Muscle Transplants for Facial Reanimation

Rationale and Results of Insertion Technique Using the Palmaris Longus Tendon

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Abstract: Thirty-one patients with unilateral long-standing facial palsy underwent 1-stage reanimation with free gracilis muscle transplant innervated by the masseteric branch of the trigeminal nerve. They were divided into 2 nonrandomized groups according to insertion technique: group I (9 patients), interrupted suture between the free flap and the orbicularis oris of the upper and lower lip on the paralyzed side; group II (22 patients), palmaris longus tendon graft placed between the gracilis free flap and the orbicularis oris of the upper and lower lip on the nonparalyzed side. Qualitative evaluation of the smile demonstrated better results in patients from group II. Comparing the position of the Cupid's bow at rest, pre- and postoperatively in each patient, we observed significant improvement of facial symmetry in both groups. During smile, however, there was a significantly higher rate of centralization of the Cupid's bow in patients submitted to reanimation with the use of the palmaris longus tendon (group II).

Key Words: tendon graft, muscle transplant, facial palsy

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Natural and balanced recovery of the labial dynamic continues to be one of the greatest challenges in reanimation of facial paralysis.[1] Movements obtained with microsurgical muscle transplants are generally localized and unidirectional and, therefore, cannot precisely reproduce the function of the 10 muscles that produce the expressions of the mouth.

Although contraction of the transplanted muscle pulls the modiolus and consequently defines the nasolabial fold (smile), philtrum centralization and lower lip movement are not proportionally or systematically achieved.

The stability of free flap insertion at the lips also interferes with the results observed.[2] Repetitive movements seem to cause gradual disinsertion and progressive shifting of the projection of the nasolabial fold on the reanimated side in some cases.

This study presents the results obtained through facial reanimation with a modified free flap fixation technique used to distribute and balance the angles of movement of the upper and lower lips from a single muscle transplant.

PATIENTS AND METHODS

From February of 2003 to August of 2007, 31 patients with complete unilateral facial paralysis were submitted to reanimation with free muscle transplant. In all cases, the standard procedure included undermining of the paralyzed hemiface under the superficial muscular aponeurotic system and dissection of neurovascular gracilis muscle flap as suggested by Manktelow and Zuker.[3] After harvested, the muscle segment was taken to the back table and a running locked 5-0 Nylon suture was placed on the side to be sutured to the orbicularis oris. We used the facial artery and vein as recipient vessels and ipsilateral masseteric nerve as the nerve source. Then the patients were divided into 2 nonrandomized groups according to labial gracilis muscle insertion technique.

Group I (Without Tendon)

Fixation with 3-0 Mersilene U stitches (ETHICON, a Johnson & Johnson company, Somerville, NJ) between the gracilis muscle and the orbicularis oris muscle, with 1 stitch at the modiolus, 3 stitches in the upper lip, and 1 stitch in the lower lip.

Group II (With Tendon)

Fixation according to the technique described later. Palmaris longus tendon graft was obtained through small transverse incisions along the nondominant forearm. Using a Reverdin needle, the tendon was tunneled through the flap directly under the running locked suture. As in group I, 5 U stitches were used, transfixing the tendon graft and joining the flap and orbicularis oris muscle as shown in Figure 1.

Incisions of approximately 5 mm were made on the vermilion-one on the upper lip and one on the lower lip–both 6 to 7 mm off-midline on the nonparalyzed side (NPS). With the reverdin needle, the ends of the tendon were pulled through the respective incisions (Fig. 2).

On the vermilion, the tension of the tendon graft was adjusted to balance the length of the paralyzed and nonparalyzed segments of the upper and lower lips. The tendon was sutured to itself after being looped through the orbicularis oris on the NPS (Fig. 3).

In the patients of both groups, the other end of the flap was secured to the periosteum of the zygomatic arch and the parotid fascia with nonabsorbable 3-0 Mersilene U stitches (ETHICON) to produce the traction and tension necessary to define of the nasolabial fold on the paralyzed side (PS). Figure 4 shows final fixation, vascular anastomosis, and nerve coaptation.

Three patients were not submitted to insertion with palmaris longus tendon due to the absence thereof. The other 6 were submitted to facial reanimation before the introduction of this modified fixation technique.

Age, sex, duration of paralysis, and follow-up interval of the patients in each group are shown in Table 1.

All patients were photographed and filmed pre- and postoperatively. The pictures and videos recorded were analyzed by the team that performed the surgical procedures.

RESULTS

No microvascular complications were observed in this clinical study. No significant complaints were registered or complications observed with respect to muscle flap and tendon donor sites.

On follow-up, 1 week after surgery, 3 patients presented a collection of fluid in the parotid region, which they claimed grew during meals. The fluid was aspirated. On returning 1 week later, 2 patients were asymptomatic; one patient presented more fluid in

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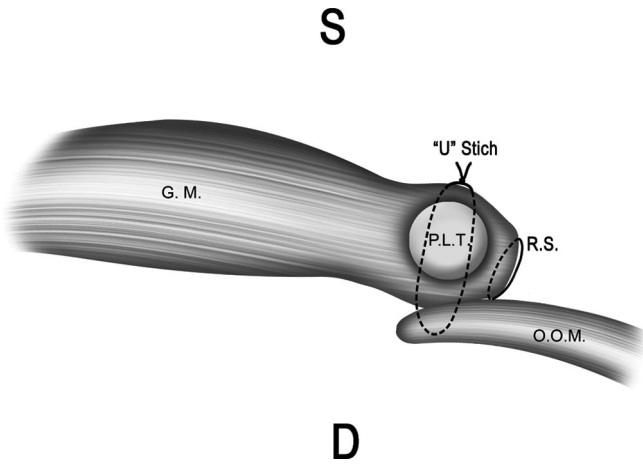

FIGURE 1. Cross-sectional view of gracilis muscle fixation on the lip. S indicates superficial plane; D, deep plane; RS, running locked suture; PLT, palmaris longus tendon; GM, gracilis muscle; OOM, orbicularis oris muscle; "U" stitch.

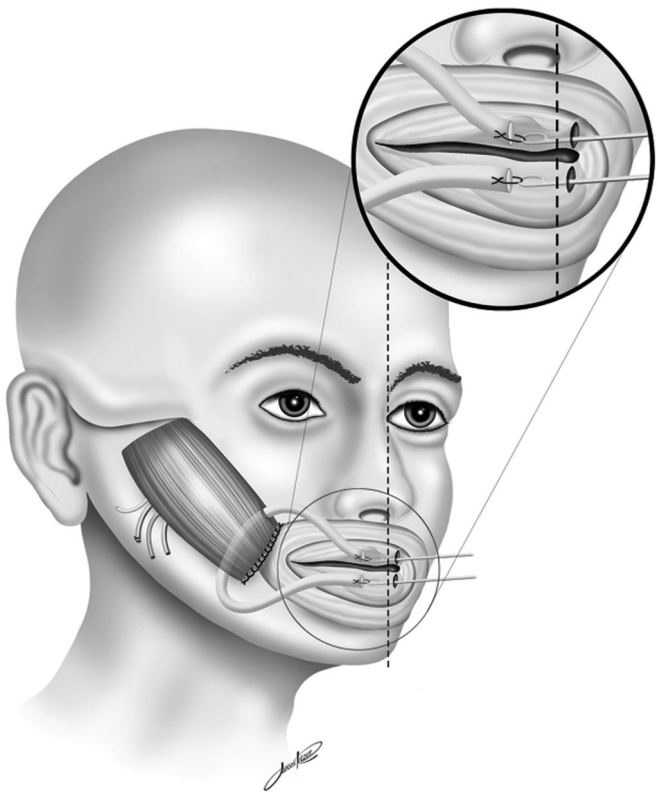

FIGURE 2. Position of the palmaris longus tendon through the gracilis flap and the lips.

the same region, which was aspirated 3 more times before surgical reintervention. During surgery, the viability of the muscle transplant and the presence of a small laceration in the parotid duct at the hilum of the gland were confirmed. The orifice was sutured and recovery was uneventful. The first contractions after muscle flap transfer were observed from 3 to 6 months (mean: 3.5 months).

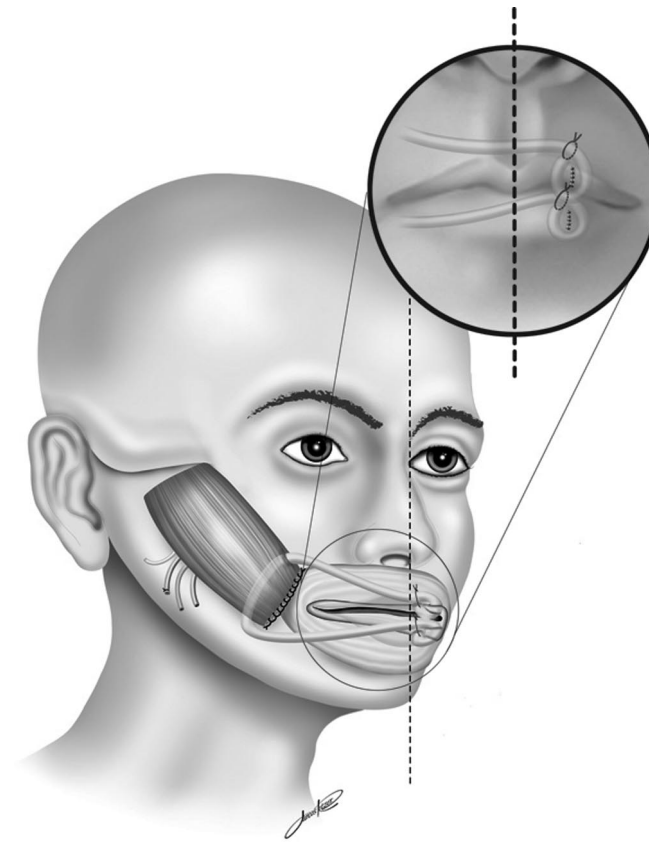

FIGURE 3. Fixation of the tendon ends on the orbicularis oris beyond the midline on the upper and lower lips.

The smile achieved was graded based on intensity and shape, without consideration of the position of the philtrum or dynamic of the lower lip:

Absence of movement

Poor: muscle contraction visible without movement of the modiolus.
Fair: movement of the modiolus present but not enough to form a smile.
Good: adequate smile shape but asymmetric with the NPS.
Excellent: symmetrical smile (shape and intensity).

In group I, 55.5% of the patients, and in group II, 91% of the patients presented good/excellent results (Table 2).

The distances of the modiolus from both the PS and NPS to the center of the Cupid's bow were measured from printed pre- and postoperative images. The measurement of the distance from the PS was divided by the sum of the measurements of the PS and NPS. The value of 50% means absolute balance and, therefore, philtrum positioned on the median plane. Values higher than 50% indicate deviation of the philtrum toward the NPS. Values lower than 50% indicate deviation of the philtrum toward the PS.

Measurements taken in a single patient were evaluated using the repeated measure analysis of variance model to compare behavior of the groups over time. Values of $P < 0.05$ were considered statistically significant.

Comparison of the preoperative measurements showed that there was no statistically significant difference between the 2 groups at rest and during voluntary smile.

There was a statistically significant difference ($P < 0.05$) at rest between the pre- and postoperative values in both groups.

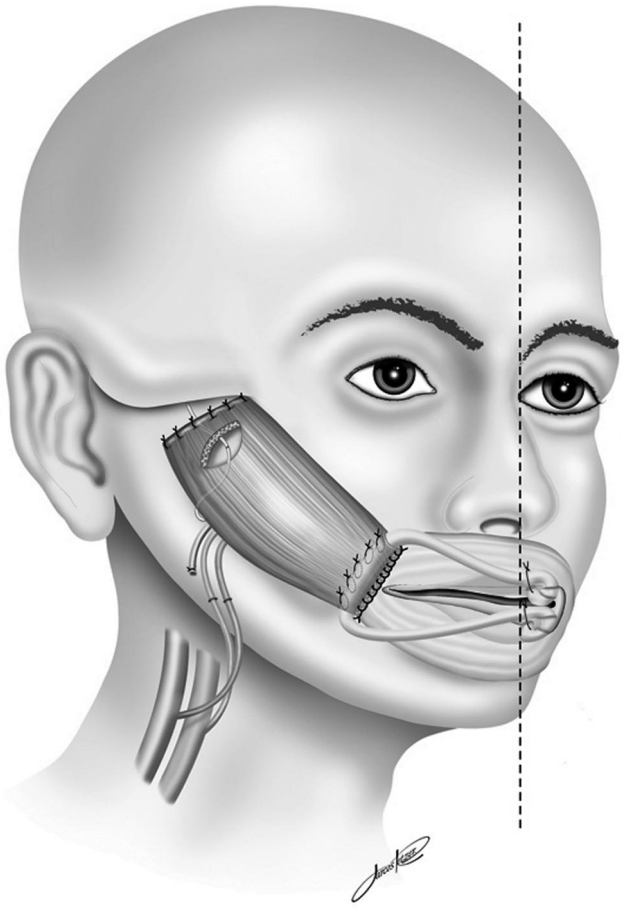

FIGURE 4. Final muscle insertion, vascular anastomosis, and nerve coaptation.

TABLE 1. Patient Demographics

	Group I (Without Tendon)	Group II (With Tendon)
No. cases	9	22
Age	7–58 yr (mean: 33.4 yr)	7–52 yr (mean: 31.1 yr)
Sex	5 M:4 F	6 M:16 F
Duration of paralysis	2–16 yr (mean: 6.9 yr)	2–21 yr (mean: 7.4 yr)
Follow-up (postoperative)	1–3 yr (mean: 22 mo)	1–4 yr (mean: 31 mo)

TABLE 2. Intensity and Shape of the Voluntary or Involuntary Smile After Facial Reanimation

	n	Absent	Poor	Fair	Good	Excellent
Group I	9	0	0	4	3	2
Group II	22	0	0	2	5	15

Comparison of the postoperative measurements at rest between the 2 groups, however, showed no differences (Table 3).

During voluntary smile produced by clenching of the teeth, there was a significant difference between the pre- and postoperative measurements only in group II ($P = 0.001$). In group I, no statistically significant difference was observed between the dynamic pre- and postoperative measurements ($P = 0.564$). On comparison of the dynamic measurements of the 2 groups we found significantly lower values in group II ($P = 0.001$), thus achieving a more balanced smile with the use of the palmaris longus tendon (Table 4).

TABLE 3. Relative Distance Between the Modiolus and the Center of the Cupid's Bow on the Paralyzed Side at Rest

	Preoperative (%)	Postoperative (%)	
Group I (n = 9)			
Mean	59.7	56.5	($P < 0.01$)
Range	50–67	50–61	
Group II (n = 22)			
Mean	56.3	52.6	($P < 0.01$)
Range	50–64	48–58	
	($P = 0.09$)	($P = 0.10$)	

TABLE 4. Relative Distance Between the Modiolus and the Center of the Cupid's Bow on the Paralyzed Side During Smile

	Preoperative (%)	Postoperative (%)	
Group I (n = 9)			
Mean	61.2	63.0	($P = 0.56$)
Range	56–66	54–72	
Group II (n = 22)			
Mean	58.6	50.0	($P < 0.01$)
Range	52–66	47–54	
	($P = 0.056$)	($P < 0.01$)	

FIGURE 5. Pre- and 22-month postoperative view of smile in patient from group I (without tendon). Grade of the smile: good.

Figures 5 to 7, show pre- and postoperative images of patients from group I. Despite the good appearance of the smile there is still a slight deviation of the Cupid's bow toward the NPS in the patient in Figure 5. The upper lip of the patient in Figure 6 is well positioned while the lower lip remains fully deviated. Figure 7 shows a wide distance between the nasolabial fold and the modiolus, an example of deteriorating result.

Figures 8 to 10 show pre- and postoperative images of patients from group II. In Figure 10, a slight deviation of the Cupid's bow toward the reconstructed (paralyzed) side is observed. None of the patients studied reported any functional limitation or dissatisfaction with the aspect of the scars at the palmaris longus tendon donor site.

FIGURE 6. Pre- and 24-month postoperative view of smile in patient from group I. Grade of the smile: good. Upper lip is well positioned while the lower lip is still fully deviated.

FIGURE 7. Pre- and 18-month postoperative view of smile in patient from group I. Classification of the smile: fair. Partial medial disinsertion.

FIGURE 8. Pre- and 17-month postoperative view of smile in patient from group II (with tendon). Grade of the smile: excellent.

FIGURE 9. Pre- and 22-month postoperative view of smile in patient from group II. Grade of the smile: excellent.

FIGURE 10. Pre- and 18-month postoperative view of smile in patient from group II. Grade of the smile: excellent. Transmission of traction forces was so effective that the philtrum is slightly deviated toward the PS.

DISCUSSION

Muscle transplants are currently the most efficient method for reconstructing the smile in patients with long-standing facial paralysis. As we showed in a previous study, 1-stage facial reanimation using the gracilis muscle innervated by the masseteric nerve produces more predictable results when compared with 2-stage reanimation (crossface followed by gracilis transplant) and to 1-stage reanimation using the latissimus dorsi flap.[4] However, definition of the nasolabial fold and adequate movement of the modiolus restored with the transplants may not be enough to achieve complete labial symmetry. Position of the lips in relation to the median plane and movement of the bottom lip are additional important elements of this dynamic.

The flaccidity of the orbicularis oris of the PS does not allow the tonus or traction on the modiolus to be fully transferred to the philtrum. Thus, static and/or dynamic deviation of the philtrum may persist after the procedure for reanimation of the perioral region. This study shows that the distance between the modiolus and the philtrum tends to increase on the PS when compared with the same distance on the NPS during the smile.

A similar phenomenon is observed in the lower lip. Because the muscle flap is positioned obliquely on the paralyzed hemiface, its medial extremity is further away from the midline of the lower lip than the upper lip, and, therefore, it is generally easier to center the upper lip than the lower lip.

Inserting the flap closer to the midline can increase the efficiency of the muscle transplant in the correction of labial deviation. The more medial insertion, however, may affect the definition of the nasolabial fold and the contour of the lips and risk the integrity of the nerve graft (crossface) in the cases of 2-stage facial reanimation.

The palmaris longus tendon is inelastic and once placed in the lips allows the philtrum to be positioned on the midline at rest. During the smile, limited stretching of the paralyzed orbicularis oris

allows the forces from muscle contraction to be transferred to the philtrum. The technique for inserting gracilis muscle flap in the buccal region, using the palmaris longus tendon, combines the principles of static suspension and dynamic reanimation.

Theoretically, dynamic reanimation procedures for the lower lip have been proposed.[5] However, in practice, they seem to produce more containment or limitation of movement than effective movement of the operated side.[6]

Because the lower lip has relatively no anatomic references, its center cannot be as easily determined in the images as that of the upper lip, therefore, the distances of the lower lip were not measured. Nonetheless, comparison of the still images demonstrated similar qualitative centralization of both the lower and upper lip in patients submitted to facial reanimation with palmaris longus tendon technique.

Although we used the palmaris longus tendon, other tendons or structures with similar mechanical properties may be used, such as, for example, the fascia lata, advocated in static suspension by some authors.[7] Our preference for the palmaris longus tendon is based on the simplicity of harvesting and low donor-site morbidity.

Insertion of the gracilis muscle with palmaris longus tendon is an improvement on the facial reanimation technique, capable of correcting static and dynamic labial deviations from the midline, and reducing rates of inadequate fixation and partial or total disinsertion of the muscle flap in the buccal region.

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