51. Nemergut EC, Zuo Z, Jane JA Jr et al. Predictors of diabetes insipidus after transsphenoidal surgery: a review of 881 patients. *J Neurosurg* 2005;103:448–454
52. Patel SK, Christiano LD, Eloy JA, et al. Delayed postoperative pituitary apoplexy after endoscopic transsphenoidal resection of a giant pituitary macroadenoma. *J Clin Neurosci* 2012;19:1296–1298

Electromyographic Evaluation of Temporalis Muscle Following Temporalis Tendon Transfer (Facial Reanimation) Surgery

Orhan Ozturan, MD, Berke Ozucer, MD,**
and Azize Esra Gursoy, MD†

Abstract: Facial paralysis is a significant functional and aesthetic handicap. Many techniques have been defined for facial reanimation. The aim of the study was to evaluate postoperative electromyographical (EMG) activity of temporalis muscle to assess the potential neural impairments related to the surgical procedure.

Methodology: Four patients with facial paralysis were operated with the temporalis muscle tendon transfer technique. Simultaneous surface electromyographic (sEMG) activity at first postoperative year from the bilateral temporalis and masseter muscles was obtained at mandibular rest position and then during maximal clenching.

Results: Patients were followed for a minimum period of 18 months. Surface electromyographic evaluations during passive state revealed similar values for the operated and contralateral side. Measurements during active "clench-smiling" of the jaw revealed similar amplitudes for both muscles of the operated side in all cases except case #2. Case #2 revealed lower values for both measurements of temporalis and masseter muscles of the operated side compared with the contralateral side. Dissonant results of case #2 can be the consequence of impaired temporalis muscle activity because of the tension on the muscle as a consequence of overcorrection.

Conclusion: Temporalis muscle transfer to the perioral region does not hinder contractility of the muscle as long as the facial deformity is not overcorrected.

Key Words: Facial paralysis, facial reanimation, temporalis tendon transfer, electromyography

From the *Department of Otorhinolaryngology and Head and Neck Surgery, Bezmialem Vakif University; and †Department of Neurology, Bezmialem Vakif University, Fatih, Istanbul, Turkey.
Received October 8, 2014.
Accepted for publication June 28, 2015.
Address correspondence and reprint requests to Berke Ozucer, MD, Department of Otorhinolaryngology, Medical Faculty, Bezmialem Vakif University, Fatih, Istanbul, Turkey;
E-mail: berkeozucer@gmail.com
The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000002027

Facial paralysis is considered a significant functional and aesthetic handicap. It severely impairs mastication, speech production, and eye protection, but above all it deprives one of the essential means of mental and affective expressions: mimesis and the smile. Many operative techniques have been defined for facial reanimation. Rubin, Baker, and Conley popularized use of the temporalis muscle turn-down flap in reanimation of the paralyzed lower face in the early 1970s.[1,2] The classic technique of temporalis muscle transfer described by Rubin and others has the disadvantages of donor site depression and midfacial widening. In addition, it depends on a nonanatomic contraction of the transposed muscle segment. McLaughlin[3] described the orthodromic transoral technique for transferring the coronoid process with the attached temporalis tendon to the corner of the mouth. This process avoids the fullness over the zygomatic arch area and the temporal donor site depression that is produced by the turned-down temporalis muscle flap. Dynamic temporal muscle tendon transfer was recently reintroduced and refined by Boahene et al.[4]

As with the other muscles of mastication, control of the temporal muscle comes from the third (mandibular) branch of the trigeminal nerve. Specifically, the muscle is innervated by the deep temporal nerves. Thorough dissection and freeing of the temporalis muscle required for complete releasing and transfer of the tendon with the coronoid process is needed during this procedure. Temporalis tendon transfer necessitates to stretching of the tendon along with the coronoid to the perioral region. It is necessary to mobilize the temporalis muscle by performing releasing dissections over and below the muscle and tendon. Temporalis muscle innervation has the potential to be injured because of exposure, release, and transfer of the temporalis muscle tendon.

Surface electromyography (sEMG) has been reliably used to evaluate the functional status and innervation of the facial musculature after surgery. The aim of this study was to evaluate postoperative electromyographical (EMG) activity of temporalis muscle in comparison with the unoperated contralateral side.

PATIENTS AND METHODS

Four patients who had facial paralysis >2 years were operated with the temporalis muscle tendon transfer technique as reported by Boahene et al.[4]

Surgical Technique

Through the melolabial crease, an approximately 2-cm incision was made. Through this incision, dissection was bluntly performed in the buccal space, and deep retractors were placed to retain the buccal fat. By palpation and by manually opening and closing the jaw, the anterior edge of the ascending mandibular ramus was identified. Using an angled clamp, the mandibular notch was identified, and the coronoid process was exposed. Dissection was performed bluntly to expose the anterior edge of the ascending mandibular ramus. Using electrocautery, the periosteum was incised, and soft tissues enclosing the temporalis tendon were elevated from the medial and lateral aspects of the coronoid process and ascending ramus. The coronoid process was cut of using osteom and drill-burr at the level of incisura mandibula and kept attached with the temporal tendon. Temporalis tendon was isolated as medial as possible and down to the buccinator muscle to obtain adequate tendon length. The temporalis tendon was transposed through the buccal space and was secured to the orbicularis oris and zygomaticus muscle insertion. The tendon was then sutured into place with 3-0 taper mattress sutures.[4] Incisions were meticulously

FIGURE 1. Case #1: preoperative and postoperative photos—A, passive; B, smile; and C, eye closure. Facial reanimation (temporalis muscle dynamic tendon transfer and golden weight applied to left eyelid) as well as septoplasty (septal subluxation to left can be observed on preoperative photos) and Paniello suture applied for correction of left nasal valve deformity.

sutured with absorbable sutures following cauterization of bleeding sites.

Surface Electromyographic Recording

Postoperative sEMG of the temporalis muscles was recorded individually during rest and maximal clenching. Values were compared with healthy contralateral side: all the study participants underwent an sEMG recording with a commercially available device—a 4-channel electromyograph (Keypoint-Dantec, Skovlunde, Denmark). The patients were comfortably seated in a chair inside a room with a controlled temperature (22°C). After the skin was cleaned with 95% alcohol, the recording was performed by the use of silver/silver chloride bipolar surface electrodes (diameter 10 mm, interelectrode distance 21 ± 1 mm). The electrodes were placed bilaterally on the patient's skin overlying the anterior temporalis, vertically along the anterior muscular margin, approximatively over the coronal suture. For the masseter, the electrodes were placed parallel to muscular fibers, with the upper pole of the electrode at the intersection between the tragus–labial commissure and the exocanthion–gonion lines, perpendicular to the skin surface. A plate ground electrode was secured to the forehead.

FIGURE 2. Case #2: preoperative and postoperative photos—A, passive; B, smile; and C, eye closure.

FIGURE 3. Case #3: preoperative and postoperative photos—A, passive; B, smile; and C, D, profile. Facial reanimation (temporalis muscle dynamic tendon transfer and golden weight applied to right eyelid) as well as wide open septorhinoplasty operation to ptotic nose with thick skin.

Simultaneous sEMG activity from the bilateral temporalis and masseter muscles was obtained at mandibular rest position and then during maximal clenching. The patient was asked to clench the teeth as hard as possible, 10 times for 5 seconds, with 10-second relaxation between each clench. The tests were explained and shown to the patients, who practiced before actual data acquisition. By using the derived EMG, the root mean square (RMS) value in microvolts was calculated, using a data analysis system. For evaluation, the mean value of 10 recordings at resting position and 10 consecutive clenching cycles was recorded.[5]

RESULTS

Three patients were male and one was female (Figs. 1–4Figs. 1-4). Mean age was 40 years. Patients were followed for a minimum period of 18 months (Table 1), mean duration of follow-up was 21.0 ± 2.4 months. Patients were subjected to sEMG assessment at first postoperative year. Surface electromyographic evaluations during passive state revealed similar values of RMS and amplitude for the operated and contralateral side. Measurements during active "clench-smiling" of the jaw revealed either equal or slightly higher amplitudes for both muscles of the operated side in all cases except case #2 (Table 1) (Fig. 2). Case #2 revealed lower values for both measurements of temporalis and masseter muscles of the operated side compared with the contralateral side.

Ratio of amplitudes of temporal and massater muscles were calculated individually for each case (Table 2). All temporal-to-massater ratios, except case #2, in both the operated and contralateral side were ≤ 1 (Table 2). This value was 1.52 and 1.22 for operated and contralateral sides of case #2, respectively.

DISCUSSION

Temporalis tendon transfer necessitates to stretching of the tendon along with the coronoid to the perioral region. It is necessary to mobilize the temporalis muscle by performing releasing dissections over and below the muscle and tendon. The exposure, release, and transfer of the temporalis muscle insertion may cause impairment of temporalis muscle innervation. All surgical techniques have some drawbacks and shortcomings.

Results revealed unhampered activity of the temporalis muscle on the operated side. Mobilization and transfer of the temporalis

FIGURE 4. Case #4: postoperative photos—A, passive; B, smile; and C, eye closure.

TABLE 1. Comparison of Operated and Contralateral Side EMG values During Active "Clench-Smiling"

					Operated Side—Temporal Muscle		Contralateral Temporal Muscle		Operated Side—Massater Muscle		Contralateral Massater Muscle	
	Time Elapsed	Age	Sex	Operated Side	Amp.	RMS	Amp.	RMS	Amp.	RMS	Amp.	RMS
Case #1	24 mo	40	F	Left	430	189	394	177	430	190	409	185
Case #2	21 mo	36	M	Right	279	97	381	167	183	56	313	131
Case #3	21 mo	52	M	Right	398	171	354	149	421	177	429	184
Case #4	18 mo	30	M	Left	301	124	287	111	313	137	272	108

Amp., amplitude (microvolts); EMG, electromyographical; F, female; M, male; RMS, root mean squared.

TABLE 2. Comparison of Operated and Contralateral Temporal/Massater EMG Amplitude Ratios

	Operated Temporal/Massater	Contralateral Temporal/Massater
Case #1	1	0.96
Case #2	1.52	1.22
Case #3	0.95	0.83
Case #4	0.96	1.05

EMG, electromyographical.

muscle to the perioral region does not hinder contractility of the muscle as long as the facial deformity is not overcorrected.

In the presented photos of the operated patients (Figs. 1–4), case #2 presents with a slight overcorrection of temporal reanimation repair compared with other three cases (Fig. 2). Dissonant results of case #2 can be the consequence of impaired temporalis muscle activity because of the tension on the muscle. Therefore, we concluded overcorrection in these type of patients will limit the activity of temporalis muscle and adaptation to "clench-smiling."

CONCLUSION

Although dynamic muscle transfer may cause postoperative impairment of temporalis muscle activity, postoperative training for adaptation to "clench-smiling" and compensation of this impairment can yield satisfactory clinical and EMG results. Results revealed unhampered EMG activity of the temporalis muscle on the operated side. Mobilization and transfer of the temporalis muscle to the perioral region does not hinder contractility of the muscle as long as the facial deformity is not overcorrected. Overcorrection in these cases may limit the activity of temporalis muscle and adaptation to "clench-smiling."

REFERENCES

1. Rubin LR, ed. *Reanimation of the Paralyzed Face. Reanimation of the Paralyzed Face*. St Louis, MO: CV Mosby; 1977
2. Baker DC, Conley J. Regional muscle transposition for rehabilitation of the paralyzed face. *Clin Plast Surg* 1979;6:317–331
3. McLaughlin CR. Permanent facial paralysis: the role of surgical support. *Lancet* 1952;2:647–651
4. Boahene KD, Farrag TY, Ishii L, et al. Minimally invasive temporalis tendon transposition. *Arch Facial Plast Surg* 2011;13:8–13
5. Haughton JF, Little JW, Powers RK, et al. M/RMS: an EMG method for quantifying upper motoneuron and functional weakness. *Muscle Nerve* 1994;17:936–942

Characteristics of Maxillary Morphology in Unilateral Cleft Lip and Palate Patients Compared to Normal Subjects and Skeletal Class III Patients

Chanyuan Jiang, MD, Ningbei Yin, MD, Yilue Zheng, MD, and Tao Song, MD

Abstract: This study is to investigate the anatomical features of maxillae in unilateral cleft lip and palate (UCLP) patients with maxillary retrusion. Additionally, the dissimilarities of retruded maxillae between the UCLP patients and the skeletal class III patients were compared. Craniofacial measurements were carried out among 32 UCLP adult patients with maxillary retrusion (GC), 24 adult patients in class III (SNA $< 80^\circ$, ANB $< 0^\circ$) patients (GIII), and 32 normal controls (GN). The authors measured the width and length of the maxillae, as well as their relative positions to the coronal plane passing through basion. The independent sample group *t* test was performed, and $P < 0.05$ was regarded as statistically significant. In the GC group, the anterior and posterior maxillary length (A_1-$P_{3M}\perp$CP and P_{3M}-$P_{6M}\perp$CP) and overall maxillary length (A_1-$P_{6M}\perp$CP) at the dental level, the interdental widths of the maxillae, the maxillary volume (G_M), and the volume consisting of maxilla and maxillary sinus (G_T) significantly reduced compared with the GN group ($P < 0.05$). The distances from the points on the maxillae to the coronal plane ($A_1\perp$CP, $P_{3M}\perp$CP, and $P_{6M}\perp$CP) in

From the Center of Cleft Lip and Palate Treatment, Plastic Surgery Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China.
Received December 6, 2014.
Accepted for publication June 28, 2015.
Address correspondence and reprint requests to Tao Song, MD, Center for Cleft Lip and Palate Treatment, Plastic and Surgery Hospital, Chinese Academy of Medical Science, Peking Union Medical College, No 33, Ba-Da-Chu Rd, Shi Jing Shan District, Beijing 100144, China; E-mail: songtao2059@gmail.com
This work was supported by the Capital Medical Development Fund of China (Z141107002514095).
The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000002028