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Deep-planes lift associated with free flap surgery for facial reanimation☆

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ABSTRACT

Between April 1999 and April 2008, 37 patients with long-standing facial paralysis underwent a one-stage facial reanimation with neuromuscular free flaps: 28 patients (group A) underwent flap transposition only; 9 patients (group B) underwent a deep-planes lift (DPL) composed of the superficial muscoloaponeurotic system + parotid fascia at the time of facial reanimation. The postoperative and final results were compared between groups A and B, following the classification of Terzis and Noah (1997). Before the onset of contraction, only group B patients (100%) showed good or moderate symmetry at rest, while none of the patients of group A had a symmetric face.

The respective final results for patients in groups A and B who already showed the onset of flap contraction were excellent in 28.6% and 44.5%, good in 42.9% and 33.3%, moderate in 10.7% and 22.2%, and fair or poor and fair in 17.8% and 0% of patients, respectively. The DPL allows immediate symmetry of the face at rest and contributes to upgrading the final static and dynamic results in facial reanimation with free muscular flaps.

1. Introduction

Surgical treatment of established paralysis of the middle third of the face may be performed using static or dynamic techniques. Static methods include soft tissue suspensions, usually performed to correct cheek ptosis and facial asymmetry (Liu and Sherris, 2008), while dynamic processes, or *facial reanimations*, are used to restore facial movement with the transposition of new musculature (Harii et al., 1976).

Static techniques may be performed at any time from the onset of paralysis, but do not lead to facial movement recovery. During time soft tissue ptosis generally worsens, impairing surgical results. So those techniques are currently mainly utilized for older patients or as ancillary procedures. Facial reanimation with free flaps has the aim to partially restore facial movement, especially lid closure and smiling. These are performed after 18–24 months, when muscle atrophy is considered irreversible and when no signs of mimetic musculature fibrillation are present on an electromyogram (EMG). The transplantation of free flaps is now the mainstay of facial reanimation, as this leads to the best morpho-functional results. There are two main options described in literature to apply those flaps. The classical one is a two-stage procedure: during the first operation a cross-face nerve graft with sural nerve is performed. Eight to 12 months later a muscle free flap is set into the paralyzed hemiface and anastomized to the nerve transfer (Vedung et al., 1984). The second option is a one-stage transfer with immediate anastomosis of the muscle nerve to the contralateral facial nerve branch (Harii et al., 1998) or to the homolateral masseter motor nerve (Zuker et al., 2000). In the last case recovery of contraction is quicker (3–4 months instead of 7–9 needed for Harii's procedure) and "quantity" of smiling seems to be more guaranteed. Controversies remain around spontaneity of smiling using this trigeminal motor source (Manktelow et al., 2006; Faria et al., 2007). For this reason, surgeons who consider it important to obtain an emotional contraction prefer the use of the contralateral facial nerve as the motor source (Biglioli et al., 2009).

In 1998, Harii et al. (1998) proposed a single-stage reanimation technique to transplant the latissimus dorsi flap into a paralyzed hemiface and to anastamose the thoracodorsal nerve to one or more branches of the musculus zygomaticus major branch of the contralateral facial nerve. This technique allows the recovery of facial movement 7–9 months after surgery (Biglioli et al., 2009). The final results are analyzed by observing both the facial symmetry at rest and the flap contraction while smiling (Terzis and Noah, 1997).

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Ancillary procedures such as cranial repositioning of the flap or static soft tissue suspension are often required to correct residual facial ptosis after free flap reanimations (O'Brien et al., 1990; Terzis and Noah, 1997; Takushima et al., 2005). From this experience, it was hypothesized that static suspension of the midface may be performed at the same time as facial reanimation, to obtain immediate postoperative symmetry at rest and the best final result.

We performed a deep-planes lift (DPL) composed of the superficial muscoloaponeurotic system + parotid fascia (Gosain et al., 1993) in association with facial reanimation with a free latissimus dorsi flap in a group of patients with established unilateral facial paralysis. The results were compared to those of a group of patients who underwent flap transposition only.

2. Materials and methods

Between April 1999 and April 2008, 44 patients with long-standing (24 months to 57 years, mean 47.7 years) unilateral facial paralysis underwent a one-stage facial reanimation with neuromuscular latissimus dorsi free flaps (Harii et al., 1998). Among those the first 29 formed a group of patients who received only free flap transposition. Since February 2005, all patients have been operated on with a simultaneous DPL and free flap transposition. A second group of 16 patients receiving both procedures contemporaneously was added into the study. DPL consisted of harvesting a flap compound by a superficial muscoloaponeurotic system antero-inferiorly and parotid fascia flap postero-superiorly (Fig. 2). The flap is lifted superiorly, and fixed to the periosteum of the zygomatic arch with 3/0 prolene stitches, with sufficient tension to obtain symmetry of the midface with a slight overcorrection (Figs. 1 and 2). Incisions define a flap 4–5 cm wide and are designed in a curvilinear form, following the main axis of smiling. Inferior extension of the incisions stops (generally 2–3 cm from lip structures) when pulling of the flap allows a significant superior lift of cheek tissues and definition of the nasolabial fold. A small area above the posterior part of parotid gland is left without fascia.

Only the 37 patients who had a postoperative follow-up of 24 months were included in this study, because their results were considered stable. The 37 (20 males, 17 females) patients included in the study were divided into two groups: group A consisted of 28 patients who underwent the flap transposition only and group B consisted of 9 patients who underwent a DPL at the same time as the facial reanimation. Age of the patients ranged from 6 to 71 years, mean 51.3 years. The cause of paralysis was sequelae of surgery for eighth and seventh nerve neurinoma in 27 cases (72.9%), congenital paralysis in four cases (10.8%), cranial base trauma in three cases (8.1%), sequelae of meningitis in one case (2.7%), sequelae of Bell's Palsy in two cases (5.5%).

Three weeks after the surgery, when most of the postoperative oedema had regressed, all 37 patients underwent a clinical examination of the facial symmetry at rest (Table 1), following the classification of Terzis and Noah (1997).

Postoperative examinations were performed every 3 months. After the onset of flap contraction, the facial symmetry at rest and during activation of the mimetic musculature was evaluated (Terzis and Noah, 1997), paying attention to the contribution of the DPL to the final static and dynamic results. The results were based on photographic evaluation and rated on a scale from I to V, with I considered "poor" and V "excellent" (Table 1).

Six patients in group A underwent a secondary revision of the flap tension: in these cases, follow-up started after the second procedure (Figs. 3 and 4).

After the onset of contraction all patients received bio-feedback physiotherapy, watching in front of a mirror the effect of activation of the flap and learning the quantity of stimulus that would allow

Fig. 1. The deep-planes flap elevated before its lift upward and backward.

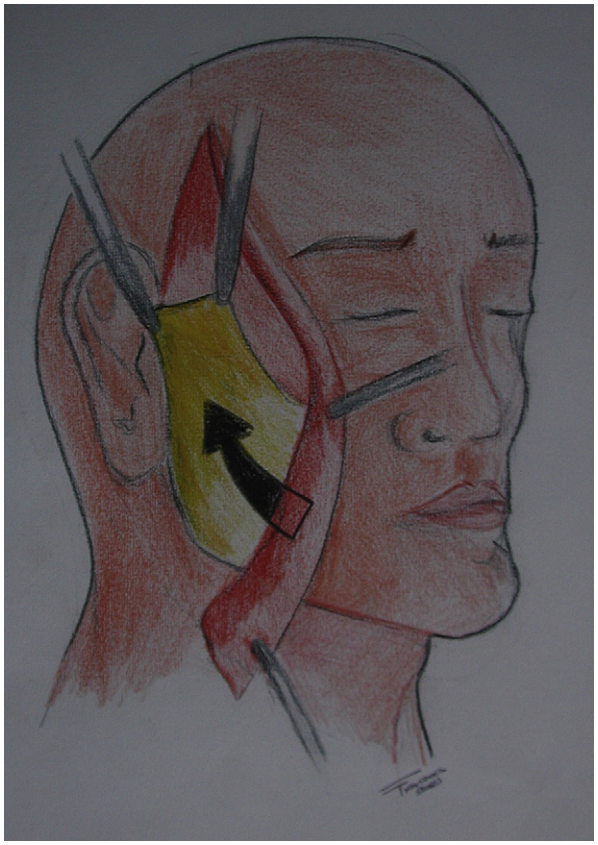


Fig. 2. Drawing of the DPL: a SMAS and parotid fascia flap with inferior pedicle is lifted cranially in order to contrast soft tissues ptosis.

Table 1
Results classification (Terzis and Noah, 1997).

5	Excellent	Symmetrical smile with teeth showing, full contraction
4	Good	Symmetry, nearly full contraction
3	Moderate	Moderate symmetry, moderate contraction
2	Fair	No symmetry, minimal contraction
1	Poor	Deformity, no contraction

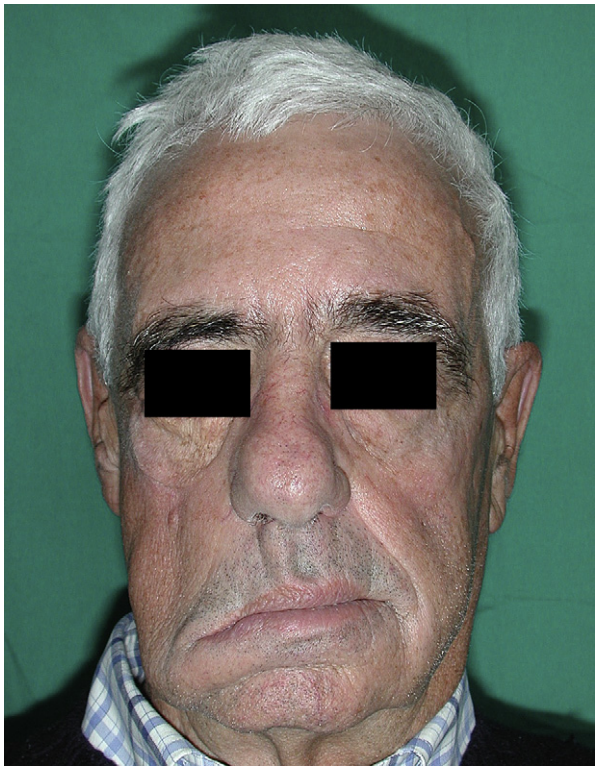


Fig. 3. Case 1: preoperative view of a patient with complete right facial paralysis and evident ptosis of soft tissues.

the most pleasant and symmetric smile. As the patient became confident with his new smile, exercises with the mirror were progressively stopped. No physiotherapy was given to obtain a spontaneous smile (Fig. 5).

3. Results

None of the 28 patients of group A showed a symmetric midface at the postoperative evaluation performed 3 weeks after surgery (100% grade 1 following Terzis and Noah).

In contrast, all nine patients in group B showed partial recovery of symmetry at rest, owing to the restoration of the nasolabial fold and the correction of soft tissues ptosis and labial philtrum deviation. The quality of the static result was good (grade 4) in seven (77.8%) and moderate (grade 3) in two (22.2%) patients. No dynamic result was yet present. The four patients in group B who had the worst preoperative lagophthalmos showed an improvement in their symptoms related to corneal exposure and a reduced use of lubricant eye drops and sunglasses.

The median recovery time of the flap contraction was 8.9 months (50 days to 22 months).

The evaluation of the dynamic results, performed after 24 months, showed that eight patients (28.6%) in group A had an excellent result, i.e., good symmetry of the middle third of the face

Fig. 4. Case 1: preoperative view of the patient while activating facial musculature. It is evident the disfigurement of facial mime.

Fig. 5. Case 1: 1 month postoperatively: the patient appears almost symmetric at rest. The right eyebrow is slightly overcorrected to prevent subsequent ptosis.

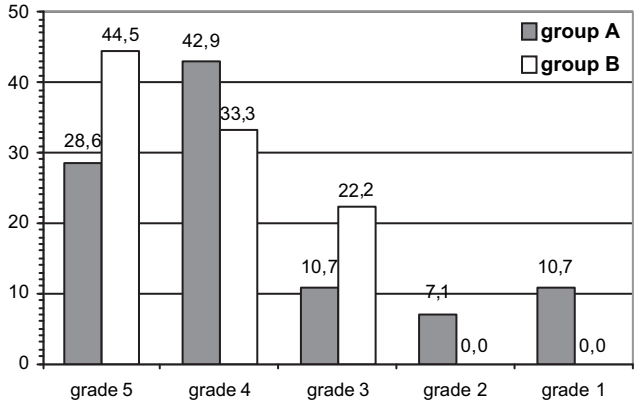
Fig. 6. Case 1: the patient 2 years after surgery, with good symmetry at rest.

Fig. 7. Case 1: the patient 2 years after surgery: the symmetry of the face is maintained during smiling.

Table 2
Immediate static and final static-dynamic results, according to Terzis and Noah grading scale, with grade 1 considered poor and grade 5 considered excellent result (Terzis and Noah, 1997).

Grade	Three weeks after surgery		Twenty-four months after surgery	
	Only static result		Static–dynamic result	
	Group A	Group B	Group A	Group B
	28 pt (%)	9 pt (%)	28 pt (%)	9 pt (%)
5	/	/	8 (28.6%)	4 (44.5%)
4	/	7 (77.8%)	12 (42.9%)	3 (33.3%)
3	/	2 (22.2%)	3 (10.7%)	2 (22.2%)
2	/	/	2 (7.1%)	/
1	28 (100%)	/	3 (10.7%)	/

Table 3
Final results according to Terzis and Noah grading scale, with grade 1 considered poor and grade 5 considered excellent result (Terzis and Noah, 1997). Results are expressed in percentage (%).



at rest and full flap contraction while smiling, with teeth showing bilaterally (grade 5) (Figs. 6 and 7). In 12 patients (42.9%), the final result was good (grade 4), with good symmetry at rest and a symmetric, nearly full flap contraction. Three patients (10.7%) had a moderate result (grade 3), with slight asymmetry at rest and moderate flap contraction while smiling; two cases (7.1%) had a fair final result (grade 2), and facial reanimation failed (grade 1) in three cases (10.7%). In group B, the results were excellent (grade 5) in four (44.5%), good (grade 4) in three (33.3%), and moderate (grade 3) in two (22.2%) patients. The final results are summarized in Tables 2 and 3.

No age-related differences were observed between the two groups. There was no correlation between time of the paralysis onset and time of recovery.

Six patients in group A (21.4%) underwent a flap tension revision: in three cases, the muscle tension was reduced by disconnecting and releasing the superior two-thirds of the flap from the superficial and deep planes and repositioning the flap more inferiorly; however, this was effective in only one patient, who improved from grade 3 preoperatively to grade 5 postoperatively, as evaluated according to Terzis and Noah (1997). The other two patients had renewed pseudospasm within a few months, which we treated with local injections of botulinum toxin, which resolves the pseudospasm temporarily and is administered every 4 months. Another three patients needed superior repositioning of the muscle. The score remained at 3 in one patient, while it improved from 3 to 4 and from 3 to 5 in the other two. The mean improvement of the six patients who underwent secondary surgery was 0.83. The results are shown in Table 4.

Table 4
Revision of muscular tension (grading following Terzis and Noah classification).

Scale of pre-operation (No. of patients)	Scale of postoperation	No. of patients	
		Unchanged	Improved
Grade 3 (6)	Grade 3	3	
	Grade 4		1
	Grade 5		2

Fig. 8. Case 2: preoperative image of a 44-year-old patient with complete long-standing facial palsy. Note filter contralateral deviation and ptosis of the homolateral modiolus.

None of the 15 patients in group B underwent secondary surgery for flap tension correction.

In two cases sialoceles occurred and healed spontaneously in 15 days.

4. Discussion

Static soft tissue suspensions are traditionally used to improve aging faces (Senechal et al., 1982; Calderón et al., 2004, 2008). Use of a deep-plane facial lift in association with other static suspension techniques may achieve symmetry of the midface (Rubin and Simpson, 1996; Sasaki and Cohen, 2002; Sasaki et al., 2003). The SMAS flap is also known as a technique used in primary post-parotidectomy reconstruction for benign parotid tumours (Giannone et al., 2008), although a total conservative parotidectomy should be considered carefully in case of superficial adenomas because of the increased risk of facial nerve injury despite the same recurrence risk as superficial approaches (Zernial et al., 2007).

Facial reanimation with neuromuscular free flaps is actually the gold standard treatment of chronic facial palsy (Biglioli et al., 2009) (Fig. 8). Single-stage facial reanimation has been proposed to

Fig. 9. Case 2: gross distortion of the face while activating mimetic musculature preoperatively.

Fig. 10. Case 2: substantial symmetrization of the face 2 months after surgery. Static result is achieved mainly by DPL as flap function began 6 months postoperatively.

Fig. 11. Case 2: maintenance of static result achieved soon after surgery at 2 years postoperatively.

Fig. 12. Case 2: good contraction of the flap with little asymmetry of smiling graded 4 according to Terzis and Noah.

reduce the time required for treatment and recovery (Wang et al., 1989). The single-stage procedure involves one nerve anastomosis instead of two, as required by the two-stage technique with nerve cross-face grafting (Kumar, 1995; Kumar and Hassan, 2002). This would allow the passage of a higher number of fibres, though results are not better than those of most two-stage techniques (Harii, 1987; Kumar and Hassan, 2002).

Takushima et al. (2005) considered static suspensions as ancillary procedures after facial reanimation with free neuromuscular flaps, when a correct flap tension was not obtained and residual cheek ptosis was observed.

Analysis of our results showed that patients who underwent a DPL at the time of facial reanimation with free flaps had better immediate and final results than patients who underwent the flap transposition only (Tables 2 and 3). In patients with poor free flap postoperative contraction, the DPL allowed an improvement of the final static result (Figs. 9 and 10).

The DPL allows the surgeon to obtain intraoperative symmetry of the midface leading to an immediate postoperative result much superior to that of a flap transposition without static suspension (Harii et al., 1976; Harrison, 1985; Frey, 1999; Takushima et al., 2005). This has a positive psychological impact on patients waiting for the onset of flap contraction; for the same reason, some authors suggest performing temporary suspensions, even in acute palsies, before normal facial movement recovers (Ozaki et al., 2008). For those who fail to reach adequate contraction of the flap, at least symmetry of the face at rest is obtained. This is the case of three patients of group A graded 1. Cause of failures could have been thrombosis of pedicle vessels leading to a switch of transposed tissues from flap to graft, without significant contractile potential. Otherwise too little ingrowth of axons into the flap may be the cause of failure. If a DPL had been accomplished simultaneously to the free flap transposition, static symmetry would have been improved.

The group A patients who had the most severe preoperative asymmetry were treated with an overcorrection of the flap tension: this led to a painful contraction of the flap in five cases (21.3%), requiring a reduction in flap tension with superior repositioning of the flap in three cases and botulinum toxin injection in the other two cases. This complication was avoided in the group B patients, because the deep-planes lift resulted in immediate symmetry of the face and led to a more accurate tension of the muscular flap.

The improvement of symptoms related to corneal exposure in the group B patients who had the worst preoperative lagophthalmos may be due to reduced downwards traction on the lower lid by the lifted midface tissues. This constitutes a further advantage of the DPL. The DPL does not substitute for dynamic lagophthalmos surgical corrections, such as temporal fascia and muscle flap rotation (Brusati et al., 1998), but can improve the results of lid surgery. In borderline or asymptomatic cases, for which an eventual surgical correction of the lid incompetence is debatable, this decision may be postponed until after midface surgery.

Comparing the results of groups A and B (Tables 3 and 4), 44.5% of the patients in group B obtained an excellent final result versus 28.6% in group A. Moreover, no group B patients had poor results (grades 1 and 2). These data suggest that the improved final results in group B patients were attributable to the contribution of the DPL in combination with facial reanimation with free flaps (Figs. 11 and 12).

5. Conclusion

A deep-planes lift combined with facial reanimation with free flaps is a useful technique for the surgical correction of long-term facial paralysis. It facilitates the correct setting of the flap tension in the paralyzed hemiface, and gives an immediate postoperative

result, which is important for patient satisfaction, thereby improving patient compliance. The technique also improves the final static and dynamic results of facial reanimation.

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Conflict of interest

The authors had full freedom of investigation and there were no potential conflicts of interest. There was no grant support for this study.

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