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British Journal of Oral and Maxillofacial Surgery xxx (2015) xxx–xxx

BRITISH Journal of Oral and Maxillofacial Surgery

www.bjoms.com

Masseteric-facial nerve transposition for reanimation of the smile in incomplete facial paralysis

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Accepted 8 June 2015

Abstract

Incomplete facial paralysis occurs in about a third of patients with Bell's palsy. Although their faces are symmetrical at rest, when they smile they have varying degrees of disfigurement. Currently, cross-face nerve grafting is one of the most useful techniques for reanimation. Transfer of the masseteric nerve, although widely used for complete paralysis, has not to our knowledge been reported for incomplete palsy. Between December 2008 and November 2013, we reanimated the faces of 9 patients (2 men and 7 women) with incomplete unilateral facial paralysis with transposition of the masseteric nerve. Sex, age at operation, cause of paralysis, duration of denervation, recipient nerves used, and duration of follow-up were recorded. Commissural excursion, velocity, and patients' satisfaction were evaluated with the FACIAL CLIMA and a questionnaire, respectively. The mean (SD) age at operation was 39 (±6) years and the duration of denervation was 29 (±19) months. There were no complications that required further intervention. Duration of follow-up ranged from 6-26 months. FACIAL CLIMA showed improvement in both commissural excursion and velocity of more than two thirds in 6 patients, more than one half in 2 patients and less than one half in one. Qualitative evaluation showed a slight or pronounced improvement in 7/9 patients. The masseteric nerve is a reliable alternative for reanimation of the smile in patients with incomplete facial paralysis. Its main advantages include its consistent anatomy, a one-stage operation, and low morbidity at the donor site.

Keywords: Incomplete facial paralysis; Masseteric nerve

Introduction

Bell's palsy is an acute, idiopathic and usually unilateral facial paralysis and is the most common cause of acquired facial paralysis.[1] Typically, it resolves spontaneously in about two-thirds of patients within the first 6 months of onset. In the remaining third, recovery is incomplete and is characterised by symmetrical tone at rest but muscular weakness, motor synkinesis, and hemifacial spasm on movement that leave undesired cosmetic results in some cases. Reluctance to smile in public may also have psychological and social consequences. This group of patients therefore seeks a solution that involves recovery of commissural excursion, so noticeable in a full smile.

Despite the efforts of different authors to treat incomplete long-standing facial paralysis satisfactorily, it still remains a challenge. Options of reanimation in these cases include hypoglossal-facial nerve transfer, one-stage muscle transfer, temporalis lengthening myoplasty and cross-face nerve grafting.[2–8] A reliable alternative to the latter is masseteric nerve transfer. During the last decades this technique has gained increasing popularity in the treatment of facial paralysis, and has been successfully used for short-term complete facial paralysis and regeneration of a divided nerve in long-standing disease.[9,10] However, despite its wide use in

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http://dx.doi.org/10.1016/j.bjoms.2015.06.011

Please cite this article in press as: Hontanilla B, Marre D. Masseteric-facial nerve transposition for reanimation of the smile in incomplete facial paralysis. *Br J Oral Maxillofac Surg* (2015), http://dx.doi.org/10.1016/j.bjoms.2015.06.011

complete facial paralysis, we currently know of no reports that evaluate its efficacy for incomplete facial palsy.

Here we describe our experience with the masseteric nerve for reanimation of the smile in incomplete facial paralysis.

Patients and Methods

Between December 2008 and November 2013, we reanimated the incomplete unilateral facial paralysis of 9 patients by transposition of the masseteric nerve. The senior author did all the operations after there had been no electrophysiological recovery or clinical improvement for a minimum of 12 months. We recorded sex, age at operation, underlying cause, duration of symptoms, donor and recipient nerve, and complications.

Evaluation of FACIAL CLIMA

FACIAL CLIMA (stt systems, San Sebastian, Spain) is an automatic optical system in which a system of video recording with 3 infrared cameras captures the subject doing the following movements: smiling, puckering the mouth, closing the eyes, and raising the forehead.[11] With these four movements, several vectors are obtained and analysed and ultimately converted to velocities, distances, and areas. The accuracy of the measurement is between 0.13 mm and 0.41°, and reliability is 99%. To evaluate recovery of the smile after operation, we evaluated two variables for each patient using the FACIAL CLIMA system: commissural contraction velocity (mm/second), which is the mean maximum velocity of contraction, and oral commissure displacement (mm), which is the mean difference between the minimum and maximum commissural displacement at rest and when contracted. Both measurements were made on the normal and the reanimated sides. Because all the patients presented with incomplete facial paralysis, the preoperative values of both measurements on the paralysed side were first subtracted from those on the normal side. Then, at follow-up, recovery was recorded as the percentage reduction of the preoperative difference. For example, a patient who had a difference of 4 mm in commissural displacement between both sides preoperatively, and postoperatively had a 2 mm difference, is considered to have had a recovery of 50% **(supplementary video 1)**.

Operative technique

A cheek flap is raised through a preauricular incision on the paralysed side until the anterior margin of the parotid gland can be seen, and the zygomaticofacial trunk is visible. At this point, divisions of the trunk are dissected distally and stimulated. Throughout our experience we have found that in incomplete facial paralysis, the movement obtained by individually stimulating each branch during operation is significantly greater than that seen when the patient smiles. We hypothesise that this is because reinnervation of the fibre that ultimately produces a weak muscular contraction is disorganised, but maintains muscular trophism. A branch that produces a noticeable commissural excursion is selected, on the basis that when the masseteric nerve reinnervates the branch in a more organised manner, the movement obtained will be similar to the one seen during operative stimulation.

The nerve is usually transected at the level of the anterior margin of the parotid or a few millimetres proximal to that, to allow direct, tension-free, coaptation with the transposed masseteric nerve. Please note that this procedure does not reanimate the marginal mandibular branch. The masseteric nerve is then harvested as described previously.[12] At a point 4 cm anterior to the tragus, 1 cm below the zygomatic nerve, and 1.5 cm deep, the fibres of the masseter muscle are separated until the nerve is seen coursing on its undersurface. Next the nerve is dissected distally and, once an adequate length has been obtained, it is transected, transposed superficially, and coapted end-to-end with the recipient branch of the facial nerve (Fig. 1).

It is important to note that given the loss of a functioning zygomatic or buccal branch, a transient worsening of both

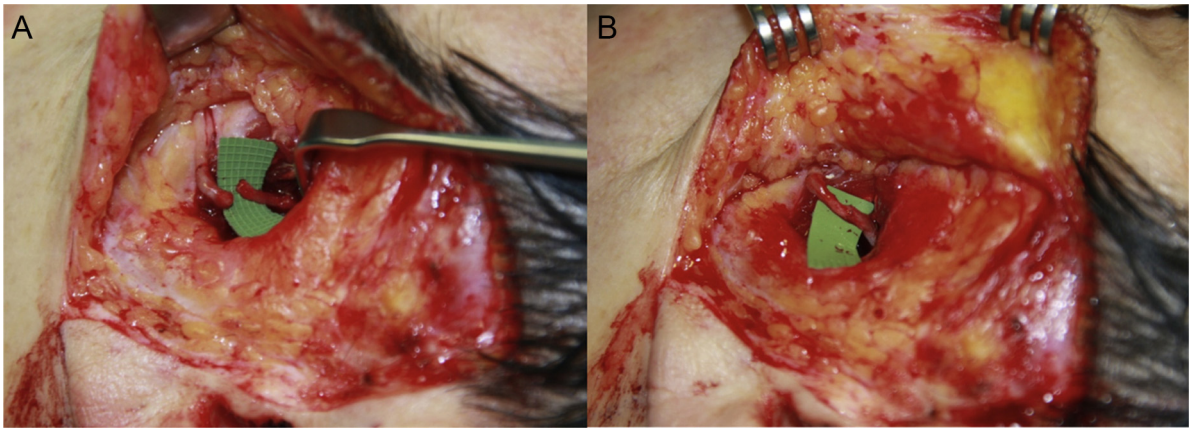

Fig. 1. A 27 year-old woman with an incomplete left facial paralysis (Bell's palsy). A. Preoperative smile**.** B. Postoperative smile. The improvement in the smile can be seen as the left canine is exposed, which was not apparent preoperatively.

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Table 1
Details of patients and their operations.

Case No.	Sex	Age (years)	Aetiology	Time (months)	Recipient nerve	Follow-up (months)
1	M	41	Bell's palsy	16	Zygomatic (n=2)	14
2	F	30	Bell's palsy	25	Buccal (n=1)	12
3	F	27	Bell's palsy	18	Zygomatic (n=1)	10
4	F	35	Bell's palsy	17	Zygomatic (n=1)	17
5	F	43	Ramsay Hunt syndrome	43	Buccal (n=1)	26
6	F	55	Cholesteatoma	65	Zygomatic (n=2)	9
7	F	38	Ramsay Hunt syndrome	39	Zygomatic trunk	13
8	M	46	Bell's palsy	13	Zygomatic (n=1)	6
9	F	37	Bell's palsy	28	Buccal (n=1)	21

Table 2
Quantitative and qualitative outcomes.

Case No.	Gain		Recovery		Qualitative assessment		
	CD (mm)	CCV (mm/s)	CD (%)	CCV (%)	Satisfied	Repeat operation	Overall grading (1 – 5)
1	1.5	10.3	82	78	Yes	Yes	5
2	1.0	7.7	83	85	Yes	Yes	4
3	1.2	8.2	94	86	Yes	Yes	5
4	1.7	8.8	82	85	Yes	Yes	5
5	0.3	3.1	45	32	No	No	3
6	1.1	9.1	72	64	Yes	Yes	4
7	0.6	4.1	69	58	No	No	3
8	1.4	7.6	80	76	Yes	Yes	4
9	1.2	8.8	81	77	Yes	Yes	4
Mean (SD) ((SD) (SD)	1.1 (0.4)	7.5(2.3)	76.4(13.7)	71.2 (17.5)			

CD=commissural displacement; CCV: commissural contraction velocity. Grading scale: 1: marked permanent worsening; 2: slight permanent worsening; 3: no change; 4: slight improvement; 5:pronounced improvement.

the static and dynamic facial paresis is expected during the early postoperative period. Patients must be warned about this, and reassured that it will improve once the masseteric nerve reinnervates that branch.

Results

The aetiology of the paralysis, age at operation, duration of denervation, the recipient branches of the facial nerve, and duration of follow-up are summarised in Table 1. Quantitative assessment using the FACIAL CLIMA showed improvement of both commissural excursion and velocity greater than 75% in 6 patients, greater than 50% in 2 patients and less than 50% in one. All but 2 patients mentioned improvement of commissure excursion. None of the patients complained of permanent worsening (Table 2 Fig. 2, supplementary **videos 2-5**).

Discussion

A large-scale study[13] on the spontaneous course of Bell's palsy showed that 29% of 2500 patients did not recover completely, and 4% of them developed severe complications. Contracture and associated movements were present in 17% and 16% of patients, respectively.[13] Although some patients actually learn to cope, there is still a group that seeks treatment, usually for improvement in commissural excursion.

Options for reanimation of incomplete facial paralysis include cross-face nerve grafting, transposition of the hypoglossal nerve, free muscle transfers, and temporalis-lengthening myoplasty.[2–8] Irrespective of the technique, most authors agree that the challenge of reanimating incomplete facial palsy lies in restoration of what is missing without damage to what has recovered. In this sense, Frey et al. advocate one stage cross-face nerve grafting with end-to side coaptation distally on the recipient nerve of the paralysed side.[5] They reported 3 cases with long-standing incomplete paralysis who had reanimation using this technique and achieved good function and symmetry. This initial experience seems promising, but the real advantages over traditional end-to-end coaptation still need to be investigated.

In 2007, Yamamoto et al. introduced the neural supercharge concept through a facial–hypoglossal network system.[2] However, this technique requires partial sacrifice of the hypoglossal nerve and may produce synkinesis or mass movements when the coaptation is made to the trunk of the facial nerve, even with end-to-side neurorrhaphy. Other authors have reported the use of one-stage free muscle transfer with a latissimus dorsi minigraft, with considerable improvement in the symmetry of the smile.[6] The authors argued that this approach offers an assured method with which to obtain adequate muscle contraction, suggesting that

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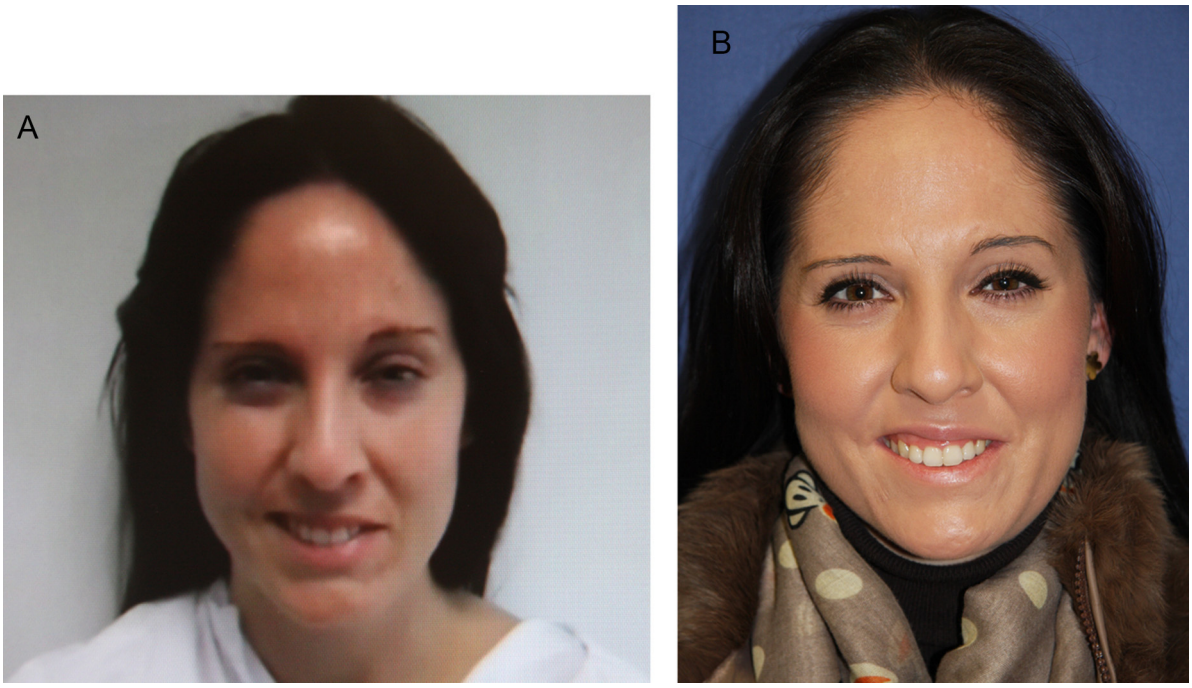

Fig. 2. Intraoperative view of transposition of the masseteric nerve and coaptation to a branch of the facial nerve. (A) Before coaptation. (B) After epineural end-to-end coaptation (published with the permission of the patient).

it may be superior to cross-face nerve grafting with or without muscle transfer, although they made no formal comparison.

The one-stage concept surely offers an advantage over two-stage procedures and is more straightforward; however, to recommend a free tissue transfer without offering the patient a chance of rehabilitation with "simpler" techniques (such as a cross-face nerve graft or nerve transposition) may seem somewhat aggressive. Another technique reported for reanimation of incomplete facial palsy is temporalis-lengthening myoplasty.[7] This technique, although it shares some common ground with the masseteric nerve transfer, has some drawbacks. In the first place it is more traumatic as it requires osteotomy of the coronoid process and incisions in the nasolabial fold. Secondly, there is a need to harvest strips of fascia lata, which adds to the morbidity. Thirdly, in the tunnelling of the fascial strips, there could be inadvertent injury to the remaining facial innervation. Fourthly, should the masseteric nerve transposition not work, the temporalis can always be a valuable second string, but by doing it the other way around, scarring and manipulation from a temporalis- lengthening myoplasty might render the masseteric nerve harder to locate and transpose.

Masseteric-facial nerve transposition has gained increasing popularity for reanimation of complete facial paralysis.[9,10,14–16] However, we are not aware that its use for incomplete facial palsy has been reported. This nerve offers several advantages for partial reanimation. First, it is a one stage procedure, which is a major advantage over the two-stage cross-face nerve graft. Secondly, it provides a considerable number of axons,[15] which translates into a strong pull and good degree of symmetry at rest and on smiling.[9,10] Thirdly, because it is in close proximity to the branching 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 preserve all recovered branches of the facial nerve, which is paramount when treating incomplete palsy. We should also take account of the fact that the surgical approach to harvest the masseter nerve is the same as that used to localise the branches of the facial nerve through a preauricular incision, and this is an important advantage over the submandibular incision that is made to harvest the hypoglossal nerve. Lastly, the proximity between the masseteric nerve and branches of the facial nerve eliminates the need to use a nerve graft, and so reduces the morbidity of the whole procedure and avoids the loss of power that is attributed to the use of grafts when there are two coaptation sites.

In addition, harvest of the masseteric nerve produces little, if any, donor site morbidity thanks to its pattern of branches that allows transection of the nerve distal to some of the other branches and results in partial denervation of the muscle.[12,17] In any case, should the muscle be completely deprived of neural input, the effect on mastication is hardly noticeable and patients have rarely, if ever, complained of this. Even though (partial) denervation of the masseter could leave a slight asymmetry of contour, in our experience of using it for facial reanimation in both complete and partial paralysis, no patient has ever commented on it.

The main disadvantage of using the motor nerve to the masseter for facial reanimation is the issue of movement dissociation and spontaneity. As far as movement dissociation is concerned, during the first months after onset of movement

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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 only slightly clenching the teeth without completely biting. Eventually, a number of patients achieve this to varying extents.[8,9,18–21] Previous authors have already stated that to develop cortical plasticity mere training is not enough; the stimulus must have some form of behavioural relevance.[22]

As far as quantitative evaluation of outcomes in reanimation of facial paralysis is concerned, several scales, scores, and optical systems have been developed in an effort to quantify the degree of improvement accurately.[23,24] We use the FACIAL CLIMA, which allows not only comparison between patients but also assessment of symmetry with the healthy side.[11] Although this system gives information about the whole face, for the purpose of this paper we have evaluated only commissural excursion and commissural contraction velocity, as all patients had had dynamic reanimation of the smile. The forehead and lower lip have not been discussed because they were not treated uniformly in all patients, and only static procedures were done when needed. It must also be noted that the FACIAL CLIMA gives absolute values (excursion in mm and velocity in mm/second).

However, to have more accurate information about improvement, each patient's record is transformed into a percentage of recovery considering his or her healthy side as the reference. With this, we avoid bias from variations that may occur between patients with different smiles. This system enabled us to identify some recovery in all patients objectively. Importantly, none of the patients showed a reduction in commissural excursion. However, cases 5 and 7 had little increase in either variable that, not surprisingly, did not translate into a satisfactory outcome (both graded their result as 3, that is - no recovery). Factors that may have influenced such an outcome could be more damage from infection or inflammation than from the other causes, and a long period of partial denervation (39 and 43 months), although in theory the duration of denervation should not be that important because the facial musculature remains trophic and partially functional. As far as case 7 was concerned, although this patient had an acceptable recovery on the FACIAL CLIMA evaluation she was not completely satisfied, probably because her expectations were too high. Reanimation of a partially paralysed face seeks to restore the normal smile as much as possible, nevertheless a 100% symmetry with the opposite side is hard to obtain, and this should be clearly stated in the preoperative consultation.

In conclusion, we think the masseteric nerve is a consistent and reproducible nerve for reanimation of incomplete facial paralysis. Its constant anatomy, considerable load of axons, strong pull, the need for only one operation, fast recovery compared to other techniques, and reduced donor site morbidity, make this a reliable method of reinnervation. However, it must be explained to the patient that transient worsening of the incomplete facial paralysis will ensue postoperatively until the masseteric nerve reaches the facial muscles.

Conflict of Interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

The patients gave permission for their full images to be published in photographs or videos, in reviews, or in other ways for scientific purposes.

Financial Disclosure

The authors declare neither financial interests nor conflict of interests regarding this article. There has been no source of funding supporting this work.

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.2015.06.011.

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