Recovery of Emotional Smiling Function in Free-Flap Facial Reanimation

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Purpose: Long-standing unilateral facial palsy is treated primarily with free-flap surgery using the masseteric or contralateral facial nerve as a motor source. The use of a gracilis muscle flap innervated by the masseteric nerve restores the smiling function, without obtaining spontaneity. Because emotional smiling is an important factor in facial reanimation, the facial nerve must serve as the motor source to achieve this fundamental target.

Materials and Methods: From October 1998 to October 2009, 50 patients affected by long-standing unilateral facial paralysis underwent single-stage free-flap reanimation procedures to recover smiling function. A latissimus dorsi flap innervated by the contralateral facial nerve was transplanted in 40 patients, and a gracilis muscle flap innervated by the masseteric nerve in 10 patients. All patients underwent a clinical examination that analyzed voluntary and spontaneous smiling.

Results: All patients who received a latissimus dorsi flap innervated by the contralateral facial nerve and recovered muscle function (92.5%) showed voluntary and spontaneous smiling abilities. All patients who received a gracilis free flap innervated by the masseteric nerve recovered function, but only 1 (10%) showed occasional spontaneous flap activation. During those rare activations, much less movement was visible on the operated side than when the patient was asked to smile voluntarily.

Conclusions: The masseteric nerve is a powerful motor source that guarantees free voluntary gracilis muscle activation; however, it does not guarantee any spontaneous smiling. Single-stage procedures that use a latissimus dorsi flap innervated by the contralateral facial nerve have a lower success rate and obtain less movement; however, spontaneous smiling is always observed.

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Current facial reanimation procedures to correct long-standing facial paralysis aim to restore facial symmetry at rest while activating the mimetic musculature.[1-3] Surgeons have concentrated their reconstructive efforts on the recovery of 2 main movements: eyelid closure and smiling. Eyelid closure is functionally most important, because without it, the eye globe is insufficiently protected and lubricated, and keratitis and corneal ulcers can develop, leading to partial or total loss of visual function.

Smiling is the most important facial movement for communication, the demonstration of a positive attitude toward others, and the sharing of positive emotions. One can smile voluntarily to communicate

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friendship and a positive attitude or spontaneously from an emotional stimulus. Spontaneous smiling is perceived as more pleasant and natural; indeed, most people dislike their appearance in photographs with a forced and unnatural smile.

The first experience of Harii et al[4] with gracilis muscle transplantation innervated by a trigeminal branch, the deep temporal nerve, as a motor source provided good smiling function, but failed to produce spontaneity. To achieve more natural smiling function, the procedure was refined using a contralateral facial nerve branch as the motor source.[5,6] The use of this technique has produced satisfactory smiling quality and spontaneity. However, the proportion of recovered muscle function and quantity of contractions has varied.[7,8] Similar results, with a shorter recovery time, can be obtained with single-stage facial reanimation procedures. The most common is based on transplantation of a latissimus dorsi free flap.[9]

Manktelow et al[10] recently applied the facial reanimation technique proposed by Zuker et al[11] in patients with Möbius disease and long-standing acquired facial paralysis. They reported the recovery of 100% of transplanted muscle function and high percentages of spontaneous smiling function. The ability to shift from voluntary to spontaneous smile production was noted in a consistent number of patients and attributed to brain plasticity. Faria et al[12] used the same technique, but observed no recovery of spontaneous smiling function.

The transplantation of a gracilis muscle flap innervated by the masseteric nerve seems to achieve better functional outcomes than the use of free flaps innervated by the contralateral facial nerve.[11,12] However, the failure to achieve the goal of recovering emotional smiling function is unacceptable.

The present study examined the recovery of smiling function in response to an emotional stimulus in patients who had undergone facial reanimation procedures using free flaps.

Materials and Methods

In accordance with the ethical principles stated by local institutional review board, from October 1998 to October 2009, 50 patients affected by long-standing unilateral facial paralysis underwent single-stage free-flap reanimation procedures to recover smiling function. A latissimus dorsi flap neurotized by a contralateral branch of the facial nerve was used in 40 patients (group 1), and a gracilis muscle free flap anastomised to the homolateral masseteric nerve was used in 10 patients (group 2). Group 1 contained 28 males and 12 females, ranging in age from 6 to 77 years (mean 47.4). Group 2 contained 8 males and 2 females, ranging in age from 16 to 63 years (mean 42.3).

All patients had complete homolateral facial paralysis (House–Brackman stage VI), confirmed by preoperative electromyographic evaluation of the mimetic musculature. The contralateral facial nerve branches and homolateral masseteric nerve were also tested to ascertain their suitability as donor nerves.

The etiology of paralysis in group 1 was previous cranial base surgery in 22 (55%), trauma in 4 (10%), parotid surgery in 4 (10%), congenital in 4 (10%), Bell's palsy in 2 (5%), brain surgery in 2 (5%), sequelae of meningitis in 1 (2.5%), and radiotherapy in 1 (2.5%). The etiology of paralysis in group 2 was previous cranial base surgery in 8 (80%) and congenital in 2 (20%).

Postoperative clinical examinations were performed at 3, 6, 9, and 12 months after surgery. At each office visit, facial objectivity was evaluated at rest and during the activation of the mimetic musculature.

The patients were asked to contact the surgical team to schedule an immediate examination when they or those close to them observed the first voluntary movement of the commissure. On the initiation of muscle function, the patients were referred to our team's physiotherapist, who instructed each patient to perform physical training in front of a mirror and, later, without a mirror.

At 12 months after the initial transplanted muscle contraction, all patients underwent a prolonged clinical examination to analyze the voluntary and spontaneous smiling functions. Standardized photographs were taken at rest and during standardized facial movements. The results were classified according to the 5-stage system developed by Terzis and Noah.[13] Needle electromyography was also performed to test flap contraction during the activation of the masseteric or contralateral facial nerve.

To evaluate spontaneous smiling function, the patients underwent a prolonged clinical examination during which they were given time to become comfortable. Videos of the patients watching a comedic movie were also recorded and analyzed. Each patient was left alone in the viewing room to avoid embarrassment or the inhibition of spontaneity. To ensure the success of the test, each patient was asked to select a preferred movie from a series of available movies. The videos were analyzed later by a team consisting of 2 surgeons and 1 physiotherapist.

Results

The initial recovery of muscle function was achieved within an average of 7.4 months (range 2 to 22) in the 40 patients who underwent latissimus dorsi transplantation innervated by the contralateral facial nerve. The standardized photographs were analyzed according to the Terzis and Noah system; the recov-

ery of muscle function was classified as excellent in 14 patients (35%), good in 15 (37.5%), average in 5 (12.5%), poor in 3 (7.5%), and failed in 3 patients (7.5%).

The 10 patients who underwent gracilis muscle transplantation innervated by the masseteric nerve recovered initial muscle function within an average of 4.2 months (range 3 to 13). The results were classified as excellent in 3 patients (30%; Figs 1-5), good in 5 (50%), and average in 2 (20%). No patient in this group was classified as having poor or failed functional recovery.

All patients who underwent latissimus dorsi transplantation and recovered muscle function were able to smile voluntarily and spontaneously. Slightly less muscle function was detected between spontaneous and voluntary activation in a few cases.

Only 1 patient (10%) who underwent gracilis muscle transplantation innervated by the masseteric nerve recovered spontaneous smiling function. Rare spontaneous flap activation was observed in this patient; while watching a comedic movie, the patient activated the flap once in every 9 spontaneous smiles. The contraction was barely visible during spontaneous activation and was much less pronounced than the contractions obtained during voluntary activation.

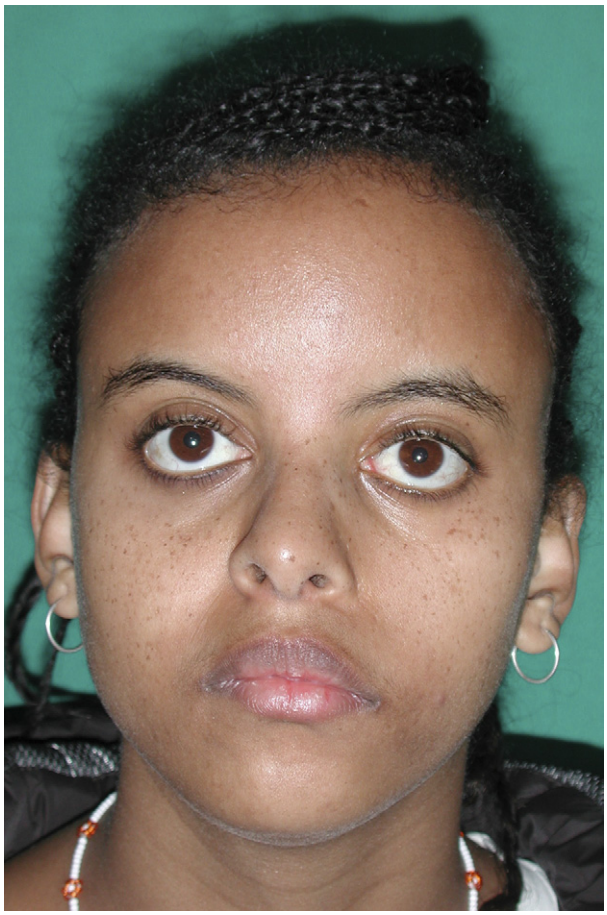

FIGURE 1. Preoperative view showing patient with congenital facial paralysis at rest: slight asymmetry of facial features.

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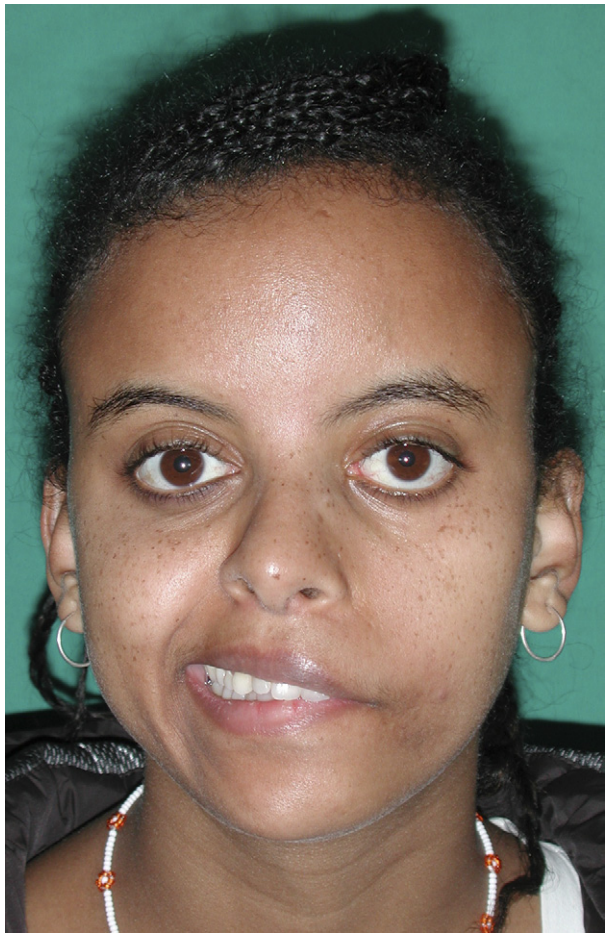

FIGURE 2. Preoperative view showing worsening of facial asymmetry during smiling.

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Discussion

Zuker et al[11] proposed the use of a gracilis muscle flap anastomised to the masseteric nerve for facial reanimation in patients with Möbius disease who were affected by bilateral facial paralysis. This procedure consistently achieved the rapid reinnervation of the flap (within 2.5 to 4 months) and a high quantity of contractions.[14] The investigators reported no flap failure in their series of 10 patients. From these positive results, the procedure gained great popularity and was also used in adults and for unilateral paralysis.[15] In an effort to improve facial reanimation outcomes, we changed from a single-stage latissimus dorsi procedure to the use of a gracilis flap neurotized by the masseteric nerve in response to these outstand-

FIGURE 3. Intraoperative view showing facial reanimation by gracilis free-flap transplantation.

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ing reports. The new procedure resulted in satisfactory static symmetry and smiling function outcomes. However, the spontaneous smiling function results were disappointing, as noted when talking to the patients during the examinations and observing them when spontaneously smiling. The patients never used the flap during spontaneous smiling and appeared to remain paralyzed. Thus, some goals of facial reanimation were attained, such as the restoration of symmetry at rest, voluntary smiling function, and the improvement of eating, drinking, and speech functions; however, the paralysis remained evident when the patients spontaneously expressed themselves.

Relatives and friends provided a range of responses when asked whether the patients generally used the flap when smiling voluntarily. Although the patients were generally able to smile without clenching their teeth after a few months of physiotherapy, flap activation requires a voluntary effort in some instances. Although the stimulus becomes automatic over time,[10,15] this process is not consistent, and activation does not become spontaneous. One does not need to think about the performance of an automatic movement, such as taking a spoon from the table to eat cereal at breakfast. Spontaneity is related to emotional expression, such as crying in response to sad news. Patients who underwent gracilis transplantation innervated by the masseter nerve could often activate the flap automatically when smiling at someone they met, but they did not use the flap when laughing at a joke.

Although some investigators[10,16-18] have hypothesized that brain plasticity is responsible for the conversion to spontaneous masticatory nerve stimulus, this might be true only for patients with Möbius disease, who have made up the largest proportion of analyzed patients. Faria et al[12] and Gousheh and Arasteh[19] observed no spontaneous smiling function in large series of patients without Möbius disease who were affected by long-standing facial paralysis.

The recovery of emotional smiling function is not optional in facial reanimation. The intentional neglect of this function leads to failure in the most pleasant aspect of outcomes. People frequently dislike their smiling appearance in photographs because the voluntary smile is perceived as unnatural and slightly false. We can only imagine the extent to which this psychological situation is amplified in a patient with long-standing facial paralysis. Thus, the ability to smile in a pleasant way is extremely important.

Initial experiences with free-flap facial reanimation made it clear that the use of the facial nerve was the

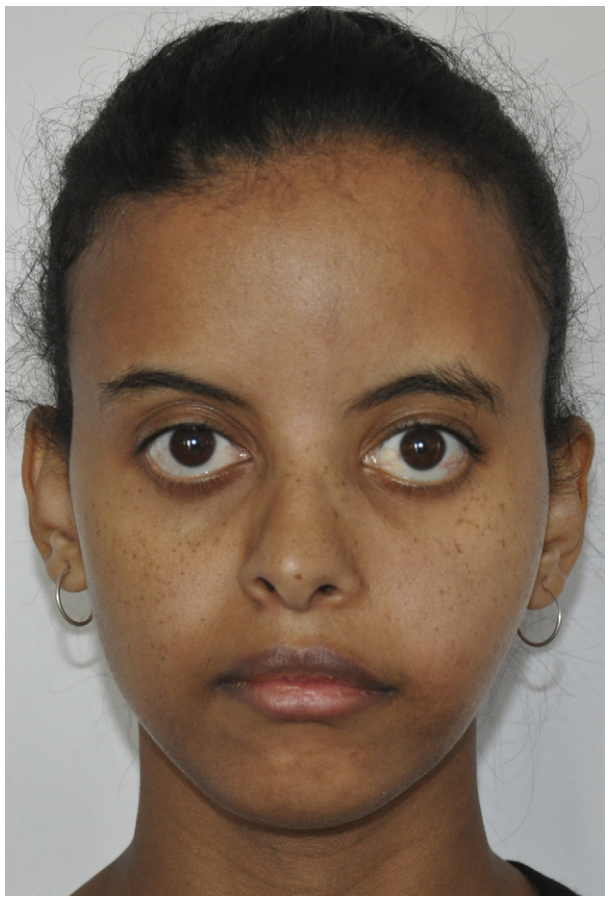

FIGURE 4. View at 18 months postoperatively showing increased facial symmetry at rest.

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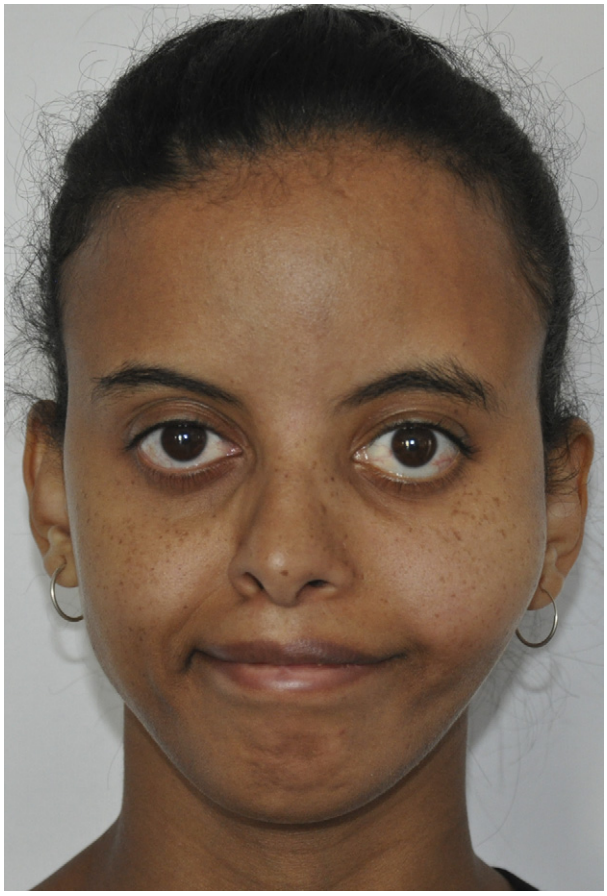

FIGURE 5. View at 18 months postoperatively showing good quality of voluntary smiling but results were spoiled by no visible movement during spontaneous smiling.

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only method to consistently achieve spontaneous smiling function. The initial procedure of Harii et al,[4] who neurotized the transferred gracilis muscle using the deep temporal nerve, was refined by Vedung et al[6] and O'Brien et al[7] to improve the natural response to stimuli. However, the results obtained in our series of patients have indicated that the use of the masseteric nerve does not achieve spontaneous smiling function. Numerous studies have confirmed that the use of the facial nerve is the only method to guarantee the ability to produce spontaneous facial expressions.[20-22]

In an effort to achieve a satisfactory quantity of contraction and appropriate activation of the contralateral facial nerve, Watanabe et al[23] used a latissimus dorsi flap innervated directly by the contralateral facial nerve, according to the technique developed by Harii et al,[4] and then created a second neurotization through close contact with an area of the masseter muscle. The results of this combined procedure were convincing, and our team is working to develop a similar technique. From the observation that gracilis transplantation innervated by the masseter muscle achieves better contraction than transplantation using a latissimus flap, we devised a new single-stage reanimation technique with dual innervation: a gracilis muscle flap innervated by the masseteric nerve received a second nerve input with a cross-facial sural nerve graft anastomised to a contralateral facial nerve branch. The preliminary results seem to be encouraging.

In conclusion, the use of the masseteric nerve in facial reanimation procedures does not achieve spontaneous smiling function. The use of the facial nerve is the only method to ensure correct stimulus production for facial mimicry, although the outcomes could vary quantitatively.

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