Suprazygomatic Aponeurotic McLaughlin Myoplasty for Facial Reanimation

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Background: Suprazygomatic aponeurotic McLaughlin (SAM) myoplasty technique for facial reanimation is based on the classical McLauglin's lengthening temporalis myoplasty with a series of new modifications. A comprehensive review of previously described other orthodromic temporalis myoplasty techniques is also included to give a succinct comparison.

Methods: Twelve adult patients of facial palsy underwent SAM myoplasty for a period of 4 years. Three had congenital facial palsy, 4 patients had facial palsy secondary to acoustic neuromas, 3 were posttraumatic, and 2 patients had Bell's palsy.

Results: Range of modiolus excursion achieved as measured at 3 months postoperatively on reanimation in our patients was 5 mm to 20 mm with an average of 12.6 mm. With SAM myoplasty technique, we were able to achieve excellent result in 4 patients and good results in 8 patients as evaluated with May and Druker scoring system.

Conclusions: Suprazygomatic aponeurotic McLaughlin myoplasty for facial reanimation demonstrates a successful modification of the classical McLaughlin lengthening temporalis myoplasty, making it more customizable, simple, and predictable by taking the level of transection to the temporalis aponeurosis without the need for zygomatic osteotomy. A new classification of orthodromic temporalis myoplasty based on level of transections is also proposed for the first time. Good to excellent outcomes coupled with high patient satisfaction and low morbidity should make this technique popular among the facial reanimation surgeons.

Key Words: facial palsy, facial reanimation, temporal myoplasty, oats myoplasty, orthodromic temporal myoplasty, aponeurotic temporal myoplasty, temporalis myoplasty with fascia lata lengthening

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Charles Bell said, "A human being's facial expression fascinates me because it serves the most basic and bestial pleasure and participates in the most gentle emotion of spirit." Facial palsy deprives an individual of one of the basic expressions of emotion, a smile, along with severe handicaps in mastication, speech, and eye protection. It is the asymmetry at the corner of the mouth, which is most visible on the face. These functions can be restored by facial reanimation, which involves a number of procedures tailored to the needs of the patients depending on the time of presentation and etiology.

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Many techniques have been described in literature to achieve static and dynamic animation of the face. The advantage of a dynamic reanimation over simple static suspension extends beyond a symmetrical and coordinated smile, because it increases the cheek tone and enables better speech and chewing.

The use of a regional muscle for rehabilitation of facial paralysis is a respectable solution to this multifaceted problem. Temporalis tendon transfer has emerged as a popular choice of facial reanimation for surgeons because it is a single-stage dynamic technique. Also, it is a single vector, expendable muscle with a powerful action, making it a suitable choice for smile reconstruction. The ideal length-tension relationship of the donor muscle determines the force generated by the transferred muscle tendon unit (MTU). It is commonly believed by surgeons that a direct transfer of the temporalis tendon without any interposition graft will generate a higher force of contraction, but it has been proven by experiments conducted on the biomechanics of MTU transfer that overstretching of MTU will actually result in the generation of a lower active force. In this context, temporalis muscle lengthening with a fascia-lata graft not only reduces the tension but also generates adequate force to produce a good excursion at the angle of mouth.[1]

The temporalis muscle originates from temporalis fossa and the temporal crest. It has deep and superficial fibers, which converge and attach on to the coronoid process. The deep fibers attach on to the anterior aspect of the coronoid. Temporalis tendon covers the top of the coronoid and is wrapped around it like a coil. It emerges from the aponeurosis, which has an average width of 4 to 6 cm.[2,3] Temporalis muscle is intimately attached to the masseter muscle especially under the zygomatic arch. These masseter fibers can insert up to 2 cm above the zygomatic arch on the deep temporalis fascia. Guerreschi et al[4] recommended that masseter muscle fibers must be cleared from the surface of the temporalis muscle to get a good hold of the temporalis tendon and avoid deviating to a wrong path ending in the deep part of the masseter muscle. The buccal fat pad, anterior to the temporalis tendon, is capable of providing a smooth, tension-free, healthy gliding bed for the transferred MTU and, hence, should be handled with care while dissecting to prevent scarring and tendon adhesion. Figure 1 illustrates the surgical anatomy of the structures related to the temporalis muscle.

Keeping the aforementioned principles in mind, we propose a suprazygomatic aponeurotic McLaughlin (SAM) myoplasty technique for facial reanimation, which is a modification of the classic McLaughlin technique[5] with additional advantages of being easier, anatomic, reproducible, and minimally invasive. In this case series, we also compare our technique of SAM myoplasty with Labbé's and traditional McLaughlin's and other modifications described in literature.

METHODS

Twelve consecutive patients of facial palsy underwent SAM myoplasty in our department for a period of 4 years. The mean age of the patients (ranging from 20 to 65 years) was 38 years. Three patients had congenital facial palsy with late presentation in adulthood. There were 4 patients with facial palsy secondary to excisions of central nervous system (CNS) tumors, which in our series were all acoustic neuromas. One of the patients had undergone bilateral CNS tumor

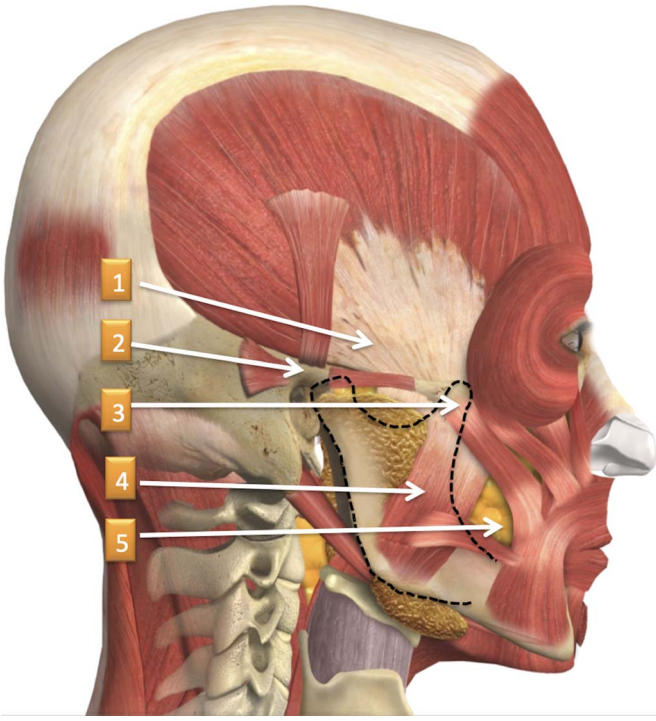

FIGURE 1. The anatomy of temporalis muscle and related structures as relevant to the facial reanimation procedure. 1, Temporalis aponeurosis converging to form the tendon. 2, Zygomatic arch providing attachment to masseter fibers. 3, The coronoid process with temporalis tendon and masseter fibers insertion. 4, Masseter muscle with its close association with temporalis tendon and zygomatic arch. 5, Buccal pad of fat just anterior to the coronoid process and under the masseter muscle. full color online

excisions and presented with bilateral facial palsy. All the other patients had unilateral palsy. Three patients were posttraumatic presentations after bomb blast injuries with multiple facial scars, and 2 patients had Bell's palsy. Average surgical time taken was 3 hours, and no patient required blood transfusion. Table 1 displays a summary of all the clinical cases.

Surgical Technique

The patient was evaluated preoperatively for the strength of the temporalis muscle by palpating the contraction over the temporal area while the patient was asked to clench their teeth. The smile and severity of asymmetry were analyzed as the patient animated. After infiltration with a solution of 1:100,000 adrenaline (in normal saline), a preauricular incision extending into the temporal area was made after waiting for 20 minutes postinfiltration. Once the white deep temporal fascia was visible, further separation of the skin flap was done over the temporal fascia in the loose areolar plane with blunt dissection.

An inverted-T, suprazygomatic incision was made on the central part of the deep temporal fascia to reflect it, thereby exposing the temporalis muscle underneath. Although the aponeurosis takes origin from the muscle about 2 to 3 cm above the zygomatic arch, it is not immediately visible on opening the temporal fascia because it is covered by a thin layer of temporalis muscle fibers. This is an important point to note, as the aponeurosis can be approached directly from above the zygomatic arch without any need for an osteotomy thus, avoiding unnecessary dissection and trauma. A gentle teasing of the superficial fibers of the temporalis muscle with a hemostat just above the zygomatic arch is all that takes to reveal the hidden, glistening white temporalis aponeurosis.

With the assistant holding the mandible in occlusion, the aponeurosis was then held with a Babcock's forceps above the zygomatic arch, without any attempt to forcefully pull the temporalis tendon from the coronoid process. Under gentle upward traction, the fan-shaped temporalis aponeurosis was completely transected in an anterior to posterior direction, just above the zygomatic arch. Care was taken not to damage the deep muscle fibers and also not to dissect deep behind the zygomatic arch to avoid unnecessary damage and scarring of the deep masseter fibers. The complete transection of the aponeurosis was confirmed by asking the assistant to open the mouth, and any restricting remaining fibers of the temporalis aponeurosis were identified and divided.

At this stage, a fascia-lata graft, approximately 12- to 15-cm long and 1.5- to 2-cm wide, was harvested from either thigh, and distal 4 cm of the fascia-lata strip was divided to create a tri-fork, one each for the upper and the lower lip and a short central slip for the commissure. A 1.5- to 2-cm incision was made along the nasolabial fold and dissected to reveal the oral commissure musculature. A fine hemostat was used to create blunt tunnels into the core of the upper and lower lip musculature for feeding the fascia-lata strips from the nasolabial incision. All the 3 strips were sutured with appropriate tension to the upper lip, modiolus, and lower lip with 4-0 nonabsorbable polypropylene sutures.

TABLE 1. Clinical Data Summary of SAM Myoplasty Case Series for Facial Reanimation Surgery

Patient No	Etiology	Age, y/Sex	Unilateral/bilateral	Excursion Achieved Measured at 3 mo, mm	May and Druker Outcome Ranking
1	Congenital	25/F	Unilateral	20	Good
2	Congenital	34/M	Unilateral	18	Good
3	Congenital	23/F	Unilateral	12	Good
4	CNS tumor excision (acoustic neuroma)	50/M	Unilateral	15	Excellent
5	CNS tumor excision (acoustic neuroma)	53/M	Unilateral	15	Excellent
6	CNS tumor excision (acoustic neuroma)	42/F	Unilateral	13	Excellent
7	CNS tumor excision (acoustic neuroma)	20/F	Bilateral	18	Excellent
8	Trauma	31/M	Unilateral	05	Good
9	Trauma	32/M	Unilateral	10	Good
10	Trauma	35/M	Unilateral	10	Good
11	Bell's palsy	34/F	Unilateral	10	Good
12	Bell's palsy	65/F	Unilateral	05	Good

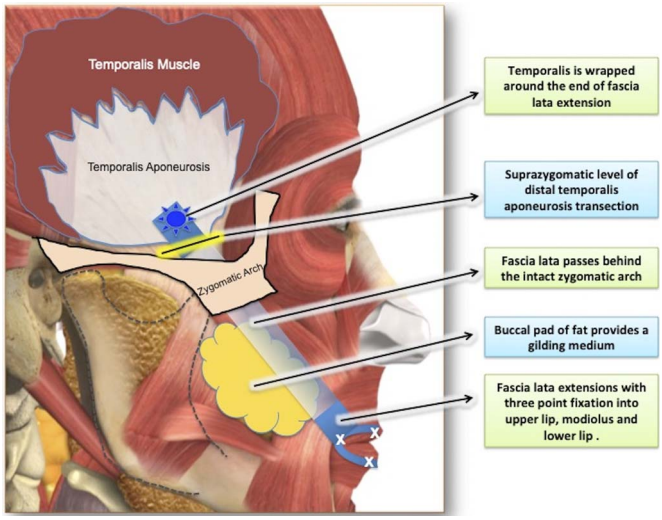

FIGURE 2. This figure illustrates components of SAM myoplasty facial reanimation surgery. The temporalis aponeurosis is transected above the zygoma arch and transferred to the modiolus and upper and lower lips with the help of fascia-lata extension graft. Note the anatomical relationship of the fascia-lata extension with surrounding structures. The fascia-lata extension graft is passing through the buccal fat pad and attached to the lips and modiolus with 3-point fixation. full color online

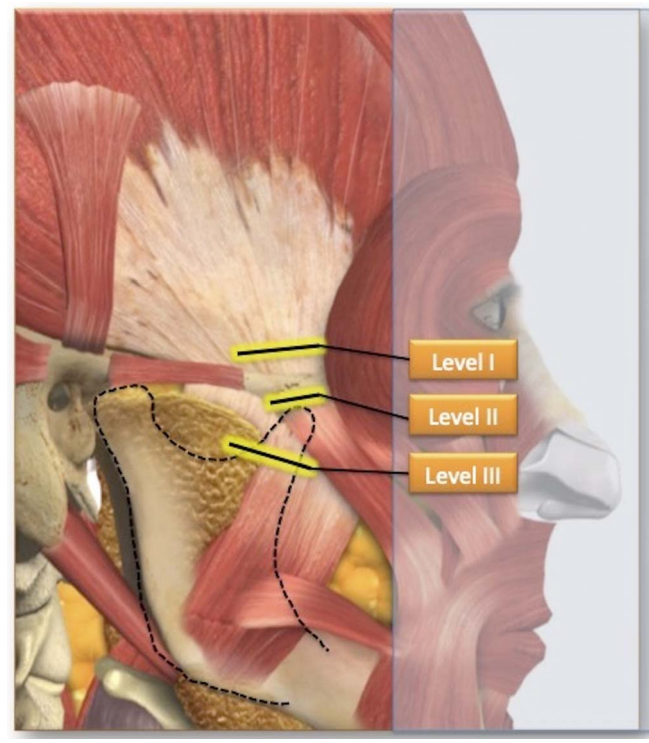

FIGURE 3. Illustration showing level of transection of the temporalis for easy understanding and classification of temporalis transfer procedures. Level I is the suprazygomatic division of the aponeurosis in SAM myoplasty. Level II represents division of temporalis just at the insertion of coronoid. Level III is the division of temporalis after its attachment to coronoid. full color online

Once this 3-point fixation was achieved, the proximal end of the fascia-lata graft was tunneled to the temporal fossa from the nasolabial incision through the natural buccal fat plane, passing under the zygomatic arch. The superior end of fascia-lata was pulled to simulate the desired smile based on preoperative Rubin smile classification.[6] At this point, it is easy to balance the pull at the 3 fixation points, that is, upper lip, modiolus, and lower lip, to achieve desired smile symmetry by matching it to the patient's opposite side. If any of the fixation points need to be tightened or loosened, releasing the suture and revising the fixation with appropriate tension can easily do it.

Next, the cut end of the temporalis aponeurosis was converted from a flat structure into a round cylindrical structure, which was wrapped around the proximal end of the fascia-lata interposition graft and secured with multiple through and through Pulvertaft like 2-0 nonabsorbable sutures, which were further reinforced by a 5-0 nonabsorbable continuous suture to smoothen the anastomotic site. Only mild overcorrection of about 10% to 15% in the pull is desirable to compensate for any loss of tension in time. Figure 2 shows the SAM myoplasty with relevant anatomy.

In almost all the patients, we routinely perform an elliptical excision of excess nasolabial skin once the myoplasty is in place. The extent

TABLE 2. Comparison of Previously Described Orthodromic Temporalis Myoplasty With SAM Myoplasty for Facial Reanimation

Viterbo et al[12]	Classical McLaughlin's[5]	Labbé's[13]	SAM Myoplasty
Orthodromic temporalis tendon transfer with fascia lata graft and simultaneous end to side cross facial nerve graft	Coronoidectomy with fascia lata lengthening	Lengthening myoplasty, temporalis muscle detachment and advancement	Attachment of fascia lata to temporalis aponeurosis cranial to zygomatic arch with preservation of deep fibers
Immediate creation of nasolabial fold	Immediate creation of nasolabial fold	Poor nasolabial fold	Immediate creation of nasolabial fold
No temporal hollowing	No temporal hollowing	Temporal hollowing	No temporal hollowing
• Have potential of straying in the wrong path • Excessive pulling to retrieve tendon insertion from coronoid can potentially cause localized trauma and subsequent adhesions limiting the excursion.	• Less tension as coronoid is lengthened with fascia lata. • Difficult intraoral coronoidectomy • Development of adhesions • Risk of infection due to intraoral contamination	• Excessive mobilization of the muscle resulting potential damage to neurovascular structure • Extensive scarring and dissection • Involves zygoma osteotomy—not suitable for incomplete palsy • Repair is under tension. • Extensive procedure and long learning curve	• Easiest dissection and minimal trauma

FIGURE 4. Preoperative picture of a 20-year-old female patient presenting with bilateral complete facial palsy, after bilateral CNS tumors (acoustic neuromas) excisions. full color online

of nasolabial skin excision is individually tailored to give a good symmetrical aesthetic appearance of the nasolabial fold. In older patients with asymmetrical facial sagging, a sub-musculo-aponeurotic-system plication hemi-facelift and excision of excess skin are routinely performed for achieving a better aesthetic result and good resting symmetry. Paralyzed side lips often have excessive mucosal over hangs that are corrected at the time of surgery for better aesthetic symmetry. The temporalis fascia and the skin incision are closed with absorbable sutures in layers. No drain is required.

Key points in our technique are the following:

1. Aponeurosis and not the tendon
   Usage of aponeurosis of temporalis just above the zygoma as opposed to the tendon in the previously described techniques reduces the excessive tension on the MTU thereby, decreasing chances of overstretching and loss of excursion with time.
2. "Smile tuning"—what you see intraoperatively is what you get
   Attaching the tri-fork of fascia-lata extension to the modiolus and lips first and simulating the smile by pulling the superior end after feeding it to the temporal fossa under the zygomatic arch allow retrograde calibration of tension in each fixation point to match the type of smile, a surgeon wishes to create on the basis of preoperative smile assessment (Supplementary Video 1, http://links.lww.com/SAP/A456).
3. "Piston in barrel" wrap
   Temporalis aponeurosis is wrapped around the fascia-lata graft and strongly sutured with the graft like a Piston in Barrel.
4. Less is better
   Only mild overcorrection of 10% to 15% is sufficient to achieve a good, stable long-term result. This is perhaps due to the larger surface area of fixation between the graft and the temporalis tendon with the wrap-around technique, which makes it very strong and decreases the possibility of loosening as feared in older techniques of tendon to fascia repair.
5. Direct nasolabial fold excision
   Direct nasolabial fold skin excision is performed in all patients once the myoplasty is in place with desired tension for better symmetry. Older patients may also require a sub-musculo-aponeurotic-system based hemi-facelift with a standard facelift incision-excision pattern.

Previous studies have proven that controlled early mobilization reduces the degree of muscle degeneration and increases vascularity. We also encourage early mobilization of myoplasty at 3 weeks postoperatively.[1] All patients are kept on soft diet and minimal vocalization for 3 weeks after which physiotherapy sessions are started with mirror training and progressive muscle strengthening using biofeedback techniques.

In our series, all patients were able to get a mandibular smile on clenching of teeth with good voluntary control. Excursion improvement was observed for a period of 2 to 3 months, and most patients were able to get a good and reproducible modiolus excursion of 1 to 2 cm.

RESULTS

Range of modiolus excursion achieved as measured at 3 months postoperatively on reanimation in our patients was 5 to 20 mm with an average of 12.6 mm. Results were evaluated by 3 independent surgical observers, using the scale proposed by May and Drucker,[7] which rates as follows:

1. Poor, the corner of the mouth on the paralyzed side dropped;
2. Fair, the corners of the mouth symmetrical with face in repose;

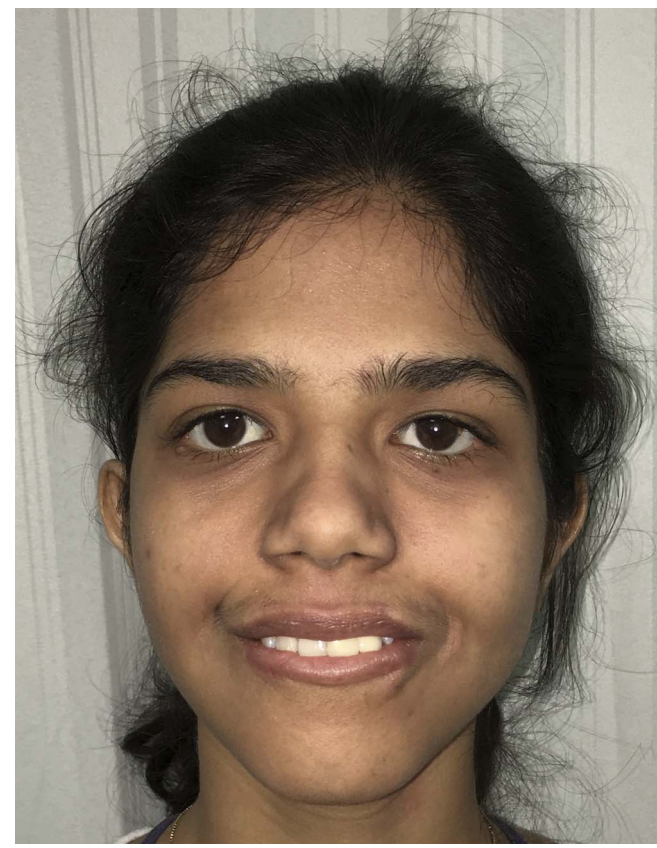

FIGURE 5. Postoperative picture of the same patient (Fig. 4) in animation after SAM myoplasty. *Excellent* smile result can be seen as per May and Drucker classification. The patient is able to smile voluntarily with exposure of teeth. full color online

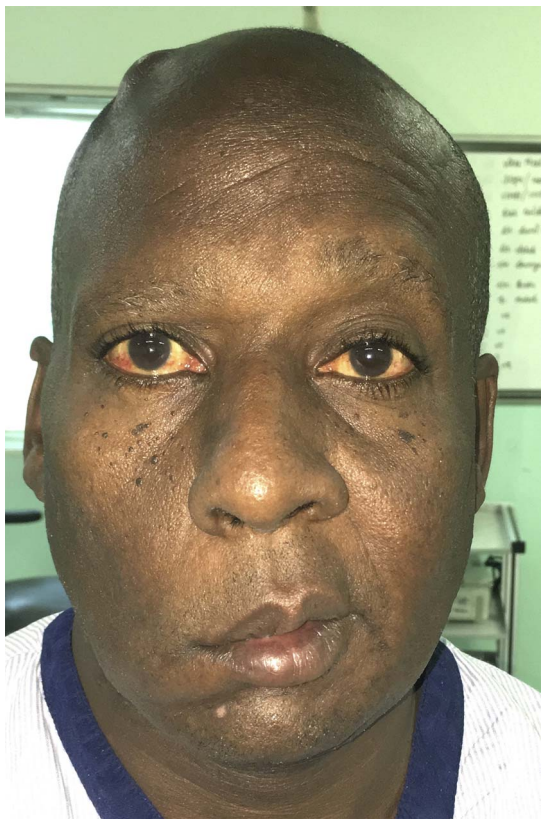

FIGURE 6. Preoperative image of a 53-year-old male patient presenting with left complete facial palsy after CNS tumor excision. full color online

3. Good, discreet smile pulling up the corner of the mouth;
4. Excellent, patient smiles voluntarily with exposure of the teeth.

With the SAM technique, we were able to achieve excellent results in 4 patients and good results in the rest of the 8 patients. No patient had a poor result. No patient asked for a revision surgery. With good physiotherapy, approximately 40% of the patients, especially the younger ones, were able to develop a voluntary smile without clenching their teeth with an open mouth in 6 months to 1 year. Almost all patients in our study were able to integrate well into their social milieu and expressed great satisfaction with the outcome of the procedure (Supplementary Videos 2, http://links.lww.com/SAP/A457, and 3, http://links.lww.com/SAP/A458).

DISCUSSION

Rubin[6] has described three basic types of smiles, namely, Mona Lisa, canine, and full denture smile. In Rubin's study,[6] 67% of the people had a predominant lateral and upward extension of the angle of the mouth, which resulted in the Mona Lisa smile. In 31% of patients, a strong levator labii superioris action generated upward movement of the lips followed by lateral excursion resulting in a canine smile. A full denture smile was seen in about 2% of people and was attributed to simultaneous contraction of lip elevators and depressors exposing the dentition. The analysis of the smile preoperatively helps in determining the appropriate site of attachment and tension adjustment of the fascia-lata graft extension.

The goal of facial reanimation surgery is to achieve symmetry at rest, voluntary motion, spontaneous smile, and oral competence. Temporal myoplasty can be a good single-stage option in selected patients. Gillies[8] first described reverse temporal muscle transfer in 1934 where he reflected the middle third of the muscle over the zygomatic arch along with fascia-lata graft. It was an antidromic transfer and always suffered from the drawback of abnormal cheek bulge and temporal hollowing.[8]

McLaughlin[5] in 1953 described the transoral approach wherein the coronoid process was transected and transferred to the modiolus along with the temporalis tendon insertion with fascia-lata extension. This technique was orthodromic with added benefits of eliminating cheek bulge and temporal hollowing.[4] The drawbacks of the classical Mclaughlin's procedure are difficult intraoral dissection, risk of intraoral contamination, and temporomandibular joint dislocation.[9] There have been many modifications described such as the minimally invasive temporalis tendon transposition by Boahene et al[10] in 2011 wherein they approached the coronoid externally through the nasolabial fold, which prevents intraoral contamination. In another modification by Aum et al,[11] they have approached the coronoid with preauricular incision below the zygoma. However, all external techniques of temporalis coronoid insertion through the nasolabial incision require a wide exposure resulting in a big scar and also can be quite a struggle on occasions especially in a patient with a chubby face. They involve extensive dissection through the masseter and have the risk of damaging residual working branches of facial nerve and Stensen duct, temporomandibular joint dislocation, and late adhesion formations.[11]

Our exposure of the temporalis is similar to the one published by Viterbo et al[12] in 2014, which we came across during our literature search. They are proponent of orthodromic transfer of temporalis muscle in combination with cross facial nerve grafts.[12] The difference is that they apply progressive tension with Kelly's clamp to forcefully divide the temporalis tendon from its coronoid insertion. Because this involves excessive pull and blind dissection, there is a danger of more local trauma,

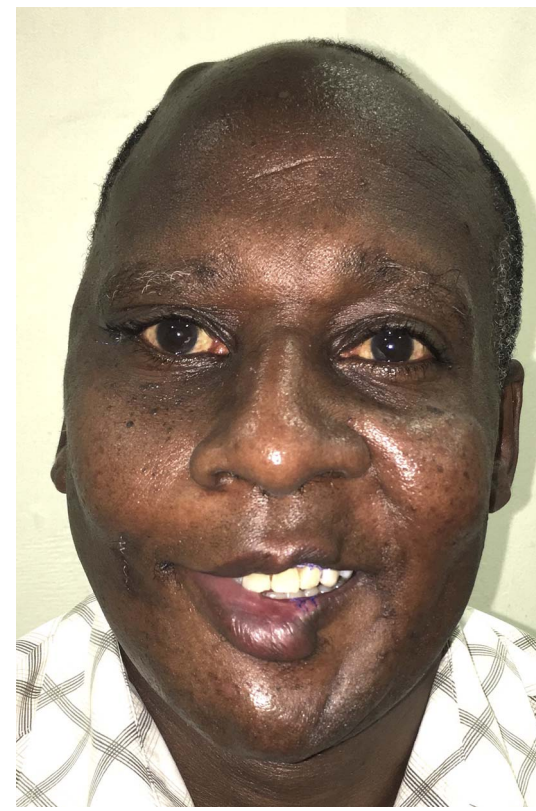

FIGURE 7. Postoperative picture of the same unilateral facial palsy patient (Fig. 6) after SAM myoplasty. Note the spontaneous smile, showing teeth signifying an *Excellent* result as per May and Drucker classification. full color online

FIGURE 8. Preoperative image of a 32-year-old male patient presenting with left posttraumatic complete facial palsy. full color online

which can cause delayed adhesions. In our technique, unnecessary excessive pulling of the temporalis tendon is avoided, because transection is much higher at the level of the aponeurosis itself just above the zygomatic arch. As discussed before, this does not interfere with intermingling fibers of the masseter under the zygoma and gives a smooth plane for the tendon gliding in the buccal fat pad. It also prevents straying into inadvertent wrong path of dissection through the deep fibers of the masseter as alluded to by Guerreschi et al.[4]

Labbé[13] in 1997 described the popular lengthening temporalis myoplasty. This had the advantage of being a single-step procedure and allegedly "simple" compared with microsurgical reanimation. Initially, Labbé[13] performed osteotomy of zygoma to dissect under vision and safely transect the temporalis tendon. This paved the way for smooth gliding of the tendon due to reflection of the masseter fibers off the temporalis muscle.[14] Panciera et al,[15] in their objective outcome analysis of Labbé's procedure, demonstrated that it gives an excellent static correction compared with the dynamic outcome. Boahene[1] states that this is due to the overstretching of the native resting length of the muscle reducing its excursion on contraction. Another point to note is that the true lengthening happens at the expense of the posterior half of the temporalis muscle reducing its strength and causing posterior temporal hollowing.[16] The extensive dissection in the cheek and under the zygomatic arch leads to scarring and suboptimal results in many patients as reported in published series. In a series by Panossian,[16] with Labbé's procedure, about 64% patients needed revision surgery, average operating time was approximately 6 to 7 hours, and some patients even needed blood transfusion. We believe that our technique of SAM myoplasty has many advantages over Labbé's procedure, and Table 2 gives a comparative analysis of the same.

Figure 3 illustrates the level of temporalis transection for myoplasty in different techniques.

We would also like to propose a new classification of orthodromic temporalis myoplasty techniques on the basis of the level of transection and need for zygomatic osteotomy as under.

Orthodromic Temporalis Myoplasty Classification

Type I is the level I transection at temporalis aponeurosis without transection of the zygomatic arch as described in our technique of SAM myoplasty.

Type II is at level II or just above the insertion on the coronoid process without the coronoid osteotomy. It is further divided into the following:

Type IIA, level II transection without zygomatic arch osteotomy as described by Viterbo et al[12] and Champion et al[17];

Type IIB, level II transection with zygomatic arch osteotomy as described by Breidahl et al.[18]

Type III is level III composite with coronoid process osteotomy. It can be further divided into the following:

Type IIIA, level III transection without zygomatic arch osteotomy as described by McLaughlin,[5] Aum et al,[11] and Boahene et al[10];

Type IIIB, level III transection with zygomatic arch osteotomy as described by Labbé[13] and Dhirawani et al.[19]

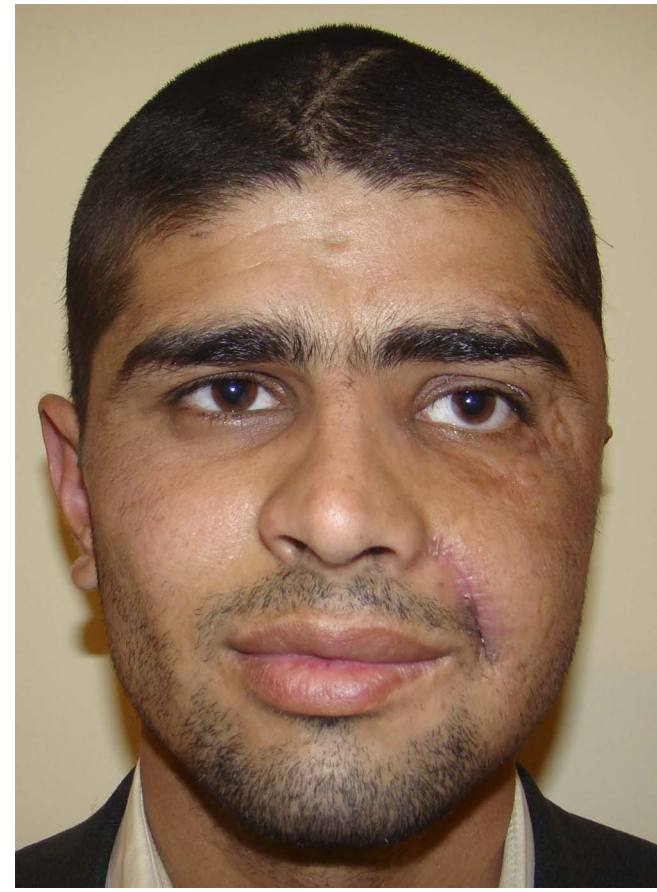

FIGURE 9. Postoperative picture of the same patient (Fig. 8) after SAM myoplasty. *Good* result achieving smile pulling up the corner of mouth May and Drucker classification. full color online

FIGURE 10. Preoperative image of a 42-year-old female patient presenting with left complete facial palsy after CNS tumor excision. full color online

Note: Types I and II always require a fascia-lata extension for adequate length but type III may be possible without fascia-lata extension, for example, Labbé[13] and Boahene et al.[10] Type IIIA may be further divided into intraoral (McLaughlin[5]) or extraoral (Aum et al[11] and Boahene et al[10]) coronoid approaches.

Figures 4 to 11 show clinical outcomes based on May and Drucker classification in 4 representative patients who underwent SAM myoplasty for facial reanimation. Details are attached in the legend accompanying the images.

Harii et al[20] first reported 2-staged free functional muscle transfer (FMT) with gracilis and cross nerve free graft (CNFG) in 1976. Functional muscle transfer with CNFG is often described as the criterion standard in facial reanimation techniques because it has the best potential for providing a natural spontaneous smile for facial reanimation. However, it does have its own shortcomings like an unsatisfactory resting symmetry, cheek bulk in both resting and animated states, unpredictable final position of the nasolabial fold, and muscle excursion until the reanimation occurs. The excursion is achieved after 2 to 6 months, once the reinnervation of the muscle ensues. It also involves 2 stages of transferring the nerve initially and then with free gracilis muscle flap. The surgery is technically challenging with a long duration of recovery for the patient and a long learning curve for the surgeon. There are also added concerns like prolonged hospitalization and extensive financial implications and the risk of flap loss.[16]

Cross facial nerve grafting produces purposeful facial movements and a resting tone, but its main disadvantage is that the results are inconsistent with donor site morbidity and the presence of dyskinesis.[21]

Table 3 summarizes the differences between our technique of SAM myoplasty and gracilis FMT and CNFG. It is essentially a comparison between temporalis myoplasty and FMT, the 2 main procedures of dynamic reanimation.

Boahene et al[22] determined the muscle excursion using transcutaneous electrical stimulation and found that the mean excursion of temporalis tendon after release was 20.6 mm and after insertion was 15.5 mm with a range of 8 to 23 mm. According to Paletz et al,[23] the average excursion at the oral commissure is 14 mm along a line from the commissure to the helix. In many of our patients, we were able to achieve the excursion of 15 to 20 mm as measured by the ruler. Poor excursion was seen in patients who presented with etiology of facial trauma, and this could be attributed to scarring. However, even these patients were satisfied with their outcomes because of significantly improved facial symmetry.

Suprazygomatic aponeurotic McLaughlin myoplasty technique for facial reanimation comes with many advantages. Aponeurotic division just above the intact zygomatic arch is perhaps the easiest of all described approaches for temporalis myoplasty. The aponeurosis is strong and, once wrapped around the fascia lata, provides a smooth transition into the extension. Minimal trauma to the masseter attachments on the zygoma and coronoid should lessen the chances of late adhesions that often reduce active excursion. It obviously carries all the other advantages of previously described orthodromic transfers.

Lambert-Prou[24] has described 3 phases in the gaining of a spontaneous smile. It starts with a mandibular smile followed by a voluntary temporal smile. The final phase is a spontaneous emotional smile, which is independent of a mandibular effort. Garmi et al[25] have proven in the magnetic resonance imaging study of the brain, in patients

FIGURE 11. Postoperative picture of the same unilateral facial palsy patient (Fig. 10) after SAM myoplasty. Spontaneous smile, showing teeth signifying an *Excellent* result as per May and Drucker classification, is seen in this picture. full color online

TABLE 3. Comparison of SAM Myoplasty With FMT Transfer

SAM Myoplasty	Gracilis FMT With CNFG
Single stage	Multiple-staged procedure
Simple technique	Long duration surgery and requires microsurgical skill
Can be done for older patients	Poor results in older patients
In incomplete palsy, there is no damage to functional nerve and no dissection on opposite side face.	Not usually suitable for incomplete facial palsy especially the milder varieties
Produces mandibular smile and in most patients can give voluntary smile	Gives spontaneous and emotional smile
Good resting tone resulting in better resting symmetry	Poor resting tone often requiring an additional mini-temporalis/fascia lata transfer for achieving resting symmetry
Good predictable results in bilateral cases with advantage of a short but effective single stage procedure	Lengthy surgery and in bilateral cases not possible to give spontaneous smile as the donor nerve is 5th cranial nerve (masseteric nerve)
Early recovery and quick results	Long recovery with loss of working hours
	Takes a long time for result to manifest

undergoing temporalis myoplasty, that changes in cortical areas representing smiling had increased in size and intensity extending up to the chewing area and sometimes merging as well. These changes were noted after 3 months of surgery and persisted beyond 5 years. Owing to these findings, we evaluated all our patients at 3 months postoperatively for analyzing their outcomes. All our patients were able to achieve voluntary temporal smiles. Development of the spontaneous and emotional smile, although possible in some patients, was not seen in our series of patients at 3 months postoperatively. A longer than 3 months follow-up was not possible in most patients, because being a tertiary center, our patients were not all locals and they came from far and wide. No patient in our study complained about the inability to develop a spontaneous smile.

We observed that the extent of excursion was not always directly related to patient satisfaction, and it was the symmetry of the smile, which was more important in terms of defining patient satisfaction. Symmetry of the smile even if the excursion was less was always rated high by the patient in terms of a satisfactory result.

We noted an interesting observation in the patients with facial palsy secondary to acoustic neuroma excisions; they had better results after facial reanimation in our series as compared with all the other causes of facial palsy. Although we were unable to explain this particular observation, we wonder whether it has to do with a phenomenon called *cross-modal neuroplasticity*, wherein if the brain loses inputs in 1 major faculty, it adapts and enhances itself in other faculties. Such a phenomenon has been described with proven scientific evidence in congenitally adult deaf patients, although we did not come across any such reference in facial palsy patients.[26]

The limitation of our series is that it is small and retrospective with a short follow up. But we believe that our outcomes at 3 months are adequate to show that the procedure has good efficacy in most patients. In future, we intend to publish a larger series with a longer follow up to further enhance the strength of this series.

A common limitation of any temporal myoplasty including our technique, used for facial reanimation, is that none of them is capable of producing a perfect spontaneous emotional smile. In our particular series, none of our patients received contralateral botulinum toxin injections because of financial considerations. We believe that in some patients it could have improved their symmetry even better. No simultaneous cross facial nerve graft was done because all the patients presented late after 2 years of facial palsy.

Every patient must be treated as per their requirements and eligibility for a procedure after all the surgical options are explained to them. Many patients may not be able to qualify for functional muscle transfer with cross facial nerve graft, and thus, temporal myoplasty becomes the best-suited surgical procedure for them. However, even when given an equal choice between functional muscle transfer versus temporal myoplasty, after proper counseling, many patients would choose the simpler option of temporal myoplasty as their preferred option. Thus, although many surgeons consider FMT as the criterion standard, we believe that this concept of the so-called criterion standard is a thing of the past, because every treatment must be tailored according to the patient and the surgeon.[27]

CONCLUSIONS

Suprazygomatic aponeurotic McLaughlin myoplasty for facial reanimation demonstrates a successful modification of the classical McLaughlin lengthening temporalis myoplasty, making it more customizable, simple, and predictable by taking the level of transection to the temporalis aponeurosis without the need for zygomatic osteotomy. Good to excellent outcomes coupled with high patient satisfaction and low morbidity should make this technique popular among the facial reanimation surgeons.

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REFERENCES

1. Boahene KDO. Principles and biomechanics of muscle tendon unit transfer: application in temporalis muscle tendon transposition for smile improvement in facial paralysis. *Laryngoscope*. 2013;123:350–355.
2. Benateau H, Alix T, Labbé D, et al. Anatomic study of the tendinous insertion lamina of the temporalis muscle. *Surg Radiol Anat*. 2004;26:281–284.
3. Geers C, Nyssen-Behets C, Cosnard G, et al. The deep belly of the temporalis muscle: an anatomical, histological and MRI study. *Surg Radiol Anat*. 2005; 27:184–191.
4. Guerreschi P, Gahagnon T, Vacher C, et al. Masseter muscle termination over the deep surface of the temporal fascia: look out on the wrong path. *Surg Radiol Anat*. 2011;33:863–868.
5. McLaughlin CR. Surgical support in permanent facial paralysis. *Plast Reconst Surg*. 1953;11:302–314.
6. Rubin LR. The anatomy of a smile: its importance in the treatment of facial paralysis. *Plast Reconstr Surg*. 1974;53:384–387.
7. May M, Drucker C. Temporalis muscle for facial reanimation. A 13- year experience with 224 procedures. *Arch Otolaryngol Head Neck Surg*. 1993;119:378–382.
8. Gillies H. Experiences with fascia Lata grafts in the operative treatment of facial paralysis: (section of otology and section of laryngology). *Proc R Soc Med*. 1934;27:1372–1382.
9. Sidle DM, Simon P. State of the art in treatment of facial paralysis with temporalis tendon transfer. *Curr Opin Otolaryngol Head Neck Surg*. 2013;21:358–364.
10. Boahene KD, Farrag TY, Ishii L, et al. Minimally invasive temporalis tendon transposition. *Arch Facial Plast Surg*. 2011;13:8–13.

11. Aum JH, Kang DH, Oh SA, et al. Orthodromic transfer of the temporalis muscle in incomplete facial nerve palsy. *Arch Plast Surg*. 2013;40:348–352.
12. Viterbo F, Romao A, Brock RS, et al. Facial reanimation utilizing combined orthodromic temporalis muscle flap and end to side cross- face nerve grafts. *Aesthetic Plast Surg*. 2014;38:788–795.
13. Labbé D. Lengthening of temporalis myoplasty and reanimation of lips. Technical notes. *Ann Chir Plast Esthet*. 1997;42:44–47.
14. Moubayed SP, Labbé D, Rahal A. Lengthening temporalis myoplasty for facial paralysis reanimation: an objective analysis of each surgical step. *JAMA Facial Plast Surg*. 2015;17:179–182.
15. Panciera DT, Sampieri C, Deganello A, et al. Lengthening temporalis Myoplasty: objective outcomes and site-specific quality-of-life assessment. *Otolaryngol Head Neck Surg*. 2017;157:966–972.
16. Panossian A. Lengthening temporalis myoplasty for single stage smile reconstruction in children with facial paralysis. *Plast Reconst Surg*. 2016;137:1251–1261.
17. Champion R. Re-animation of facial paresis in children. *Plast Reconstr Surg Transplant Bull*. 1958;22:188–193.
18. Breidahl AF, Morrison WA, Donato RR, et al. A modified surgical technique for temporalis transfer. *Br J Plast Surg*. 1996;49:46–51.
19. Dhirawani RB, Balaji SM, Singha S, et al. Temporalis muscle transfer with fascia lata sling: a novel technique for facial animation. *Ann Maxillofac Surg*. 2018;8: 307–310.
20. Harii K, Ohmori K, Torii S. Free gracilis muscle transplantation, with microneurovascular anastomoses for the treatment of facial paralysis. A preliminary report. *Plast Reconstr Surg*. 1976;57:133–143.
21. Coyle M, Godden A, Brennan PA, et al. Dynamic reanimation for facial palsy: an overview. *Br J Oral Maxillofac Surg*. 2013;51:679–683.
22. Boahene KDO, Ishii LE, Byrne PJ. In vivo excursion of the temporalis muscle- tendon unit using electrical stimulation: application in the design of smile restoration surgery following facial paralysis. *JAMA Facial Plast Surg*. 2014;16:15–19.
23. Paletz JL, Manktelow RT, Chaban R. The shape of a normal smile: implications for facial paralysis reconstruction. *Plast Reconstr Surg*. 1994;93: 784–789.
24. Lambert-Prou MP. The temporal smile. Speech therapy for facial palsy patients after temporal lengthening myoplasty. *Rev Stomatol Chir Maxillofac*. 2003;104: 274–280.
25. Garmi R, Labbé D, Coskun O, et al. Lengthening temporalis myoplasty and brain plasticity: a functional magnetic resonance imaging study. *Ann Chir Plast Esthet*. 2013;58:271–276.
26. Karns CM, Dow MW, Neville HJ. Altered cross-modal processing in the primary auditory cortex of congenitally deaf adults: a visual somatosensory fMRI study with a double flash illusion. *J Neurosci*. 2012;32:9626–9638.
27. Khanna S, Choudhary S, Mantri R, et al. The gold standard: It's time to shun the term. *Ann Plast*. 2019;82:485.