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Masseteric nerve for reanimation of the smile in short-term facial paralysis

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Abstract

Our aim was to describe our experience with the masseteric nerve in the reanimation of short term facial paralysis. We present our outcomes using a quantitative measurement system and discuss its advantages and disadvantages. Between 2000 and 2012, 23 patients had their facial paralysis reanimated by masseteric-facial coaptation. All patients are presented with complete unilateral paralysis. Their background, the aetiology of the paralysis, and the surgical details were recorded. A retrospective study of movement analysis was made using an automatic optical system (Facial Clima). Commissural excursion and commissural contraction velocity were also recorded. The mean age at reanimation was 43(8) years. The aetiology of the facial paralysis included acoustic neurinoma, fracture of the skull base, schwannoma of the facial nerve, resection of a cholesteatoma, and varicella zoster infection. The mean time duration of facial paralysis was 16(5) months. Follow-up was more than 2 years in all patients except 1 in whom it was 12 months. The mean duration to recovery of tone (as reported by the patient) was 67(11) days. Postoperative commissural excursion was 8(4) mm for the reanimated side and 8(3) mm for the healthy side ($p = 0.4$). Likewise, commissural contraction velocity was 38(10) mm/s for the reanimated side and 43(12) mm/s for the healthy side ($p = 0.23$). Mean percentage of recovery was 92(5) mm for commissural excursion and 79(15) mm/s for commissural contraction velocity. Masseteric nerve transposition is a reliable and reproducible option for the reanimation of short term facial paralysis with reduced donor site morbidity and good symmetry with the opposite healthy side.

Keywords: Facial paralysis; Masseteric nerve; Nerve transpositions; Facial reanimation

Introduction

Finding the gold standard for reconstruction of the smile in reanimation of facial paralysis is still a challenge. Adequate treatment depends on numerous factors of which denervation time is the most important.[1] In facial paralysis of less than 3 months' duration, crossface nerve grafting gives adequate results.[2] In short-standing facial paralysis (3 months–2 years) the facial musculature is still available and so nerve transpositions provide the best option.[3] When denervation time exceeds 2 years, transplantation of a muscle is necessary because the facial musculature has irreversibly atrophied and so is not available.[4] Various nerves have been used for transposition including the spinal, phrenic, and hypoglossal nerves,[5–7] the latter being the most widely used.[8–10] At first, direct facial–hypoglossal coaptation at the stylomastoid foramen yielded good results in terms of restoration of movement, but it was associated with severe atrophy of the tongue, facial synkinesis, and mass movements.[8,9] The use of a nerve graft between the hypoglossal nerve and the branches of the facial nerve partly solved these problems but had the added morbidity of harvesting a nerve graft and longer duration of regeneration.[11,12]

Direct end-to-side coaptation has also been described[13] as has split-harvest of the hypoglossal nerve (also called the

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hemihypoglossal nerve).[10] Although these procedures allow faster onset of movement and spare the use of nerve grafts some problems arise, such as more facial synkinesis and moderate atrophy of the tongue.[10] Since the description of the use of the masseteric nerve for reanimation of short-term facial paralysis in 1977 by Spira,[14] several anatomical and clinical studies have been published.[15–17] The advantages of using this nerve include a relatively easy surgical technique, absence of nerve grafting, and the fact that it provokes a strong commissural pull. Transfer of the masseteric nerve has also given good results in terms of symmetry with the healthy side and the potential to develop a spontaneous smile.[18]

The aim of this paper was to describe our technique for the use the masseteric nerve for reanimation of short-term facial paralysis, and discuss its advantages and disadvantages.

Patients and methods

From 2000 to 2012, 23 consecutive patients had their complete, short-term (3 months–2 years), unilateral facial paralysis reanimated with a masseteric nerve transfer to branches of the facial nerve in the affected hemiface. As this is a retrospective review, it was not randomised. All operations were done by the senior author (BH). For all patients, sex, aetiology and duration of paralysis, age at operation, onset of movement (days between operation and the first movement reported by the patient), and follow-up were recorded. Preoperatively all patients presented with complete unilateral facial paralysis, which was defined as the absence of clinical movement on both physical examination and Facial Clima (Universidad de Navarra, Pamplona, Spain) (equivalent to House Brackmann grade VI), and no signs of recovery on needle electromyography.[19,20] In all cases a complete evaluation was made by the senior author (including physical examination, standard photographs and video, electromyography, and Facial Clima) preoperatively and 3, 6, 12, and 24 months postoperatively. Ethical approval was obtained.

Operative technique

A cheek flap is raised by a suprasuperficial musculoaponeurotic system (SMAS) dissection through a preauricular incision on the paralysed side until the anterior margin of the parotid gland and the zygomaticofacial trunk are seen. The divisions of this trunk are dissected distally. The recipient branch is selected based on the diameter of the nerve and, most importantly, on its course; special attention is paid to the zygomatic and buccal branches that will ultimately restore the movement of the smile. It is important to note that this procedure does not reanimate the marginal mandibular branch. The masseteric nerve is then harvested according to previously published anatomical references.[17] At a point 4 cm anterior to the tragus, 1 cm below the zygomatic branch, and 1.5 cm deep, the fibres of the masseter muscle are separated until

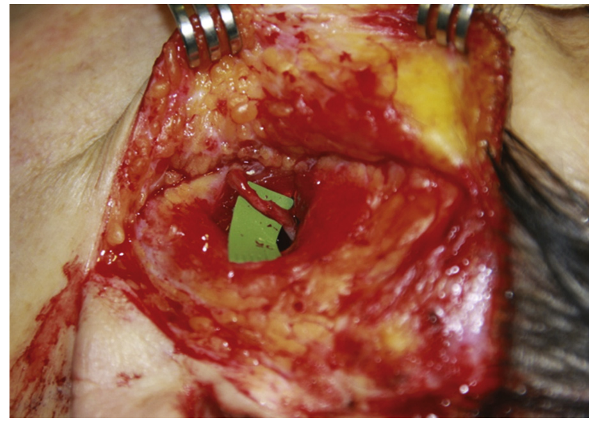

Fig. 1. Surgical detail of masseteric-facial coaptation.

the nerve is seen coursing on its undersurface. The nerve is then dissected distally and, once adequate length has been obtained, it is transected and transposed superficially. Finally, the nerve is coapted to the previously selected branches of the facial nerve end-to-end with a 10/0 nylon epineural suture under microscopic magnification (Fig. 1).

Evaluating the Facial Clima system

Facial Clima is an automatic optical system with which facial movements are captured by placing special reflecting dots on the subject's face following a predetermined configuration. A system of video recording with 3 infrared-light cameras captures the subject smiling, puckering the mouth, closing the eyes, and raising the forehead. With these 4 movements, several vectors are obtained and analysed. Images from the cameras are automatically processed by computer software that generates customised information such as three-dimensional data on velocities, distances, and areas. The most important variables in the analysis of a smile are commissural excursion (mm) and commissural contraction velocity (mm/s). The accuracy of the measurements is between 0.13 mm and 0.4°. This system has been tested in normal subjects and found to have an intra-rater reliability of 0.95 and an inter-rater reliability of more than 0.9 with an intraclass correlation of 0.92.[18]

Results

Details of patients, aetiology and duration of paralysis, mean time to recovery of tone, and duration of follow-up are summarised in Table 1. Mean postoperative commissural excursion of the reanimated side was 7.9(3.8) mm compared with 8.4(3.1) mm of the healthy side ($p = 0.4$). Mean postoperative commissural contraction velocity of the reanimated side was 38.4(9.6) mm/s compared with 43.1(11.5) mm/s of the healthy side ($p = 0.23$). The lack of a significant difference between the sides indicates adequate symmetry of the smile (Fig. 2). Taking the normal side as the reference, the

Fig. 2. (a) Preoperative photograph when smiling of a 31 year-old woman with complete left facial paralysis of 4 months' duration after operation for cholesteatoma. Reanimation was by transposition of the masseteric nerve. (b) The same patient smiling 2 years postoperatively (photographs published with the patient's permission). (c) A 65 year-old man with complete right facial paralysis of 7 months duration after resection of an acoustic neuroma preoperatively when smiling. He had the masseteric nerve transposed together with a gold weight implant suspended in his upper eyelid and suspension of his lower eyelid with a tendon sling. (d) The same patient when smiling one year postoperatively (photographs published with the patient's permission).

mean (SD) percentage recovery was 92(5) for commissural excursion and 79(15) for commissural contraction velocity. There were no postoperative complications that required revision. None of the patients complained of impaired eating. At follow-up all patients noted improvement of oral competence with no drooling or spillage of food or liquid.

Discussion

Short term facial paralysis is best treated by nerve transposition.[1] Different nerves have been described with varying results, but the most popular is the hypoglossal–facial nerve anastomosis and crossface nerve grafting.[2,7,10] Since its original description by Korte,[7] the hypoglossal–facial nerve anastomosis has been progressively modified in an effort to improve the results and reduce morbidity at the donor site. At first the technique consisted in a complete section of the hypoglossal nerve, which was coapted to the trunk of the facial nerve.

Certainly the facial movement obtained was remarkable but at the expense of unequivocal paralysis of the hemitongue with varying degrees of impairment of speech and swallowing. Mass movements and synkinesis were common given the strong recovery supplied by the totality of the axons.[21] These aspects led to the search for variations that would allow a similar restoration of movement while minimising atrophy of the tongue and facial synkinesis. To reduce the morbidity

Table 1
Details of the 23 patients. Data are number of patients (unless otherwise stated).

Variable	Value
Male	15
Female	8
Mean (SD) age (years)	43(8)
Aetiology	
Acoustic neuroma	16
Fracture of skull base	3
Schwannoma	1
Varicella zoster	2
Cholesteatoma	1
Mean (SD) duration of paralysis (months)	16(5)
Mean (SD) time to onset of movement (days)	67(11)
Duration of follow up (months)	24

Variable	Value
n	23
Male (*n*)	15
Female (*n*)	8
Age, years (mean(SD))	43.1(7.6)
Aetiology (*n*)	
-Acoustic neurinoma	16
-Skull base fracture	3
-Schwannoma	1
-Varicella zoster	2
-Cholesteatoma	1
Evolution, months (mean(SD))	16.1(4.8)
Movement onset, days (mean(SD))	67(11.3)
Follow-up, months (mean(SD))	23.5

of the tongue, Sawamura and Abe described the use of a jump graft coapted end-to-end to the trunk of the facial nerve and end-to-side to the hypoglossal nerve.[13] However, drawbacks to this included a less powerful pull because of the presence of 2 coaptation sites, and the need to use a nerve graft adds morbidity to the procedure.

Other authors have advocated drilling a hole in the mastoid to obtain an adequate length of facial nerve to reach the hypoglossal nerve without the use of a graft.[11] We think that this is overly aggressive considering that simpler and equally effective techniques of reanimation are available, such as the one presented here.

Another option is to harvest only a part of the hypoglossal nerve (transposition of the hemihypoglossal nerve), which preserves lingual motor innervation,[10] but synkinesis is common as a result of coaptation to the trunk of the facial nerve. Further refinements have included a more distal coaptation to branches of the facial nerve using nerve grafts to minimise synkinesis and obtain a more selective reanimation.

Spira in 1977 was the first to report the use of the masseteric nerve connected to the ipsilateral facial nerve for reanimation of facial paralysis.[14] To our knowledge, this study reports the largest series of patients published so far whose faces have been reanimated using transposition of the masseteric nerve. In parallel to the publication of case reports and small series of patients, the anatomical landmarks and histological characteristics of the nerve have also been thoroughly studied, and show its constant anatomy and the important number of axons it contains.[15–17] This finding further supports and explains the general observation that the motor nerve to the masseter provides strong reinnervation capable of achieving adequate symmetry of the paralysed side with the contralateral healthy side, both at rest and smiling.[12] These important characteristics are some of the reasons that have encouraged surgeons to use this nerve for facial reanimation, though there are several others.

From a surgical point of view, dissection of the masseteric nerve is relatively straightforward and safe and it can readily be identified.[15–17] The approach to harvest of the masseter nerve is the same as that used to localise the branches of the facial nerve through a preauricular incision, which is better than the submandibular one for harvest of the hypoglossal nerve. Another important advantage of the masseteric nerve for facial reanimation is that, because of its proximity to the branches of the facial nerve within the parotid gland, it is possible to select one specific trunk or branch directed to the middle-lower third of the face, and so obtain a “purer” reinnervation with less synkinesis and practically no mass movements such as those seen when it is coapted to the trunk of the facial nerve.

We prefer to reanimate the smile with dynamic techniques and address the upper third of the face (the eye) with static procedures such as gold weight implants for the upper eyelid and tendon sling suspensions for the lower lid. The proximity between the branches of the masseteric and facial nerves eliminates the need to use a nerve graft, which reduces morbidity and avoids the loss of power that is attributed to the use of grafts because of the presence of two coaptation sites. Another important advantage of the masseteric nerve is the lack of donor-site morbidity.

Previous papers have shown that this nerve has an arborisation pattern as it courses on the undersurface of the masseter muscle.[17,22] This allows the nerve to be transected distal to some of the arborising branches and so it denervates the muscle only partially. In any case, should the muscle be completely deprived of neural input, the effect on mastication is hardly noticeable and, in our experience, patients have rarely if ever complained about it. The masseteric nerve has become our preferred way of reanimation of the smile for patients with viable facial musculature because of its consistent anatomy, reliable number of axons, relatively straightforward surgical approach, possibility of selectively reanimating the desired branches of the facial nerve, and its practically non-existent morbidity at the donor site.

The main disadvantage of using the motor nerve to the masseter for facial reanimation is that, like all reanimations with nerves other than the facial nerve, there are the problems of dissociation of movements and spontaneity. During the first months after onset of movement patients are instructed to bite to activate the facial musculature. Later, when reinnervation is nearly complete, they are told to practice smiling by "triggering", that is to activate the movement of smile by slightly clenching the teeth without a completely bite. Eventually, most patients achieve this goal in varying degrees, with some of them being able to smile with an open mouth. Other authors have reported on this previously.[18,23]

Spontaneity, however, is more complicated. These patients need not only to learn to dissociate the movements of mastication from those of smiling, but also to develop a degree of cortical reorganisation. Rubin et al. reported the development of a spontaneous smile in patients with facial paralysis that had been reanimated with transposition of the temporalis muscle.[24] Because the temporalis and masseter muscles are both involved in mastication and act synergistically, it is most likely that a spontaneous smile can eventually be achieved in patients in whom the masseteric nerve has been transposed. Previous authors have already stated that to develop cortical plasticity mere training is not enough; the stimulus must have some form of behavioural relevance.[25]

Finally, we think that selective reanimation of the smile provides a more natural restoration than that obtained with coaptations to the trunk of the facial nerve. This approach also has implications on the method used to assess outcomes. Traditionally, the House–Brackmann scale has been the most widely used tool to evaluate facial paralysis and the results after reanimation.[19] However, when the smile is reanimated selectively, this scale cannot be used because it evaluates the whole face as a single unit without distinguishing between the upper, middle, and lower thirds. This is why we prefer to report our results using a quantitative system such as the Facial Clima.[20]

The fact that it is a retrospective review is an important limitation of the study. Nevertheless, it should be noted that a prospective, randomised study of facial reanimation is not feasible as no one patient can be randomised a priori to have a particular operative technique.

In conclusion, we think that the masseteric nerve is a valid option for reanimation of short-term facial paralysis in which the facial musculature is still viable. Its advantages include consistent anatomy, a safe and straightforward harvesting technique with an inconspicuous scar, low morbidity at the donor site, and reliable strength of pull given the large number of axons that it provides. Its proximity to the branches of the facial nerve also allows for selective reanimation without the use of nerve grafts, which eliminates mass movements and reduces facial synkinesis to a minimum.

Ethical approval

This work has been conducted under strict ethical adherence. Patient permission was obtained.

Conflict of interest statement

None.

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