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Immediate facial reanimation in oncological parotid surgery with neurorrhaphy of the masseteric-thoracodorsal-facial nerve branch

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Abstract

The extracranial facial nerve may be sacrificed together with the parotid gland during a radical parotidectomy, and immediate reconstruction of the facial nerve is essential to maintain at least part of its function. We report five patients who had had radical parotidectomy (two with postoperative radiotherapy) and immediate (n = 3) or recent (n = 2) reconstructions of the masseteric-thoracodorsal-facial nerve branch. The first mimetic musculature movements started 6.2 (range 4–8.5) months postoperatively. At 24 months postoperatively clinical evaluation (modified House-Brackmann classification) showed grade V (n = 3), grade IV (n = 1), and grade III (n = 1) repairs. This first clinical series of masseteric-thoracodorsal-facial nerve neurorrhaphies has given encouraging results, and the technique should be considered as an option for immediate or recent reconstruction of branches of the facial nerve, particularly when its trunk is not available for proximal neurorrhaphy.

Keywords: Facial reanimation; Facial nerve reconstruction; Facial nerve branching; Thoracodorsal nerve; Masseteric nerve

Introduction

The extracranial course of the facial nerve may be involved as a consequence of a neoformation that has arisen in the parotid region, in which case excision of the lesion will require resection of branches of the facial nerve.[1] Multiple operations for consecutive recurrences of a pleomorphic adenoma may also result in amputation of the facial nerve because it is impossible to trace and spare its branches. If the facial nerve is resected together with the tumour, immediate reconstruction is necessary to limit functional and aesthetic deficits,[2] and the best way is to substitute the facial nerve with a graft from one, the sacrifice of which carries a lower morbidity.[3–5]

Neither of the most commonly used nerves, the sural nerve and great auricular nerve, has enough collateral branches to reconstruct all the main terminal branches of the facial nerve that are present at the periphery of the parotid gland (normally 5-8). In contrast, the thoracodorsal nerve trunk readily matches with the extracranial facial nerve trunk and its distal branches resemble branches of the facial nerve, both numerically and in calibre.[5]

In some cases, it is not advisable to use the proximal stump of the facial nerve as a motor source because a frozen section

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Table 1
Characteristics of the patients.

Case No	Sex M/F	Age (years)	Aetiology	Operation	N° of reconstructed branches
1	F	49	Sixth recurrence of pleomorphic adenoma	Radical parotidectomy + access ostectomy of mandibular ramus with subsequent replacement. Masseteric-thoracodorsal-facial nerves neurorrhaphy.	6
2	M	70	Previous radical parotidectomy + radiotherapy for parotid adenocarcinoma	Masseteric-thoracodorsal-facial nerve neurorrhaphy.	5
3	M	67	Squamous cell carcinoma	Radical parotidectomy + masseteric-thoracodorsal-facial nerves neurorrhaphy + postoperative radiotherapy.	5
4	M	46	Multiple schwannomas of the facial nerve	Radical parotidectomy + masseteric-thoracodorsal-facial nerves neurorrhaphy + cross-face nerve graft for orbicularis oculi.	6
5	F	42	Previous radical parotidectomy + radiotherapy for parotid adenocarcinoma	Masseteric-thoracodorsal-facial nerves neurorrhaphy + 2 cross-face nerve grafts for orbicularis oculi and great zygomatic muscle.	6

taken during the pathological examination might be invaded, and would subsequently require a boost of radiotherapy postoperatively. If reconstruction of branches of the facial nerve is secondary to excision and radiotherapy, axonal sprouting of the facial nerve may be reduced, and the process of finding its intraosseous course may damage the nerve and lower its potential for regeneration. In such cases it is advisable to consider another nerve as the motor source that will be connected to the thoracodorsal nerve graft.

Recently, the masseteric nerve has been used successfully for various facial reanimation procedures,[6,7] and here we have analysed its use as a motor source for immediate extracranial reconstruction of facial nerve branching by a masseteric-thoracodorsal-facial nerve branch neurorrhaphy.

Patients and methods

The research protocol was approved by the ethics committee of San Paolo University Hospital in accordance with the Helsinki Declaration.

Five patients (three men and two women, median (range) age 55 (49-70) years) had their facial nerve branches reconstructed using masseteric-thoracodorsal-facial nerve neurorrhaphies between September 2011 and February 2013. They were all operated on by the same surgeon (FB).

Aetiology

The causes were the sixth recurrence of a pleomorphic adenoma (n = 1), multiple extracranial facial nerve schwannomas (n = 1), extended carcinoma and pleomorphic adenoma (n = 1), and previous radical parotidectomy plus radiotherapy with no attempt to reconstruct the facial nerve at the time (n = 2). Of the last two patients, who were operated on elsewhere, one was reanimated 6 months after oncologial surgery and the other 8 months' postoperatively.

Investigations

Facial nerve function was evaluated preoperatively according to the modified House-Brackmann classification.[8] Three cases were grade VI (complete paralysis) and the other two grade III (intermediate). Subsequent radical parotidectomy, together with removal of branches of the facial nerve, resulted in complete facial nerve paralysis immediately postoperatively in all cases (grade VI).

Electromyography was used preoperatively to test the presence of mimetic muscular fibrillations at rest, indicating "live" muscles to be reanimated. Fibrillation was evident in all cases. The masseter muscle was also tested electromyographically to confirm the availability of the masseteric nerve as the donor motor nerve. Nerve function was normal in all cases. There were six reinnervated distal branches of the facial nerve in three patients, and five in the other two (Table 1).

Surgical technique (Figs. 1 and 2)

A facelift-type incision, hidden by the tragus, is extended cranially into the temporal region and caudally into the neck with a submandibular extension. A skin flap is raised to gain access to the masseteric-parotid region. At this point, all branches of the facial nerve at the periphery of the parotid region are identified gently. Generally, they number between five and eight.

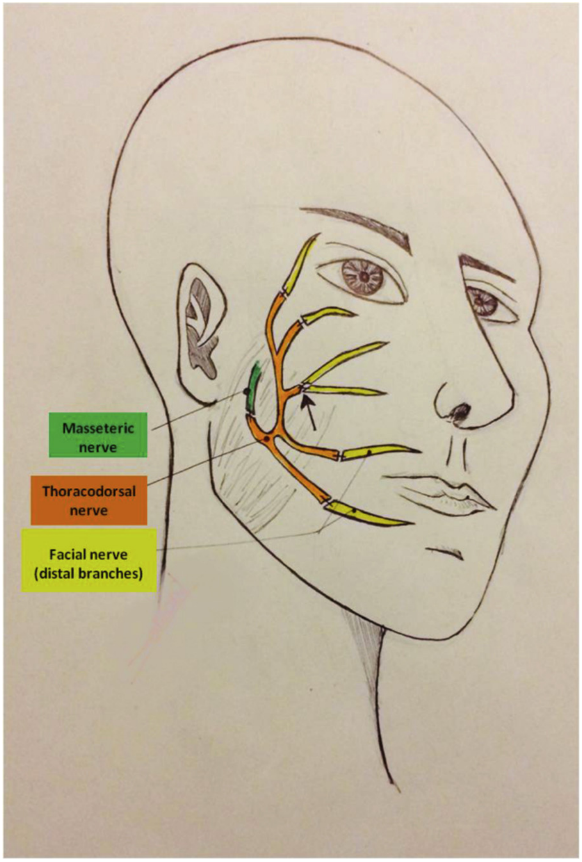

Fig. 1. The thoracodorsal nerve graft (orange) is neurorraphied proximally to the masseteric nerve (green) and distally to several facial nerve branches (yellow). If necessary two or more facial nerve branches contiguous to each other may be joined to one bigger thoracodorsal nerve branch (arrow).

Fig. 2. 5 neurorraphies between facial nerve branches and thoracodorsal branches (small arrows) at the end of microsurgery: note two facial branches joined to a single main thoracodorsal branch (big arrow). *= neurorraphy between the masseteric nerve and the trunk of the thoracodorsal nerve.

The masseteric nerve must be identified into the masseter muscle. Surgical landmarks include the zygomatic arch and the rear edge of the muscle. It is best to enter the muscle 1.5 cm below the zygomatic arch and 1 cm anterior to the posterior border of the muscle itself. At this point, the masseteric nerve is ∼1.5–2 cm deep to the surface of the muscle and is best visualised by gently sectioning the muscle fibres along the major axis: the masseteric nerve crosses the muscle going caudally and medially at an angle of ∼45° to the muscle fibres. Once the nerve is found, it is traced distally for 2–3 cm until its axis clearly shrinks because of collateral branching. Simultaneously, the main trunk of the contralateral thoracodorsal nerve and its main collateral branches are harvested meticulously from the axillary region on the undersurface of the latissimus dorsi muscle by a second surgical team. Once the recipient surgical field is ready, the thoracodorsal nerve is removed to be used as an interpositional graft, and its trunk is joined to the trunk of the masseteric nerve.

Distally, the branches of the thoracodorsal nerve are attached to the previously identified branches of the facial nerve with a few 10/0 epineural sutures surrounded by fibrin glue. If the number of branches of the facial nerve and thoracodorsal nerve do not correspond, two or more tiny branches may be anastomosed to a single bigger one.

Simultaneous cross-face nerve grafting was added in the last two cases to improve the spontaneity of facial movement. Anastomoses on the healthy side were end-to-end, whereas anastomoses on the paralysed side were end-to-side.[9] The aim was to add neural stimuli without depriving the recipient nerve branches of the possibility of being innervated by the masseteric nerve. In one case, a branch of the orbicularis oculi muscle received the cross-face nerve neurorrhaphy, while in the other, two cross-face nerve grafts were added: one to the branch for the orbicularis oculi and another for the great zygomatic muscle.

Postoperative care

Patients were instructed to contact our surgical unit as soon as the first facial movement was noted postoperatively. A visit to include electromyography was then arranged every three months. After facial movements had begun, all patients were instructed by our physiotherapist to exercise the mimetic muscles by clenching their teeth in front of a mirror (bio-feedback) three times/day for 5 minutes. After 2∼3 months, they were encouraged to think about moving the face without clenching their teeth, but just thinking about smiling or closing the eyes. At 4∼5 months after the onset of

Table 2
Our results graded according to the modification of the House-Brackmann classification that was published by Henstrom et al.[8]

Case No	Immediate postoperative grading	24 months' postoperative grading
1	I	V
2	I	V
3	I	III
4	I	V
5	I	IV

facial nerve movements, they were encouraged to smile on the reconstructed side at the same time as smiling on the healthy side. They were instructed to reduce smiling on the healthy side until good symmetry had been obtained with the reconstructed side. Biofeedback from the mirror was fundamental for this exercise as a motivational reinforcement tool. Two patients were able to come directly to appointments with the physiotherapist, but for the remaining three patients most appointments were done by Skype.

The final evaluation was 24 months postoperatively by a panel of two surgeons and one physiatrist who had not been involved in treatment. Results are given according to the Henstrom classification (Table 2).[8] The patient's ability to smile spontaneously was confirmed by recording a video of the patient watching a funny movie while alone in a dedicated room, as suggested by Terzis and Noah.[10]

Results (Figs. 3 and 4)

Wound healing and physical recovery of the patients were uneventful. The first signs of functional recovery of the facial muscle began at a mean time of 6 months (range 4-8.5 months).

At 24 months postoperatively, three patients were classified as grade V on the modified House-Brackmann scale, as they had good symmetry at rest and during smiling. In one case, there was a little asymmetry at rest with almost complete symmetry while smiling (grade IV). In the other

Fig. 3. Patient 24 months' postoperatively, showing a smiling face with good symmetry (published with the patient's permission).

Fig. 4. Patient 24 months'postoperatively showing complete eyelid closure (published with the patient's permission).

case, the asymmetry was more evident and the grade of contraction reduced (grade III). More effort was required generally by the patients to close their eyelids, which was complete in four of them. Stronger descending synkinesis (smiling during closure of the eyelid) was apparent in three cases. Little ascending synkinesis (closure of eyelids while smiling) was also noticeable in two cases. Control of synkinesis was taken into account on the physiotherapist's advice.

At the end of the period of rehabilitation all patients were able to smile while thinking about it, without the need to clench their teeth (as they had at the beginning of functional recovery). Spontaneity of smiling was recorded in two cases when they watched a funny film – they were the patients who also had cross-face nerve grafting, coupled with the facial nerve branch for the great zygomatic muscle. Smiling was spontaneous with a perceptible and natural movement. The excursion of the oral commissure was lower than that on the healthy side and also lower than the smile obtainable during "voluntary" smiling. In two cases, movement of the frontal muscle was possible with maximal effort, together with the activation of all homolateral mimetic musculature (Table 2).

Discussion

Sparing of the facial nerve during oncological resection of the parotid gland is obviously desirable when it is not involved with the neoplasm.[11] However, if the nerve is removed together with the tumour (because sparing it would necessarily imply surgical rupture of the mass) the facial nerve and its branches must be reconstructed to re-establish the passage of neural stimuli to the mimetic muscles. That is generally accomplished by placing an interpositional graft, because direct suturing of nerve stumps requires the loss of only a minimal length of the nerve.[2]

Several donor nerves have been suggested to replace the facial nerve.[12] The sural nerve, great auricular nerve, antebrachial medial or lateral cutaneous nerves, and the thoracodorsal nerve are possible sources for grafts.[3–5] In cases where "traditional" sural nerve grafting is used, two or more nerve grafts may need to be joined to the facial nerve trunk, and matching is difficult because of the large calibre of the sural nerve with consequent axonal loss at the anastomotic site. Only a few main branches of the facial nerve may be reconstructed because of the limited number of grafts that may be anastomosed to its trunk. Results are incomplete and often disappointing.

In 2006, White et al.[13] published what we think is the first report of the use of the thoracodorsal nerve graft to reconstruct the facial nerve. Recently, the thoracodorsal nerve graft has been described as an immediate replacement for grafting the facial nerve during parotidectomy for oncological reasons.[5] In particular, it has been emphasised that the matching of the thoracodorsal and the facial nerve trunks is optimal; the same may be argued for the branches of the facial and thoracodorsal nerves. This ideal matching, together with the large number of thoracodorsal nerve branches available to reconstruct distal branches of the facial nerve, makes the technique particularly suitable for total substitution of facial nerve branches.[5] The neurotisation of the mimetic musculature is consequently more complete.

At the end of a total parotidectomy, the facial nerve trunk is undoubtedly the ideal donor motor nerve. Nerve stimulus is good and it becomes activated at the right moment. If the trunk is in an intraoperative frozen section, much drilling may be required to follow it retrogradely into the cranial base, and postoperative radiotherapy will be added. Consequently, the reliability of axonal facial nerve trunk sprouting is reduced. In such cases, it is reasonable to choose an alternative motor nerve. The same considerations apply if radiotherapy has already been given before the secondary reconstruction.

An alternative motor nerve, because of the quality of the stimulus provided, is the contralateral facial one, as suggested in 1971 by both Smith and Scaramella.[14,15] Unfortunately, this procedure has too many failures because there are so few neural fibres regenerating through the cross-facing grafts, and it takes so long for them to reach the contralateral side. The mimetic musculature may be definitely atrophic by the time that axonal ingrowth has started, particularly for those treated with irradiation, and two operations are required to maximise the chances of success, all of which add to the morbidity. The classic use of the hypoglossal nerve anastomosed to the facial nerve trunk is not applicable in the present cases because the facial nerve branches were missing. Again, grafting of the thoracodorsal nerve branch between the hypoglossal nerve and residual facial nerve branches could be hypothesised, but again the hypoglossal nerve has a high morbidity.[16] It seems more reasonable to use the procedure proposed in 1984 by Terzis and Tzafetta, the so-called “baby-sitting procedure”.[17] In this case, just a part of the hypoglossal nerve is coapted to reinnervate distal facial nerve branches to maintain the mimetic musculature “alive”, while a cross-face nerve graft is reinhabited by growing axons. Even this procedure requires an intact facial nerve trunk, which is not the case with these patients.

More recently, the masseteric nerve has gained popularity in the field of facial reanimation.[6,18] It has been shown to be effective as a substitute for the facial nerve in the treatment of recent paralysis, as well as in established cases. The amount of stimulus does not differ significantly from that of the hypoglossal nerve, while it is associated with less morbidity. Typically the patient hardly notices the loss. The nerve is harvested close to the parotid resection, and there is no need to enlarge the surgical field. Finally, the type of stimulus required to produce basic facial movements, such as smiling and closing the eyes, is much easier for the patient to produce than that required when the hypoglossal nerve is the donor.[19]

We conclude that facial reanimation is best accomplished at the same time as total parotidectomy. In this preliminary study, masseteric-thoracodorsal-facial nerve branch neurorrhaphy has given good results. The proper indications for the use of the masseteric nerve as the main motor source are when the facial nerve trunk cannot be used. Adding cross-face nerve grafts may help to encourage natural blinking and emotional smiling. When ablative resection and radiotherapy are done before reconstruction the presence of fibrillations of mimetic musculature must be confirmed preoperatively by electromyography. If they are not detectable, the musculature must be considered irreversibly atrophied. For such cases, alternative procedures to substitute the function of the mimetic muscles must be considered.[20,21]

Conflict of Interest

We have no conflict of interest.

Ethics statement/confirmation of patients’ permission

The research protocol was approved by the ethics committee of San Paolo University Hospital in accordance with the Helsinki Declaration. The patient has given her consent to the publication of the photographs.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.bjoms.2016.02.014.

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