Use of Mini-Temporalis Transposition to Improve Free Muscle Outcomes for Smile

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Background: In managing late facial paralysis, association of cross-facial nerve grafting and free muscle transfer proves superior to any other method of mid-face reanimation. Nevertheless, predicting functional recovery remains a struggle, and in a minority of patients, results are deceiving. In this study, cases of fair or moderate outcomes from a free muscle transfer received a segmental temporalis transposition to upgrade the functional and aesthetic results.
Methods: From 1981 to 2007, 153 patients received a free muscle transfer for smile restoration in the authors' center. Of all patients, 72 percent (110 patients) required a third stage of revisions. In 41 cases, mini-temporalis transfer was used to augment moderate outcomes of a free muscle transfer. The exclusion criterion was less than 3 months' follow-up; thus, six patients were not evaluated. Each patient was videotaped at three successive time points (preoperatively, following free muscle transfer, and following mini-temporalis transfer). Five independent observers graded patients' videos using a five-category scale from poor to excellent.
Results: In all of the patients, the averaged scores were higher after free muscle transfer in comparison with the preoperative scores (Wilcoxon signed rank test, $p < 0.0001$). After mini-temporalis transfer, 97.1 percent of the patients had scores that were increased further and 2.8 percent had the same scores. Alopecia along the coronal incision was seen in four patients, and hollowing of the infratemporal fossa was seen in five.
Conclusion: Analysis of these clinical data supports the use of mini-temporalis transfer as a safe and reliable method of correcting imperfect outcomes following a free muscle transfer for smile restoration. (*Plast. Reconstr. Surg.* 122: 1723, 2008.)

The critic will dwell on the obvious but the surgeon, like an intuitive builder, can sniff out the hidden rot in his beams and occasionally will have the courage to rip out and rebuild.

—B. S. Freeman, 1979

Irreversible facial paralysis is a complex and devastating condition. The psychological burden of facial asymmetry adds insult to patients troubled by eye complications, speech and eating difficulties, and communication barriers.

Assisting eye and oral dysfunction with static reconstructive methods is partial at best, and dynamic reanimation makes coherent sense. However, any attempt to dynamically reanimate a facial target, whether it is the upper, mid, or lower face, is limited by our inability to predict final functional outcomes.[1–4] Reconstructive surgeons must make this limitation clear to their patients on the first consultation: exact reproduction of the animated hemiface is simply unrealistic.

The objectives of midface reanimation are restoration of smile symmetry at rest and on animation; spontaneous coordination; and an increase of the cheek's muscular tone to improve speech, mobilization of food, and oral hygiene. In the authors' view, a two-stage free muscle transfer innervated by the contralateral facial nerve by means of a cross-facial nerve graft withstands the highest probabilities of achieving these goals. However, the ability to estimate with any precision final functional recovery eludes our skills, because several vari-

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ables (e.g., regenerative capacity, generated muscle power, tension) have an effect on outcomes.[5–8] Even in experienced hands, a free muscle transplant can result in contractions that are too weak or too strong. In 1997, the senior author (J.K.T.) in a series of 100 free muscle transfers stated that some 67 percent of the patients required additional revisions at a later stage. Recently, Frey and Giovanoli emphasized the need for a third stage of revisions if the best possible outcomes of a free muscle transfer are to be achieved.[2]

This current study focuses on the correction of fair or moderate outcomes of free muscle transfer for smile restoration. In this article, a single surgeon's experience using a dynamic mini-temporalis transposition to upgrade functional and aesthetic outcomes of a free muscle transfer is presented. Although secondary revisions for the eye sphincter and depressor functions are routinely undertaken at the same time, discussion of those interventions is beyond the scope of this study. At our institution, data for a review article on revisional procedures available to the reconstructive surgeon to improve the overall outcomes are currently being compiled.

Functioning microneurovascular free muscle transfer for facial reanimation was broached by Harii et al. in 1976.[9] This principle, soon combined with cross-facial nerve grafting by O'Brien and colleagues,[10] has since been the mainstay of treatment in midface reanimation. Temporalis muscle transposition has long been used for reanimation of the upper and middle face. In 1911, Lexer and Eden first documented the use of temporalis for reanimation of the paralyzed eyelid.[11] Four years later, Rosenthal used temporalis transposition for muscle-to-muscle neurotization of the orbicularis oculi.[12] Gillies gained valuable experience with the use of temporalis transposition for traumatic facial reconstruction during the First World War[13] and in 1934 described a technique to reanimate either the eye or the oral sphincter using temporalis transposition.[14] In Gillies' technique, the muscle was detached from its origin, folded over the zygomatic arch, and elongated with a strip of fascia lata.

In 1953, McLaughlin introduced a different approach to temporalis transposition by mobilizing the temporalis tendon to the oral commissure instead of the muscle origin.[15] Both techniques are limited by two common factors: the need to elongate the muscle flap to reach the oral commissure and the lack of spontaneous coordination. Fascia lata and deep temporalis fascia have been used widely for this purpose.[16–20] Currently, most reconstructive surgeons use a segment of the temporalis muscle—a "mini-temporalis"— and different series have demonstrated efficient and reproducible results.[21]

In this study, we set out to test the hypothesis that mini-temporalis transposition is a reliable method of correcting functional and aesthetic asymmetries following cross-facial nerve grafting and free muscle transfer. Tendon transfers, fascial supports, reanchoring of the muscle graft, or selective myectomies are techniques commonly used for final corrections following a free muscle transfer.[1,2,4,22,23] However, the literature on these secondary interventions is rather sparse.[3,4,23–26] In 1997, the senior author first documented the use of mini-temporalis transfer at the revision stage in facial reanimation.[1] Five years later, a report by Kumar and Hassan mentioned the use of mini-temporalis transfer in one case to upgrade the outcome of a free muscle transfer for smile restoration.[25]

PATIENTS AND METHODS

From 1981 to 2007, 153 patients underwent free muscle transfer for midface reanimation at out center (n = 164 transfers). Of these patients, 72 percent (110 patients) required additional revisions to upgrade the function or increase the aesthesis of midface reconstruction. In 41 patients, a mini-temporalis transfer was used to increase the functional and aesthetic outcomes following a free muscle transfer for smile restoration. The total population included 26 adults and 15 children, whose ages ranged from 6 to 60 years (mean ± SD, 22.75 ± 2.17 years). Of these 41 patients, 35 who met the criterion of longer than 3 months' follow-up were evaluated. A description of the demographic variables and details of the surgical procedures of these 35 patients are summarized in Table 1 (pediatric cases) and Table 2 (adult cases). Eleven of the 41 patients (26.8 percent) had previous surgery for facial reanimation elsewhere, and these interventions are also listed in Tables 1 and 2.

Surgical Procedures

All of the procedures were carried out by the senior author (J.K.T.). Cross-facial nerve grafting and free muscle transfer were performed as described in earlier reports.[1] Of the 41 patients, the gracilis muscle was used in 25 cases, the pectoralis minor in 14 cases, the segmental latissimus dorsi in one case, and the rectus abdominis in the other. The time interval between the second stage of free muscle transfer and the mini-temporalis transpo-

Table 1. Demographic and Intraoperative Variables in the Pediatric Patients

Patient	Age (yr)	Sex	Cause	Side	Degree	DT (mo)	Previous Surgery Elsewhere	Stage		
								1	2	3
1	8	F	Developmental	L	Complete	59	No	CFNG ×2	Pectoralis	Mini-temporalis
2	15	F	Developmental	L	Complete	161	No	CFNG ×3	Pectoralis	Mini-temporalis
3	13	F	Developmental	R	Complete	77	No	CFNG ×4	Pectoralis	Mini-temporalis
4	7	F	Giant lymphoma	L	Partial	60	No	CFNG ×2	Pectoralis	Mini-temporalis
5	15	F	Astrocytoma	L	Complete	118	No	CFNG ×3, XII–VII	Gracilis	Mini-temporalis
6	14	M	Developmental	L	Complete	132	No	CFNG ×3	Pectoralis	Mini-temporalis
7	10	F	Cerebellopontine arachnoid cyst	R	Partial	54	No	CFNG ×3	Pectoralis	Mini-temporalis
8	13	M	Mobius	B	Partial	147	No	CFNG ×1	Gracilis	Mini-temporalis
9	6	M	Developmental	R	Partial	44	Fascia lata sling	CFNG ×3	Pectoralis	Mini-temporalis
10	10	M	Developmental	R	Partial	88	No	CFNG ×3	Pectoralis	Mini-temporalis
11	14	M	Cystic hygroma	R	Complete	132	Temporal fascia sling	CFNG ×4	Gracilis	Mini-temporalis
12	8	M	Traumatic	R	Partial	30	No	CFNG ×2	Gracilis	Mini-temporalis
13	13	F	Developmental	R	Partial	15	No	CFNG ×3	Pectoralis	Mini-temporalis
14	8	F	Developmental	L	Partial	120	CFNG 2 and fascia lata sling	CFNG ×3	Pectoralis	Mini-temporalis

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

sition in the revision stage ranged between 12 and 72 months (mean ± SD, 29.61 ± 2.85 months).

At the revision stage, the superficial temporal fascia is preserved and a segment of the temporalis muscle is raised, using the deep fascia and a section of periosteum as an extension of the muscle flap (Figs. 1 and 2). In 36 cases, the middle third of the temporalis muscle was transposed; in four cases, both the middle and posterior thirds were used; and in one case, the posterior segment was used. The deep fascia is peeled off the temporalis and fixed to its cranial edge together with a periosteal extension, with two rows of 5-0 Prolene horizontal mattress sutures (Ethicon, Inc., Somerville, N.J.). The attached fascia-periosteal extension is then divided in a variable number of slips (one to four), depending on the reconstruction needed and the preoperative position of the philtrum and commissure.

Careful blunt dissection is aided by detailed visual records of previous stages, and working from the temporal incision toward the commissure, a generous passage is made underneath the free muscle graft. In 35 cases, the mini-temporalis was folded over the zygomatic arch, and in six cases, it was tunneled under it. In two cases, the segment of temporalis transferred was rather bulky; thus, the middle portion of the zygomatic arch was burred down in one case and resected in the other (in the latter case, the zygomatic arch exhibited a nonunited fracture following craniofacial trauma). The mini-temporalis is then passed underneath the free muscle graft in most cases. In three of the 41 cases, a subcutaneous passage was performed and the mini-temporalis was placed on the top surface of the muscle graft under direct visualization of its pedicle.

Through two small intraoral incisions, dissection in a submucosal plane is undertaken, and the mini-temporalis' slips are tunneled to their attachment points. Fixation of the extension limbs to the modiolus and/or upper lip follows preoperative markings and meticulous intraoperative evaluation of the patient's preoperative photographs and videos. Bilateral preoperative measurements of distances between the commissure and fixed anatomical points (i.e., tragus, helix base, and mid infraorbital rim) at rest and on smiling guide the surgeon during the anchoring of the mini-temporalis slips. If the lateral excursion (retraction) of the commissure achieved with the free muscle transfer is adequate but the upper teeth are not equally shown, the temporalis flap extensions are divided in several slips destined to elevate the upper lip. In contrast, if lateral excursion (retraction) is insufficient, the mini-temporalis extension is fixed undivided to the modiolus exclusively to balance the smile. In all cases without exception, the required correction is exaggerated, allowing a degree of overcorrection that will settle over the course of a few weeks. All patients were fitted with an external splint that protected and supported the angle of the mouth, anchored by means of an elastic band to a 2 × 2-inch elastic bandage placed around the forehead.

Table 2. Demographic and Intraoperative Variables in the Adult Patients

Patient	Age (yr)	Sex	Cause	Side	Degree	DT (mo)	Previous Surgery Elsewhere	Stage		
								1	2	3
1	17	F	Iatrogenic	R	Partial	420	No	CFNG ×3	Pectoralis	Mini-temporalis
2	17	M	Traumatic	L	Compete	72	No	CFNG ×3	Pectoralis	Mini-temporalis
3	20	F	Developmental	R	Partial	156	No	CFNG ×3 and XII–VII	Gracilis	Mini-temporalis
4	16	F	Developmental	R	Partial	183	No	CFNG ×2 and NG–XII	Gracilis	Mini-temporalis
5	19	M	Traumatic	R	Partial	80	No	CFNG ×2	Latissimus	Mini-temporalis
6	18	M	Cystic hygroma	R	Partial	180	CFNG ×1	CFNG ×2	Gracilis	Mini-temporalis
7	17	M	Traumatic	R	Partial	132	No	CFNG ×3	Gracilis	Mini-temporalis
8	39	M	Parotic pleomorphic adenoma	R	Complete	156	Masseter transfer	CFNG ×2	Gracilis	Mini-temporalis
9	21	F	Traumatic	B	Complete	50	No	CFNG ×4	Gracilis	Mini-temporalis
10	36	F	Traumatic	L	Partial	66	Parascapular flap	Gracilis	Mini-temporalis	
11	40	M	Bell's palsy	L	Complete	36	CFNG ×3	Pectoralis	Mini-temporalis	
12	45	F	Infantile parotid hemangioendothelioma	R	Partial	456	Fascia lata sling	CFNG ×4	Gracilis	Mini-temporalis
13	45	M	Cholesteatoma	R	Partial	228	No	CFNG ×4	Gracilis	Mini-temporalis
14	22	F	Traumatic	L	Partial	29	No	CFNG ×4	Gracilis	Mini-temporalis
15	32	F	Developmental	L	Partial	372	Temporalis fascia sling	CFNG ×3	Gracilis	Mini-temporalis
16	19	F	Developmental	R	Partial	204	No	CFNG ×3	Gracilis	Mini-temporalis
17	36	F	Lymphangioma	L	Partial	348	No	Rectus abdominis	Mini-temporalis	
18	23	F	Idiopathic	R	Partial	216	Temporalis fascial sling, masseter transfer	IPNG ×2 to XI and XII	Gracilis	Mini-temporalis
19	20	F	Idiopathic	R	Partial	48	No	CFNG ×3	Pectoralis	Mini-temporalis
20	31	M	Acoustic neuroma	L	Partial	21	No	CFNG ×4	Gracilis	Mini-temporalis
21	55	F	Schwannoma	L	Partial	84	XII–VII	CFNG ×4	Gracilis	Mini-temporalis

DT, denervation time; F, female; M, male; L, left; R, right; B, bilateral; CFNG, cross-facial nerve grafts; XII–VII, partial hypoglossal–to–facial nerve transfer; NG, nerve graft; IPNG, ipsilateral nerve graft.

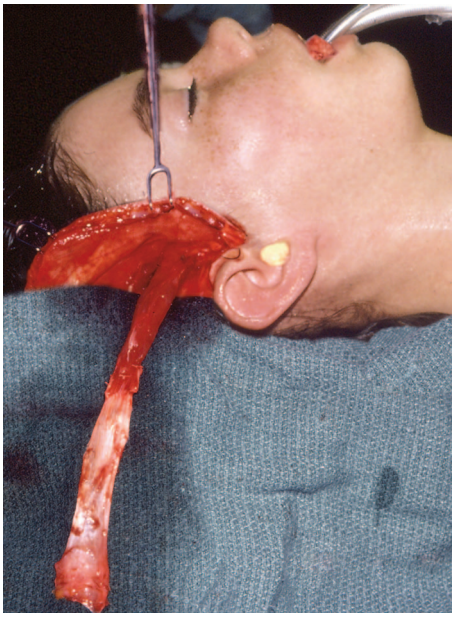

Fig. 1. Intraoperative photograph of mini-temporalis to oral commissure transfer. The middle section of the temporalis muscle is raised and elongated with a strip of deep temporal fascia and periosteum (undivided in this case, as this patient needed only assistance with upper lip elevation).

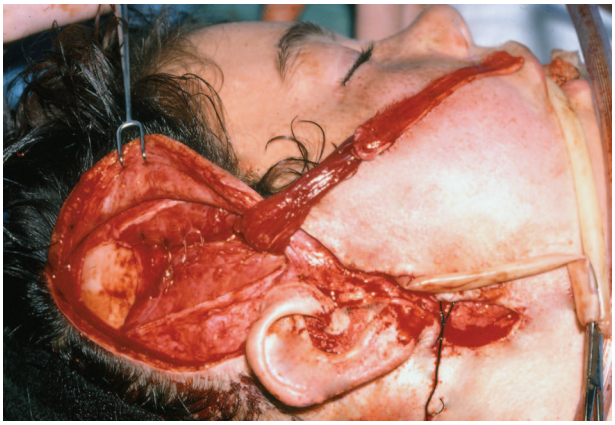

Fig. 2. Intraoperative photograph of mini-temporalis to oral commissure transfer. To prevent donor-site hollowing, anterior advancement of the posterior temporalis and approximation to the anterior third is undertaken.

All of the patients were instructed to observe a blended diet for the first month and start physical therapy for smile training at 6 weeks after surgery. Postoperatively, patients were evaluated in our clinic at 3 months and 6 months and reviewed thereafter according to their progress. On each visit, patients underwent needle electromyographic studies, and a series of photographs was obtained. They were also videotaped using a standard protocol: face at rest, exhibiting a series of facial expressions, conversing with the photographer, and watching a funny movie. Patients were asked to smile with and without temporalis activation, and this sequence was videotaped. For the purposes of this study, preoperative electromyographic records and videotapes were collected, along with those corresponding to the 12-month visit after free muscle transfer and those following the mini-temporalis transposition. Five independent observers graded separately the patients' videotapes at these three stages using the Terzis' Facial Grading System published in 1997[1] (Table 3). The functional and aesthetic smile was graded from 1 to 5, corresponding to a five-category scale (i.e., poor, fair, moderate, good, and excellent).

Post–free muscle and post–mini-temporalis electromyographic studies were compared to evaluate whether the secondary intervention downgraded to any extent the function of the free muscle, and to establish whether the transposed temporalis segment was fully innervated. Informed consent was obtained from each patient. This study was reviewed and approved by the Eastern Virginia Medical School Institutional Review Board.

Data Analysis

All collected data were coded so that no patient identification was possible. None of the observers had any information about the patients' demographic characteristics or the surgical procedures used. The Cronbach coefficient α was calculated for the interrater reliability of the five observers' scores on three successive evaluations ($\alpha = 0.806$ preoperatively, $\alpha = 0.884$ after free muscle transfer, and $\alpha = 0.929$ after mini-temporalis transfer). The outcome parameter of interest was defined as the averaged observer's scores granted to each patient at these successive time points. To evaluate the effect of free muscle transfer and mini-temporalis transposition, the observers' scores in these successive stages were compared using the Wilcoxon signed rank test.

Table 3. Terzis' Functional and Aesthetic Grading System for Smile

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

The Mann-Whitney test was used to compare the outcome measure among groups of population, grade, and gender, and to evaluate the effect of the denervation time (12 to 24 months and >24 months) and the type of free muscle used (gracilis/pectoralis). 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 as 0.05.

RESULTS

Of the 41 patients in this population, six had shorter than 3 months' follow-up and were excluded from evaluation. For the 35 patients studied, follow-up ranged from 3 to 228 months (mean ± SD, 38.57 ± 59.03 months). To one degree or another, the free muscle transfer increased the averaged preoperative scores in all the patients (Wilcoxon signed ranks test, $p < 0.0001$). The panelists' scores improved further following correction of the free muscle outcomes using mini-temporalis transposition in 97 percent of the patients (Wilcoxon signed ranks test, $p < 0.0001$), and a minority of cases (3 percent) obtained the same scores (Fig. 3). The average scores awarded to each patient at the different evaluations are listed in Table 4. The function of the free muscle transfer was not downgraded by the mini-temporalis transposition, as demonstrated by needle electromyographic studies.

No significance was found when comparing the averaged observers' scores by groups of population, grade, gender, type of free muscle transfer, or denervation time (Mann-Whitney test, $p > 0.05$). Exemplary cases of mini-temporalis transfer used to correct asymmetries following free muscle transfer are depicted in Figures 4 through 6.

Complications

Four patients developed an area of alopecia along the coronal incision, which required scar revision. In most cases in this series, temporalis fossa hollowing was prevented efficiently by approximation of the posterior temporalis to the anterior third (Fig. 2). In five patients, the donor area was filled with a pad of fat enveloped with superficial fascia (four cases) and with a Silastic spacer (one case). Of the 41 patients managed with mini-temporalis transfer, only one complained of depression at the donor site postoperatively; this patient had a Proplast spacer (Nova Med, Inc., Houston, Texas) implanted at a later date.

DISCUSSION

In facial reanimation surgery, slight asymmetry of the smile might be much more disturbing to the treating physician than to the afflicted patient. A modest outcome, which often satisfies the patient, may not fulfill the surgeon's expectation, who struggles with the pursuit of perfect balance and symmetry. The experience gained over the past three decades allows us to tell the patient with late facial paralysis that, following cross-facial nerve grafting and free muscle transplantation, there will be an improvement and that his or her appearance will not worsen. As previously stated by

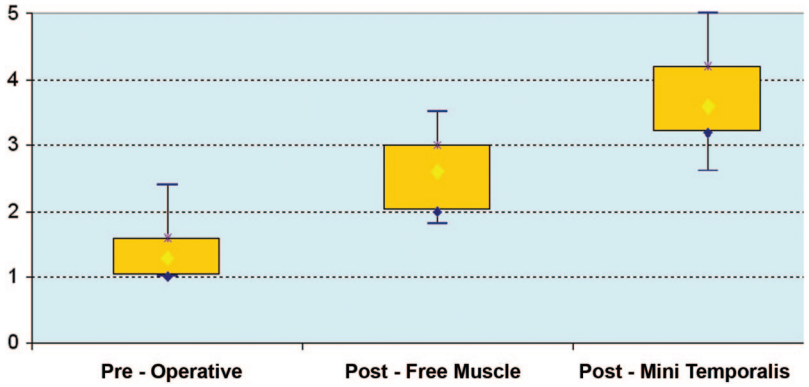

Fig. 3. Outcomes in our center with mini-temporalis transposition to improve free muscle outcomes. This figure shows the average scores awarded by the panel of observers using Terzis' Functional and Aesthetic Grading System for Smile. Patients were evaluated at three stages: (1) preoperatively, (2) after free muscle transfer, and (3) after mini-temporalis transfer. To different degrees, all patients increased their smile scores after mini-temporalis correction of the free muscle outcomes (Wilcoxon matched-pairs signed rank test, $p < 0.0001$).

Table 4. Average Observers' Scores for Patients' Preoperative and Postoperative Videotapes

	Preoperatively		After Free-Muscle Transfer		After Temporalis Transfer	
Patient	Score	Description	Score	Description	Score	Description
1	2	Fair	3	Moderate	4.4	
2	1.4	Poor	2	Fair	3	Moderate
3	2.2	Fair	2.6	Moderate	3.8	Good
4	1	Poor	2	Fair	3	Moderate
5	1.6	Fair	3	Moderate	4.4	Good
6	1.4	Poor	2.8	Moderate	3.4	Moderate
7	1	Poor	2.2	Fair	3.2	Moderate
8	1	Poor	3	Moderate	4	Good
9	1.6	Fair	3	Moderate	3.4	Good
10	1.4	Poor	2.2	Fair	4.2	Good
11	1.6	Fair	3.4	Moderate	4.8	Excellent
12	1.6	Fair	3.2	Moderate	4.2	Good
13	1	Poor	2.2	Fair	5	Excellent
14	1.4	Poor	3.4	Moderate	3.8	Good
15	1.2	Poor	2	Fair	3.4	Moderate
16	1.2	Poor	3.4	Moderate	4.8	Excellent
17	1.2	Poor	1.8	Fair	2.6	Moderate
18	2.4	Fair	2.6	Moderate	4.2	Good
19	1.2	Poor	2	Fair	3	Moderate
20	1.6	Fair	3.2	Moderate	4.3	Good
21	1.4	Poor	2.6	Moderate	3.4	Moderate
22	1	Poor	3.4	Moderate	4.2	Good
23	1.8	Fair	2.2	Fair	3.2	Moderate
24	1	Poor	2	Fair	3	Moderate
25	1	Poor	3	Moderate	4	Good
26	1	Poor	2.8	Moderate	3.4	Good
27	1.2	Poor	3	Moderate	4.4	Good
28	1.2	Fair	2	Fair	3.2	Moderate
29	1.8	Fair	2.8	Moderate	3.6	Good
30	2.4	Fair	2.8	Moderate	4	Good
31	1.2	Fair	2.2	Fair	2.8	Moderate
32	1.2	Fair	2	Fair	3.4	Good
33	1.2	Fair	3.4	Moderate	4	Good
34	1	Poor	2	Fair	2.8	Moderate
35	1	Poor	1.8	Fair	2.8	Moderate

the senior author in 1997, it is not yet possible to foresee the degree of functional recovery of a transplanted muscle, as many different factors may have a positive or negative influence on its final function.[1] Previous series on smile restoration have indicated the need for additional revisions after the free muscle transfer in a high number of patients. Terzis, in 1997,[1] documented that 66.6 percent of these patients required revisions; Frey and Giovanoli, in 2002,[2] stated a minimum 80 percent (95 percent adults, 30 percent children); and Takushima et al., in 2004, indicated a 39.1 percent rate.[22] Reports by other groups have listed secondary revisional interventions without an indication of the number or percentage of patients who benefited from them.[2–4]

In the senior author's experience, the majority of these patients (71.9 percent of 153 patients in our center) required some additional revisions after a free muscle transfer for smile restoration. These revisions can be aimed at improving the functional outcome of the muscle graft, toward correction of any remaining asymmetry, or both. In those cases where the free muscle transfer resulted in fair or moderate outcomes, the possible options to improve function and aesthesis included the following: (1) mini-temporalis transposition; (2) reanchoring the free muscle graft at the zygomatic or modiolus ends; and (3) tightening the free muscle by plication, which may increase the tension and may enhance the degree of contraction.

Over the past two decades, the experience of the senior author with manipulation of the free muscle in the revisional stage (usually 1 year or so later) has not always yielded the anticipated results. In contrast, provision of a new pedicled muscle (mini-temporalis transfer) has given a much more predictable result. Nevertheless, revisional surgery should be planned on an individual basis after careful consideration of the functional and aesthetic needs of each patient.

Fig. 4. Case 1. This 10-year-old girl suffered from right-sided facial paralysis following the extirpation of a cerebellopontine arachnoid cyst. She presented to our clinic in 1986, 54 months after the insult (*left*). She underwent three cross-facial nerve grafts in August of 1986, followed by pectoralis minor transfer 11 months later, in July of 1987. Outcomes of the free muscle transfer are depicted (*center*). In August of 1988, she underwent mini-temporalis transposition to improve the result obtained with the free muscle transplant. The results following the mini-temporalis transposition are shown at a more recent follow-up (*right*). She was awarded the following scores by the panel: 1.6 (fair) preoperatively, 3.4 (moderate) after free muscle transfer, and 4.8 (excellent) following mini-temporalis transposition.

Fig. 5. Case 2. This 17-year-old girl presented with left-sided iatrogenic facial paralysis following corrective surgery for otosclerosis. She was first assessed by the senior author in February of 1986 (*left*). On the first stage in July of 1986, she had three cross-facial nerve grafts followed by a free pectoralis minor transfer at the second stage, 12 months later. (*Center*) Photograph showing the outcomes achieved following the two main stages of reconstruction (cross-facial nerve graft and free muscle transplant). In August of 1988, she underwent mini-temporalis transposition to augment the symmetry of the smile (*right*). The independent evaluators rated her smile as 2 (fair) before surgery, 3 (moderate) after free muscle transfer, and 4.5 (excellent) after mini-temporalis transposition.

Fig. 6. Case 3. This 45-year-old patient presented with right-sided facial paralysis following extirpation of a cholesteatoma in 1968. He was first assessed at our center in February of 1985 (*left*). He had four cross-facial nerve grafts in July of 1987. Eleven months later, in June of 1988, he underwent free gracilis muscle transfer to the right cheek. (*Center*) Photograph obtained at the follow-up visit after the free muscle transfer. In March of 1990, he had mini-temporalis transposition to correct the asymmetry at the angle of the mouth (*right*). The independent evaluators rated his smile as 1.2 (poor) preoperatively, 3 (moderate) after free muscle transfer, and 4.4 (good) after mini-temporalis transposition.

Mini-temporalis transposition has long been used in facial reanimation for restoration of either the eye or oral sphincter. In our institution, we have often combined facial nerve microsurgery and mini-temporalis transposition as an alternative strategy in patients whose prognosis or wishes contraindicated a free muscle transfer. Mini-temporalis transposition is also suitable for those patients who, having undergone the two main stages of reconstruction, exhibited some degree of asymmetry. Mini-temporalis transposition after free muscle transfer is only safe and effective when detailed documentation is available from previous stages. With the understanding that revisions may be needed after any dynamic method of reconstruction, each intervention undertaken at our institution is videotaped, and a series of still photographs are taken. This information is then supported by a detailed dictation of the procedure and meticulous color drawings depicting the placement of the free muscle, the exact position of the pedicle, and the location of the previously tunneled cross-facial nerve grafts. These are all clearly documented, and distances to fixed points are measured.

Frey and Giovannoli stated their reluctance to use temporalis muscle transfer in the pediatric population because of concerns of a possible negative effect on craniofacial growth.[2] In this series, 15 children underwent mini-temporalis transposition, with the youngest recipient being 6 years old at the time of the transfer. Follow-up in the pediatric group ranged from 3 to 228 months (mean ± SD, 63.12 ± 83.9 months). In the senior author's experience, the use of mini-temporalis transposition in this group did not have any noticeable effect on craniofacial growth. The only other series with long-term follow-up on the use of temporalis in children dates back to 1979, when Freeman reported on the use of mini-temporalis transposition in 14 pediatric patients. In his series, patients were followed for a minimum of 5 years; the author indicated partial tears or stretching of the muscle with growth as the only complications observed.[18]

CONCLUSIONS

Analysis of the clinical data presented in this series supports the use of mini-temporalis transposition as a reliable and reproducible method for correcting inadequate outcomes following a free muscle transfer. Segmental temporalis efficiently upgraded both functional and aesthetic results in patients with remaining asymmetries following the

two main stages of reconstruction. Further investigations should provide valuable information on identifying and gradually controlling those factors that dictate free muscle functional recovery so that, eventually, the need for additional interventions may be diminished.

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