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Lengthening temporalis myoplasty and reduction of the swallowing oral phase dysfunction in facial palsy patients

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Lengthening temporalis myoplasty;
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Abstract *Introduction:* Facial palsy can cause dysfunction in the oral phase of swallowing. Lengthening temporalis myoplasty is a widely used technique for correction of facial asymmetry in facial palsy. The aim of this study was to determine whether lengthening temporalis myoplasty could reduce the dysfunction in the oral phase of swallowing in patients with facial palsy.

Materials and Methods: This prospective study enrolled 13 patients undergoing lengthening temporalis myoplasty. Lip continence, bolus residue, and perceived disability before surgery and at 3 months and 6 months after surgery were compared. Lip force was evaluated with a manometric test and drooling with a self-administered questionnaire. Bolus residue was assessed visually. Perceived disability was evaluated using a self-administered questionnaire.

Results: Lip force improved significantly (from 58.23 ± 23.35 mmHg to 91.15 ± 18.36 mmHg; $p = 0.001$). Drooling showed a corresponding reduction, with the score decreasing from 4.31 ± 1.8 to 3 ± 1.41; $p = 0.025$. A decrease in bolus residue was also noted; the score decreased from 1.39 ± 0.77 to 0.46 ± 0.66; $p < 0.001$. These changes contributed to a significant reduction in perceived physical disability; the score decreased from 6.15 ± 3.74 to 3.46 ± 5.70; $p = 0.004$).

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Conclusion: Lengthening temporalis myoplasty, in addition to providing smile reanimation, may also reduce the dysfunction of the oral phase of swallowing in patients with facial palsy.

Introduction

Facial palsy (FP), which may be due to various causes, has an incidence of 50 per 100,000 people per year.[1,2] Paralysis of the facial muscles can have a major impact on esthetics and function. The facial nerve innervates the buccinator, orbicularis oris, risorius, and zygomatic muscles, all of which have important roles in the oral phase of swallowing.[2-5] Many studies have confirmed that patients with FP experience swallowing problems. De Swart et al.[6] found that patients with peripheral facial nerve palsy develop eating and drinking problems immediately after disease onset. Seçil et al.[7] reported that 79% of patients with FP have difficulties in managing food in the mouth and 55% have swallowing dysfunction on electrophysiological analysis. Moverare et al.[8] also reported swallowing problems in 48% of their patients. Both De Swart et al.[6] and Moverare et al.[8] found that the discomfort level during eating is not linked to the FP severity.

Most patients recover from FP. Facial nerve palsy persisting for $\geq$18 months is considered permanent.[2,9] Various surgical techniques have been used to restore the lower face in patients with permanent FP.[10] Currently, one of the most frequent procedures is the lengthening temporalis myoplasty (LTM), which was first described by Labbé,[11] even if the gold standard remains the neurotized gracilis.[12] LTM has undergone many modifications[13] since its introduction and has proved its efficiency in esthetic restoration and lips reanimation.[9]

The aim of this study was to determine whether LTM could improve the oral phase of swallowing in patients with FP. To answer this question, we have proceeded as follows: we quantified the swallowing disorder by measuring lip force, drooling, bolus residue, and perceived disability. The total follow-up was 6 months, with intermediate checkpoints of swallowing at 3 and 6 months.

Materials and methods

Patients

This prospective single-institution study was conducted at the Maxillofacial Surgery Department of Tours University Hospital, France, between September 2017 and June 2018. The inclusion criteria were all the patients over 6 years old who had been operated using LTM and who had permanent FP with a Freyss test measuring severity less than 15. For the exclusion criteria, all patients with potential impact on swallowing, such as TMJ disorder or psychiatric diseases, were excluded from our study. Finally, 13 patients were included in our study; 12 patients had definitive FP for >18 months and one patient had FP due to facial nerve sectioning, with no prospect of short-term recovery. The etiologies included neurinoma of cranial nerve VIII ($n=4$), meningioma of the cerebellopontine angle ($n=1$), congenital FP ($n=3$), Bell palsy ($n=1$), parotidectomy ($n=2$), shingles ($n=1$), and cavernoma bleeding ($n=1$). All enrolled patients underwent preoperative electromyogram of the facial and temporalis muscles to confirm the diagnosis of FP and to ascertain normal functioning of the temporalis muscle.

Informed consent was obtained from each patient before inclusion in the study. The regional Ethical Review Board in Caen, France (RIPH3-RNI17/MATPF), approved the study protocol.

Surgery

All 13 patients underwent LTM by the Labbé technique;[9] the same surgeon performed all operations. The temporalis muscle was entirely extracted from its fossa, and then, osteotomy of the zygomatic arch was performed. The temporalis muscle tendon was spread out along the length of the nasolabial fold, trying to respect the preoperative smile analysis. To avoid elevation of the lip commissure at rest, the temporalis muscle was reintegrated without stress in the temporal fossa. After these procedures, the muscle operated as a cutaneous muscle. A coronal approach was adopted for LTM because it allows access to the corrugator and contralateral frontalis muscle to perform myectomies and facilitates ipsilateral scalp resection to lift the eyebrow. No patient received botulinum toxin during the study period.

Physiotherapy

After surgery, all patients underwent intensive postoperative reeducation under the supervision of a physiotherapist with specialization in orofacial rehabilitation. Physiotherapy started on the fourth postoperative day with measures to improve lymphatic drainage and limit postoperative edema. From the 21st postoperative day onward, physiotherapy focused on a softening massage of the nasolabial fold scar and the retraining of the temporalis muscle to develop a natural smile. The Maxillofacial Surgery Department protocol includes 3 steps.

The first one is the temporal mandibular smile, i.e., the patients have to clench their teeth in front of a mirror in order to smile. The exercises must not be painful (short and smoothly). The patients are also asked to perform the exercises at home, 5–6 times a day. This step lasts for approximately 2 months, once a week with a physiotherapist.

The second step is the voluntary temporal smile. The patients must think of contracting the temporal muscle without clenching their teeth to smile. Exercises of muscular

Figure 1 A. A 9-year-old patient with a right congenital facial palsy. We can notice the asymmetric smile. B. At 6 months postoperation, the smile is spontaneous and symmetric.

Figure 2 Photography of the technique used to measure the lip force.

relaxation and symmetric and asymmetric smile contraction are also performed twice a week with a physiotherapist, and 5 self-exercises per day. This step lasts for approximately 2 months.

The last step is the spontaneous smile (Figure 1). The patients must not think to smile. They work role-playing with the physiotherapist (reading aloud and whistle). The facial expressions are made on order, in imitation, or in situation. The patient works with the physiotherapist once every 3 weeks.

No special re-education for swallowing was provided.

Evaluation of swallowing

The oral phase of swallowing extends from the moment the food passes into the mouth until it enters the pharynx. It is a voluntary phase. Patients were evaluated using self-administered questionnaires and clinical tests (performed by an otolaryngologist specialized in swallowing problems). The patients were followed up for 6 months after surgery with evaluations conducted at three checkpoints: before surgery, at 3 months after surgery, and at 6 months after surgery.

Two key aspects of the oral phase of swallowing were evaluated: lip continence and mastication efficiency. Lip continence was evaluated through a clinical test. There is no gold standard test for assessing lip continence.[14] In our study, the patients were asked to contract lips forcefully on a breathing tube balloon linked to a manometer to measure the lip force (in mmHg) (Figure 2). Lip continence was also assessed using a self-administered questionnaire—the Drooling Severity and Frequency Scale (DSFS),[15] which is used in Parkinson disease. With this questionnaire, drooling severity can be graded on a scale of 1-5 (1 = never, 2 = mild, 3 = moderate, 4 = severe, 5 = profuse) and drooling frequency on a scale of 1-4 (1 = never, 2 = occasionally, 3 = frequently, 4 = constantly). The total drooling score is the sum of the severity and frequency subscores.

Mastication efficiency was evaluated by having the patient chew a standardized cracker on the paretic side. The mastication time was recorded, and the bolus residue at the end of mastication was assessed visually. On this test, the score can range from 0 to 4 (0 = no residue, 1 = residue $<^1/_4$, 2 = residue between ¼ and ½, 3 = residue between ½ and ¾, 4 = residue $>^3/_4$).

Disability was evaluated using the self-administered Deglutition Handicap Index (DHI) questionnaire, which includes 30 questions for evaluating three aspects of disability (physical, functional, and emotional/social). Each question is scored on a scale of 0-4 (0 = never, 1 = almost never, 2 = sometimes, 3 = almost always, 4 = always). The maximum possible score is 120. The handicap is considered slight if the score is <30, moderate if the score is 31-60, and severe if the score is >61.

Statistical analysis

For each test, the mean and the standard deviations were calculated. The measurements were compared using the Wilcoxon test for paired series (Wilcoxon signed-rank test). Data were analyzed with R software (http://www.R-project.org/); α error of 5% was considered acceptable.

Results

Demographic data

A total of 13 patients (7 females, 6 males) with a mean age of 49 years (range, 9-80 years) were enrolled in this study (Table 1). One of the patients did not attend the follow-up at 3 months after surgery; nevertheless, we included the patient in the analysis.

Lip continence

Lip continence showed steady improvement with time after surgery. The manometric scores were 58.23 ± 23.35 mmHg before surgery, 74.33 ± 20.92 mmHg at 3 months after surgery, and 91.15 ± 18.36 mmHg at 6 months after surgery (Figure 3). The differences from baseline were statistically significant at both time points after surgery ($p = 0.011$ at 3 months and $p = 0.001$ at 6 months).

Drooling

Drooling showed a steady decrease after surgery. The mean DSFS was 4.31 ± 1.8 before surgery, 3.83 ± 1.85 at 3 months after surgery, and 3.0 ± 1.41 at 6 months after surgery (Figure 4). The difference from baseline was not significant

Table 1 Cohort characteristics.

Patient	Sexe	Age (y)	Etiology	Duration of palsy (months)
1	M	56	Right acoustic neurinoma	23
2	M	9	Congenital facial Palsy	108
3	F	66	Right acoustic neurinoma	20
4	F	10	Congenital facial Palsy	120
5	M	10	Congenital facial Palsy	120
6	M	72	Right acoustic neurinoma	144
7	F	58	Left Facial palsy zona	19
8	F	47	Left Facial palsy of Charles Bell	60
9	M	80	Left parotidectomy	18
10	F	64	Left acoustic neurinoma	11
11	F	59	Left cerebral meningioma	19
12	F	54	Right cerebral cavernoma hemorrhage	23
13	M	53	Right parotidectomy	18

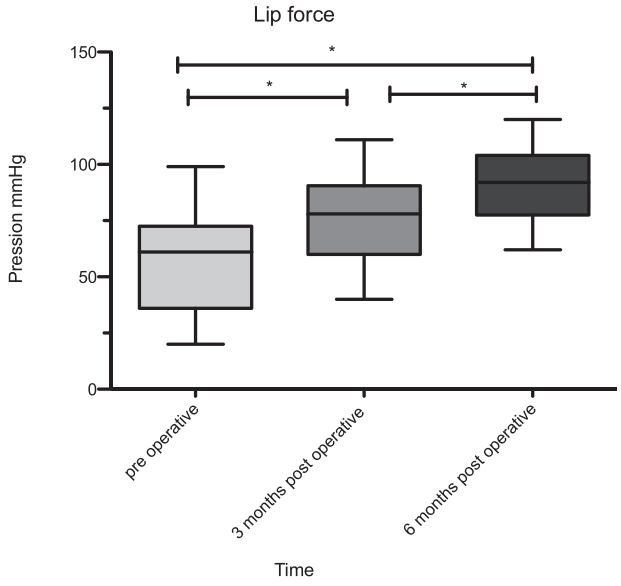

Figure 3 Lip force results
Average with 95% confidence interval and minimal and maximal values at the 3 checkpoints of the lip force. The average increases up significantly between preoperation and 6 months postoperation ($^*p < 0.05$).

at 3 months ($p = 0.275$); however, at 6 months, the difference was statistically significant ($p = 0.025$).

Mastication

The bolus residue at the end of mastication showed a steady decrease over time. The mean score was 1.39 ± 0.77 before surgery, 0.75 ± 0.75 at 3 months after surgery, and 0.46 ± 0.66 at 6 months after surgery (Figure 5). The difference from the baseline value was statistically significant at 3 months and 6 months ($p = 0.003$ and $p < 0.001$, respectively).

The mean mastication duration was 3.52 ± 1.52 min before surgery, 3.28 ± 1.37 min at 3 months after surgery, and 3.30 ± 1.50 min at 6 months after surgery. The changes in mastication duration did not show statistically significant difference ($p = 0.10$ at 3 months and $p = 0.12$ at 6 months)

Disability

The overall mean DHI score was 12.31 ± 9.51 before surgery. The scores for the individual components were as follows: 6.15 ± 3.74 for physical disability, 2.62 ± 3.57 for functional disability, and 3.54 ± 4.79 for social handicap.

At 3 months after surgery, the mean overall DHI score was 9 ± 10.85. The score for the individual components of disability was as follows: 4.08 ± 5.21 for physical disability, 1.59 ± 2.43 for functional disability, and 3.33 ± 5.99 for social disability.

At 6 months after surgery, the mean overall DHI score was 8.69 ± 16.35. The scores for the individual components were as follows: 3.46 ± 5.70 for physical disability, 1.92 ± 4.41 for functional disability, and 3.31 ± 6.68 points for social disability.

The changes in total DHI score from baseline values were not significant at 3 months or at 6 months after surgery ($p = 0.098$ and $p = 0.104$, respectively). However, the change in the physical handicap score was significant at both time points ($p = 0.032$ at 3 months and $p = 0.004$ at 6 months) (Figure 6). The changes in functional ($p = 0.11$ at 3 months and $p = 0.18$ at 6 months) and social ($p = 0.28$ at 3 months and $p = 0.46$ at 6 months) disabilities were not statistically significant.

Discussion

This prospective study aimed to evaluate whether LTM could improve different aspects of the oral phase of swallowing (lip continence, mastication, and disability) in patients with FP. We found that the technique of LTM significantly improved lip force and reduced drooling at 6 months after surgery and thus reduced physical disability in patients with FP.

Preoperatively, patients in this study presented swallowing problems. The main complaint was drooling due to labial incompetence on the side of the palsy. The majority of pa-

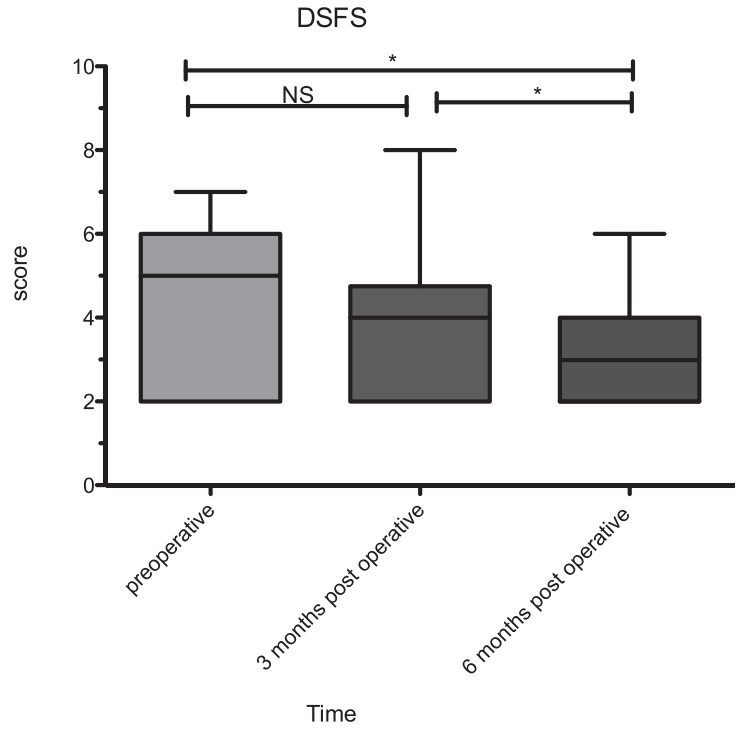

Figure 4 DSFS results
Average with 95% confidence interval and minimal and maximal values at the 3 checkpoints of the DSFS results. The average decreases significantly between preoperation and 6 months postoperation ($^{*}p < 0.05$).

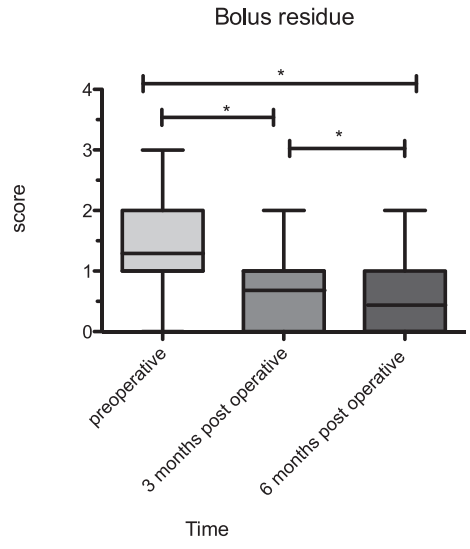

Figure 5 Bolus residue results
Average with 95% confidence interval and minimal and maximal values at the 3 checkpoints of the Bolus residue results. The average decreases significantly between preoperation and 6 months postoperation ($^{*}p < 0.05$).

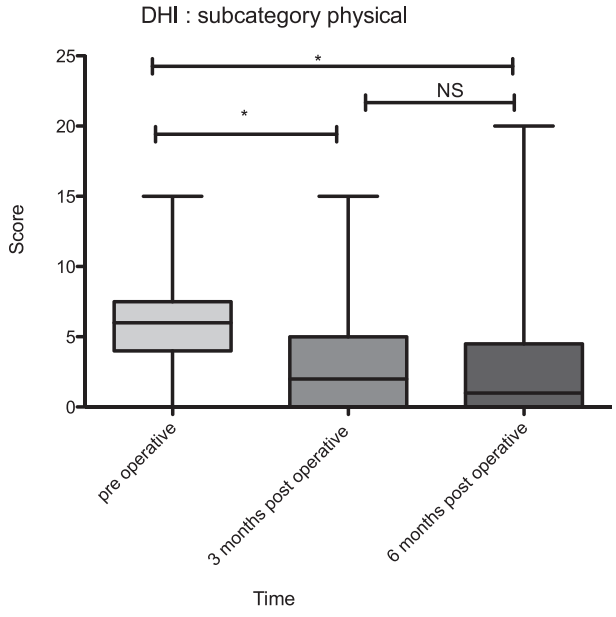

Figure 6 DHI: subcategory physical results
Average with 95% confidence interval and minimal and maximal values at the 3 checkpoints of the DHI results (subcategory physical). The average decreases significantly between preoperation and 6 months postoperation ($^{*}p < 0.05$).

tients ($n = 9$) had a score of >4 on the DSFS, indicating frequent episodes of moderate drooling. Oral bolus residue after swallowing was increased because of the failure of the buccinator muscle to play its role of pushing food back from the vestibule. A total of 12 patients continuously presented a bolus residue.

At 3 months after surgery, 10 patients showed increase in lip force and 2 of them showed decrease in lip force. Drooling improved in 5 patients, was unchanged in another 5, and was worse in 2.

In one patient, the worsening of symptoms was due to a scarring retraction of the nasolabial fold, which aggravated the lip incontinence. Bolus residue decreased in 8 patients and was unchanged in 4; no patient had increase in bolus residue. Disability perception was decreased in most of the patients ($n = 9$). At 3 months after surgery, re-education of the temporalis muscle, which is a masticatory muscle, was still in its early stage, and patients had not yet developed a spontaneous smile.

At 6 months after surgery, the results were more satisfactory. *Re*-education was continuing, and patients had developed spontaneous smiles. Lip force was improved in 12 patients. The mean lip force value was 91.15 mmHg, i.e., a 36% increase over the preoperative value. The patient with the scarring complication was the only one who did not show improvement in lip force. Drooling was decreased in 7 patients and unchanged in 5; however, the latter group admitted that the frequency of drooling incidents was reduced. The DSFS score was $\leq$4 in 11 patients (mild drooling). Bolus residue after mastication also showed marked decrease in 11 patients; 8 patients had a score of 0. Disability was decreased in 9 patients, with 5 of them having a score of 0. Only the patient with scarring complication continued to have moderate handicap. The mean total score was 8.69, i.e., a fall of 30% from baseline. The mean physical handicap score decreased by 44%; the scores for functional and social handicap did not show much change.

The discrepant results compared to results of series for some patients can be explained by the age (80 years old). Hembd et al.[16] reported that LTM is not as successful for restoration of smile in patients >70 years of age as it is in younger patients. It is possible that the effect of LTM on swallowing follows a similar pattern. Moreover, the benefits of this surgery are closely linked to proper re-education, and all patients may not show the same dedication.

Our findings are consistent with those given in earlier reports. Byrne et al.[17] used a different surgical technique—transfer of the temporal muscle tendon to the lip commissure—and reported satisfactory improvement in swallowing in patients with FP. The authors also reported improvement in food satisfaction (as assessed with a self-administered questionnaire). Choi et al.[3] used electrical stimulation of facial muscles and reported improvement in swallowing efficiency.

Starmer et al.[5] showed that FP reduces lip force by approximately 69%, thereby leading to bolus leakage. He also demonstrated that hyaluronic acid injections to restore volume increased lip force on the palsy side by approximately 1.4 times, but it was still inferior to the healthy side. This finding is consistent with that reported in our study in which LTM increased lip force by a mean of 1.55 times. Panciera et al.[18] assessed disability using the Facial Disability Index (FDI) and demonstrated significant improvement in disability, with the FDI score increasing from 33.4 points to 49.9 points, i.e., an improvement of 33% ($p < 0.001$)

These results are concordant with our study results, in which the DHI scores fall from 12.3 points to 8.69 points, i.e., a reduction of 30%.

Laure et al.[19] reported improvement in dysarthria in patients with FP after LTM, proving that the technique has an impact on multiple aspects of FP, including esthetics, phonation, and feeding. Rozen et al.[20] used an alternative technique—gracilis free neuromuscular flap innervated by the masseteric nerve—but found that many patients complain of involuntary contractions during mastication. Therefore, for all these reasons and the fact that the LTM according to Labbé presents a reduced operating time and less comorbidities, we use preferably this technique in our Department instead of the gracilis neurotized technique. Moreover, other positive points are a similar efficiency and reliability with no risk of failure related to microvascular anastomosis.[21,22]

This study has been conducted on a short-term period (10 months) with a limited number of patients enrolled because of the specificity of this surgery. As such, this is a limitation. Another limitation is the use of self-administered questionnaires including a part of subjectivity in the answers. The visual assessment of the bolus residue is also a potential bias.

Conclusion

LTM followed by orofacial reeducation may reduce the dysfunction in the oral phase of swallowing. The findings of this study need to be confirmed in larger prospective studies with long-term follow-up.

Conflict of interest

None.

Acknowledgment

We have adhered to the STROBE guidelines, and the study has been registered on ClinicalTrials.gov under No. CT03284125.

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