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One-stage dual latissimus dorsi muscle flap transfer with a pair of vascular anastomoses and double nerve suturing for long-standing facial paralysis☆

Okazaki Mutsumi*, Tanaka Kentaro, Uemura Noriko, Usami Satoshi, Homma Tsutomu, Okubo Alisa, Hamanaga Mayuko, Mori Hiroki

Department of Plastic and Reconstructive Surgery, Graduate School of Science, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo, Japan

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KEYWORDS
Facial paralysis;
Double latissimus dorsi muscle transfer;
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Summary *Objective:* Various types of neurovascular free-muscle transfers have been reported as surgical treatments for long-standing facial paralysis. Among one-stage methods, two approaches, that is, latissimus dorsi transfer with nerve suturing to the contralateral facial nerve and gracilis transfer with nerve suturing to the ipsilateral masseteric nerve, have recently become popular. The former method has the advantage of making spontaneous smiling possible, but the contraction strength of the transferred muscle varies, whereas the latter approach has the advantage of guaranteeing voluntary contraction of the transferred muscle, but makes spontaneous smiling difficult. Recently, dual innervation methods have also been reported, but uncertainty remains about the utility of such approaches. To overcome these drawbacks, we devised a hybrid method combining the two previously established techniques.
Methods: Two latissimus dorsi muscle flaps containing the thoracodorsal vessels from one side are transferred with a pair of vascular anastomoses. The true trunk of the thoracodorsal nerve, which innervates one of the muscle flaps, is sutured to the contralateral facial nerve, while the short branch of the thoracodorsal nerve, which innervates the other muscle flap, is sutured to the ipsilateral masseteric nerve. From November 2011 to October 2013, we used this method in four patients with long-standing facial paralysis.
Results: Smiling was assessed in the three patients who were followed up for more than 1 year, and satisfactory results were obtained (Harii score: 4—5). In one patient, the movement

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* Corresponding author. Tel.: +81 3 5803 5923; fax: +81 3 5803 0218.
E-mail address: okazaki-m@umin.ac.jp (O. Mutsumi).

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mediated via the contralateral facial nerve was a little weak, but this was compensated for by the muscles controlled by the ipsilateral masseteric nerve.
Conclusion: Our novel one-stage method, which involves a combination of two previously established methods, guarantees early voluntary smiling, and spontaneous smiling becomes possible later. In addition, it is free from the uncertainty associated with double innervation and does not require nerve grafts. So, stable results can be expected in most patients with long-standing facial paralysis.

Introduction

Since the first clinical application of the free gracilis muscle transfer method by Harii et al., in 1976,[1] various types of neurovascular free-muscle transfers have been reported as surgical treatments for long-standing facial paralysis.[1–9] In such methods, the number of stages (one-stage or two-stage), transferred muscle (gracilis, latissimus dorsi, serratus anterior, or rectus abdominis), and motor source (ipsilateral masseteric, contralateral facial nerve, etc.) can vary. Among the numerous reported procedures, one-stage methods have a firm advantage over two-stage methods as they involve a shorter period of recovery from paralysis and only require one operation. At present, the two most popular one-stage methods are neurovascular latissimus dorsi transfer combined with the suturing of the thoracodorsal nerve to the contralateral facial nerve[6,10,11] and gracilis muscle transfer combined with the suturing of the obturator nerve to the ipsilateral masseteric nerve.[7,12,13] The former method has the advantage of allowing spontaneous and natural smiling and it achieves good synchronicity between the paralyzed and non-paralyzed sides of the face; however, the contraction strength of the transferred muscle can vary.[10,11] The latter method has the advantage of guaranteeing voluntary contraction of the transferred muscle and smiling and involves a shorter period of recovery from paralysis, but makes spontaneous smiling difficult.[9,10,12,13]

To overcome the drawbacks of these two procedures, Watanabe et al.[8] reported a dual innervation method, in which they transferred a latissimus dorsi flap that was innervated by a contralateral facial nerve and then performed a second neurotization procedure involving close contact with the masseteric muscle. More recently, Biglioli F et al.[9] reported a one-stage dual innervation method and applied it to four patients. In the latter method, they transferred a gracilis muscle flap that was innervated by the masseteric nerve and performed a second neurotization procedure in which they anastomosed a cross-face sural nerve graft to a contralateral facial nerve branch. Although the latter method seemed to produce good results, uncertainty remains about the utility of double innervation.[9] In this paper, we present an alternative method that is free from the uncertainty surrounding double innervation and does not require nerve grafting: one-stage dual latissimus dorsi muscle transfer with double nerve suturing. In this method, two muscle flaps containing the descending and transverse branches of the thoracodorsal vessels (from the same side) are transferred to the face. The true trunk of the thoracodorsal nerve, which innervates one muscle flap, is sutured to the contralateral facial nerve, while the short branch of the thoracodorsal nerve, which innervates the other muscle flap, is sutured to the ipsilateral masseteric nerve. This method guarantees early voluntary smiling, and spontaneous smiling becomes possible later.

Operative procedure

Muscle flap elevation

The latissimus dorsi muscle flaps are generally harvested on the same side as the paralyzed part of the face according to Harii's method.[6] Two muscle flaps containing the descending and transverse branches of the thoracodorsal vessels are then elevated (Figure 1A). The muscle flap whose nerve is to be sutured to the contralateral facial nerve (muscle A) is larger (~3–4 cm wide and 9–11 cm long) than the flap whose nerve is to be sutured to the ipsilateral masseteric nerve (muscle B) (~2–3 cm wide and 9–11 cm long) because muscle A suffers more atrophication due to late neurotization. To ensure that the optimal segments of the latissimus dorsi muscle are harvested, muscle contraction is examined by electrically stimulating the branches of the thoracodorsal nerve. A section of the thoracodorsal nerve measuring more than 14 cm long, which is long enough to cross through the upper lip and reach the facial nerve branches in the non-paralyzed cheek, is prepared in order to innervate muscle A. After being harvested, the branch of the thoracodorsal nerve that innervates muscle B is divided from the true trunk of the thoracodorsal nerve (Figure 1A). De-epithelialized adiposal flaps containing the thoracodorsal perforators are used to correct depressed cheeks where necessary.

Recipient preparation and muscle flap transfer

A subcutaneous pocket is created in the paralyzed cheek via a preauricular skin incision and is used to hold the transferred muscle flaps. The dissection of the skin flap is extended approximately 1–2 cm beyond the nasolabial fold to the upper and lower lips. Several (usually five) stay sutures are then placed at the lateral border of the atrophied orbicularis oris muscle in the upper lip and the angle of mouth. Among them, the three sutures for muscle A are placed in the white lip slightly medial to the nasolabial fold, and the two caudal sutures for muscle B are placed in the white lip and the angle of the mouth (Figure 1B). This

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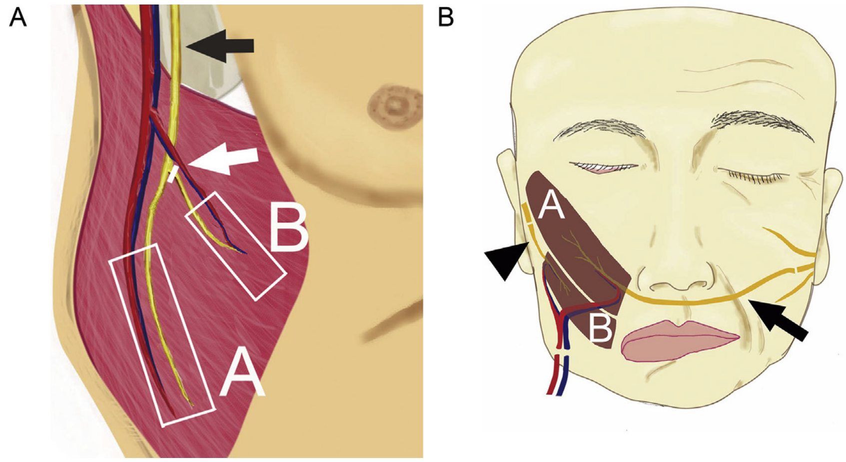

Figure 1 A) Schematic representation of the harvesting of the two muscle flaps containing the thoracodorsal vessels. A: muscle A, B: muscle B; The black arrow indicates the thoracodorsal vessels and nerve. The white arrow indicates the part at which the short branch of the thoracodorsal nerve is cut off from true trunk of the thoracodorsal nerve. B) Schematic representation of the transfer of the muscle flaps to the face Muscle A is innervated by the contralateral facial nerve, and muscle B is innervated by the masseteric nerve. The proximal end of muscle A is fixed to the nasolabial region, whereas the distal end of muscle B is fixed to the nasolabial and angular region of the mouth. The arrow indicates the true trunk of the thoracodorsal nerve, and the arrowhead indicates the short branch of the thoracodorsal nerve.

determines the final positions of the ends of the transferred muscle flaps. Fascia lata grafts to the lower lip (for lip elevation) and/or to the upper lip (for correct lip deviation) are added where necessary.

On the non-paralyzed side of the face, several buccal branches of the facial nerve are exposed through a small incision (~1.5 cm long) made in the cheek. Of these, two to three branches with insertions into the zygomatic (major and minor) muscles are identified. After the involvement of these branches in smiling movement is confirmed with an electrostimulator, appropriate branches are made ready for the recipient motor nerve. Then, the masseteric motor nerve is identified within the masseteric muscle and is harvested as reported previously.[9] Two to three small branches of the masseteric nerve are cut to obtain 1.5–2 cm of nerve, which is turned superficially to facilitate suturing. Next, the ipsilateral facial artery and vein are prepared for the recipient vessels through a small right submandibular incision.

The harvested neurovascular muscle flaps are immediately placed into the recipient cheek pocket, and the muscles are stabilized using the medial attachment defined by the previously placed sutures. The proximal end of muscle A is then fixed to the nasolabial region using the above mentioned stay sutures. On the other hand, the distal end of muscle B is fixed to the nasolabial region and the angle of the mouth (Figure 1B). The true trunk of the thoracodorsal nerve of muscle A is passed through the upper lip to the contralateral small incision for nerve suturing. Then, to minimize the period of ischemia experienced by the muscle flaps, microvascular anastomoses are created between the thoracodorsal vessels and the facial vessels. After revascularization has been confirmed, the true trunk of the thoracodorsal nerve is sutured to the selected contralateral facial nerve, and the short branch of the thoracodorsal nerve of muscle B is sutured to the ipsilateral masseteric nerve. Finally, the distal end of muscle A and the proximal end of muscle B are fixed to the periosteum overlying the zygomatic body and arch. The cheek skin is then closed and subjected to suction drainage.

Patients and methods

From November 2011 to October 2013, four patients (two females and two males) with long-standing facial paralysis were treated using the above mentioned method at Tokyo Medical and Dental University Hospital. The patients' mean age at the time of surgery was 44 years (range: from 33 to 53 years). A summary of the patients' background information is shown in Table 1. Regarding the etiology of the patients' facial paralysis, it was congenital in one case, caused by parotid tumor and a brain tumor in one case each, and of uncertain origin (a tumor resection had been performed during infancy) in the final case. Before surgery, the patients had lived with their paralysis for 5–53 years, and one and three patients had complete and incomplete paralysis, respectively. The latter patients chiefly complained of severe asymmetry and little facial movement during smiling. The preoperative state of the patients' facial paralysis and their House–Brackmann scores[14] are shown in Table 1. Fascia lata grafts were simultaneously transferred to the lower lip in three patients and to the upper lip in two patients. Two tensor fascia lata slings (for the upper and lower lips) were added in two patients (patients 2 and 3) because the tonus of the orbicularis oris muscle on the affected side was severely reduced. It was suspected that if tensor fascia lata slings had not been employed in these cases, then the transferred muscles would not have been able to subject the patients' lips to sufficient tension during smiling, even if they had contracted appropriately. The mean follow-up period was 24 months (range: 10–34 months). As our method focuses on the restoration of smiling function, the

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patients' functional results were evaluated according to Harii's grading scale[6,15] in the three patients who were followed up for more than 1 year.

Table 1 Patients summary.

Patient	Age	Sex	Etiology	Duration of paralysis (years)	Type	Preoperative House-Brackmann's score	Start contraction (postoperative months)		Fascia lata graft	Additional tissue	Harii's score	Follow-up (months)
							Muscle-A	Muscle-B				
1	53	F	Congenital	53	Incomplete	V	4	8	Lower lip		5	34
2	46	M	Parotid tumor	5	Complete	VI	2	10	Upper and lower lip	Adiposal flap	5	30
3	33	M	Brain tumor	15	Incomplete	V	3	7	Upper and lower lip		4	22
4	45	F	Uncertain	40	Incomplete	IV	5	7	(−)			10
Average	44			28.3			4	8			4.7	24

Results

None of the four patients suffered vascular complications or exhibited obvious signs of muscle necrosis. An electromyographic examination performed 10 days after the operation confirmed that both muscles had survived (denervation potential (+)) in all patients. Voluntary contraction of muscle B was observed within 5 postoperative months (range: 2–5 months), and spontaneous contraction of muscle A was possible within 10 postoperative months (range: 7–10 months) (Table 1). Three patients who were followed up for more than 1 year developed the ability to smile in a voluntary and spontaneous manner (patient 1: Figure 2A–F, patient 2: Figure 3A–F) (Videos 1–3). According to the five-stage ($1 < 5$) evaluation criteria developed by Harii,[6,15] two patients had grade 5 outcomes (symmetric balance and good facial tone at rest; sufficient muscle power during voluntary contractions; synchronous and natural expressions during emotional facial movements, especially during smiling), and one patient had grade 4 outcomes (symmetric balance and good facial tone at rest; active muscle contraction acquired, but not sufficiently synchronous) at 20 months after surgery. In addition to their smiling abilities, these three patients were able to move the angles of their mouths laterally on the paralyzed side using muscle B (which was controlled via masseteric innervation) independent of the healthy side (Video 4). In one patient (patient 3), the movement controlled by muscle A was a little weak during smiling although it was strong enough when he closed his eyes. However, he was soon able to smile with the help of muscle B, which was controlled by the ipsilateral masseteric nerve.

Supplementary video related to this article can be found at http://dx.doi.org/10.1016/j.bjps.2015.02.013.

Discussion

Our series only consisted of four patients, but stable results can generally be expected in patients with long-standing facial paralysis because our method involves a combination of two previously established techniques (i.e., latissimus dorsi muscle transfer combined with nerve suturing to the contralateral facial nerve and gracilis muscle transfer combined with nerve suturing to the ipsilateral masseteric nerve). Our method is comparatively simple, can be achieved in a single stage, does not require nerve grafts, and is free from the uncertainty surrounding the utility of double innervation. The two neurovascular muscle flaps containing thoracodorsal vessels can be easily harvested. Since 2003, we have experienced more than 50 one-stage latissimus dorsi transfers for long-standing facial paralysis. In this series, the thoracodorsal nerve was sutured to the contralateral facial nerve in most patients whereas it was sutured to the ipsilateral masseteric nerve in several patients. The former method is considered to provide optimal

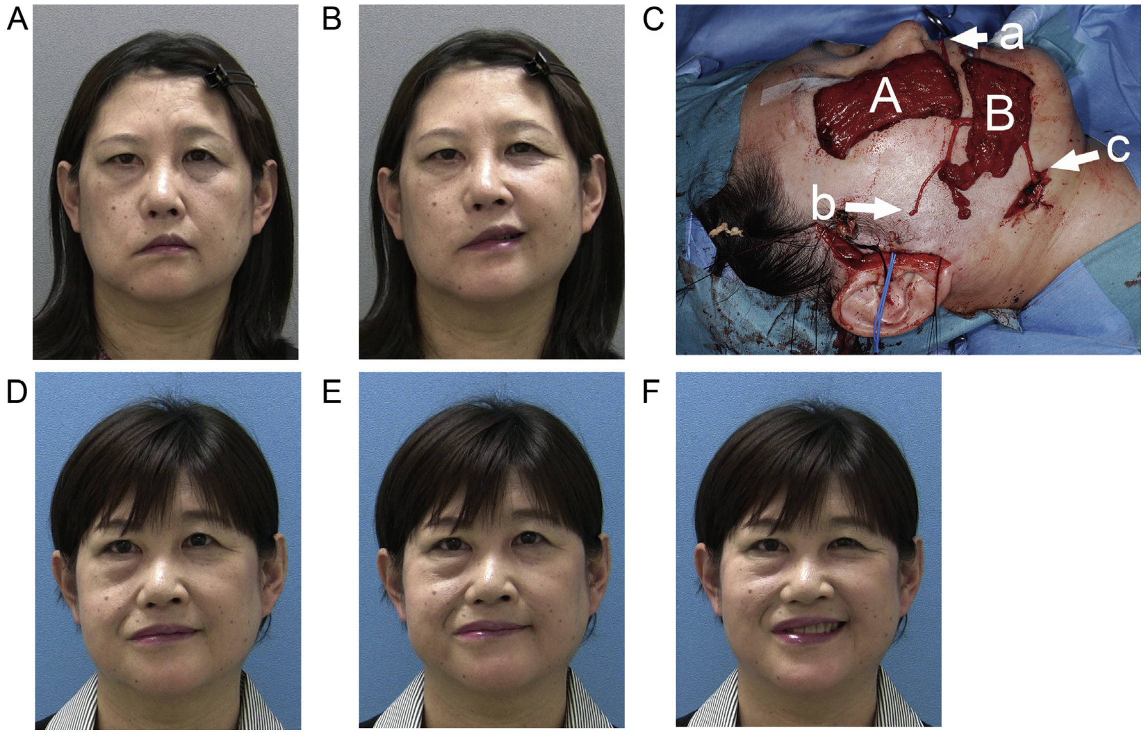

Figure 2 A) (Patient 1) Preoperative view at rest in a patient with severe incomplete long-standing right facial paralysis. B) Preoperative view during smiling. C) Intraoperative view. A: muscle A, B: muscle B, a: true trunk of the thoracodorsal nerve, b: short branch of the thoracodorsal nerve, c: thoracodorsal vessels. D) The same patient at rest at 30 postoperative months. In this patient, the adhesion between the grafted muscles and cheek skin was released at 26 postoperative months. E) Voluntary smiling during clenching. F) Spontaneous smiling. Note that the patient was able to produce a better smile after the operation compared with that seen before the operation.

results in patients with good muscle function, but sometimes it results in weak muscle power. We developed the method described in this study in order to reduce the number of patients who were discouraged after being left with muscles with little function. In our method, reinnervation of muscles A and B was established within a mean of 8 and 3 postoperative months, respectively, which agrees with the findings of previous reports.[6,12,13,15,16] The patients who underwent our procedure were relieved to see the muscle graft contract. In addition, they were soon able to smile voluntarily and became able to smile spontaneously after about one postoperative year. Moreover, they were able to consciously move the right and left angles of their mouths laterally in an independent manner. In our method, muscle B (which is involved in voluntary smiling) is placed on the caudal side of muscle A (which is involved in spontaneous smiling) because the commissures of the lips move laterally during voluntary smiling whereas the nasolabial folds move cranio-laterally during spontaneous smiling. In one patient (patient 3), the movement of muscle A was a little weak during smiling although it was sufficiently strong when he closed his eyes. However, he became able to smile with the help of muscle B, which was under the control of the ipsilateral masseteric nerve. It has been found that in a proportion of the patients who received single latissimus dorsi muscle grafts the transferred muscle contracted more strongly during eye closing than during smiling. However, some of these patients (especially the female patients) became able to smile naturally after exercise. We consider that patient 3 would have become able to smile naturally if he had made an effort, but he was not very eager to do this.

In neurovascular free-muscle transfers for long-standing facial paralysis, one of the most important factors influencing whether a satisfactory result is obtained is the selection of a suitable motor nerve for innervating the transferred muscle. Most authors agree that the contralateral facial nerve provides the grafted muscle with sufficient stimulation to enable the reanimation of facial paralysis because it (exclusively) makes natural and spontaneous smiling possible.[9,15,17] However, this technique results in weak contraction in a considerable proportion of patients.[9,10] Biglioli et al.[9] attributed such negative outcomes to the long length of the flap nerve and the long denervation time, which leads to muscle atrophication. On the other hand, since Zuker et al.[7] reported stable results for a surgical procedure in which a gracilis muscle flap was anastomosed to the masseteric nerve with the aim of reanimating bilateral regions of facial paralysis in patients with Moebius syndrome, several authors have preferred to use this technique for adult patients with unilateral paralysis and have reported stable results.[12,13] Although this approach guarantees the rapid reinnervation of the muscle (within 4 months) and results in satisfactory functional recovery of the muscle in almost all patients, spontaneous smiling is not possible in most cases.[9,10,12,13] Thus, motor

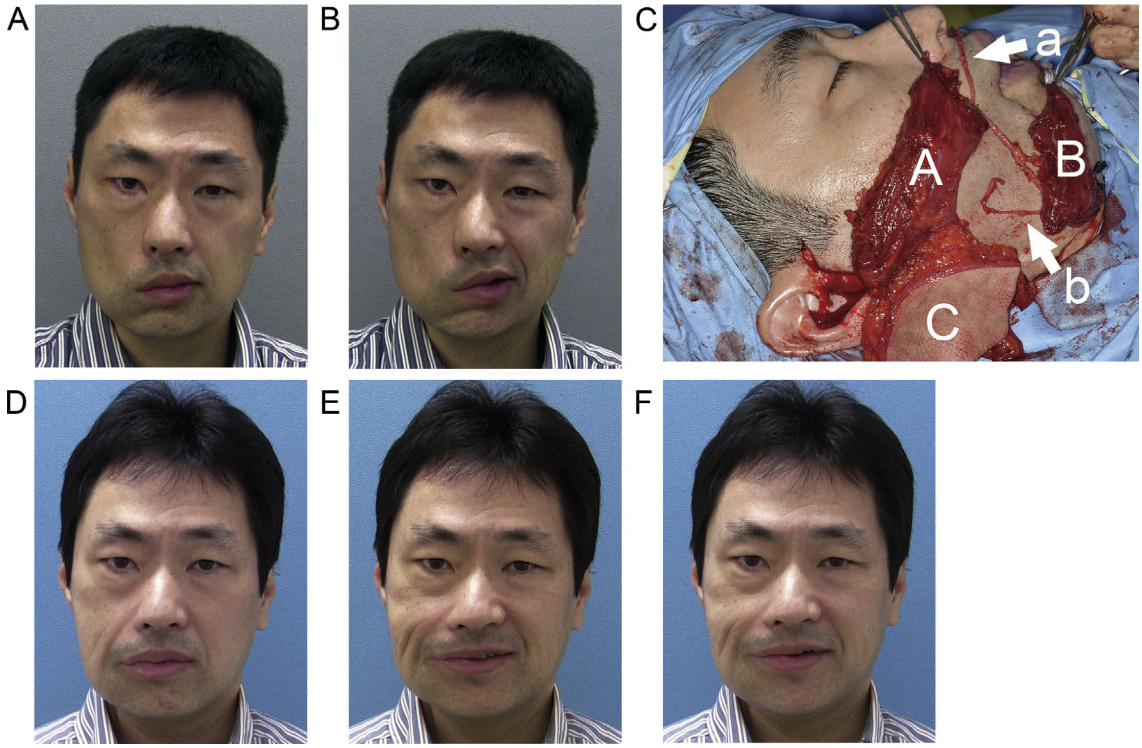

Figure 3 A) (Patient 2) Preoperative view at rest in a patient with complete long-standing right facial paralysis after parotid tumor ablation. B) Preoperative view during smiling. C) Intraoperative view. A: muscle A, B: muscle B, C: adiposal flap used to augment the depressed parotid region, a: true trunk of the thoracodorsal nerve, b: short branch of the thoracodorsal nerve. D) The same patient at rest at 30 postoperative months. E) Voluntary smiling during clenching. F) Spontaneous smiling.

nerves should be selected depending on the main aims of the operator, for example, reliable muscle contraction or the ability to smile spontaneously.

Recently, one-stage neurovascular muscle transfer methods involving double innervation were reported.[8,9] The method described by Biglioli F et al.[9] is a revised version of the method developed by Watanabe Y et al.,[8] in which the gracilis muscle is transferred, its motor nerve is sutured to the ipsilateral masseteric nerve, and a sural nerve graft is sutured to the contralateral facial nerve. Biglioli F et al.[9] reported that all four patients recovered the ability to smile voluntarily and spontaneously. In comparison with their method, our approach has several advantages. First, it does not require nerve grafting, which reduces the amount of work that has to be performed by the operator and axonal loss, as the use of two nerve suture points (an end-to-end anastomosis between the contralateral facial nerve and a cross-facial nerve, and an end-to-side anastomosis between the distal end of the graft and the anterior obturator nerve) reduces the number of axons that are able to innervate the grafted muscle.[18] The second advantage of our method is that it is free from the uncertainty about the utility of double innervation because our method involves a combination of two previously established methods. Moreover, a latissimus dorsi adipocutaneous flap and/or scapular bone can be simultaneously transferred when the patient's bone and/or soft tissue is deformed due to ablative surgery.[19] Takushima et al.[15] reported that one-stage latissimus dorsi transfers can sometimes result in weak muscles, especially among middle-aged male patients with fatty and heavy cheeks, and notified that it might be better to use the ipsilateral trigeminal nerve than the contralateral facial nerve branch in such patients. However, our method could be the best option for such patients because the masseteric nerve input guarantees voluntary smiling, even in cases in which innervation from the cross-facial nerve graft does not provide enough stimulation to produce clinically significant results. One drawback of our method is that unconscious movements caused by ipsilateral masseteric nerve stimulation during clenching might remain, even after the contralateral facial nerve has made spontaneous smiling possible. However, we consider that in the majority of cases such problems could be overcome with time. In cases in which this does not happen, touch-up surgery including reducing the size of muscle B is a potential solution. Reducing the size of muscle B without damaging muscle A is not very difficult because the two muscle flaps are transferred and innervated independently in our method.

Conclusion

Our method involves a combination of two previously established techniques. In addition, it is comparatively simple, can be achieved in a single stage, does not require nerve grafting, and is free from the uncertainty associated with double innervation. So, stable results are expected in many patients. We consider that this method provides an alternative approach to the reanimation of long-standing facial paralysis.

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Conflicts of interest

We do not have any conflicts of interest to declare.

Ethical approval

Not required.

References

1. Harii K, Ohmori K, Torii S. Free gracilis muscle transplantation, with microneurovascular anastomoses for the treatment of facial paralysis. A preliminary report. *Plast Reconstr Surg* 1976; **57**:133–43.
2. O'Brien BM, Franklin JD, Morrison WA. Cross-facial nerve grafts and microneurovascular free muscle transfer for long established facial palsy. *Br J Plast Surg* 1980;**3**:202–15.
3. Vedung S, Hakelius L, Stalberg E. Cross-face nerve grafting followed by free muscle transplantation in young patients with longstanding facial paralysis. Reanimation of the cheek and the angle of the mouth. *Scand J Plast Reconstr Surg* 1984;**18**: 201–8.
4. Terzis JK. Pectoralis minor: a unique muscle for correction of facial palsy. *Plast Reconstr Surg* 1989;**83**:767–76.
5. Koshima I, Moriguchi T, Soeda S, et al. Free rectus femoris muscle transfer for one-stage reconstruction of established facial paralysis. *Plast Reconstr Surg* 1994;**94**:421–30.
6. Harii K, Asato H, Yoshimura K, et al. One-stage transfer of the latissimus dorsi muscle for reanimation of a paralyzed face: a new alternative. *Plast Reconstr Surg* 1998;**102**:941–51.
7. Zuker RM, Goldberg CS, Manktelow RT. Facial animation in children with Möbius syndrome after segmental gracilis muscle transplant. *Plast Reconstr Surg* 2000;**106**:1–8.
8. Watanabe Y, Akizuki T, Ozawa T, et al. Dual innervation method using one-stage reconstruction with free latissimus dorsi muscle transfer for re-animation of established facial paralysis: simultaneous reinnervation of the ipsilateral masseter motor nerve and the contralateral facial nerve to improve the quality of smile and emotional facial expressions. *J Plast Reconstr Aesthet Surg* 2009;**62**:1589–97.
9. Biglioli F, Colombo V, Tarabbia F, et al. Double innervation in free-flap surgery for long-standing facial paralysis. *J Plast Reconstr Aesthet Surg* 2012;**65**:1343–9.
10. Faria JC, Scopel GP, Busnardo FF, et al. Nerve sources for facial reanimation with muscle transplant in patients with unilateral facial palsy: clinical analysis of 3 techniques. *Ann Plast Surg* 2007;**59**:87–91.
11. Cuccia G, Shelley O, d'Alcontres FS, et al. A comparison of temporalis transfer and free latissimus dorsi transfer in lower facial reanimation following unilateral longstanding facial palsy. *Ann Plast Surg* 2005;**54**:66–70.
12. Lifchez SD, Matloub HS, Gosain AK. Cortical adaptation to restoration of smiling after free muscle transfer innervated by the nerve to the masseter. *Plast Reconstr Surg* 2005;**115**: 1472–9.
13. Bianchi B, Copelli C, Ferrari S, et al. Facial animation with free-muscle transfer innervated by the masseter motor nerve in unilateral facial paralysis. *J Oral Maxillofac Surg* 2010;**68**: 1524–9.
14. House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg* 1985;**93**:146–7.
15. Takushima A, Harii K, Asato H, et al. Fifteen-year survey of one-stage latissimus dorsi muscle transfer for treatment of longstanding facial paralysis. *J Plast Reconstr Aesthet Surg* 2013;**66**:29–36.
16. Manktelow RT, Tomat LR, Zuker RM, et al. Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: effectiveness and cerebral adaptation. *Plast Reconstr Surg* 2006;**118**:885–99.
17. Bae YC, Zuker RM, Manktelow RT, et al. A comparison of commissure excursion following gracilis muscle transplantation for facial paralysis using a cross-face nerve graft versus the motor nerve to the masseter nerve. *Plast Reconstr Surg* 2006; **117**:2407–13.
18. Harii K. Experimental and clinical studies of nerve and muscle grafts for the treatment of facial paralysis. *J Jpn Plast Reconstr Surg* 1987;**7**:347–72.
19. Takushima A, Harii K, Asato H, et al. One-stage reconstruction of facial paralysis associated with skin/soft tissue defects using latissimus dorsi compound flap. *J Plast Reconstr Aesthetic Surg* 2006;**59**:465–73.

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