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The masseteric nerve: a versatile power source in facial animation techniques

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Abstract

The masseteric nerve has many advantages including low morbidity, its proximity to the facial nerve, the strong motor impulse, its reliability, and the fast reinnervation that is achievable in most patients. Reinnervation of a neuromuscular transplant is the main indication for its use, but it has been used for the treatment of recent facial palsies with satisfactory results. We have retrospectively evaluated 60 patients who had facial animation procedures using the masseteric nerve during the last 10 years. The patients included those with recent, and established or congenital, unilateral and bilateral palsies. The masseteric nerve was used for coaptation of the facial nerve either alone or in association with crossfacial nerve grafting, or for the reinnervation of gracilis neuromuscular transplants. Reinnervation was successful in all cases, the mean (range) time being 4 (2–5) months for facial nerve coaptation and 4 (3–7) months for neuromuscular transplants. Cosmesis was evaluated (moderate, $n = 10$, good, $n = 30$, and excellent, $n = 20$) as was functional outcome (no case of impairment of masticatory function, all patients able to smile, and achievement of a smile independent from biting). The masseteric nerve has many uses, including in both recent, and established or congenital, cases. In some conditions it is the first line of treatment. The combination of combined techniques gives excellent results in unilateral palsies and should therefore be considered a valid option.

Keywords: Masseteric nerve; Facial palsy; Facial reanimation; Smile surgery; Unilateral facial palsy; Bilateral facial palsy

Introduction

The use of the masseteric nerve in facial animation was first described by Spira in 1978,[1] and since then several similar papers have been published.[2,3] This success has been the result of the many advantages of the technique, including the low morbidity, the proximity of the masseteric nerve to the facial nerve, the strong motor impulse that it provides, its reliability, and the fast reinnervation achieved by most patients.[4]

Reinnervation of neuromuscular transplants in long-standing facial palsies has been the main indication for the use of the masseteric nerve for several years,[5,6] but only in the last few years have its indications in recent facial palsies been popularised. In particular, the use of combined techniques has been reported, such as crossfacial nerve grafting and masseteric nerve coaptation,[7] "babysitter" procedures using the masseteric nerve,[8] and direct masseteric–facial nerve coaptation.[2,9] This emphasises its great versatility in the treatment of both recent and long-standing facial palsies. Despite the great advantages and potential to adopt it for the reanimation of almost all facial palsies, careful selection is essential to achieve satisfactory results. Emotion-related contractions have not yet been reported with sufficient clinical evidence, as we know of only anecdotal cases.[10,11] It should be assumed, therefore, that spontaneous contraction cannot be guaranteed, making the use of the opposite facial nerve preferable in many patients with unilateral palsies. However, this issue remains debatable.

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The purpose of this paper was to review the indications for the use of the masseteric nerve in techniques for facial animation taking account of the patient's features, the type of palsy, and the available sources of innervation.

Patients

Sixty patients who had facial animation procedures using the masseteric nerve between 1 January 2003 and 1 January 2013 were evaluated retrospectively. All procedures were done by the first author (BB) and the rest of his team. Approval from the Institutional Review Board was not required because the study was retrospective. There were 23 male and 37 female patients, mean age 28 (range 6–73) years. Thirteen patients had recent (less than 18 months' onset) unilateral facial palsies, 21 had established or congenital unilateral palsies, and the remaining 26 had established or congenital bilateral palsies.

Recent facial palsies were related to resection of an acoustic neuroma ($n=8$) and removal of a tumour of the cerebellopontine angle in the remaining five. The masseteric nerve was used in four as the only procedure for direct facial–nerve coaptation, and in the remaining nine for coaptation of the inferior branch of the facial nerve in association with a crossfacial nerve-grafting technique.

Among the 21 patients with long-standing unilateral palsies, 15 were congenital, 11 of which were diagnosed as Moebius-like syndromes according to the classification described by Terzis and Noah.[12] Of those 11, four were treated for a previously failed crossgraft. The remaining six patients had acquired palsies caused by resection of an acoustic neuroma ($n=3$), resection of a tumour of the cerebellopontine angle ($n=2$), and resection of a neurofibroma (in a patient with type 2 neurofibromatosis).

The masseteric nerve was identified in all patients using the posterior margin of the masseter muscle and the zygomatic arch as landmarks, and we used blunt dissection to uncover the belly of the masseter muscle. We then dissected the nerve using electrostimulation under magnification, and prepared for the coaptation with the recipient nerve. We used the masseteric nerve as a unique source of power for the reinnervation of a gracilis neuromuscular transplant in 17 patients, and in the remaining four we used it in association with a crossgraft technique to achieve double innervation of the gracilis muscle transplant.

Established bilateral facial palsies were congenital in all but one patient. Twenty-one had Moebius syndrome, which in four was considered to be incomplete because they still had some remnants of movements on one side of the face.

The last patient was treated for an acquired bilateral palsy that developed after the resection of an extensive tumour of the cerebellopontine angle. In all patients the masseteric nerve was used for reinnervation of a gracilis neuromuscular transplant on the same side.

Results

Masseteric reinnervation was effective in all patients (Table 1). When we used direct masseteric–facial nerve coaptation facial contraction was restored after a mean of 4 (range 2–5) months. In patients treated with crossfacial nerve grafting and masseteric–facial nerve coaptation of the inferior

Table 1
Results.

Technique	No of patients	Diagnosis	Mean (SD) reinnervation time (months)	Synkinesia	Spontaneity	Cosmetic outcome
Masseteric–facial coaptation	4	Acoustic neuroma ($n=1$) Tumour of the cerebellopontine angle (CPA) ($n=3$)	3.75	Eye ($n=1$) Platysma ($n=1$) Eye and platysma ($n=1$)	None	Moderate ($n=3$) Good ($n=1$)
Crossfacial nerve grafting and masseteric coaptation	9	Acoustic neuroma ($n=7$) Tumour of the CPA ($n=2$)	3	None	9/9	Moderate ($n=1$) Good ($n=5$) Excellent ($n=3$)
Unilateral gracilis transplantation with double innervation	4	Acoustic neuroma ($n=3$) Tumour of the CPA	3.9	None	4/4	Good ($n=2$) Excellent ($n=2$)
Unilateral gracilis transplantation innervated by masseter alone	17	Congenital ($n=15$) (crossgraft failure $n=4$) Tumour of the CPA ($n=1$) Neurofibromatosis type 2 ($n=1$)	4.3	None	None	Moderate ($n=4$) Good ($n=8$) Excellent ($n=5$)
Bilateral gracilis transplantation	26	Moebius syndrome ($n=21$) Incomplete Moebius syndrome ($n=4$) Tumour of the CPA ($n=1$)	4.2	None	2/26	Moderate ($n=2$) Good ($n=14$) Excellent ($n=10$)

facial nerve branch, contraction was noted in response to activation of the masseter after a mean of 3 (range 2–4) months. Reinnervation of neuromuscular transplants was achieved after a mean interval of 4 (range 3–7) months.

There was no major complication, and no impairment of masticatory function.

All patients had postoperative physiotherapy, and a smile independent from biting contraction was achieved in all cases. Three patients treated with masseteric–facial nerve coaptation developed synkinesia, which involved the eye in 1, the platysma in 1, and both the eye and platysma in the remaining 1. All patients treated with crossfacial nerve grafting and masseteric coaptation of the branch of the inferior facial nerve, and those treated with double innervation of the gracilis muscle, developed spontaneous smiles. Two patients treated with neuromuscular transplantation for bilateral palsy also developed spontaneous contractions.

Cosmetic outcomes were evaluated using the Functional and Aesthetic Grading System described by Terzis and Noah[12] (poor = deformity, no contraction; fair = no symmetry, minimal contraction; moderate = moderate symmetry and contraction; good = symmetry, nearly full contraction; and excellent = symmetrical smile with full contraction). The aesthetic results were moderate in 10 patients, good in 30, and excellent in the remaining 19.

Discussion

Facial nerve paralysis is a functionally, aesthetically, and psychologically disabling condition. Restoration of symmetry, the ability to contract muscles, and spontaneity, are the goals of rehabilitation. However, a review of published papers showed that there is currently no consensus about the best treatments for these conditions, and that the surgeon's choice should usually be based on the type of facial palsy, when it occurred, and the patient's age, prognosis, and general condition.[13]

One of the key factors in procedures for facial animation is the choice of the motor nerve to be used for coaptation of the facial nerve in patients with recently acquired facial palsies, or who are to have reinnervation of a neuromuscular transplant when they have congenital or established facial palsies. The ideal donor nerve should provide reliable reinnervation, a strong impulse to ensure adequate movement of the reinnervated structures, and rapid activation to prevent denervation and subsequent atrophy of the musculature. The donor nerve should be placed in an anatomically favourable position that allows it to be used without grafting. In addition, harvest of the donor nerve should cause minimal morbidity, and its activation should be guided by emotions to ensure the achievement of a spontaneous smile. The masseteric nerve has most of these features, as illustrated by the series of patients reported

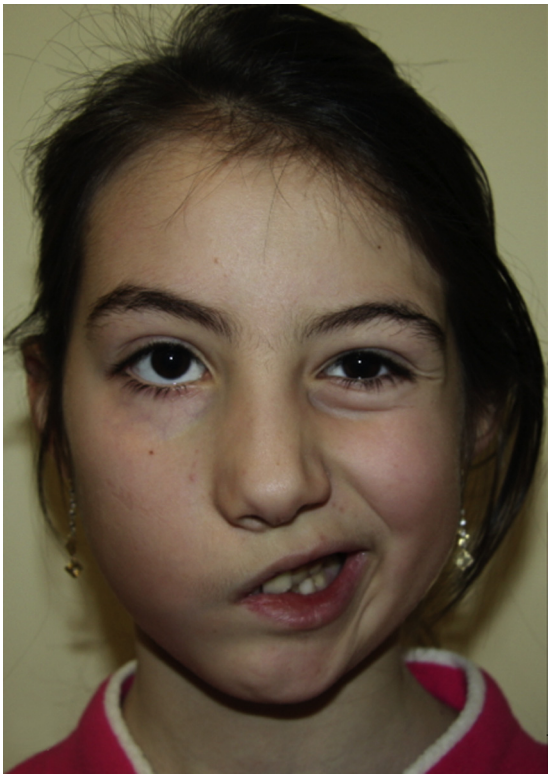

Fig. 1. Unilateral right facial palsy of 4 months' duration after resection of a tumour of the cerebellopontine angle in a 10-year-old girl (photograph published with the permission of the parents).

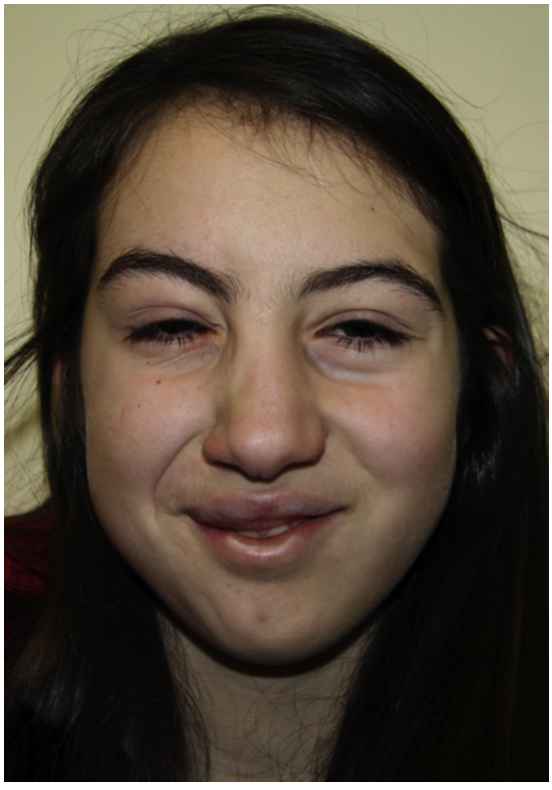

Fig. 2. Results of crossfacial nerve grafting and coaptation of the masseteric nerve after 2 years' follow-up (photograph published with the permission of the parents).

here, and in previously published papers.[14] The success rate is high, reinnervation is rapid (often less than 4 months), there is virtually no morbidity, masticatory function is not impaired, its impulse is powerful and ensures excursion of the oral commissure up to 2.5 cm, no additional grafts are required, and in patients who have had neuromuscular transplants it is possible to do it in one stage.

The main issue concerning the use of the masseteric nerve is spontaneity. We noted emotional activation when the opposite facial nerve was associated with use of the masseteric nerve, but only in two cases when the motor nerve to the masseter was the unique source of activation. However, some encouraging reports of spontaneous activation after masseteric reinnervation of neuromuscular transplants have recently been published. Cortical plasticity seems to be the key to cortical adaptation and spontaneous activation of the nuclei of the V nerve.[15] This has been studied using neuroimaging techniques that confirmed the clinical findings, but few cases are available; spontaneity-related activation of the masseteric nerve should therefore be considered to be hypothetical. However, physiotherapy can achieve excellent results with activation of the bite-release movement, together with synchrony and symmetry, which are achievable in most patients. The masseteric nerve could therefore be an excellent motor nerve to use in facial animation procedures in both recent, and established congenital, facial palsies.

In recent unilateral facial palsies, the masseteric nerve could be used alone or in association with crossfacial nerve-grafting procedures. Direct masseteric–facial nerve coaptation involves an anastomosis between the masseteric nerve and the main trunk of the facial nerve.[16] This is indicated when a single, rapid, reliable procedure is required after proximal damage to the facial nerve such as after resection of an acoustic neuroma or tumour of the cerebellopontine angle, in elderly patients, or in patients in poor general condition. In these cases the reliability of coaptation of the masseteric nerve ensures satisfactory results at a low cost. However, the lack of spontaneous activation and the high rate of synkinesia limit the procedure to selected cases. The combination of crossfacial nerve grafting and coaptation of the masseteric nerve is indicated in healthy young patients with recent unilateral facial palsy. It involves the use of two crossfacial nerve grafts to reanimate the upper and middle third of the face, followed by coaptation of the masseteric nerve and the inferior branch of the paralysed facial nerve to maximise the excursion of the oral commissure during smiling. The crossfacial grafting impulse alone is usually not powerful enough

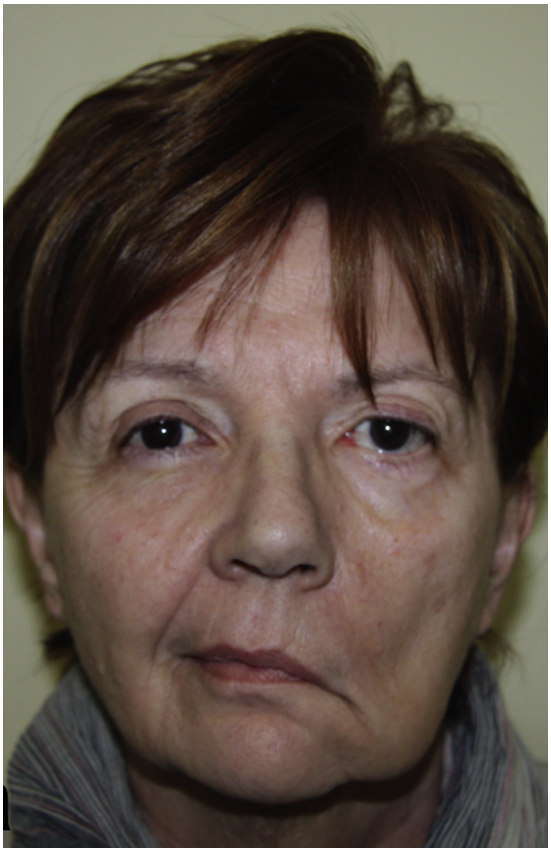

Fig. 3. Unilateral left facial palsy of 5 years' duration after resection of an acoustic neuroma in a 62-year-old woman, who is pictured smiling (photograph published with the permission of the patient).

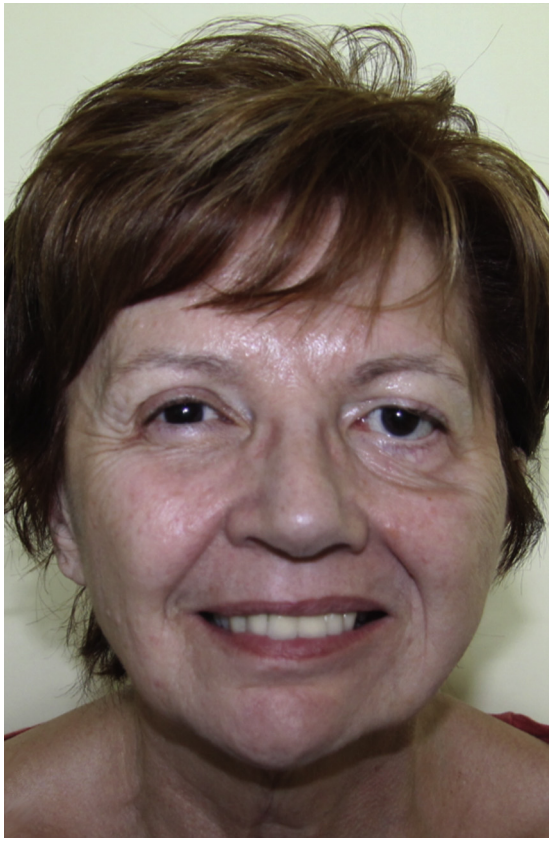

Fig. 4. Results 16 months postoperatively after a left gracilis neuromuscular transplant had been reinnervated with the masseteric nerve (photograph published with the permission of the patient).

to ensure adequate movement in the inferior third of the face. As recently reported in another paper we found a emotional activation in all our patients, and a high rate of good or even excellent aesthetic results (Figs. 1 and 2).[7]

In patients with congenital or established facial palsies, the masseteric nerve expresses all its potential in the reinnervation of neuromuscular transplants. To achieve spontaneous contraction of the transplanted muscle in patients with unilateral palsies, the opposite healthy facial nerve should be used whenever it is available.[17] However, there are some specific conditions in which the masseteric nerve is preferable, including incomplete bilateral palsies. In such cases, when only small facial movements are present on the healthy side, the use of the opposite facial nerve by a crossgrafting technique could worsen the condition and lead to weak contraction of the reinnervated muscle because the impulse provided is poor.[18] Masseteric reinnervation is therefore preferable. The opposite problem (strong contraction on the healthy side) could be another indication for the use of the masseteric nerve. In these cases, the impulse provided by a crossgraft is usually not enough to achieve adequate excursion of the muscle, which results in poor symmetry during contraction. The powerful impulse of the masseteric nerve could solve this problem. When a single and reliable procedure is preferable because of poor general condition, age (patients over 50 years of age), or the wishes of the patient, the masseteric nerve may be used[19] (Figs. 3 and 4). It may also be used in the treatment of previously failed crossgraft procedures when a single-stage, reliable technique is required for rescue.[20]

Double innervation of neuromuscular transplants with both facial crossgrafting and the masseteric nerve is a recently described procedure with encouraging results.[21] We used it in only four patients, and achieved spontaneity in all four. There was also a more rapid and powerful contraction than in patients treated with facial crossgrafting alone. However, it seemed difficult to establish, which contributed to the contraction of the crossgraft, and further studies are required.

For bilateral palsies the motor nerve to the masseter is the gold standard for reinnervation of neuromuscular transplants as has clearly been shown by other authors (Fig. 5).[22–24] Once again, its reliability, effectiveness, and low morbidity make it preferable to other motor nerves such as the hypoglossal or accessory spinal nerve. Physiotherapy has an important role in the rehabilitation of these patients, as it encourages a strong contraction, good symmetry, and an automatic (and, in some cases, perhaps even a spontaneous) smile.

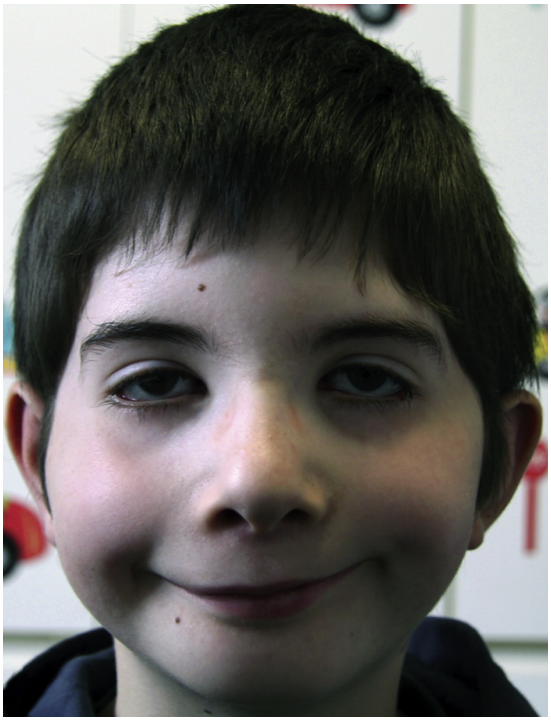

Fig. 5. Bilateral facial animation in a child with complete facial paralysis as a result of Moebius syndrome showing the results 24 months after bilateral gracilis neuromuscular transplant had been reinnervated with the masseteric nerve (photograph published with the permission of the parents).

Conflict of interest

Authors disclose any financial and personal relationship with other people or organization that could inappropriately influence their work.

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