Facial Reanimation by Staged, Split Masseter Muscle Transfer

Malcolm A. Lesavoy, MD, Kenneth L. Fan, MD,† Andrew G. Goldberg, MD,**
Brian P. Dickinson, MD, and Fernando Herrera, MD**

Background: Facial paralysis of the lower face presents severe functional and aesthetic disturbance to patients. The gamut of facial paralysis correction is diverse and must be tailored to the patient. When nerve repair or free functional muscle transfer is unavailable, regional muscle transfer has become a staple in surgical management of facial paralysis. Previous masseter transfers relied on orbicularis oris attachment, which may be atrophic, adhered, or lengthened. Using fascia lata grafts, we describe the senior author's method of staged, split masseter transfer as a reliable method for reanimating the lower third of the face in appropriate candidates.
Methods: The staged, split masseter muscle transfer is a 3-part repair. The first stage places a hemioral fascia lata graft to act as an anchor reinforcement. The second stage transfers the split masseter muscle, suturing to the fascia lata reinforced oral commissure. The third stage, a reefing procedure, is performed 6 to 10 months later under local anesthesia to reinforce attachments.
Results: Six patients underwent the staged, split masseter muscle transfer. Mean age was 43 (15–67) years. Mean time to surgery from onset of deficit was 174 months (3 months to 65 years). All patients had significant improvement over preoperative symptoms. Symmetry was restored in repose. On movement, commissure excursion went from 0 to 6.67 mm in the superolateral vector. Of the 6 patients, 5 required an average of 1.5 outpatient revisions to achieve satisfactory results on average of 4.67 (4–127) months after the final stage.
Conclusions: The staged, split masseter transfer is useful for restoring subtle reanimation in patients presenting with facial paralysis. The staged, split masseter transfer provides bulk and restores both static and dynamic function. We present a case series demonstrating excellent long-term functional results.

Key Words: facial paralysis, split masseter, muscle transfer, case series

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Patients with paralysis of the lower face often complain of functional disturbances, as drooling, difficulty eating, asymmetry due to unequal pull, articulation defects, exposure of teeth, and significant aesthetic deformities.[1] Such complaints are a result of denervation of the orbicularis oris, buccinator, and elevator muscles at the angle of the mouth. The surgical goal of facial reanimation is to restore both function and aesthetics to the paralyzed face combining knowledge of muscle anatomy, physiology, and physiotherapy. Successful reanimation requires a procedure that will allow static, symmetric, and dynamically spontaneous movement of the involved muscle groups. Vascularized functional muscle transfers have provided excellent outcomes.[2] In the subset of patients unable or unwilling to tolerate such extensive procedures, regional muscle transposition is a viable alternative.

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From the *Division of Plastic and Reconstructive, David Geffen School of Medicine at UCLA, Los Angeles, CA; and †University of Miami, Miller School of Medicine, Miami, FL.
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Reprints: Malcolm A. Lesavoy, MD, 16311 Ventura Blvd, Suite 555, Encino, CA 91436-4314. E-mail: drlesavoy@aol.com.

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Described by Lexer in 1867, regional muscle transfers have become a staple in surgical management of facial paralysis.[3–7] However, his technique routinely damaged neural supply resulting in poor functional outcome.[8,9] With respect to anatomy, modifications by Hastings,[4] Pickerill,[6] De Castro Correia and Zani[9] improved results with a full or split muscle transfer.[5] These procedures rely on attachments directly to the orbicularis oris, which may be atrophic, adhered, or overly lengthened on the affected side in longstanding facial paralysis patients.[10]

The staged, split masseter transfer developed in the senior author's practice is a reliable method of reanimating the lower third of the face.[5,11] Instead of orbicularis oris anchoring, our technique uses a hemicircular fascia lata graft in the first stage, and a split masseter transfer in the second, to function both as a static sling and dynamic muscle. Facial symmetry at rest is imparted by restoring equal static pull at the mouth angles. Although sufficient excursion and force for a full smile is not achieved with this technique, functional control of the mouth is almost always accomplished. The purpose of our report is to describe our split muscle technique and review our series of cases performed at a single center.

ANATOMY

The facial nerve has intratemporal and extratemporal components. Lesions involving the nerve within the temporal bone can also affect the parasympathetic fibers to the lacrimal gland, as well as the nasal and oral mucosa, leading to dry eye and decreased oral secretions. The chorda tympani can also be affected with subsequent loss of taste. Once outside the bony canal, the facial nerve has a varied branching pattern and can be injured at any level, affecting only facial animation. Lesions in the zygomatic and buccal regions, anterior to the border of the lateral canthus, often do not yield permanent deficits because of the high degree of cross-branching in those areas.

There are 18 paired muscles of facial expression and 1 which is unpaired. The unpaired orbicularis oris can be thought of as a sphincter, a contractor, or a sphincter-contractor muscle. Evaluation and treatment of deficits can also be compartmentalized by separating orbital, nasal, and buccolabial muscle groups. One component, the buccal fat pad, can also play a significant role in facial contour. This is a multilobulated structure adjacent to the buccinator muscle with projections between the masseter, pterygoid, and temporalis muscles. Because of the loss of surrounding muscle tension in facial paresis, the contour of the fat pad is often altered and can become concave on the cheek. The nasolabial fold is an important structure in determining the configuration of an aesthetic smile and facial symmetry in repose. It is comprised of dense fibrous tissue and muscle fibers originating from both the levator muscles of the upper lip and from the nasolabial fold fascia. Reconstruction of these attachments to the vermillion and the dermis of the upper lip are crucial in reanimation of the perioral region. This may be stimulated by anchoring muscle onto an inserted fascia lata graft, as will be further discussed.

Understanding of the masseter anatomy is important in regional muscle transfer. The blood supply is from the superficial temporal, facial, and maxillary arteries, and innervation is from the masseteric nerve off the mandibular division (V3) off the trigeminal nerve.[12] The masseteric nerve enters the muscle obliquely near the coronoid

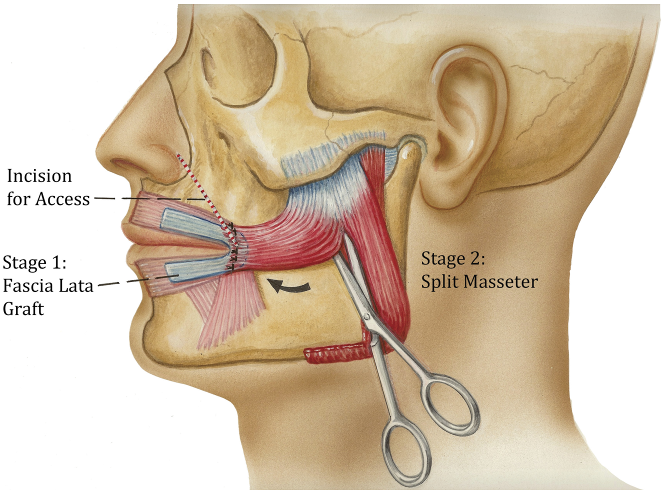

FIGURE 1. Staged split masseter muscle transfer. A, Stage 1: Fascia lata graft placed perorally. B, Stage 2: After 3 months, the medial third of the masseter muscle is split.

notch of the mandible between the deep and middle layer of the muscle to split into the superior and inferior branch, each giving several branches.[12] In 70% of cases, the nerve crosses the middle point of the artery and tracks superiorly. In the other 30%, the masseteric nerve runs above the artery without crossover. Anatomic dissections by De Castro Correia and Zani[9] indicate masseter dissection and transposition should occur at the border of the anterior two thirds and the posterior one third of the muscle to avoid the masseteric nerve. Further analysis by Hwang et al[12] found the safety zone to be wider.

SURGICAL TECHNIQUE

The staged, split masseter transfer aimed to restore static and dynamic oral function in a 3-stage operation. In the first stage, an ipsilateral, 1-cm-thick, 10 to 12-cm-long fascia lata graft is placed perorally and subdermally through 3 mucosal incisions, namely, the midline upper and lower lip mucosa and at the paralyzed oral commissure (Figs. 1A and 2A). The graft is passed through a created subcutaneous tunnel linking the 3 incisions just deep to the orbicularis muscle. The graft is sutured with 3–0 chromic to the underlying orbicularis. Three months is allowed for graft incorporation. The single graft encompasses the affected commissure but is not continuous circumferentially, obviating a tight oral aperture. The fascia lata reinforces the oral commissure and provides an attachment site for the masseter transfer.

After 3 months, the muscle transfer is performed via a nasolabial incision for the second-stage procedure (Figs. 1B and 2B, C). (Alternatively, a preauricular incision can be used to elevate the skin flap, similar to a facelift procedure.) Dissection frees the cheek skin flap inferiorly to the lower border of the angle of the mandible, the zygomatic prominence superiorly, and medially to expose the incorporated fascia lata. The medial third of the muscle is vertically separated, careful to avoid the neurovascular bundle (see previous section), and elevated with a periosteal elevator. The inferior-most portion near the horizontal ramus is retained to include tendinous fibers and periosteum for suturing (Fig. 1B). The masseter is imbricated to the incorporated fascia lata with 2–0 vicryl at overcompensated tension to increase the prominence of the nasolabial fold to account for eventual loosening. Appropriate tension can be confirmed intraoperatively by a lifting of the oral commissures superiorly and laterally. To create a nasolabial fold and prominence, the medial flap is deepithelialized and buried underneath the laterally base dermal flap, in a "pants under vest" technique.

After 6 to 10 months, after adequate healing, softening, and functioning of the muscle, a third reefing procedure is usually performed under local anesthesia as an outpatient procedure for further tightening. We call this stage 3 because of the frequency it is performed. The patient is asked to smile by clenching teeth, and the masseter can be advanced 1 to 3 cm with 2–0 vicryl suture. The nasolabial scar can be revised during this time as well. This procedure can be repeated several times until satisfactory results are achieved.

METHODS

A retrospective chart review was performed of all patients with facial paralysis treated with the staged, split masseter transfer between the years of 1990 and 2000 performed by a single surgeon, the senior author (M.A.L.), at the University of California, Los Angeles. The medical records were reviewed for age, sex, etiology of facial paralysis, and surgical complications, including revisions. Results were tabulated and analyzed in Excel (Microsoft, Redmond, WA). Incomplete charts were omitted.

RESULTS

We identified 10 patients who underwent split masseter transfer for facial paresis at UCLA Medical Center in that period. Four patients were excluded because of incomplete charts. The mean age was 43 years, ranging between 15 and 67 years. The mean time to surgery from onset of deficit was 174 months, ranging from 3 months to

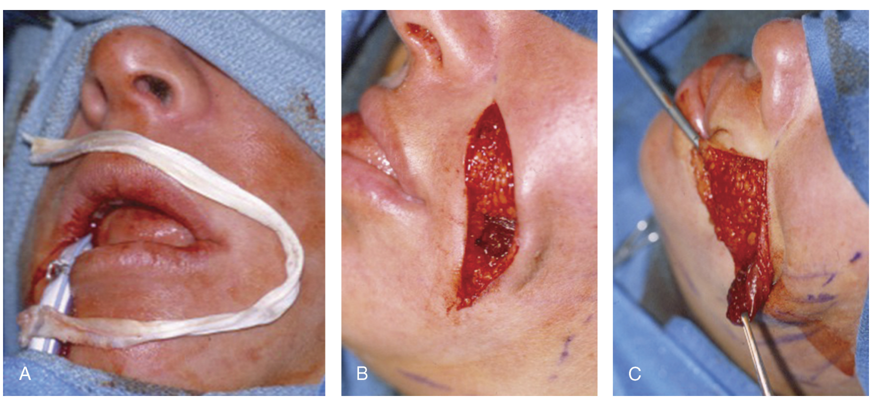

FIGURE 2. A, Stage 1: An ipsilateral, thick fascia lata graft is placed in the perorally. B and C, Stage 2: A muscle transfer is performed via a nasolabial incision. The medial third of the muscle is sutured to the implanted fascia lata from the first stage.

TABLE 1. Results of Case Series

Age, y	Sex	Etiology	Time Between Injury and Repair, mo	Time Between Stages 1 and 2, mo	Stage 3	Additional Revision Surgeries	Time Until Revision, mo	Excursion on Stage II, mm
57	M	Acoustic neuroma	4 mo	3 mo	Yes	3	5, 49, 127 mo	8
18	F	Bell palsy	90 mo	3 mo	Yes	1	11 mo	5
17	F	Salivary gland growth	105 mo	3 mo	Yes	0	—	6
67	F	Traumatic	65 y	3 mo	Yes	1	4 mo	7
56	F	Sarcoidosis	60 mo	4 mo	Yes	3	4, 12, 35 mo	8
44	F	Four left parotidectomies with radiation therapy	6 mo	3 mo	Yes	1	4 mo	6
43.2			174.2 mo	3.167 mo		1.5	4.67 mo (average until first revision)	6.67

65 years. The etiology of facial nerve paralysis included acoustic neuroma, traumatic causes, sarcoidosis, Bell palsy, and resection of a facial soft tissue tumor (Table 1). Preoperatively, half of the individuals had significant problems with oral continence and loss of saliva. Two of the patients had difficulty forming intelligible speech. All patients had no excursion ability of the oral commissure and all had aesthetic issues. These issues were resolved with the staged, split master repair.

Upon muscle transfer, all patients achieved significant improvement over preoperative symptoms. Symmetry was restored in repose, based on patient as well as surgeon satisfaction. In the immediate postoperative period, all of the patients had some asymmetry with animation. Using a mirror for visual feedback and cortical reeducation, patients were encouraged to clench teeth to practice commissure excursion several times a day.[13] Similarly described by Terzis and Noah,[2] patients were encouraged to smile contralateral to the repair, ipsilaterally, then symmetrically several times a day in front of the mirror. Through this method, individual developed a fair degree of voluntary oral movement. Marked improvement in oral continence and speech were apparent in the early postoperative period.

All patients had stage 3 revisions performed. Of the 6 patients, 5 required an average of 1.5 outpatient revisions after stage 3 to achieve satisfactory results, with an average of 4.67 (4–127) months passed. All were completed via an external approach through the previous nasolabial incision as an outpatient procedure with local anesthesia. On 1-year follow-up after final revision, commissure excursion was corrected from no movement to 6.67 mm (Table 1) of superior lateral movement on average. These measurements were of the commissure on repose to maximal excursion. All were performed by the senior author to eliminate interrater bias. There was only 1 complication in our series, which occurred 3 months after stage 2. The 57-year-old male physician (case 2, below) developed an erythematous draining wound. This was excised and found to harbor multiple deep hair follicles, probably the beginnings of a sebaceous cyst.

Case Reports

Case 1

An 18-year-old woman presents with history of bilateral Bell palsy for 7 years. At 13 years, patient underwent bilateral facial nerve decompression, with good result on the right and minimal success on the left.

Physical examination revealed slight asymmetry in repose, with a 3-mm downward pull of the left commissure (Fig. 3A). No drooling, ectropion of the oral commissures, or ectropion of the lower eyelid was noted. She has excellent squinting and hard closure of

FIGURE 3. A and B, An 18-year-old woman presents with bilateral Bell palsy. Asymmetry on the left side is worse than the right. C and D, The patient, on split masseter transfer and a revision 7 months later, gains 4 to 5 mm of excursion on the left commissure.

both eyes. However, there is a weakness and asymmetry of facial expression muscles, with no movement of the left oral commissure on smile (Fig. 3B). The patient consciously suppresses the right commissure on movement to compensate for the left. Although the entire spectrum of facial paralysis options was presented, muscle transposition on the left side was chosen for speed of recovery and restoration of motion.

Fascia lata graft was placed initially, with split masseter transfer 3 months later. Seven months after stage 2, loosening of the masseter muscle was further corrected in stage 3. The patient was very satisfied with the results. At rest, symmetry of the commissures was noted (Fig. 3C). The left commissure excursion measured 4 to 5 mm contributing to a more symmetrical smile (Fig. 3D).

Case 2

A 57-year-old physician presents with right facial nerve paralysis after an acoustic neuroma resection. An intracranial cable graft procedure was deemed not possible at the time by neurosurgery. Physical examination reveals slightly asymmetrical facial appearance, with complete absence of function in all 5 branches of the right facial nerve. Although mild right scleral injection was noted, no drooling or ectropion of the oral commissure and lower eyelid exists. In repose, there is right commissure dystopia, exaggerated when attempting to smile or grimace. His speech is slightly dysarthritic.

The patient was presented with the facial paralysis gamut, including static slings, free muscle flaps, cross facial nerve grafts, etc, but chose the split masseter transfer because of its speed in rehabilitation. The patient had the fascia lata graft placed, and then the masseter transfer 2.5 months later. Three months after the masseter transfer, an erythematous, draining wound developed at the right nasolabial border. A lenticular excision of 3.5 × 8 cm was found to harbor multiple deep hair follicles, probably the beginnings of a sebaceous cyst. The excision did not influence the reconstruction, which provided 8 mm of motion at the left commissure. However, a tightening revision was performed to the full effect 5 months after stage 3 when excursion decreased to 4 mm. Further revisions occurred at 49 and 127 months to maintain 8-mm excursion. Upon follow-up at 11 years, the patient reports overall satisfaction with slight facial asymmetry much improved from previous, oral competence, and minimal difficulty with speech and eating (Fig. 4A, B).

DISCUSSION

When direct nerve approximation, nerve grafting, or nerve crossover are not possible, other reconstructive options must be made available to restore function based on the cause of facial paralysis, type of injury, location, and the anticipated duration.[5] Defined surgical goals are necessary to outline patient and surgeon expectations and choice of technique. Patients who desire symmetry solely at rest can take advantage of static repairs with fascia and prosthetic materials.[7] Shortening or plication of weakened muscles, and rhytidoplasties have also been described for aesthetic improvement of the paralyzed face.[14,15]

Dynamic repair are those that allow conscious control of the oral commissure and smile. These include direct nerve repair, reinnervation using interposition nerve grafts, cross facial nerve grafts, and free functional muscle transfers.[4,6,16–18] When available, these choices are seen by some as standard of care.[2] However, nerve grafts are often times unavailable because of slow axonal regrowth, because of postoperative radiotherapy. Furthermore, nerve repair must be done within a window of time (ie, 18 months) before motor end plates of the muscle deteriorate. In such cases when primary muscles were unsalvageable, regional or free muscle transfers are used. Although excellent results have been achieved, free vascularized functional muscle transfers are technically challenging and demanding on the patient.[19]

As an alternative, regional muscle transposition is indicated in situations when nerve repair is not possible, as in atrophy of mimetic muscles due to longstanding paralysis (ie, Moebius syndrome). In elderly patients with high-grade malignant tumors with facial nerve destruction, muscle transposition rehabilitates the face more expeditiously than facial nerve grafting.[5,20] The patient is able to return to recuperate before postoperative radiation commences. The 2 most popular muscles used are the temporalis and masseter.[5,19] Because of the muscle bulk deformity over the zygomatic arch associated with temporalis transposition, the staged, split masseter muscle technique has worked best in our practice.

Loss of innervation to the oral musculature leads to difficulties in oral continence, collection of food in the buccal vestibule, unintelligible speech, and facial asymmetry. These problems were adequately improved in our series. Several variants to the regional masseter transfer are presented in the literature. Sachs and Conley[13] proposed an intraoral approach to masseter muscle transposition without the use of fascia lata. In an effort to adequately recreate upward movements of the upper lip and corner of the mouth, Shinohara et al[20] uses the zygomatic arch as the wheel in a pulley, the tensor fascia lata as the string, and the detached masseter muscle as the force. The technique of Shinohara et al[20] produces similar commissure excursion (3–7 mm). Rubin[21] uses temporalis and masseter transposition for reanimation of the upper and lower lip, respectively. Ragnell[11] described a temporalis transfer using a tendon graft to transfer force to a fully encircling fascia lata graft. Beyond facial paralysis, the split masseter technique has been described in reanimation of full thickness defects around the oral commissure requiring flap repair, proving its versatility.[1,22–24]

Our own staged, split master technique has several advantages.[3–7] Our unique use of the fascia lata graft alleviates problems with anchoring the masseter to orbicularis oris affording improved aesthetic animation. Bulk is restored to the buccal fat pad,

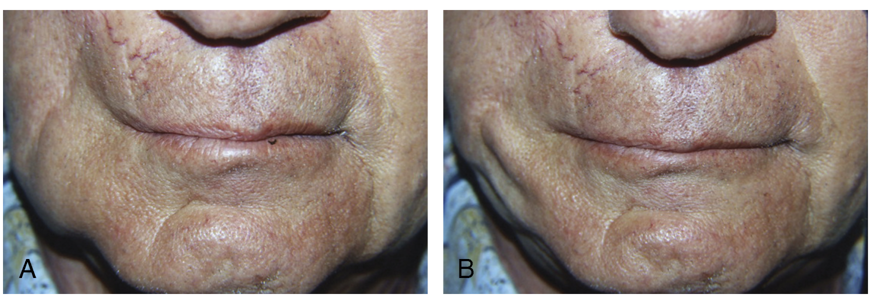

FIGURE 4. A 68-year-old physician presents on follow-up 11 years after staged, split masseter repair with satisfactory results. A, Patient in repose and (B) on smiling. Note the visible excursion of the right commissure, and appearance of the masseter muscle contracting.

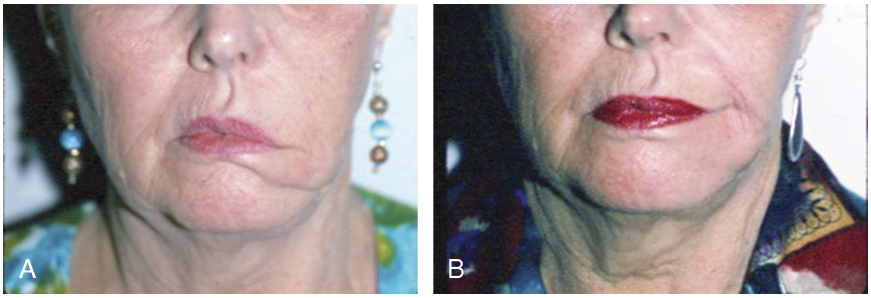

FIGURE 5. A 67-year-old woman with longstanding history of traumatic facial paralysis (A) before and (B) after split masseter transfer. The masseter muscle functions both as a static sling by pulling the oral commissure superiorly and laterally in repose, as shown, and a dynamic muscle.

which is often concave because of loss of surrounding support during paresis. As a static sling, the masseter is anchored to the fascia lata to pull the oral commissure superiorly and laterally in repose (Fig. 5). During effort, the masseter can dynamically restore oral competence and improve expression and speech. It is important to clarify that the procedure does not allow for reanimation in exaggerated movement, but is best suited for subtle smile and speech.

Although each repair was initially overcorrected, stage 3 tightening was required in almost every case, and should probably become an excepted part of the reconstruction. Revision surgeries were performed in 5 of 6 patients. Once an acceptable result was achieved, the muscle maintained a long-term degree of correction (Fig. 6). Because the masseter nerves are innervated by the fifth cranial nerve, patients need to initially smile by clenching teeth.[21] With therapy and education, this was no longer a desideratum: facial tone at rest and realistic, subtle natural smile were achieved with long-term practice. Patients report they were able to learn to coordinate the voluntary action with emotions.

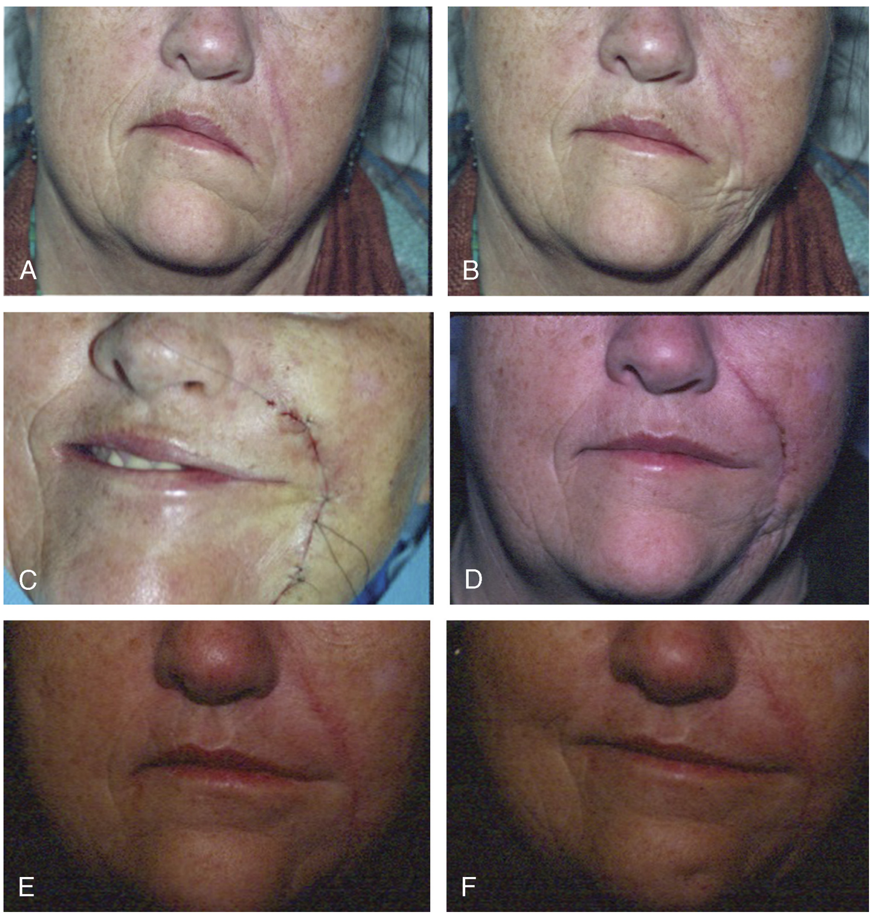

FIGURE 6. A and B, A 58-year-old female patient diagnosed with left facial palsy secondary to sarcoidosis presents 2 years postoperative with significant loosening of the masseter. Despite a 5- to 8-mm excursion, a 10-mm drooping of the left commissure exists. Reefing was deemed necessary. C and D, Patient immediately after reefing. E, and F, Two years follow-up.

Compared to others, a disadvantage to our technique includes the multiple stages necessary. However, our results demonstrate lasting commissure excursion, even on decade long follow-up (see case 2). Fascia lata graft is necessary in patients with atrophic orbicularis oris after longstanding facial paralysis, which our procedure uniquely incorporates. The staged, split masseter muscle transfer is a worthwhile procedure in the appropriately selected patient.

CONCLUSIONS

This has become the senior author's method of choice for select patients presenting with delayed lower facial paralysis. The staged, split masseter transfer provides bulk and restores static and dynamic function for those unwilling or unable to tolerate long and complex operations. In comparison to other techniques of facial reanimation, our staged, split masseter transfer is simple and yields good long-term functional results.

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