

Minimally Invasive Temporalis Tendon Transposition

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Objective: To describe a minimally invasive approach of the temporalis tendon transposition technique for dynamic reanimation in patients with long-standing facial paralysis.

Methods: We report a case series of 17 consecutive patients with facial paralysis who underwent minimally invasive temporalis tendon transposition surgery for dynamic facial reanimation between January 1, 2006, and December 31, 2008. The minimally invasive technique is described. Preoperative and postoperative records, photographs, and videos were reviewed for feasibility of the technique, symmetry, oral competence, and dynamic oral commissure movement.

Results: All the patients tolerated the procedure well, and none developed procedure-related complications. All

the patients achieved improved symmetry at rest and voluntary motion of the oral commissure. In all the patients, the temporalis tendon was transposed to the modiolus without the need for fascial extension or lengthening myoplasty.

Conclusions: The temporalis tendon can be transposed for immediate dynamic reanimation of the paralyzed lower face using a minimally invasive approach. This procedure involves a single small incision and minimal dissection, with no major osteotomies. Acquisition of desired facial movement requires intensive physiotherapy and a motivated patient.

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THE PRIMARY GOAL OF ALL FACIAL reanimation protocols is to restore facial movement that is controlled, symmetrical, and spontaneous. This is best achieved when neural input to the paralyzed facial muscles is reestablished by direct facial nerve repair. Successful reinnervation of the paralyzed face requires the presence of viable facial muscle fibers, functional motor end plates, and unfibrosed facial nerve conduits through which axonal regeneration can occur. When viable nerves or muscular units are unavailable for reinnervation, functionally innervated and vascularized regional muscles may be transferred to reproduce desired facial movements.



Video available online at www.archfacial.com

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Rubin¹ and Baker and Conley² popularized use of the temporalis muscle turn-down flap in reanimation of the paralyzed lower face in the early 1970s. The classic technique of temporalis muscle transfer described by Rubin and others has the disadvantages of donor site de-

pression and midfacial widening. In addition, it depends on a nonanatomic contraction of the transposed muscle segment. This temporalis sling procedure has undergone several refinements to improve functionality and aesthetic appearance. McLaughlin³ first described the transoral technique for transferring the coronoid process with the attached temporalis tendon to the corner of the mouth. This procedure avoids the fullness over the zygomatic arch area and the temporal donor site depression that is produced by the turned-down temporalis muscle flap. Several authors have highlighted the advantages of the transfer of the temporalis tendon in an orthodromic manner to reanimate the lower face.⁴⁻⁷ We previously described our experience with transfer of the temporalis tendon for dynamic facial reanimation.⁸ In this previous description, we used a technique that required a temporal incision and segmental removal of the zygomatic arch for exposure of the coronoid process and mobilization of the temporalis tendon. It was occasionally necessary to mobilize the temporalis muscle origin to reach the oral commissure. We subsequently found that this temporal dissection is unnecessary, and we



Figure 1. A 2-cm incision is planned in the melolabial crease based on the smile pattern and vector of pull on the unaffected side. A melolabial incision is chosen in patients with a deep contralateral crease. In patients without a melolabial crease, a transoral incision or approach is chosen.

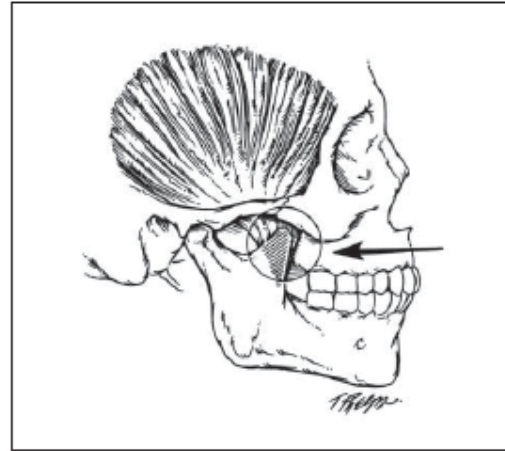


Figure 2. Transbuccal dissection provides direct access to the mandibular ramus and coronoid process.

have limited the technique to a single incision, and we approached the tendon from the nasolabial fold or transorally via a buccal sulcus incision. In this study, we describe our technique, minimally invasive temporalis tendon transposition (MIT3), for dynamic reanimation of the paralyzed lower face.

METHODS

PREOPERATIVE PREPARATION

The MIT3 technique is most commonly used for patients with long-standing facial paralysis in whom reinnervation techniques are impossible. Success critically depends on the functional capabilities of the temporalis muscle. This is best assessed by simple palpation of the patient's muscle belly with contraction.

The goal of facial paralysis treatment is to improve symmetry. This is of the utmost importance. Thus, the newly provided dynamic movement will be successful only if it is fairly symmetrical with the nonparalyzed side. Because the temporalis tendon transfer can elevate the oral commissure in only 1 dimension, it is important that the contralateral smile pattern is trained to mimic this. A "Mona Lisa" smile, in which the oral commissure is elevated by the zygomaticus musculature but no upper or lower lip elevation occurs to show the dentition, is the goal of facial retraining. This smile pattern is "practiced," linking the simple smile pattern of the contralateral side to a temporalis contraction on the involved side. The acquisition of a "temporal smile" is then the next goal, postoperatively. This is briefly described in the "Comment" section.

SURGICAL TECHNIQUE

Surgical Anatomy

The temporalis muscle is a fan-shaped muscle that originates from the temporal fossa and inserts onto the coronoid process of the mandible. The tendon starts high within the muscle in the form of a broad tendinous lamina that gradually thickens

and converges on the coronoid process. The muscle passes deep to the zygomatic arch with a glide plane between the muscle and the bone. The temporalis tendon wraps around the medial and anterior surfaces of the coronoid, extending down onto the anterior mandibular ramus. A small portion is seen on the lateral surface of the coronoid. Then, the tendon inserts on the medial and lateral surfaces of the coronoid process of the mandible. Most of the tendon is found on the medial aspect and extends inferiorly toward the buccinator line. The coronoid process can be directly approached through the buccal space. This approach requires a good understanding of the buccal space anatomy. The buccal space is bordered laterally by the superficial muscular aponeurotic system and facial mimetic muscles, medially by the buccinator muscle and buccal mucosa, and posteriorly by the masseter muscle and mandible. The buccal space is occupied mainly by the buccal fat pad, which has ligamentous projections to the buccinators, temporalis tendon, maxilla, and zygomatic arch. Except for the branch to the buccinator muscle, the facial nerve branches lie superficial to the buccal fat. Blunt dissection deep to the buccal fat, dividing the ligamentous projections to the buccinator and temporalis tendon, will lead to exposure of the coronoid process.

Marking the Patient

Preoperatively, the patient's smile pattern is determined, and a mimicking incision is planned by marking in the melolabial crease on the involved side (**Figure 1**). The desired vector of pull is then determined for attachment of the temporalis tendon.

INCISION AND BUCCAL SPACE DISSECTION

Through the melolabial crease, an approximately 2-cm incision is made. Through this incision, dissection is bluntly performed in the buccal space, and deep retractors are placed to retain the buccal fat. The ligamentous projections between the intermediate and posterior buccal fat lobes are bluntly divided, taking care not to violate the buccinator muscle and buccal mucosa. This way, oral contamination is avoided. By palpation and by manually opening and closing the jaw, the anterior edge of the ascending mandibular ramus is identified (**Figure 2**).

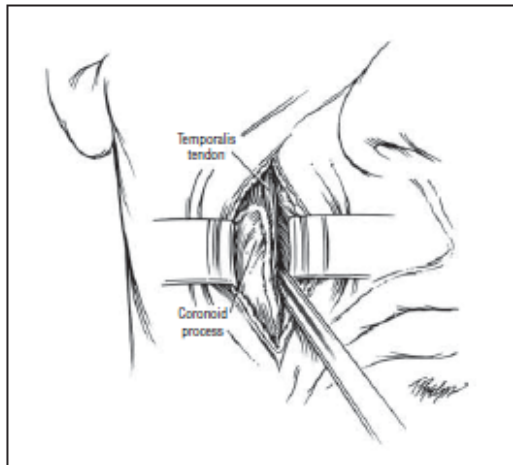


Figure 3. The temporalis tendon wraps around the coronoid process but has an extension along the mandibular ramus down to the buccinator ridge. To gain adequate tendon length, subperiosteal tendon dissection should be performed toward the buccinator ridge.

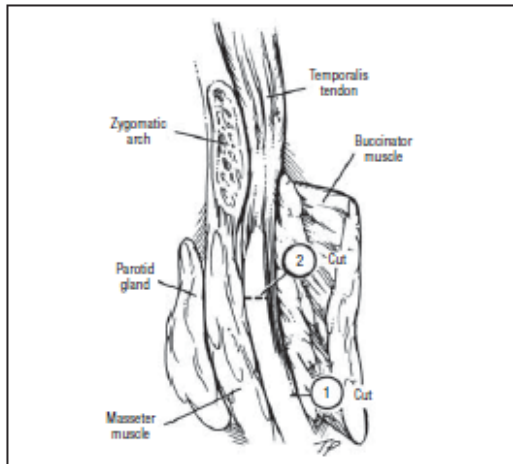


Figure 4. Osteotomy, performed at the neck of the coronoid process, allows mobilization of the temporalis tendon. 1 indicates incision in periosteum; 2, bone cut.

Using an angled clamp, the mandibular notch is identified, and the coronoid process is exposed. In patients with an indistinct melolabial crease, a buccal sulcus incision directly below the planned line of tendon insertion is used to gain access to the buccal space.

Isolation of the Temporalis Tendon and Coronoidectomy

Dissection is performed bluntly to expose the anterior edge of the ascending mandibular ramus. Using electrocautery, the periosteum is incised, and the temporalis tendon is elevated from the medial and lateral aspects of the ascending ramus (**Figure 3**). The tendon is kept attached to the coronoid process. Care is taken to isolate the temporalis tendon as medial as possible and down to the buccinator to obtain adequate tendon length. A reciprocating saw is used to divide the coronoid

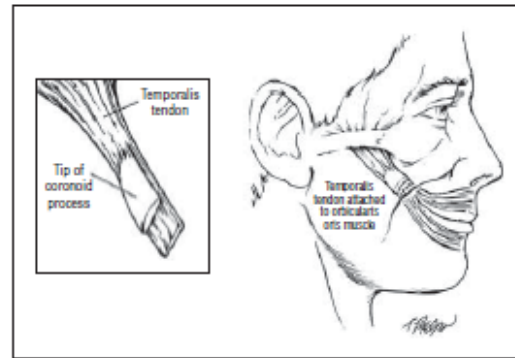


Figure 5. The temporalis tendon is transposed through the buccal space and is fixed at the modiolus based on the predetermined vector of smile.

process in an oblique manner, thus leaving as much of the tendon attached to the coronoid as possible. Before detaching the coronoid, a Kocher clamp is placed to prevent retraction. The temporalis tendon is detached as inferior as possible and is grasped with Allis forceps and retracted toward the melolabial incision (**Figure 4** and **Figure 5**).

Transposition and Insertion of the Temporalis Tendon

The temporalis tendon is transposed through the buccal space and is secured to the orbicularis oris and zygomaticus muscle insertion in the region of the modiolus. The tendon is then sutured into place in a horizontal mattress manner (**Figure 6**). The position of the tendon insertion is determined by the pre-operative smile pattern. The tendon may be unfurled to attain width for suturing across a broader plane. To aid in establishing the appropriate tension on the transposed tendon that maximizes muscle excursion, the temporalis muscle may be stimulated through surface electrodes using a muscle stimulator while varying traction tension on the tendon. With a Kocher clamp placed on the tendon and traction tension varied, the temporalis muscle is stimulated and the degree of excursion of the Kocher clamp is observed. Once the ideal tension is determined, the tendon is sutured in place at that muscle length. Muscle excursion is lost when excessive traction tension is required to reach the modiolus, and in such cases, a tendon extender graft should be considered. This gross method of establishing the appropriate muscle length and tension for inserting the transposed temporalis muscle is feasible only when long-acting paralytic agents are avoided at the beginning of the case.

Fascia Lata Extension

In some patients, the lips are pulled to the contralateral side owing to compensatory contraction. In these patients, we often place a fascia lata extension to allow fixation to the lips across the midpoint to the contralateral side. The fascia lata extension is secured to the temporalis tendon and is tunneled into the upper and lower lips. The fascia lata extension is secured to the middle of the upper and lower lips to pull the philtrum and the lower lip toward the midline (**Figure 7**).

Skin Closure

The melolabial incision is closed in a layered manner to mimic the contour of the contralateral crease. In a patient with a deep

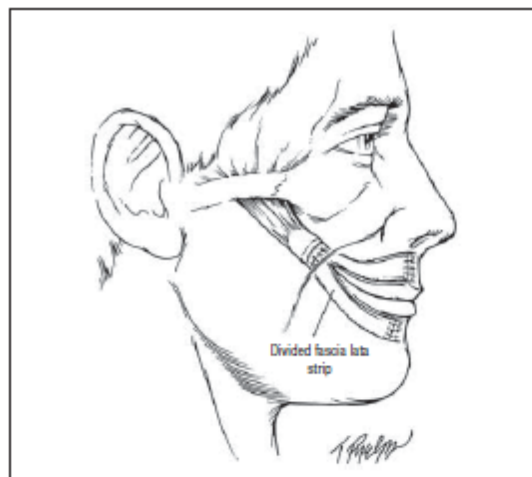


Figure 6. Fascia lata extension from the inserted tendon to the middle of the lip.

melolabial crease, the incision is closed in an overriding manner to recreate a deep crease. If the contralateral melolabial crease is shallow, the skin edges are approximated in an end-to-end manner.

PATIENTS

Seventeen consecutive patients who underwent the MIT3 procedure between January 1, 2006, and December 31, 2008, were studied. We analyzed these cases to determine the ease of access for coronoidectomy through the minimal melolabial incision and transbuccal approach, the ability to mobilize and transpose the temporalis tendon to the modiolus without fascia lata extension, the preservation of neuromuscular function by muscle stimulation, symmetry at rest, lip continence, and acquisition of oral commissure excursion.

RESULTS

Of the 17 patients, 7 experienced their facial paralysis after the excision of parotid gland malignant tumors involving the facial nerve, 1 after a motor vehicle crash, 4 after cerebellopontine angle tumor excision with postoperative facial paralysis (**Figure 8**), 1 related to progressive multiple cranial nerve palsies, 1 related to congenital facial nerve paralysis, 1 related to a glomus jugulare tumor, 1 related to hemangioma of the temporal bone, and 1 related to herpes zoster infection. All the patients tolerated the procedure, and none developed procedure-related complications. The modiolus was reached for direct tendon suturing in all the patients without the need for fascia lata extensions. All the patients achieved symmetry at rest, oral commissure movement, lip continence, and subjective improvement in articulation. In 3 patients, intraoperative temporalis muscle stimulation was performed after the MIT3 procedure, and dynamic reanimation was recorded (a video is available at <http://www.archfacial.com>). The postoperative dynamic range of oral commissure movement differed from patient to patient.



Figure 7. Intraoperative view.

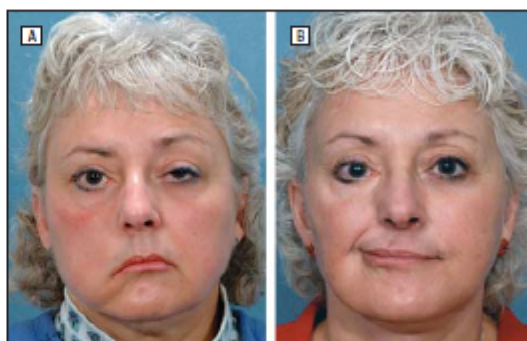


Figure 8. Preoperative (A) and postoperative (B) views of a 49-year-old woman who developed facial paralysis after surgical resection of cerebellopontine angle tumor resection.

COMMENT

We found that the MIT3 technique is an effective and reliable method of dynamic facial reanimation. The transbuccal route to the coronoid process offers direct access to the temporalis tendon without the need for extensive incisions, dissection, and osteotomies. It also ensures preservation of a glide plane between the zygoma and the temporalis tendon for untethered muscle excursion. Inadequate length of the temporalis tendon has been cited as a limitation of the temporalis tendon transposition procedure. Previous descriptions of the temporalis tendon transfer procedure by McLaughlin³ and Croxson et al⁵ have included the use of fascia lata extenders to reach the targeted insertion site. We found this unnecessary to reach the oral commissure. To attain adequate length, other surgeons advocated disinserting the temporalis muscle origin from the temporal fossa, thus allowing inferior transposition of the entire muscle and tendon. With the MIT3 procedure, adequate tendon length is achievable without disturbing the muscle origin. To do so, the temporalis tendon should be elevated off the medial surface of the mandibular ramus down to the buccinator line. An obliquely oriented osteotomy of the coronoid process ensures that most of the tendon is kept attached to the



Figure 9. Preoperative (A) and postoperative (B) views of a patient with long-standing paralysis.

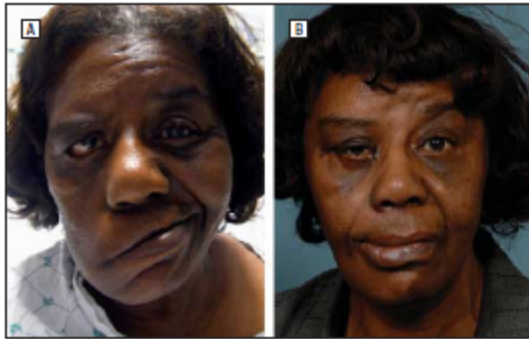


Figure 10. Preoperative (A) and postoperative (B) views of severe soft-tissue descent in a patient with long-standing paralysis.

coronoid. Bénateau et al⁶ performed a nice anatomic dissection to demonstrate the anatomic features of the temporalis tendon and its attachment to the coronoid process and mandibular ramus. We attained adequate length to reach the oral commissure in all the patients. In select cases, fascia lata extension was included to reach and correct a displaced phitrial column, as described by Sherris.⁹

Beyond the described technical aspects of the MIT3 procedure, directed physical therapy is essential to achieve an optimal outcome. The visible movement gained from dynamic muscle transposition does not translate into a spontaneous controlled smile without intensive neuromuscular retraining. A physiotherapist should perform a comprehensive evaluation, ideally before surgery, to obtain baseline data. In patients who have undergone temporalis tendon transposition, physical therapy focuses on acquisition of a temporal smile. Lambert-Prou¹⁰ described a stepwise approach to achieving a spontaneous temporal smile. The first phase in the acquisition of a mandibular smile involves mobilization of the mandible by contracting the transposed temporalis muscle and by inducing an elevation of the oral commissure. The second phase focuses on learning a voluntary temporal smile by contraction of the temporalis muscle independent of mandibular movement, which remains under voluntary control. The last phase is designed to achieve a spontaneous smile independent of mandibular movement. Coulson et al¹¹ demonstrated the efficacy of combining video self-



Figure 11. Preoperative (A) and postoperative (B) views of a very thin patient with short hair. Notice the lack of temporal depression or any protrusion over the zygoma.



Figure 12. Preoperative (A) and postoperative (B) views. Three weeks postoperatively, this patient shows the ability to smile.

modeling and implementation intentions to improve the spontaneity of a learned smile.

The MIT3 is an effective procedure for the management of long-standing facial paralysis (**Figure 9**). It is useful for all such patients, even those with profound facial ptosis. In these cases, we typically combine the MIT3 with adjunctive procedures, such as rhytidectomy, browlifting, and so on (**Figure 10**). The MIT3 offers several distinct advantages over free tissue transfer and the classic temporalis sling. These 2 alternative procedures, by their very nature, create facial asymmetry. The gracilis free flap, although an excellent option in many patients, adds bulk to the face. Revision rates are high, reinnervation is delayed up to a year, and some patients do not reinnervate. The classic temporalis sling adds bulkiness over the zygomatic arch and a depression in the temple. We have found that even very thin patients with very short hair experience none of these contour changes with the MIT3 (**Figure 11**). Rehabilitation is accelerated, with good results and movement seen in 2 to 3 weeks, which is much quicker than with other techniques (**Figure 12**).

Dynamic reanimation after facial paralysis remains challenging but can be achieved in selected patients using the MIT3. The MIT3 technique offers an option for immediate dynamic facial movement with a single procedure without the need for staged nerve grafting, as with free muscle transfer procedures. Although the tech-

nique is straightforward and dynamic movement can be demonstrated with intraoperative muscle stimulation, acquisition of desired facial movement requires intensive physiotherapy and a motivated patient.

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Online-Only Material: A video is available at <http://www.archfacial.com>.

REFERENCES

1. Rubin LR, ed. *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(3):317-331.
3. McLaughlin GR. Permanent facial paralysis: the role of surgical support. *Lancet*. 1952;2(6736):647-651.
4. Labbé D. Lengthening of temporalis myoplasty and reanimation of lips: technical notes [in French]. *Ann Chir Plast Esthet*. 1997;42:44-47.
5. Croxson GR, Quinn MJ, Coulson SE. Temporalis muscle transfer for facial paralysis: a further refinement. *Facial Plast Surg*. 2000;16(4):351-356.
6. Bénateau H, Alix T, Labbé D, Elissalde JM, Salamé E. Anatomic study of the tendinous insertion lamina of the temporalis muscle. *Surg Radiol Anat*. 2004;26(4):281-284.
7. Breidahl AF, Morrison WA, Donato RR, Riccio M, Theille DR. A modified surgical technique for temporalis transfer. *Br J Plast Surg*. 1996;49(1):46-51.
8. Byrne PJ, Kim M, Boahene K, Millar J, Moe K. Temporalis tendon transfer as part of a comprehensive approach to facial reanimation. *Arch Facial Plast Surg*. 2007;9(4):234-241.
9. Sherris DA. Refinement in reanimation of the lower face. *Arch Facial Plast Surg*. 2004;6(1):49-53.
10. Lambert-Prou MP. The Temporal Smile: speech therapy for facial palsy patients after temporal lengthening myoplasty [in French]. *Rev Stomatol Chir Maxillofac*. 2003;104(5):274-280.
11. Coulson SE, Adams RD, O'Dwyer NJ, Croxson GR. Physiotherapy rehabilitation of the smile after long-term facial nerve palsy using video self-modeling and implementation intentions. *Otolaryngol Head Neck Surg*. 2006;134(1):48-55.

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