Smile Reconstruction Through Bilateral Muscular Transplants Neurotized by Hypoglossal Nerves

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Abstract: Free transplant of gracilis muscle is the criterion-standard technique in dynamic rehabilitation of long-standing facial paralysis in which the facial musculature is atrophied. When the facial nerve is not available because of a bilateral lesion, other sources are the masseteric, hypoglossal, or accessory nerves. Although the use of hypoglossal nerve has been relegated to the background because of the morbidity caused by its loss, there are special situations in which the hypoglossal nerve should be considered the first option as donor motor nerve. The present article discusses the case of a patient with dynamic reanimation of bilateral facial paralysis with free-muscle transfer neurotized to the hypoglossal nerve. End-to-side coaptation of gracilis motor nerve and hypoglossal motor nerve allows neurotization of the transplanted muscle with minimum repercussion in speech or swallowing and can provide an adequate spontaneous smile with time.

Key Words: Smile reconstruction, muscle transplant, hypoglossal nerve

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Free transplant of gracilis muscle is the criterion-standard technique in dynamic rehabilitation of long-standing facial paralysis in which the facial musculature is atrophied. By using a crossed facial nerve graft, axons from the contralateral healthy facial nerve reach the affected side and innervate the muscle to be transferred in a second procedure.[1–6] The facial nerve is considered the best donor source of choice because it provides coordinated and synchronized movements of both sides of the face.

When the facial nerve is not available because of a bilateral lesion, other nerve sources are the masseteric,[7,8] hypoglossal,[9–13] or accessory nerves. Among these, the ipsilateral nerve to the masseter muscle is considered the best choice because it provides a powerful and reliable innervation for a free-muscle transfer when used for smile reconstruction. Furthermore, most patients develop the ability to smile spontaneously and without jaw movement. Although the use of hypoglossal nerve has not been considered the first option as a nerve source because of the morbidity caused by its loss, there are special situations in which the hypoglossal nerve should be considered the first option as donor motor nerve.

The present article describes the case of a patient with dynamic reanimation of bilateral facial paralysis with free-muscle transfer neurotized to the hypoglossal nerve. The advantages and disadvantages of this procedure are discussed.

METHODS

A 30-year-old female patient came to our center with a 2-year history of bilateral facial paralysis secondary to brain tumor resection. Both facial nerves and the right trigeminal nerve were damaged during the surgery, whereas both hypoglossal nerves were left intact. On physical examination, the patient showed complete bilateral facial palsy with total impairment of eyebrow lift and eye closure showing lagophthalmos. Null traction of both commissures was also observed (Figs. 1A, B).

Bilateral facial reanimation with free-gracilis transfers to hypoglossal nerves in 2 different surgical operations was recommended by the senior author, with a 4-month period between them. In each operation, 2 teams operated simultaneously, one on the face and the other on the thigh. In the face, a preauricular incision was performed, and the skin flap was elevated by a supra superficial muscle aponeurotic system plane. Once the mandibular angle was reached, the surgeon proceeded to a deeper plane to isolate the facial artery and vein. Then, a 4-cm-long incision at the neck 2 cm below the mandibular angle was performed to localize the hypoglossal nerve under the tendon of the digastric muscle. A subcutaneous tunnel connecting the malar area with the neck was then dissected, and 4 stitches of Ethibond 4-0 were anchored at the level of the modiolus and nasogenian sulcus, to afterward fix the muscle with the adequate points of traction. Simultaneously, the other team dissected the gracilis as described by Manktelow et al.[7] A portion of 9 $\times$ 4 cm of the muscle was resected with its neurovascular pedicle, a branch of the medial femoral circumflex artery and vein, and the obturator nerve. The muscle was then transferred to the cheek, where it was fixed with the Ethibond stitches to the modiolus. Vascular anastomosis was carried out with nylon 9-0. The obturator nerve was tunneled to the neck area and directly coapted to the hypoglossal nerve in an end-to-side manner. Finally, the muscle was fixed to the preauricular area with Ethibond 4-0 at a 45-degree inclination to the horizontal plane to achieve adequate traction of the commissure.

No incidents occurred in the immediate postoperative period after the 2 operations, and the patient was discharged on postoperative day 4. One month postoperatively, she started intensive rehabilitation, showing traction of both commissures 4 months later. At present, she has controlled movements while she moves the

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FIGURE 1. A, shows the patient at rest, preoperatively. B, shows the patient smiling, preoperatively. C, The patient 1 year postoperatively at rest. D, The patient 1 year postoperatively, smiling.

tongue, although she is learning with time and rehabilitation to dissociate smile from moving the tongue (Figs. 1C, D; see also supplemental video at http://links.lww.com/SCS/A7).

DISCUSSION

The main aim in dynamic facial rehabilitation of long-standing facial paralysis is to achieve a coordinated movement with the contralateral side. To reach this goal, it is preferable to use the healthy facial nerve as the source of motor axons by the interposition of a crossed facial nerve graft.

In cases in which a bilateral facial paralysis is present, other donor nerves have been considered, as the masseteric[7,8] or the hypoglossal[9–13] nerves. In the authors' experience, when the facial nerve is not bilaterally available, the most useful option is the masseteric nerve, because it provides strong traction of the commissure. Indeed, in unilateral facial paralysis on male patients with a strong smile and thick skin, the ipsilateral masseteric nerve is often the first option as source of axons, even if the contralateral healthy facial nerve is available.[14]

When a motor donor nerve is required for dynamic rehabilitation of the paralyzed face, the hypoglossal nerve is mainly used in the context of short-standing facial paralysis.[8–13] In 1904, Körte[8] described the technique using an end-to-end facial-hypoglossal nerve anastomosis interposing a neural graft. Conley and Baker[9] in 1979 popularized this procedure. However, total sacrifice of the hypoglossal nerve caused functional defects, such as paralysis and hypotrophy of the ipsilateral tongue, leading to impaired swallowing and speech in around 50% of patients.[15] Thus, other authors improved the technique to cause less morbidity by performing an end-to-side facial-hypoglossal suture with a nerve graft interposed,[15–19] and later, an end-to-side anastomosis without the nerve graft.[20,21] In this context, Terzis and Tzafetta[11] and Terzis[20] developed the babysitter procedure to avoid total atrophy of the facial muscles while axons cross the nerve graft and reach the musculature in short-standing unilateral facial paralysis. An end-to-side facial-hypoglossal coaptation makes it possible to preserve almost the entire XII nerve using only 40% of its fibbers, leading to less morbidity.

However, few reports in the literature describe the use of the hypoglossal as a donor motor nerve for neurotization of a free-muscle transplant in long-standing facial paralysis.[13,21] Ueda et al[13] reported a series of 17 cases of free-muscle transplantation, usually the latissimus dorsi, using the hypoglossal nerve as a recipient motor nerve for the treatment of long-standing or irreversible paralysis. They tried to minimize the functional disturbances caused by the partial section of the hypoglossal nerve, thereby obtaining good function of the grafted muscle without functional disability of the tongue. They classified the hypoglossal nerve sectioning into total, central, and lower, recommending the use of the inferior part of the nerve as the source of axons. They found some benefits with respect to the free muscle innervated by a cross-nerve graft: first, facial reanimation is achieved in 1 stage, which is preferred for old patients, and second, this method is a good option when the facial nerve is not available. However, they did not mention the advantages with respect to the use of the masseteric nerve. Other authors also mention the possibility of using this nerve in bilateral facial paralysis.[22] Thus, in long-standing facial paralysis where the facial nerve is not available as donor nerve, surgeons often prefer other sources such as the masseteric nerve rather than hypoglossal nerve, because of the morbidity that its sacrifice provokes. Total or even partial section of the hypoglossal nerve may lead, to a greater or lesser extent, to tongue atrophy, speech problems, dysfunctions in food intake such as involuntary biting of the tongue, difficulty in pushing food from the corner of the mouth with the tongue or swallowing, and, most importantly, the presence of uncontrolled facial movements with tongue action.[15] Thus, Terzis and Noah[21] published a series of 100 free-muscle transplants for facial reanimation in which in only 1 case the hypoglossal nerve was used as the donor nerve. Manktelow et al[7] also preferred the free-muscle transfer innervated by the masseteric nerve for patients who have bilateral paralysis or those patients presenting apparent unilateral facial paralysis who have no nerves to spare on the healthy side or even to effectively innervate a cross-facial nerve graft. The treatment of choice for facial reanimation in Möbius syndrome is also a neurovascular free-muscle transfer, ideally using the gracilis muscle innervated directly by the masseteric branch of the trigeminal nerve.[22] If this nerve is not present, a partial hypoglossal nerve can be used. Moreover, although partial hypoglossal-facial anastomoses have demonstrated their efficacy in smile reanimation in short-standing facial paralysis, the masseteric nerve is being considered a better option than the hypoglossal nerve in short-standing facial paralysis when the facial nerve is not available.[23]

Nevertheless, there are special situations in which the surgeon needs to use the hypoglossal nerve, usually when neither facial nor masseteric nerves are available, as was the case in this patient. We had only the left masseteric nerve available. One main issue in bilateral facial paralysis reanimation is trying to perform the same technique in both sides of the face to achieve the best possible symmetry. This principle led us to use the gracilis muscle neurotized to both hypoglossal nerves to achieve a more symmetric movement. In our patient, a bilateral and direct end-to-side coaptation anastomosis without nerve grafts was performed, and no lingual atrophy or functional deficits were observed.

Another disadvantage described when using the hypoglossal nerve as a donor nerve is the presence of a nonspontaneous smile, because the patients need to push the tongue against their teeth to smile.[9–11] However, it has been described that cerebral plasticity can lead to a coordinated smile after free-muscle transfers innervated by the masseteric nerve, independently of jaw closure, allowing a spontaneous facial expression.[7] Developing facial movement independent of jaw motion is easier in children, requiring intensive and constant rehabilitation in older patients. The same happens with the babysitter procedure in which there is duplicity of innervation, facial through crossed nerve graft and mini–hypoglossal-facial anastomoses. It has been described that, with time, the brain learns to dissociate tongue movements from facial ones.[12] Our patient shows controlled movements while she moves her tongue, although she is still learning to definitively dissociate her smile from moving the tongue, and she is improving with time and rehabilitation.

Finally, some authors suggested the need to use the latissimus dorsi muscle flap because of its long neurovascular pedicle.[5] However, the gracilis flap offers a neurovascular pedicle long enough to reach the hypoglossal nerve, allowing a tension-free nerve suture without interposing a nerve graft.[24]

In conclusion, the hypoglossal nerve is a good option to be considered as a donor motor nerve in reanimation of bilateral facial paralysis when no other nerves sources such as facial or masseteric nerves are available. End-to-side coaptation of the gracilis and the hypoglossal motor nerves allows neurotization of the transplanted muscle with minimum repercussion in speech or swallowing and can provide an adequate spontaneous smile with time.

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