Long-Term Outcomes of Free-Muscle Transfer for Smile Restoration in Adults

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Background: The cross-facial nerve grafting/free-muscle transfer strategy for smile restoration is superior to static reconstruction or regional muscle transposition. The purpose of this study was to evaluate the long-term outcomes of this technique in adult patients.

Methods: Eighty-one adult patients received a free-muscle transfer for midface reanimation in the authors' center. Of this group, the authors identified 24 cases with follow-up of 5 years or longer. Smile symmetry and function were evaluated at three points: preoperatively, early postoperatively, and at long-term follow-up. To better evaluate the effect of time, patients were divided into groups according to the length of follow-up: group A, 5 to 6 years; group B, 7 to 10 years; group C, 11 to 15 years; and group D, more than 15 years. Four independent observers rated each patient's smile using a five-category scale ranging from poor to excellent. Panelists were asked to comment on whether the patient's smile weakened over time.

Results: All patients obtained higher scores at 2 years from free-muscle transfer in comparison with their preoperative rates ($p < 0.0001$). Late outcomes demonstrated that muscle regeneration continues beyond the initial 2 years, with a further increase of the scores and motor units on electromyography at the late follow-up ($p < 0.0001$, $p = 0.0313$). No significance was found when comparing both variables among the four groups, indicating that time does not have a differential effect on muscle function. In 80 percent of the evaluations, the four observers agreed on maintained smile symmetry over time.

Conclusions: Cross-facial nerve grafting/free-muscle transfer is an effective technique for smile restoration in late facial paralysis. These data indicate maintenance of effective muscle function and progressive improvement with time. (*Plast. Reconstr. Surg.* 123: 877, 2009.)

Dynamic reanimation of the paretic midface aims at a symmetric and coordinated smile. Midface reanimation also increases cheek tone, which assists the lower eyelid against gravity and facilitates speech and food mobilization. A two-stage reconstructive strategy combining cross-facial nerve grafting and free-muscle transfer yields optimal outcomes, allowing for a spontaneous and coordinated smile. Nevertheless, as with any other corrective method, results are partial and based on mastering the technique before reproducible results can be warranted.

In the early 1970s, Tamai et al., in the dog model, demonstrated that muscle can be transplanted as a free-tissue flap.[1] One year later, cross-facial nerve grafting was introduced independently by Smith[2] and Scaramella and Tobias.[3] In 1976, Harii et al. reported the first free-muscle transfer for midface reanimation; they used the entire gracilis muscle innervated by the trigeminal nerve.[4] In 1978, Terzis et al. quantitated for the first time the working power of a free-muscle transplant in the rabbit model.[5] The same year, Gordon

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and Buncke,[6] working with monkeys, demonstrated that a free muscle can be reinnervated from a distant motor donor by means of a long interpositional nerve graft. Soon, O'Brien and colleagues[7] used this idea for a two-stage reanimation strategy by means of cross-facial nerve grafting and free-muscle transfer at a later stage. In the early 1980s, several centers reported their experience with this technique.[8–10] In the 1990s, one-stage reconstruction was introduced using a free-muscle transfer with a long supplying nerve to reach the contralateral facial nerve.[11–15] Recently, certain groups have used the ipsilateral masseteric nerve as an alternative motor donor in selective cases.[16,17]

However, cross-facial nerve grafting to the contralateral facial nerve has the great advantage of a coordinated and physiologic smile. In contrast, it involves lengthy interposition grafts and two coaptations, with increased loss of regenerating axons. In cases of bilateral paralysis, selection of an adequate motor donor demands preoperative testing of the fifth, eleventh, twelfth, or C7 root before its use. When a functional ipsilateral facial nerve is available, the free-muscle nerve can be coapted to the ipsilateral seventh nerve stump. The closer to the stylomastoid foramen the stump lies, the greater the risk of unwanted movements and free-muscle contracture.[18–20] Ueda et al. recommended preoperative electromyography and staining for acetylcholinesterase to confirm the reliability of the proximal stump as a motor source.[19]

The early results of the cross-facial nerve grafting/free-muscle strategy in our center were reviewed by the senior author (J.K.T.) in 1997.[21] This 100-case series showed an 80 percent success rate and compared favorably with other series on early outcomes. However, the literature is silent on the fate of the free-muscle transfer over time. Only by comparison of early and late outcomes of one technique, and comparison of outcomes by different methods, will we be in a position to judge facial reanimation strategies and the expected longevity of any given technique.[18,22] In the current study, the authors tested the hypothesis that the function of a free-muscle transfer to the midface is maintained after lengthy periods of follow-up.

PATIENTS AND METHODS

A retrospective search of all patients who underwent free-muscle transfer for smile restoration in our center since 1979 revealed 153 patients, of whom 81 were adults. Inclusion criteria demanded a rigorous follow-up of 5 years or longer. Twenty-four patients satisfied this criterion and their medical charts, electromyography records, and videotapes were reviewed. Patients' ages ranged from 17 to 53 years (mean ± SD, 30.71 ± 10.5) and comprised 18 female patients and six male patients. Fifteen patients had partial paralysis and nine patients presented with complete palsy. Denervation time ranged from 11 to 456 months (mean ± SD, 180 ± 146 months). Table 1 lists the different demographic variables and surgical interventions. Nine patients (38 percent) had previous surgery elsewhere, and these techniques are also listed in Table 1.

Surgical Procedures

All of the interventions were undertaken by the senior author (J.K.T.), using the same technique of cross-facial nerve grafting and free-muscle transfer described previously.[21] Informed consent was obtained in all cases. All patients except one were managed with the standard two-stage cross-facial nerve grafting/free-muscle transfer strategy for smile restoration, followed by a third stage of revisions. In the remaining case, the supplying nerve of a segmental free rectus abdominis was coapted to the ipsilateral seventh cranial nerve stump. During the first stage, 15 patients had cross-facial nerve grafting, six patients had the "babysitter" procedure (cross-facial nerve grafting and partial hypoglossal to facial nerve transfer[23,24]), and one patient with bilateral acoustic schwannoma had interpositional grafts to the ipsilateral accessory and hypoglossal nerves. One patient had already undergone cross-facial nerve grafting before consulting our center; thus, we proceeded directly to free-muscle transfer.

The time interval between the first and second stages ranged from 6 to 24 months (mean ± SD, 12.1 ± 3.66 months). One free-muscle flap was lost secondary to venous thrombosis, and another failed to function after 18 months. These two patients received a second muscle transfer; thus, the number of free-muscle flaps in the current series totaled 26. The gracilis muscle was used in 20 patients, the pectoralis minor was used in five patients, and the rectus abdominis was used in one case. In 22 patients, the donor vessels were anastomosed to the facial artery and vein, the temporal vessels were used in three cases, and the facial artery and internal jugular vein were used in one case. Ischemia time averaged 104 ± 42.6 minutes, with a range between 50 and 170 minutes. A single cross-facial nerve graft was used to neurotize the free-muscle transfer in 17 cases, and two cross-facial nerve grafts were used in two patients. The ipsilateral facial nerve was used in one case and

Table 1. Demographic and Intraoperative Variables of the Population Studied

Patient	Sex	Age (yr)	Cause	Side	Grade	DT (mo)	Previous Surgery	Stage 1	Stage 2
1	F	17	Iatrogenic	L	Partial	108	Stapedectomy and VIIth cranial nerve repair	CFNG ×3	Pectoralis minor
2	F	22	Developmental	R	Complete	168	No	CFNG × 4	Gracilis
3	F	22	Traumatic	L	Complete	48	CFNG × 2	CFNG × 3, XII-VII	Gracilis
4	F	40	Acoustic schwannoma	R	Partial	324	No	CFNG × 3, XII-VII	Gracilis
5	M	19	Developmental	R	Complete	228	Fascia lata sling	CFNG × 4	Gracilis
6	F	37	Parotid VIIth cranial nerve neuroma	L	Partial	168	Resection VIIth cranial nerve neuroma	CFNG × 2	Gracilis
7	M	47	Bell's palsy	R	Complete	36	CFNG × 3	Pectoralis minor	Revisions
8	F	37	Ramsay Hunt	R	Complete	96	Fascia lata sling	CFNG × 4, XII-VII	Gracilis
9	F	25	Acoustic schwannoma	Bil	Complete	25	Resection schwannoma	IPNGs to XI to XII	Gracilis
10	F	32	Traumatic	L	Complete	216	Temporalis transfer	CFNG × 3	Pectoralis minor
11	F	38	Parotid angioendothelioma	L	Partial	456	Fascia lata sling	CFNG × 4	Gracilis
12	M	33	Traumatic	L	Complete	11	No	CFNG × 3, XII-VII	Gracilis
13	M	23	Möbius	L	Complete	276	Craniofacial reconstruction	CFNG × 4	Gracilis
14	F	33	Traumatic	R	Partial	22	Craniofacial reconstruction	CFNG × 3	Gracilis
15	F	21	Developmental	R	Partial	264	No	CFNG × 3	Pectoralis minor
16	M	18	Traumatic	R	Partial	22	No	CFNG × 3	Gracilis
17	F	45	Glomus jugulare	R	Partial	96	Resection, 3 recurrences	CFNG × 2	Pectoralis minor
18	F	41	Idiopathic/polio	L	Partial	456	No	CFNG × 3, XII-VII	Gracilis
19	F	40	Traumatic	L	Partial	408	Craniofacial reconstruction	CFNG × 3	Gracilis
20	F	21	Traumatic	R	Partial	25	Craniofacial reconstruction	CFNG × 3	Gracilis
21	F	31	Tumor	R	Partial	348	Resection	Rectus abdominis	Revisions
22	F	17	Measles	L	Partial	216	Masseter transposition, fascia sling	CFNG × 3, XII-VII	Gracilis
23	M	25	Developmental	R	Partial	288	Masseter transposition	CFNG × 3	Gracilis
24	F	53	Parotid cyst	L	Partial	30	Resection parotid cyst	CFNG × 3	Gracilis

DT, denervation time; F, female; M, male; L, left; R, right; CFNG, cross-facial nerve graft; IPNGs, interpositional nerve grafts; Bil, bilateral; XII-VII, partial hypoglossal to facial nerve transfer.

banked interpositional graft to the accessory nerve was used in another. Thorough analysis of the contralateral side for best results cannot be overemphasized. The unrestrained motion on the normal side will display an excessive pull but is the best indicator for the precise direction of movement required. A higher or lesser degree of excursion might be acceptable, provided the direction of movement mirrors that on the normal side.[25]

Postoperatively, all patients observed the same rehabilitation program and follow-up schedule. At 6 weeks from transfer, patients were started on ultrasound therapy to help prevent adhesions between the free-muscle flap and the skin envelope. Patients were instructed to phone our office once they felt the first contractions of the transplanted muscle. From this point onward, patients were encouraged to repeat a series of training exercises in front of the mirror several times per day. Any patient who did not display forceful contractions after 9 months was referred for electrical stimulation. All patients were seen in our clinic at 3, 6, and 12 months and thereafter reviewed yearly. On each visit, patients underwent needle electromyographic studies, and a series of photographs and video recordings was obtained using a standard protocol (at rest, exhibiting a series of facial expressions, conversing with the photographer, and watching a comic movie).

For the purposes of this study, the electromyography reports and videotapes relating to the preoperative consultation, follow-up at 2 years after free-muscle transfer, and last follow-up were analyzed. Four independent observers rated separately the patients' videos at these three successive points in time using the Terzis' Facial Grading System published in 1997 and shown in Table 2.[21] Electromyography interpretations in our center are shown in Table 3. Panelists were asked to compare early outcomes in the 2-year videos with late outcome at the long-term follow-up visit, and comment on whether the functional and aesthetic smile

Table 2. Terzis' Functional and Aesthetic Grading System for Smile

Grade	Description	Score
Excellent	Symmetrical smile with teeth showing, full contraction	V
Good	Symmetry, nearly full contraction	IV
Moderate	Moderate symmetry, moderate contraction, mass movement	III
Fair	No symmetry, bulk, minimal contraction	II
Poor	Deformity, no contraction	I

Table 3. Needle Electromyography Interpretations

No. of Motor Unit Potentials	Contraction	Electrogenesis
3	Full (80–100%)	3+, full; complete interference pattern (+++)
2	Moderate (40–70%)	2+, moderate; incomplete interference pattern (++)
1	Poor (10–30%)	1+, poor (+/–)
0	None	0, none (–)

seemed weakened or less effective with time (agree/disagree).

Statistical Analysis

All data collected were coded so that no patient identification was possible. Descriptive statistics such as mean, SD, and percentage were used to present the data. Functional onset, number of motor units recruited on electromyography, and the averaged observer's scores at each successive time point were the three variables of interest. None of the observers had any knowledge regarding the patients' surgical interventions. The interrater reliability of the four observers was tested using Cronbach's α, and α values were within acceptable limits for the three evaluations ($\alpha > 0.80$). To measure early results of the free-muscle transfer against late outcomes, the number of motor units on electromyography and the mean observers' scores were compared using the Wilcoxon matched-pairs signed rank test. To further evaluate the role of time, Kruskal-Wallis nonparametric analysis of variance was computed to compare the number of motor units and averaged scores among the four groups by length of follow-up (group A, 5 to 6 years; group B, 7 to 10 years; group C, 11 to 15 years; and group D, >15 years).

The effect of demographic and surgical variables was investigated by comparison of the measured parameters (i.e., functional onset, motor units, and mean scores) by groups of sex, grade, cause, denervation time, type of muscle, and number of cross-facial nerve grafting used to neurotize the free-muscle flap (Mann-Whitney and Kruskal-Wallis tests were used where appropriate). Statistical analysis was performed using InStat version 3.00 (GraphPad Software, Inc., San Diego, Calif.) and SPSS version 12.0. (SPSS, Inc., Chicago, Ill.). The significance level was set at 0.05.

RESULTS

Twenty-three adult cases of established facial paralysis underwent reconstruction using the same strategy: two-stage cross-facial nerve grafting/free-muscle transfer for smile restoration, followed by a third stage of revisions. One patient underwent reconstruction with a one-stage free rectus abdominis transfer coapted to the ipsilateral facial nerve. Fifteen patients (63 percent) did contact us when they felt the first twitches of the muscle, and functional onset ranged from 4 to 8 months (mean ± SD, 5.5 ± 1.2 months).

Three complications were observed in this series. One muscle flap was lost following venous thrombosis, and another failed to function adequately after 18 months. A second free-muscle transfer yielded satisfactory results in these two patients. A case of temporary paraesthesia of the lower leg was noted following sural nerve harvest and resolved without any intervention. All patients underwent a third stage of revisions, and these interventions are listed in Table 4. Figures 1 through 3 illustrate cases of early and late outcomes with the cross-facial nerve grafting/free-muscle transfer strategy in our center. Late outcomes are shown at 10, 16, and 19 years.

Altogether, the length of follow-up in this series ranged from 5 to 19 years (mean ± SD, 8.4 ± 4.1). The mean values of the observers' scores were significantly higher at 2 years after free-muscle transfer in comparison with the preoperative status ($p < 0.0001$). Late outcomes were awarded

Table 4. Additional Interventions at the Revision Stage

Surgical Procedure	No. of Patients
Debulking muscle graft	12
Defatting cheek	10
Reanchoring muscle graft	3
Mini-temporalis transfer to oral commissure	7
Platysma transfer to oral commissure	3
Tendon static support	7
Selective myectomies of muscle graft	2
Reconstruction of nasolabial fold	6
Face lift	14
Cheiloplasty	5

Fig. 1. Case 1. A 21-year-old woman presented to our center with a history of right-sided developmental facial paralysis (*above*, *left*). She was managed with three cross-facial nerve grafts followed by free pectoralis minor transfer 10 months later. (*Above*, *right*) Appearance at 2-year follow-up displaying a soft smile. (*Below*) Photographs from the last clinic visit, 16 years after free-muscle transfer (at rest and with a full dental smile). The independent evaluators rated her smile as 1.5 (poor) before surgery, 3.2 (moderate) at 2 years postoperatively, and 4.7 (excellent) at the last office visit.

higher scores by the panel of observers than early outcomes shown at 2 years after free-muscle transfer ($p < 0.0001$) (Fig. 4). Undoubtedly, the third stage of revisions would have added to the superior results of the long-term videos. More significantly, none of the patients, irrespective of the length of follow-up, exhibited lesser function or downgraded symmetry over time. In all patients, there was electromyographic evidence of maintained or increased electrical activity at the long-term evaluation ($p = 0.0313$) (Fig. 5). No significance was found in values of the variables of interest when comparing patient groups A through D against each other; all groups showed maintained progress with time (averaged scores, $p = 0.7292$; motor units, $p = 0.6529$) (Figs. 6 and 7).

If the length of follow-up negatively affected the function of the free-muscle transplant over

Fig. 2. Case 2. A 33-year-old woman presented to our center 17 months after severe trauma to the right face after being involved in a motor vehicle accident. She required internal fixation of the mandible and zygoma, and extensive soft-tissue débridement (*above*, *left* and *above*, *right* relate to the initial injury and the preoperative consultation, respectively). Before facial reanimation surgery, she underwent placement of three tissue expanders and scar revisions in the forehead, cheek, and neck. One year later, she had three cross-facial nerve grafts, followed by free gracilis transfer to the right cheek. (*Below*, *left*) Photograph obtained at 2-year follow-up. (*Below*, *center* and *below*, *right*) Photographs from her last office visit at 10 years after free-muscle transfer, at rest and displaying a full dental smile. The panel graded her smile as 1.2 (fair) preoperatively, 3.7 (good) at early follow-up, and 4.5 (excellent) at the last visit.

time, this would have been apparent in the needle electromyographic studies. Instead, the number of motor units was maintained or increased over time. Also, had the function of the muscle deteriorated with time, lower rates would have been assigned by the observers' panel. Instead, the averaged scores increased significantly in all groups of follow-up (A through D), and more than 70 percent were graded as good or excellent results. In 80 percent of the evaluations, the four panelists

Fig. 3. Case 3. A 17-year-old girl presented with left-sided iatrogenic facial paralysis following surgery for otosclerosis. She underwent primary repair of the left facial nerve 10 days after stapedectomy. She presented to our center 9 years after the initial injury with partial left facial paralysis and severe synkinesis (*above*, *left*). She had three cross-facial nerve grafts followed by a free pectoralis minor transfer at a second stage 12 months later. (*Above*, *right*) Photograph demonstrating the outcome achieved following the two main stages of reconstruction (cross-facial nerve grafting and free-muscle transfer) at 2 years after free-muscle transfer. (*Below*) Photographs demonstrating the final outcome at 19 years after free-muscle transfer. The independent evaluators rated her smile as 1.5 (fair) before surgery, 3.2 (moderate) at 2 years, and 4.7 (excellent) at the long-term evaluation.

agreed that the function and symmetry of the smile did not appear less effective in the long term.

The three outcome measures showed no significant difference when compared by groups of sex, cause, denervation time, number of cross-facial nerve grafts used, or type of muscle used. However, grade of paralysis had a significant effect on final outcomes, with partial paralysis showing

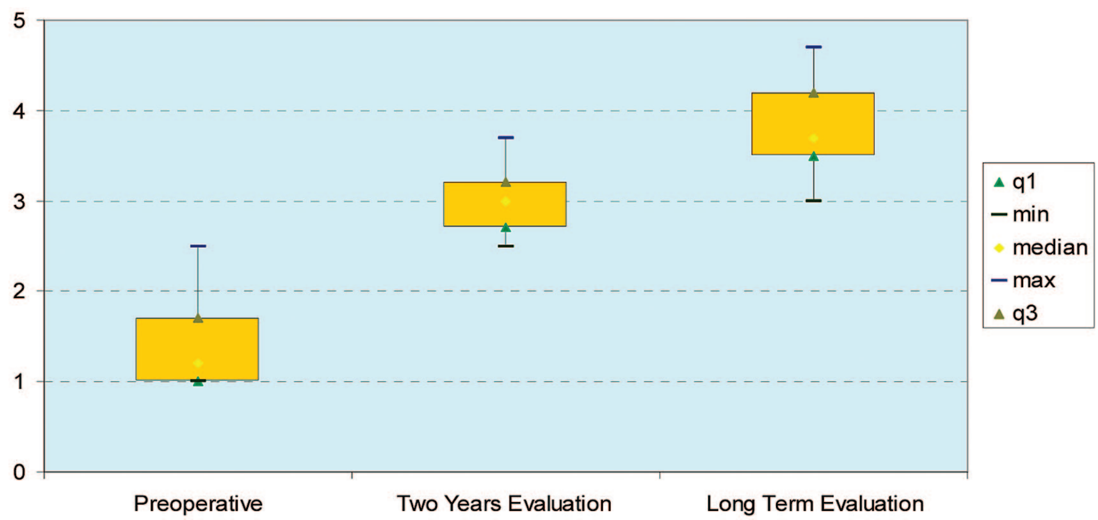

Fig. 4. Average of observers' scores at the three successive time points. This figure illustrates an increase of averaged observers' scores to patients' videos at the 2-year evaluation in comparison with the preoperative scores (Wilcoxon signed rank test, $p < 0.0001$). The mean scores awarded by the panel of observers increased further on the evaluation of the long-term videos in comparison with the early scores (Wilcoxon signed rank test, $p < 0.0001$).

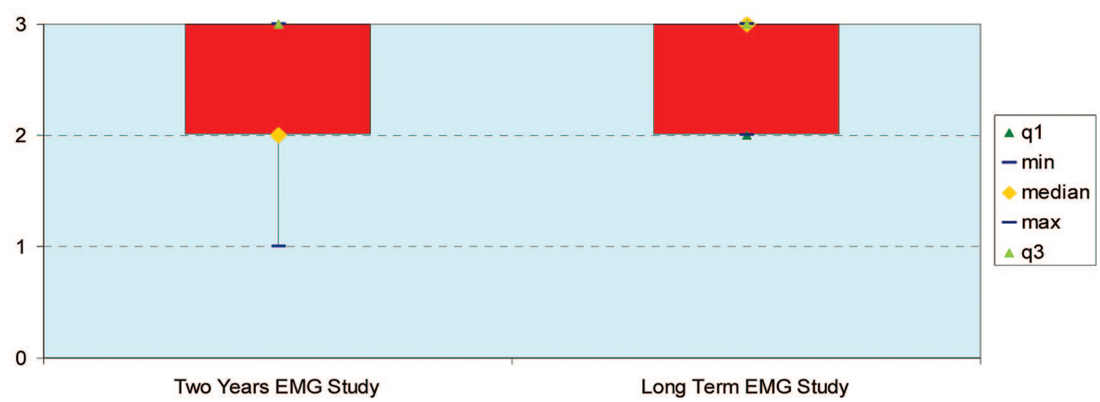

Fig. 5. Motor units on needle electromyography: early versus late evaluation. This figure demonstrates the mean values of motor units recruited on needle electromyography at 2 years after free-muscle transfer and at the long-term follow-up. All patients evidenced maintenance or improvement of the electrical activity on the transferred muscle with time (Wilcoxon signed rank test, $p = 0.0313$). *EMG*, electromyographic.

superior results than complete palsies (Mann-Whitney test, $p = 0.0092$) (Fig. 8).

DISCUSSION

In a series of 27 free-muscle transfers (26 adults and one child) with follow-up ranging from 2 to 15 years (mean, 8.5 years), Yla-Kotola et al.[22] stated that the longer the follow-up, the poorer the function of the free muscle. In a separate report,[26] the same group analyzed 15 free-muscle transfers with a mean follow-up of 7 years (range, 3 to 14 years) using magnetic resonance imaging studies. These investigators estimated that 80 percent of the muscle volume was lost with time and concluded that the longer the follow-up, the less normal the structure of the muscle and the poorer the functional result.

Based on 30 years of clinical experience and experimental studies, we believe that time is not a boundary to muscle function. It has been shown that transplanted muscle, despite immediate revascularization and neural repair, will suffer a 25 to 50 percent loss of power and bulk.[5] Regenerating axon terminals will produce new neuromuscular junctions either on or near the regions of the old neuromuscular junctions.[27] When the free-

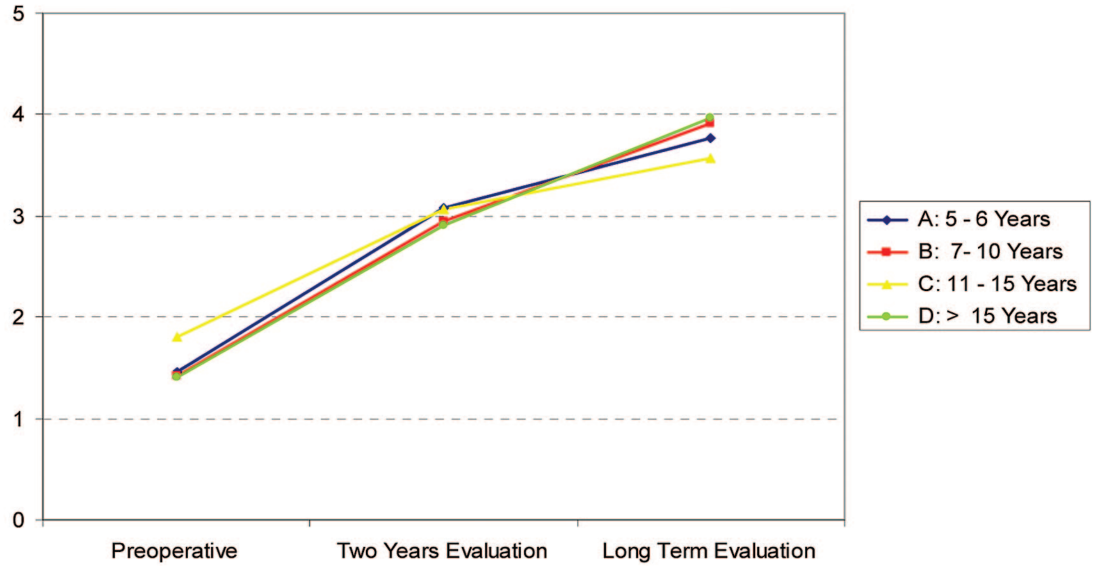

Fig. 6. Average of observers' scores by length of follow-up. All groups by length of follow-up evidenced an improvement in function and symmetry based on the averaged scores awarded by the four reviewers. No significance was found when the four groups (A through D) were compared against each other (Kruskal-Wallis test, $p = 0.7292$).

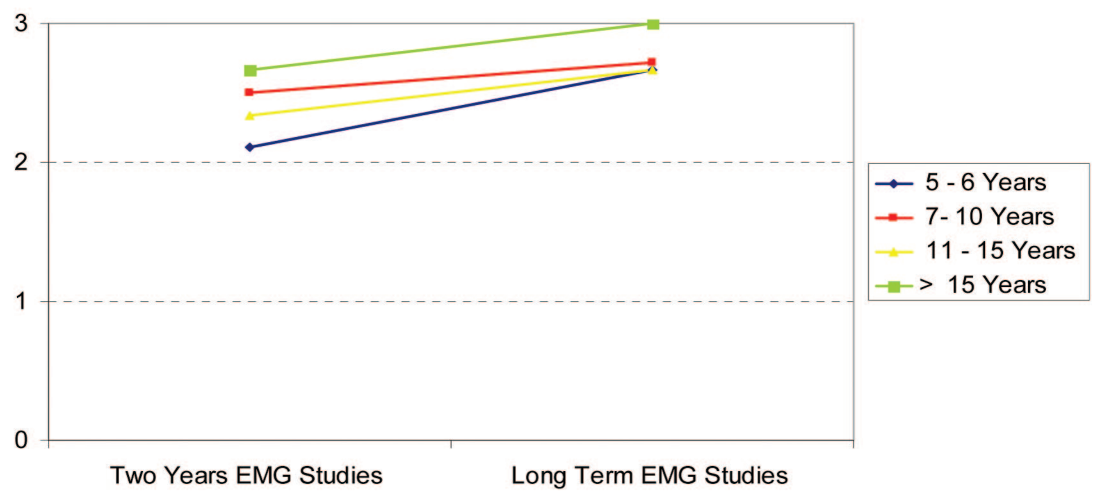

Fig. 7. Motor units on needle electromyography by length of follow-up. The length of follow-up did not influence the number of motor units recruited on needle electromyography. Groups with longer follow-up (C or D) failed to show less electrical activity on electromyography than groups with shorter follow-up (A or B). No significance was found in the mean value of motor units when groups A through D were compared against each other (Kruskal-Wallis test, $p = 0.6529$). *EMG*, electromyographic.

muscle transplant is reinnervated by a cross-facial nerve graft, despite the lengthy distances of axonal elongation, in most instances, sufficient power results in an adequate smile.[28] Watanabe et al.[29] used ultrasound to study gracilis transfers between 1 month and 1.5 years postoperatively. A gradual decrease of muscle thickness and cross-sectional area was seen until 15 to 20 weeks postoperatively; thereafter, both values increased proportional to reinnervation and amplitude of motor potentials by electromyography.

In the current study, both parameters of interest—mean observer's scores and motor units recruitment—improved with time. Comparison of the averaged scores among the four groups of follow-up was not significant, indicating that a

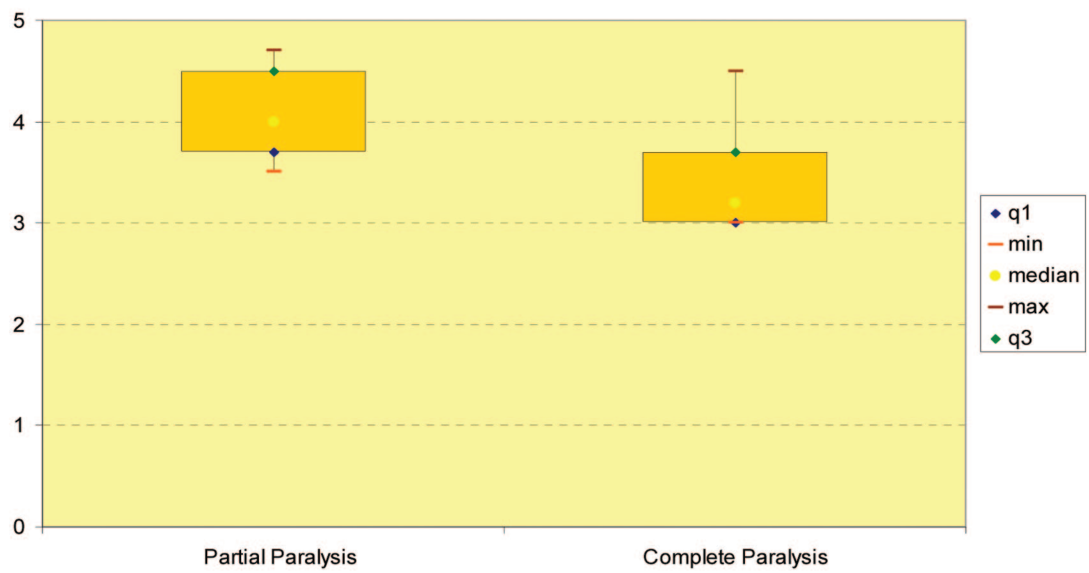

Fig. 8. Average of observers' scores by grade of facial paralysis. This figure demonstrates superior long-term outcomes in patients with partial paralysis compared with complete palsy (Mann-Whitney test, $p = 0.0092$).

shorter or longer amount of follow-up did not have a differential effect on outcomes (Fig. 6). All patients in the four groups, to one degree or another, showed a continuous improvement from their early scores. In 80 percent of the evaluations, the four observers agreed that there was no apparent loss of symmetry or function in the long term. Similarly, no significance was found when comparing the number of motor units recruited on electromyography by follow-up groups A through D (Fig. 7).

The authors feel that the findings of Yla-Kotola et al. are self-contradictory. Inasmuch as a free-muscle graft is adequately revascularized and reinnervated, it gradually recovers function and reaches a plateau at 1.5 to 2 years after transplantation.[28] It is entirely rational to presuppose that function is maintained beyond the initial 2 years, provided the muscle is functioning. When the clinical evidence shown by the data analyzed in this series is considered, it is plausible to conclude that time does not have a negative effect on muscle function and that aesthetic and functional outcomes are maintained in the long-term.

Interestingly, Yla-Kotola et al. asked their patients to rate the amount of exercise undertaken postoperatively using a scale from 1 to 4. They also studied the effect of muscle training on magnetic resonance imaging, and stated that frequent exercise was associated with higher muscle volume on magnetic resonance imaging; however, this did not influence final muscle structure or outcomes. Based on these results, the investigators hypothesized that exercise cannot influence the final function and encouraged further studies in this respect. In pediatric patients, Ueda et al.[30] reported good results, without need for any special rehabilitation such as self-training or electrical stimulation. Indeed, in our center, the authors have observed that children tend to attain satisfactory outcomes even if they are not compliant with physical training; however, this claim is untenable in adult patients. Physical training in front of the mirror greatly influences final outcomes in adults, because such exercises serve as a valuable reference of new mimics that once repeated and learned can become automatic.

It is an arduous task to compare facial reanimation outcomes with the continuous introduction of new techniques. Adding to the debate, many investigators currently support one-stage methods of reconstruction.[11–15] To date, results with the one-stage reconstruction have been contradictory. Harii et al.[31] claimed satisfactory results in 80 percent of patients, whereas Sajjadian et al.[15] concluded that outcomes were admittedly moderate. The majority of these series have shown results that are promising but inferior to those currently attainable with the standard two-stage reconstruction.[32] Animal data corroborated the superiority of the two-stage reconstruction.[33,34] In our center, the authors have found, as have others,[18,32] that patients do not normally disapprove of more procedures and a longer rehabilitation, provided they are well informed and carefully counseled that this approach is associated with optimal results. Time, nonetheless, is of much more relevance to older age groups. Patients with facial paralysis who are in their 50s or 60s may well be more persuaded by a single-stage reconstruction and shorter rehabilitation. However, again, facial reanimation should be planned on an individual basis. In this series, only the grade of the paralysis reached significance, with partial paralysis patients showing significantly superior results than patients with complete paralysis, corroborating the findings of O'Brien et al.[11] and Kaylie et al.[35]

Our hypothesis was supported by the observation that the two main variables of interest (mean value of observers' scores and number of recruited motor units on electromyography) had equal or greater values at the long-term evaluation. No significance was found in outcome measures when comparing groups with variable lengths of follow-ups. After lengthy periods of follow-up have been evaluated, long-term results have thus far been very satisfactory. The authors dissent from recent reports claiming a negative effect of time on muscle function.[22]

CONCLUSIONS

Cross-facial nerve grafting/free-muscle transfer is an effective technique for restoring a coordinated functional and symmetric smile. A progressive functional recovery over time was demonstrated, with no reduction or weakening of muscle function.

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