branches that have at least 1 synergic branch to preserve. Once the donor branches are selected, the paralyzed side is approached through a preauricular incision. The terminal branches of the paralyzed facial nerve are identified and dissected, as previously described. A zygomatic-buccal branch and a zygomatic-ocular branch to the eyelid are selected in order to reanimate the middle and the higher third of the face, respectively. With retrograde dissection, the principal inferior branch is also identified (Figure 2B). Using the posterior margin of the masseter muscle and the zygomatic arch as landmarks, the masseteric nerve is dissected and cooptation is performed under microscope magnification to the principal inferior branch of the facial nerve (Figure 2C). A tunnel is made between the 2 sides of the face passing through the superior buccal vestibule, the 2 split sural grafts are passed through this tunnel. Neural anastomoses are performed between the

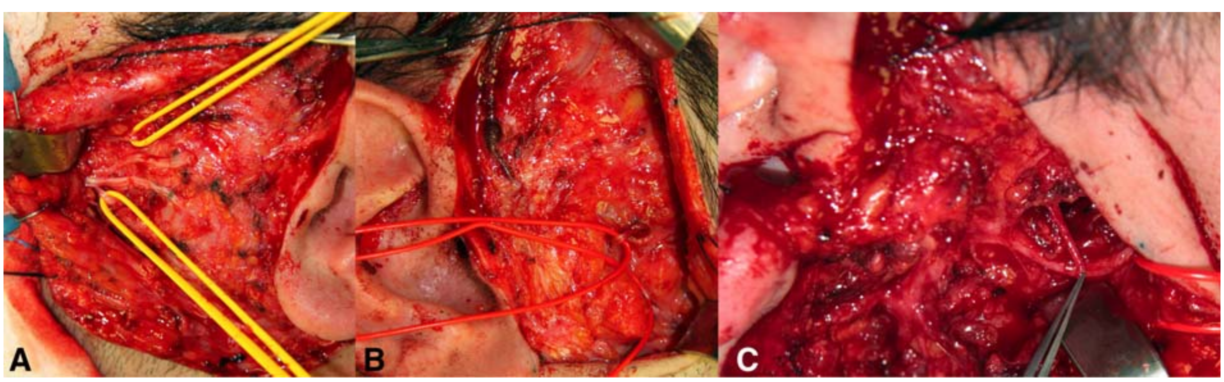

FIGURE 2. (A) Selection of left healthy facial nerve branches (line arrow: zygomatic-ocular branch to the eyelid; dotted arrow: zygomatic-buccal branch) with insetting of sural grafts (circle). (B) Recipient branches at the paralyzed side (line arrow: zygomatic-buccal branch; dotted arrow: inferior branch). (C) Masseteric nerve (line arrow) is used for facial nerve inferior branch (dotted arrow) cooptation. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

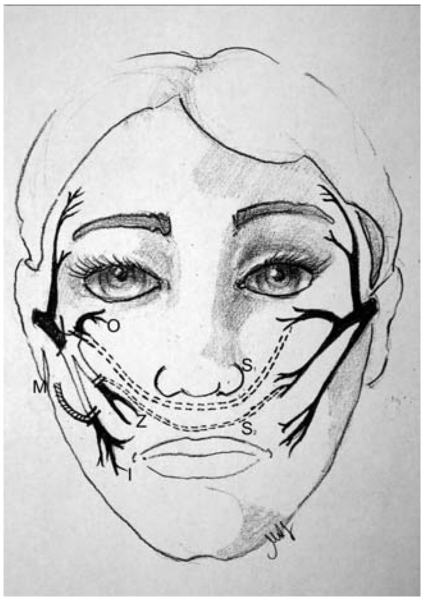

FIGURE 3. Schematic drawing of the procedure. Dotted lines and S1 and S2: sural nerve grafts. M, masseteric nerve; I, inferior branch of paralyzed facial nerve; Z, zygomatic-buccal branch of the paralyzed facial nerve; O, zygomatic-ocular branch of the paralyzed facial nerve.

sural graft and healthy selected facial nerve terminal branches on one side and the corresponding paralyzed selected facial nerve branches on the other (Figure 3). A Penrose drain is placed on both sides of the face and standard sutures are used to close the preauricular access.

RESULTS

No major complication occurred; minor complications included 1 seroma on the paralyzed side of the face and a subcutaneous seroma in the calf of 1 patient. No weakness in the healthy facial nerve or in the masseter was detected after surgery. The mean duration of hospitalization was 3.5 days (range, 2–5 days).

The mean follow-up period was 22.5 months (range, 9–45 months) and the results are summarized in Table 2 and Figure 4. Contraction of the buccal branches on the paralyzed side in response to masseteric nerve activation was clinically observed after 2 to 4 months (mean, 3 months). All patients underwent postoperative rehabilitation to release facial contractions from biting and to synchronize and increase the symmetry of smiling. Spontaneous contraction of all the face in response to cross-facial nerve grafting activation (activation of mimic muscles fully released by biting, synchronized with the healthy side and activated by emotions) was achieved 7 to 13 months (mean, 10.5 months) postoperatively (Figures 5, 6, 7, 8, 9). All patients developed spontaneous and emotional contraction with complete release from biting action. Cosmetic outcomes were evaluated using Terzis' Functional and Aesthetic Grading System[13] (poor: deformity, no contraction; fair: no symmetry, minimal contraction; moderate: moderate symmetry and contraction; good: symmetry, nearly full contraction; excellent: symmetrical smile with full contraction). The esthetic results were moderate in 1 patient, good in 5 patients, and excellent in the remaining 2 patients (Table 2).

DISCUSSION

The restoration of symmetric, spontaneous, powerful facial movement is the main objective of facial animation in patients with unilateral facial palsy. To reach this goal, the use of the contralateral healthy facial nerve as the donor nerve for reinnervation of the paralyzed side is now considered the best option, given the unique ability of this nerve to provide spontaneity and emotional activation.[14] Cross-facial nerve grafting was first described by Scaramella[2] in 1971 and, within the spectrum of facial animation procedures, is now considered in our department to be the treatment of choice in patients with acquired unilateral facial palsy when no proximal stump of the facial nerve is available, or in patients with central facial palsies. Despite the great potential of this technique, some limitations should be considered and managed with its application.

Time is the first, and, in our experience, the most critical factor when cross-facial grafting is planned; the months elapsed since the facial palsy began and the time required for facial muscle reinnervation largely influence the success rate and results.[15]

The facial mimic muscle atrophy that results from their denervation is a slow, steady process that starts with the onset of palsy and becomes irreversible in 3 to 4 years.[16] After this time, reinnervation of the mimic muscles using facial nerve grafting should be considered useless and other procedures, such as neuromuscular transplantation, are preferred for facial animation.[17] Several authors reporting their experiences have suggested different cutoff

TABLE 2. Results.

Sex/age	Complications	Hospitalization, d	Follow-up, mo	Contraction time	Spontaneity time	Aesthetic assessment, Terzis' Scale
M/34 y	Facial seroma	5	11	4	12	Good
M/45 y	None	3	19	3	11	Excellent
M/38 y	None	3	45	2	7	Good
M/68 y	Calf seroma	5	21	4	10	Excellent
M/59 y	None	3	9	3	9	Good
F/61 y	None	2	16	3	12	Good
M/44 y	None	3	25	2	13	Moderate
M/67 y	None	4	34	3	10	Good

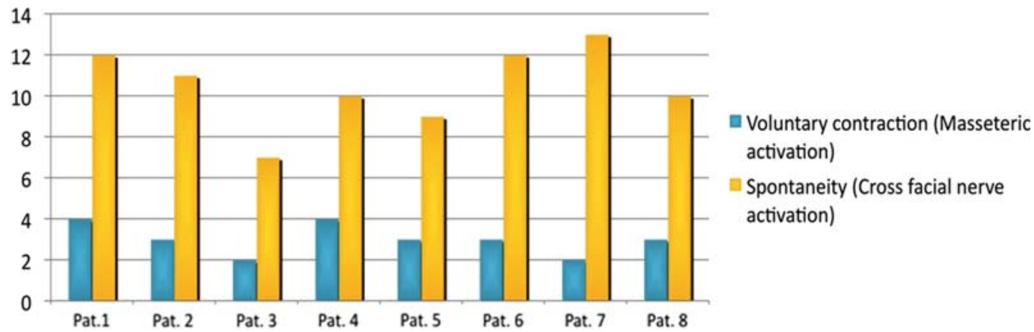

FIGURE 4. Timing of activation.

times, but there is a general consensus that the best and most predictable results are achieved with cross-facial nerve grafting when surgery is performed within 2 years of the palsy, although Conley et al[18] reported that the technique can be used within 4 years of palsy.

The time required for the cross-facial nerve graft axons to cross the midline and conduct a motor impulse to the paralyzed side of the face is also an important issue. To avoid the prolongation of muscle denervation time, babysitter procedures were introduced in the 1980s and are considered an indispensable tool.[19] The purpose of these procedures is to provide fast, safe, reliable motor reinnervation of the mimic muscles, thereby preventing their atrophy during cross-face axon regeneration. For this purpose, the hypoglossal nerve has long been considered the nerve of choice, although several authors have recently proposed the masseteric nerve as a good alternative or a better solution.[20] This nerve is closer than the hypoglossal nerve to the facial nerve branches and can be sutured directly without the need for grafting. More importantly, it provides a stronger impulse that is effective after 2 to 4 months, as reported in our case series.[21] Furthermore, the morbidity related to its use is very low and no interference with masticatory function occurs, whereas tongue impairment has been documented after hypoglossal nerve cooptation. Another important advantage in using the masseteric nerve for babysitting is related to the ability of patients to control its activation during facial expression, release from biting is achieved rapidly, and spontaneous activation after rehabilitation has been documented in an increasing number of publications.[22,23] Consequently, the use of the masseteric nerve for direct facial nerve cooptation was introduced recently[24] and we decided to combine the 2 techniques.

FIGURE 5. A 45-year-old male patient (case 2 of the list) with a left facial palsy resulted after an acoustic neuroma resection. Pictures at rest before (A) and after (B) surgery. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

The classic babysitter technique is described as a 2-stage procedure. First, hypoglossal or masseteric cooptation and cross-facial nerve grafting are performed leaving the distal stump of the facial graft in the preauricular area without suturing it to the paralyzed facial nerve; then, the motor nerve cooptation is sectioned and the regenerated cross-facial nerve graft is sutured to the terminal branches of the paralyzed facial nerve.[25]

In our patient series, we performed a single-step procedure using the masseteric nerve to coopt the inferior main branch of the paralyzed nerve and cross-facial nerve grafting sutured to its middle and upper terminal branches. Sectioning the coopted masseteric nerve was not required in any patient and its powerful impulse increased mimic muscle movements, whereas cross-facial grafting provided spontaneity and additional contraction.

Our results with this approach were encouraging, as demonstrated by the achievement of good or excellent

FIGURE 6. Patient's picture at mild contraction before (A) and after (B) surgery. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

FIGURE 7. Patient's picture at full contraction before (A) and after (B) surgery. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

outcomes in 7 of 8 patients. It is very difficult to understand whether the spontaneity we achieved in all patients was related to the presence of the cross-facial nerve graft or to the mechanism of cortical adaptation in the masseteric nerve nuclei. In this patient series, we achieved a higher rate of spontaneous activation than has been reported in other groups of patients treated with neuromuscular transplants reinnervated with the motor nerve to the masseter.[26,27] We believe that this outcome was because of the presence of facial nerve grafting. However, these findings are purely empirical and further studies are required to understand these phenomena. Functional MRI would be the ideal tool for this purpose and its application preoperatively and postoperatively could represent the next step in the evolution of our study.[28]

CONCLUSIONS

Fast, reliable, and powerful reinnervation, spontaneity, and low morbidity are the main advantages in using the masseteric nerve for facial nerve cooptation in recent years (<2 years) acquired unilateral facial palsy. Simultaneous cross-facial nerve grafting in a single-step procedure ensures stronger contraction, spontaneity, and synchronicity with the healthy side, further improving the final results.

FIGURE 8. A 61-year-old female patient (case 6 of the list) with a right facial palsy resulted after an acoustic neuroma resection. Pictures at rest before (A) and after (B) surgery. Platinum eyelid weight was used because of severe discomfort at the time of diagnosis. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

FIGURE 9. Patient's picture at full contraction before (A) and after (B) surgery. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

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