Smile Reanimation after Unilateral Facial Palsy by Lengthening Temporalis Myoplasty: Objective and Subjective Evaluation on 25 Cases

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Background: Comparison of functional results of lengthening temporalis myoplasty relies in current practice on subjective scales. The goal of this study was to define a simple, reproducible, objective scale validated through a comparison with a subjective scale for smile symmetrization results after temporal muscle myoplasty.

Methods: A retrospective study was conducted on 25 patients having a unilateral facial palsy and rehabilitated with lengthening temporalis myoplasty. Evaluation consisted of objective measures: smile horizontal symmetry between left and right sides, vertical symmetry, and smile width on healthy and paretic sides on preoperative and postoperative photographs. Subjective scales were also used (i.e., a numeric scale and the Terzis and Noah scale) by a jury (four professionals and four nonprofessionals) and the patient himself or herself. Each evaluation was performed in three conditions: at rest, at intermediary smile, and at maximum smile.

Results: Comparison of objective measures on the impaired side showed a postoperative improvement in the three conditions evaluation. Reproducibility of the numeric scale was weak for evaluation at rest and fair for maximum smile evaluation (intraclass correlation coefficient of 0.57). The Terzis and Noah scale was not reproducible from one observer to another. At maximum smile, a correlation between smile symmetry in the vertical plane, smile symmetry in the horizontal plane, and professional evaluation with the numeric scale on the one hand and global patient satisfaction on the other hand was observed.

Conclusion: Postoperative smile horizontal symmetry between left and right sides, and smile vertical symmetry, are good indicators with which to assess postoperative results of facial palsy rehabilitation. (*Plast. Reconstr. Surg.* 139: 984e, 2017.)

Complete or partial facial palsy is responsible for major functional and aesthetic impairment with reduced quality of life and has a strong impact on social and psychoaffective life. Restoration of facial nerve function primarily relies on facial nerve reconstruction by end-to-end neurorrhaphy, or with an intermediate grafting if necessary. When these procedures cannot be used, because of a long duration of the facial palsy or a nerve segment being too long to repair, muscle transfer techniques can be performed. Gillies first described temporal muscle transfer in 1934.[1] His technique was modified by McLaughlin

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in 1953.[2] During the past two decades, Labbé has proposed a lengthening of temporalis myoplasty.[3]

There is no consensus statement on postoperative evaluation of functional and aesthetic results after lengthening temporalis myoplasty. To do so, different metrics have been proposed, but none of them has been adopted by a vast community of surgeons because of their complexity, cost, or device requirements.[4–6] Thus, it is difficult to compare the results of surgical techniques for smile restoration.

The purpose of this study was to evaluate the consistency of objective and subjective evaluation methods of facial symmetry before and after lengthening temporalis myoplasty. Interrater agreement of evaluation methods was also assessed.

PATIENTS AND METHODS

Twenty-five patients with unilateral facial palsy operated on by a lengthening temporalis myoplasty technique performed by the same surgeon between November of 2010 and December of 2013 were enrolled in this study. The series comprised eight men and 17 women with a mean age of 60 years (range, 50 to 69 years). Twenty-three patients (92 percent) had severe dysfunction or total facial palsy (House-Brackmann[7] classification grade ≥5) and two patients had moderate dysfunction (grade 3). Fifteen patients were addressed for facial palsy restoration and 10 patients underwent tumor removal surgery (parotid cancer, $n = 8$; facial schwannoma, $n = 2$) and facial rehabilitation in a single-stage procedure in our department. Causes of facial palsy and affected segments of the facial nerve are listed in Table 1.

A first attempt at facial rehabilitation was noted in two patients. It was, in one case, a functional rehabilitation carried out 30 years earlier in stages with the serratus anterior muscle reinnervated transfacial by a cross-face nerve graft. In the second case, it was a masseter muscle transposition.

Surgical Technique

Tumor Removal

Ten patients with parotid cancer underwent radical parotidectomy with facial nerve sacrifice and homolateral neck dissection. Two patients with facial nerve schwannoma underwent radical parotidectomy with facial nerve sacrifice and subtotal petrosectomy adapted to tumor extension.

Smile Restoration

The surgical technique chosen for smile restoration was the lengthening temporalis myoplasty as described by Labbé in 1997.[3] This procedure was used in 11 cases because the delay between facial palsy and rehabilitation was longer than 4 years. In the 14 other cases, extracranial segments

Table 1. Main Characteristics of the Studied Population

Patient	Age (yr)	Causes	Duration of Facial Palsy (mo)	Preoperative Facial Palsy (H&B Grading)	Impaired Segment of the Facial Nerve
1	60	Carcinosarcoma of the parotid	36	6	PFN
2	67	Skin epidermoid carcinoma with parotid extension	48	5	PFN
3	80	Carcinoma of the parotid gland.	72	6	PFN
4	36	Cylindroma	0	3	MS, PFN
5	48	Facial schwannoma	9	6	LS, GG, TS, MS, PFN
6	50	Parotid adenocarcinoma	8	6	PFN
7	64	Facial schwannoma	0	3	MS, PFN
8	69	Postoperative (pleomorphic adenoma)	24	6	PFN
9	85	Postoperative (pleomorphic adenoma)	8	6	PFN
10	84	Parotid ductal carcinoma	13	6	PFN
11	65	Cylindroma	60	6	MS, PFN
12	72	Parotid adenocarcinoma	9	6	PFN
13	66	Parotid adenocarcinoma	18	6	PFN
14	55	Cylindroma	15	6	PFN
15	31	Idiopathic facial palsy	240	6	LS, GG
16	60	Idiopathic facial palsy	420	5	LS, GG
17	75	Intrapetrous cholesteatoma	84	6	LS, GG,TS, MS
18	63	Postoperative (vestibular schwannoma)	240	6	PCF
19	43	Postoperative (vestibular schwannoma)	84	5	PCF
20	50	Postoperative (jugular bulb paraganglioma)	48	6	PCF, MS
21	56	Postoperative (vestibular schwannoma)	360	5	PCF
22	55	Postoperative (cerebellopontine meningioma)	24	5	PCF
23	46	Postoperative (vestibular schwannoma)	204	5	PCF
24	19	Postoperative (brainstem glioma)	60	5	PCF
25	76	Idiopathic facial palsy	36	6	LS, GG

H&B, House-Brackmann; PCF, facial nerve in posterior cerebral fossa; IAM, facial nerve in the internal acoustic meatus; LS, labyrinthic segment; GG, geniculate ganglion; TS, tympanic segment; MS, mastoid segment; PFN, parotid facial nerve.

of the facial nerve were impaired. Eight patients had a single-stage procedure for tumor removal and rehabilitation. All of the patients had a dedicated reeducation therapy.[8]

Assessment of Face Symmetrization

Evaluation of the functional and aesthetic result was performed retrospectively based on preoperative and 6-month postoperative patient photographs in three states: at rest, at intermediate smile, and at maximum smile obtained by a forced mandibular tightening. Evaluation was performed in three steps: first an objective method was applied; then, two subjective tests were used.

Objective Measures

Measurements were collected on preoperative and postoperative photographs with Photofiltre 7 (PhotoFiltre Studio X, Antonio Da Cruz, Paris, France). To allow comparison between patients, distances were normed for each patient to real scale horizontally (with interpupillary distance) and vertically (with chin-hair growth line pattern distance). For each photograph, the following parameters were collected (Fig. 1):

Delta vertical analyzing smile symmetry in the vertical plane. Smile symmetry in the vertical plane was the space between the face vertical centerline (midpoint of the interpupillary distance and chin point) and a parallel line crossing the midpoint of the upper lip (Cupid's point).

Smile width on the healthy and affected sides was the distance between the labial commissure and the face vertical centerline on the healthy and affected sides, respectively.

Delta horizontal analyzing smile symmetry in the horizontal plane. Smile symmetry in the horizontal plane was the distance between the projection points of the labial commissures from both sides on the face centerline.

(**See Video, Supplemental Digital Content 1**, which shows patients 13 and 16 for preoperative and postoperative evaluation, ***http://links.lww.com/PRS/C120***.) All analyses of objective measures included variations of the parameters by subtracting the preoperative values from postoperative values.

Subjective Evaluation

Subjective measures were performed in the three states, on the lower third of the face, by comparing the preoperative and postoperative photographs, only to evaluate improving symmetrization of the smile. An external observer evaluation (non–self-evaluation) was performed with two scales: a numeric scale ranging from 0 (no gain observed for symmetrization) to 10 (complete symmetrization), and the Terzis and Noah five-stage classification of reanimation outcomes[6] (Table 2). Evaluation was performed independently by a jury consisting of four experts (two ear, nose, and throat surgeons; one neurophysiologist; and a speech therapist) with clinical experience with facial palsy care; and four nonexperts, from the general population, unfamiliar with facial paralysis assessment.

A self-evaluation was also performed with the same numeric scale and a global satisfaction scale with four responses (i.e., very satisfied, satisfied, not very satisfied, or not satisfied). Self-evaluation assessment was performed at rest and while smiling. To perform self-evaluation consistent with everyday life assessment, the patient was asked for a natural smile rather than a maximum smile.

Statistical Analysis

All data were computed and analyzed using R (GNU software, cran.r-project.org/). Statistical comparisons for objective measures were performed using the Wilcoxon signed rank test. To assess conformity among observers for the numeric scale, an intraclass correlation coefficient was used.[9] To assess conformity among observers for categorical date (Terzis and Noah scale), the Cohen kappa coefficient was used.[9,10] The confidence intervals were evaluated with the bootstrap method. The Spearman rank correlation coefficient was used to analyze correlation between objective and subjective measurements. A Bonferroni posttest was also applied. A value of $p < 0.05$ was considered significant.

RESULTS

Objective Measurements of Lengthening Temporalis Myoplasty Results

Preoperative versus postoperative results are described in Table 3 for the affected and healthy sides and in Figure 2 for delta horizontal (Fig. 2, *above*) and delta vertical (Fig. 2, *below*). Our results show a postoperative improvement regardless of the smile's states. The measures of the affected side postoperatively were significantly longer than preoperatively ($p < 0.001$ in the three smile states). On the healthy side, no variation between preoperative and postoperative measurements was observed ($p > 0.05$ in the three smile states). Regarding measures of delta horizontal and delta vertical, we noted a statistically significant evolution ($p < 0.001$ in the three smile states). A global overcorrection was obtained on the affected side with a mean delta horizontal at −1.06 ± 3.98 mm at rest.

Fig. 1. Objective measures at rest on patient 16 (*above*), at intermediate smile (*center*), and at maximum smile (*below*) preoperatively (*left*) and postoperatively (*right*). *Blue arrow*, delta horizontal; *red arrow*, delta vertical.

Video. Supplemental Digital Content 1 shows patients 13 and 16 for preoperative and postoperative evaluation, ***http://links.lww.com/PRS/C120***.

Table 2. Terzis and Noah Five-Stage Classification of Reanimation Outcomes*

Group	Grading†	Results	Description
I	1	Poor	Deformity, no contraction
II	2	Fair	No symmetry, bulk, minimal contraction
III	3	Moderate	Moderate symmetry, moderate contraction, mass movement
IV	4	Good	Symmetry, nearly full contraction
V	5	Excellent	Symmetrical smile with teeth showing, full contraction

*Terzis JK, Noah ME. Analysis of 100 cases of free-muscle transplantation for facial paralysis. *Plast Reconstr Surg.* 1997;99:1905–1921.
†House-Brackmann scale.

Table 3. Comparison of Preoperative and Postoperative Smile Width on the Healthy Affected Sides

Measurement	Median (SD)	*p*
Hs at rest		
Preoperatively	29.13 (5.8)	0.7257
Postoperatively	28.71 (5.16)	
As at rest		
Preoperatively	21.72 (4.34)	0.0001*
Postoperatively	26.87 (5.34)	
Hs at intermediate smile		
Preoperatively	31.65 (6.34)	0.5958
Postoperatively	30.11 (4.89)	
As at intermediate smile		
Preoperatively	22.94 (4.66)	0.0001*
Postoperatively	29.67 (6.12)	
Hs at maximum smile		
Preoperatively	34.25 (7.18)	0.7593
Postoperatively	39.48 (22.59)	
As at maximum smile		
Preoperatively	21.59 (5.82)	0.0001*
Postoperatively	32.36 (12.84)	

Hs, healthy side; As, affected side.
*Statistically significant ($p < 0.05$).

To assess the dynamic effects of lengthening temporalis myoplasty, we compared the measures of the affected side postoperatively in three different states. There were significant differences between: (1) postoperative affected side at rest versus postoperative affected side at intermediate smile ($p = 0.004$), and (2) postoperative affected side at rest versus postoperative affected side at maximum smile ($p = 0.005$). There was no difference between postoperative affected side at intermediate smile and at maximum smile ($p = 0.7$).

Subjective Measurements of Lengthening Temporalis Myoplasty Results and Observers' Assessment Conformity

Numeric Scale

Numeric scale results for expert and nonexpert observers are reported in Figure 3. Assessment conformity between experts only, nonexperts only, or both groups together could not find an intraclass correlation coefficient superior to 0.6. The lowest intraclass correlation coefficient was observed for smile evaluation at rest, with an intraclass correlation coefficient less than 0.25 for the whole observer group (four experts and four nonexperts (Table 4). The highest intraclass correlation coefficient for the numeric scale was observed for the intermediate smile state among experts (intraclass correlation coefficient of 0.57), the maximum smile state among experts (intraclass correlation coefficient of 0.54), and the maximum smile state among nonexperts (intraclass correlation coefficient of 0.57). Overall consistency is better for the maximum smile state with an intraclass correlation coefficient of 0.52 for all judges. There was therefore a poor interjudge reproducibility in the evaluation of the smile at rest and intermediate smile, but interrater agreement was improving at maximum smile.

Terzis and Noah Five-Stage Classification

At the intermediate smile state, 58 percent of the patients were evaluated as excellent or good by expert and nonexpert observers. For patients at the intermediate and maximum smile states combined, 88 percent of the patients were evaluated as improved in the postoperative photographs, by both groups, experts and nonexperts. No result was evaluated as poor in this series.

Observers' assessment conformity for the Terzis and Noah classification was poor in every state (kappa <0. 6): among experts only, nonexperts only, or both groups combined (Table 5). A higher but nonsignificant kappa value (kappa = 0.3) was observed among experts for the intermediate

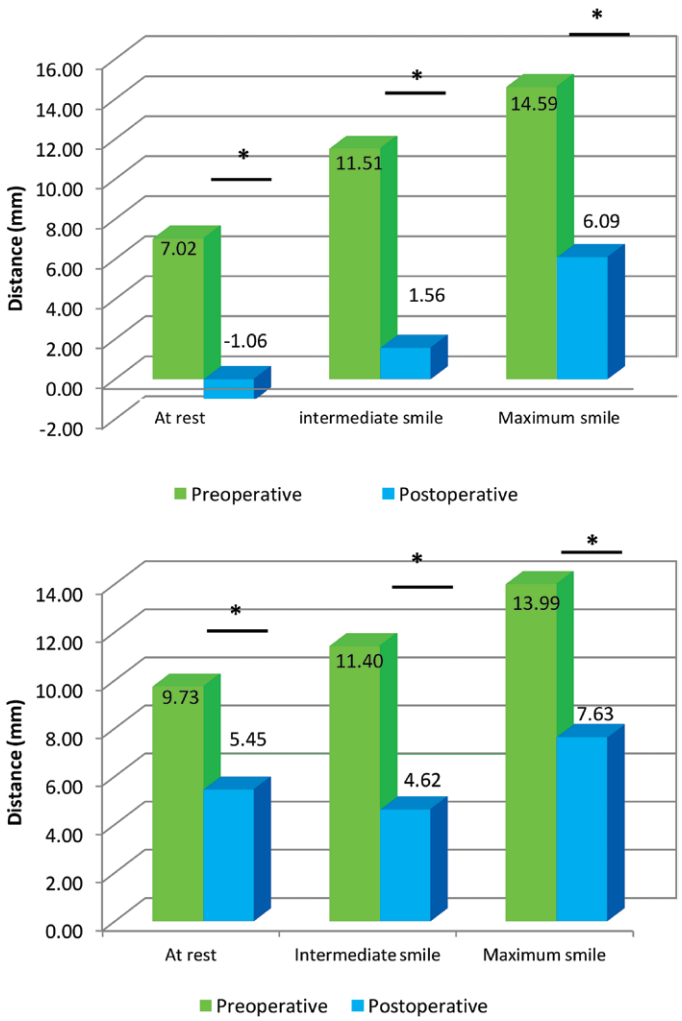

Fig. 2. Surgical results for delta horizontal (in millimeters) (*above*) and delta vertical (in millimeters) (*below*) preoperatively and postoperatively at rest, at intermediate smile, and at maximum smile (*$p < 0.001$).

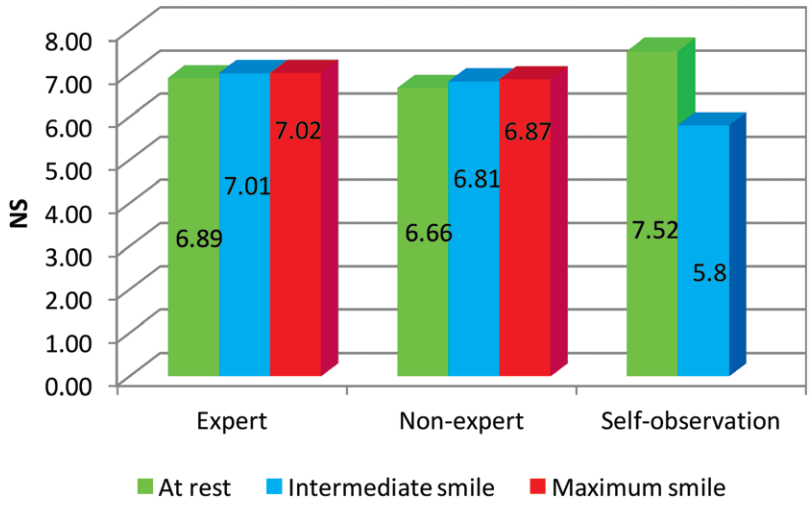

Fig. 3. Numeric scale (*NS*) results for experts, nonexperts, and patients.

Table 4. Observers' Conformity Assessment for the Numeric Scale in Different Conditions*

Condition	ICC	95% CI
Experts ($n = 4$)		
At rest	0.3023	0.1605–0.4717
Intermediate smile	0.5772†	0.4374–0.6925
Maximal smile	0.5425†	0.3483–0.684
Nonexperts ($n = 4$)		
At rest	0.2883	0.0716–0.4608
Intermediate smile	0.3313	0.1454–0.5346
Maximal smile	0.5721†	0.3053–0.7951
Both groups ($n = 8$)		
At rest	0.249	0.1284–0.4115
Intermediate smile	0.4409	0.3146–0.5846
Maximal smile	0.5238†	0.3761–0.695

ICC, intraclass correlation coefficient.
*At rest, numeric scale at rest; intermediate smile, numeric scale at intermediate smile; maximum smile, numeric scale at maximum smile. Experts (two ear, nose, and throat surgeons; one neurophysiologist; and one speech therapist) and nonexperts, $n = 4$ in both groups.
†Statistically significant ($p < 0.05$).

Table 5. Observers' Conformity Assessment for Terzis and Noah Classification in Different Conditions*

Condition	Kappa	95% CI
Experts ($n = 4$)		
Intermediate Terzis	0.2981	0.2594–0.6671
Maximum Terzis	0.0973	0.0308–0.5056
Nonexperts ($n = 4$)		
Intermediate Terzis	0.1784	0.0875–0.4444
Maximum Terzis	0.286	0.289–0.7586
Both groups ($n = 8$)		
Intermediate Terzis	0.1858	0.2559–0.5145
Maximum Terzis	0.1835	0.2005–0.5603

Intermediate Terzis, Terzis and Noah scale result at intermediate smile; maximum Terzis, Terzis and Noah scale result at maximum smile.
*Experts (two ear, nose, and throat surgeons; one neurophysiologist; and one speech therapist) and nonexperts, $n = 4$ in both groups.

smile state and among nonexperts for the maximum smile state (kappa = 0.29). The interrater agreement was very low according to the Terzis and Noah classification.

Global Patient Satisfaction Scale

None of the patients were "not satisfied" by the surgical results. Patients were "very satisfied" or "satisfied" in 87.5 percent of cases considering smile symmetrization.

Correlation between Objective and Subjective Measures

Correlations between objective measures and subjective evaluation were not statistically significant for at rest and for intermediate smile states. At the maximum smile state, numeric scale by experts and delta vertical variation were associated ($r = -0.4528$, $p = 0.0393$) (Table 6), and a tendency for association between numeric scale by experts and delta horizontal variation was observed ($r = -0.415$, $p = 0.0614$) (Table 6).

Table 6. Correlations between Preoperative/Postoperative Objectives Measures and Numeric Scale at Maximum Smile for Each Observer Group

	Experts' NS		Nonexperts' NS	
Measurement	*r*	*p*	*r*	*p*
HS	−0.357	0.1121	−0.3529	0.1166
AS	0.144	0.5335	0.0144	0.9507
ΔH	−0.415	0.0614†	−0.2346	0.3059
ΔV	−0.4528†	0.0393†	−0.3811	0.0883

NS, numeric scale; *r*, coefficient correlation; Hs, healthy side; As, affected side; ΔH, delta horizontal; ΔV, delta vertical.
*Experts (two ear, nose, and throat surgeons; one neurophysiologist; and one speech therapist) and nonexperts, $n = 4$ in both groups.
†Statistically significant ($p < 0.05$).

Table 7. Correlations between Preoperative/Postoperative Objectives Measures and Terzis and Noah Scale at Maximal Smile for Each Observer Group and Global Satisfaction Scale*

Measurement	Experts' T&N (*p*)	Nonexperts' T&N (*p*)	Global Satisfaction Scale (*p*)
HS	0.2022	0.3309	0.3262
AS	0.6618	0.2711	0.6582
ΔH	0.5296	0.305	0.0175†
ΔV	0.354	0.354	0.0185†

T&N, Terzis and Noah scale; *r*, coefficient correlation; Hs, healthy side; As, affected side; ΔH, delta horizontal; ΔV, delta vertical.
*Experts (two ear, nose, and throat surgeons; one neurophysiologist; and one speech therapist) and nonexperts, $n = 4$ in both groups.
†Statistically significant ($p < 0.05$).

The greater the variation between preoperative and postoperative delta horizontal and delta vertical at maximum smile, the more the numeric score by experts is high. At the maximum smile state, no correlation between Terzis and Noah classification variations and objective measure variations was observed ($p > 0.05$) (Table 7).

At the maximum smile state, for self-evaluation, the global satisfaction scale was associated with delta vertical variation ($p = 0.0185$) and delta horizontal variation ($p = 0.0175$). The greater the variation between preoperative and postoperative delta horizontal and delta vertical at maximum smile, the more the patient is satisfied with the surgical outcome.

DISCUSSION

Muscle transfer treatment is recommended by most authors when facial nerve repair is impossible (e.g., impaired extracranial integrity of the facial nerve) or when the duration of facial paralysis exceeds 4 years. It is therefore necessary

to supplement the facial muscles by providing a functional muscle. The lengthening temporalis myoplasty requires a single process step, allowing the production of mandibular movements necessary for an independent smile with a low incidence of complications. Cortical plasticity gives hope for obtaining a spontaneous smile in a few cases. The other advantage is the possibility of a fair procedure rehabilitation after tumor resection or even at the same time. A specific contraindication is the trigeminal nerve, the motor nerve of the temporal muscle. Other contraindications are similar to those for free transfer muscles (e.g., precarious condition, hemostatic disorder, lack of motivation). We note that the main drawbacks are alopecia and scar hypertrophy on the nasolabial fold. It may appear as a small temporal depression (two cases) and on operated side can stay edematous for a long time. The patient will then carry out a specific massage and rehabilitation protocol. Finally, it may be necessary to carry out, under local anesthesia, an adaptation of the temporal muscle tendon on the lip. In the treatment of peripheral facial paralysis, this technique will be associated with a correction of the lid malocclusion.

Free muscle transfer has the advantage of providing a more physiologic reinnervation to restore a spontaneous and emotional smile. This type of surgery is intended to restore a coordinated contralateral hemifacial smile but presents with the main disadvantages of being complex (nerve microsurgery and vascular surgery), has various results, and requires surgical revisions despite the two-stage procedure. The risk of complications is greater and is experience-dependent. Thus, lengthening temporalis myoplasty appears to be a safe method of smile rehabilitation. Consistency of objective and subjective evaluation of facial symmetry before and after lengthening temporalis myoplasty is important.

We have shown in this study that when performing smile restoration with lengthening temporalis myoplasty, changes in objective measurements on patients' face photographs could be observed. However, in our study, subjective evaluation of results with the Terzis and Noah classification had a low reproducibility in groups composed of experts or nonexperts. We have observed better conformity among observers with the numeric scale at the maximum smile state. In this state, good agreement could be observed among experts and nonexperts (intraclass correlation coefficient, 0.52). Finally, preoperative versus postoperative modifications of objective measurements such as delta horizontal and delta vertical were correlated with the numeric scale and the global patient satisfaction scale in this series.

Among the many dynamic procedures used to perform facial palsy reanimation, lengthening temporalis myoplasty seems to be an excellent technique with which to restore smile. Analysis of objective criteria to evaluate results shows that the healthy side is not modified, whereas the affected side benefits from a reduction of delta horizontal and delta vertical and a higher affected side, in every state (at rest, at intermediate smile, and at maximum smile). This result is consistent with the goals of lengthening temporalis myoplasty and fully assesses the symmetrization of the lower third of the face.

These objective evaluation measurements should be correlated with subjective evaluation tests. Smile is characterized not only by its symmetry but also by a facial expression that can be recognized by a third party or the patient himself or herself. Therefore, its evaluation remains subjective, but requires the definition of objective criteria (e.g., to compare surgical techniques). Many quality-of-life questionnaires for patients having a facial palsy have been reported.[11,12] In 1997, Terzis and Noah[6] reported 100 patients operated on with a free muscle transfer. They proposed a five-stage classification to compare preoperative and postoperative smiles. Considering lengthening temporalis myoplasty, many authors report good results with low complications and a natural smile, without analyzing their results using specific objective measurements or patient satisfaction scales.[13,14]

Many objective measurement techniques have been developed to evaluate facial symmetry of facial palsy patients and treatment efficacy.[4,15] These techniques are usually time-consuming and require costly devices such as computers, cameras, and analysis software. Frey et al. have reported one of these devices requiring a mirroring system to perform a synchronized analysis of the face.[4] To our best knowledge, this device has not been commercialized or used in routine practice by other teams. This technique allows very complex and precise measurements; however, these measurements cannot be analyzed in real time. Ueda et al.[16] have reported their results after a cross-face free muscle transfer technique in children, but a preoperative/postoperative comparison has not been reported as performed in other studies.[17,18] This objective measurement technique has never been used to evaluate lengthening temporalis myoplasty before.

Paletz et al.[19] and Manktelow et al.[5] have reported a simple technique to evaluate smiling quality with a ruler. Five landmarks are drawn on the upper lip. When placing the ruler on these points at rest, their maximal displacements can be measured. These measurements can be compared with data acquired with software dedicated to facial reanimation. A strong correlation between manual and computed measures could be found, suggesting that simple measurements with a ruler could be an efficient technique for evaluating smile of facial palsy patients. Based on this work, we report a simple technique that can used in routine practice to evaluate surgical results of lengthening temporalis myoplasty for smiling quality. It is fast (<10 minutes) and requires only a ruler and preoperative and postoperative photographs.

Subjective scales have, by their very nature, a certain degree of inaccuracy and a lack of reproducibility with which to evaluate the results. The numeric scale and the Terzis and Noah scale had a low observer assessment conformity and low metrologic quality to evaluate smile symmetrization for the at rest and intermediate smile states. However, we have observed that conformity improved for the maximal smile state according to the numeric scale but not for the Terzis and Noah scale. This could be explained by a lack of training using this scale by expert and nonexpert observers.

Because of the lack of conformity among observers with subjective scale, our study did not show any strong correlation between objective measures and subjective results. However, we have found that patient satisfaction was related to delta vertical and delta horizontal improvement. The patient's attention might naturally focus on delta vertical and delta horizontal variation that should reach zero postoperatively.

On the numeric scale, subjective answers range from 0 to 10 and might not in theory be adapted to aesthetic evaluation in this context. Thus, the mean rating attributed by the patients was 5.8, whereas more than 87 percent of the patients were "satisfied" or "very satisfied" with the surgical result. The main limitation of the numeric scale is that it does not take into account the feelings and personal history of the patients. We chose this grading system for simplicity of use. We have found the highest conformity among observers, particularly for maximum smile state evaluation. The numeric scale was also correlated to objective measurements (delta horizontal and delta vertical) to evaluate the maximum smile state among professionals. In our opinion, smile symmetrization measurements in the vertical (delta vertical) and horizontal planes (delta horizontal) are good indicators for evaluating the benefits of lengthening temporalis myoplasty.

One of the limitations of lengthening temporalis myoplasty is the rehabilitation of patients with a wide smile. Our results show that most of our patients had an overcorrection in the at rest state (postoperative delta horizontal, −1.06 mm). Thus, it seems impossible to enhance postoperative delta horizontal and delta vertical at the intermediate smile and maximal smile states, with a larger correction, that could potentially yield to an unwanted asymmetry at rest. In our opinion, optimization of postoperative delta horizontal and delta vertical can only be obtained by weakening the contractile capacity of contralateral muscles with botulinum toxin injections. In our study, we did not assess muscular atrophy on the impact of postoperative results. However, in our study, we considered our group homogenous and we compared the postoperative result to the preoperative result in the same patient. Thus, we did not evaluate the role of muscular atrophy in each patient. In a second study, we could use our evaluation method to study the impact of muscular atrophy on the results of facial palsy rehabilitation. Finally, the lengthening temporalis myoplasty provides a voluntary smile, unlike a free muscle transfer and a cross-face nerve transfer from which more spontaneity is hoped for. However, as demonstrated Blanchin et al. in 2013,[20] because of the mirror method, we can hope to obtain a spontaneous smile.

The limited size of our series and observer groups could also limit correlation between objective and subjective measures in this retrospective study. A prospective study of a larger number of cases would be interesting for confirming the value of changes in delta vertical and delta horizontal at the maximum smile state.

CONCLUSIONS

Facial palsy reanimation is a surgical challenge, and a symmetric and natural smile is the ultimate expectation for the patient. Among the many reported techniques for facial reanimation, lengthening temporal myoplasty has many advantages with good results. To better evaluate surgical results, we propose two objective measurements on preoperative and postoperative photographs assessing symmetrization in the vertical (delta vertical) and horizontal planes (delta horizontal). These parameters for maximal smile are

promising, as they were correlated with a patient satisfaction scale and experts' evaluation with a numeric scale.

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PATIENT CONSENT

Patient provided written consent for the use of patient's images.

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