

TITLE: Rehabilitation of the Paralyzed Face

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Introduction

The diagnosis of a permanent facial paralysis can be devastating to a patient. The emphasis that our society places on physical beauty contributes to this perception and often leads to isolation of these patients who are embarrassed by their appearance. However, these patients are plagued not only by a cosmetic defect but also by the functional deficits caused by loss of facial nerve function. Lagophthalmos with ocular exposure, loss of oral competence with resultant drooling, alar collapse with nasal airway obstruction, and difficulties with mastication and speech production are all potential consequences of facial paralysis.

The reconstructive surgeon attempting to rehabilitate the paralyzed face must attempt to address both the cosmetic and functional losses of the patient. The main functional goals are to protect the eye and reestablish oral competence. The primary cosmetic goals are to create balance and symmetry of the face at rest and to reestablish the coordinated movement of the facial musculature. No single technique will achieve these goals for every patient and the treating physician should be familiar with the variety of options available so that an individualized plan can be developed based on each patient's clinical picture.

Patient Evaluation

A complete discussion of all of the etiologies of facial paralysis is beyond the scope of this paper. The diagnostic evaluation of a facial nerve injury has been nicely covered in recent grand rounds and will not be reiterated again here. That being said, it is of utmost importance that a thorough evaluation be performed in every patient prior to the consideration of any rehabilitative procedure.

When seeing a patient with a facial paralysis for potential rehabilitation, areas of particular interest in the history taking include the etiology and the duration of the paralysis. Valuable information about the remaining facial nerve can be elicited from the etiology of the paralysis and this information will directly influence the choice of rehabilitative surgery. For instance, a case in which the proximal facial nerve is missing after tumor extirpation will be

addressed with a different technique than in a case where the nerve is transected but without tissue loss.

Similarly, the duration of the paralysis will directly influence the type of procedure selected for rehabilitation. Although reports in the literature vary, most authors agree that neural grafting techniques should be performed within 3 years of the injury. After this time frame significant neural fibrosis and loss of motor end plate integrity will occur and surgical outcome is much less predictable. EMG can be a useful study to differentiate between cases in which denervated but otherwise normal muscle is present and cases in which irreversible muscle atrophy has occurred. Those cases in which the facial nerve is potentially intact and may recover must be observed for a minimum of 1 year prior to committing to rehabilitative surgery.

Additional history taking should elicit the general health of the patient and the presence of any other neurological abnormalities. An elderly patient with advanced neoplastic disease will obviously benefit from different therapies than will the young healthy patient with a congenital facial paralysis. Some rehabilitative procedures utilize other nerves to reestablish neural input to the distal facial nerve or local muscle transfer to replace nonfunctioning facial musculature. Therefore, these donor tissues must be carefully evaluated to confirm normal function. Additionally the use of a donor nerve or muscle will necessarily result in donor site morbidity and one must consider how this will be tolerated by the patient.

Methods of Facial Rehabilitation

There are many procedures that have been described for surgical rehabilitation of the paralyzed face. These procedures can be grouped into those that restore neural input, those that replace nonfunctional facial muscles, those that statically resuspend facial tissues and adjunctive procedures that address specific defects.

Restoration of Neural Input

In those cases in which the proximal and distal segments of the facial nerve are present and free of disease, direct reanastomosis is the procedure of choice. This should be performed immediately in the case of obvious intraoperative facial nerve transection or as soon as possible after a traumatic nerve injury. The ability to stimulate distal nerve branches remains for approximately 72 hours post-injury and greatly assists intraoperative identification and reanastomosis. Authors generally agree that neurorrhaphy should be performed under magnification with small nylon suture after freshening the nerve endings. However, whether epineural or perineural repair is performed or whether 8-0, 9-0 or 10-0 nylon suture should be utilized seems to be surgeon's choice. It is universally accepted that the nerve must be reapproximated under absolutely no tension. This may be facilitated by rerouting of the facial nerve in the temporal bone which will typically provide as much as 1cm of additional length. If this is inadequate then it is preferable to place a nerve interposition graft than to place excessive tension on the neurorrhaphy.

When the proximal and distal facial nerve are present but there is loss of intervening nerve tissue or the reapproximation cannot be performed without tension, then interposition or cable grafting of the nerve should be performed. This procedure utilizes a donor sensory nerve

to bridge the gap between the nerve ends. The most commonly used graft is the great auricular nerve which will typically provide a graft 10cm in length. The advantages of this nerve are that it can often be harvested through the existing incision, it can be traced to its three terminal branches which can then be anastomosed to distal facial nerve branches and the donor site morbidity is minimal. The sural nerve can be used when a longer segment of nerve tissue is missing. This nerve supplies as much as 35cm in length and again its harvest has little donor site morbidity.

Nerve crossover techniques are utilized when the proximal facial nerve is anatomically or functionally disrupted. In this case, a donor motor nerve is used to reestablish neural input to the distal facial nerve branches. This procedure has been described with several donor nerves—the hypoglossal, spinal accessory, ansa hypoglossus, trigeminal and phrenic—although the most commonly used are the hypoglossal and accessory. The advantage of a nerve crossover procedure is that it will reliably reestablish neural input to the distal facial nerve, often providing good resting facial tone and symmetry. The disadvantages include donor site morbidity, development of synkinesis or hypertonia and the unpredictable ability to restore voluntary facial movements.

Donor site morbidity from the use of CN XII includes hemitongue atrophy with resultant difficulty with speech articulation and manipulation of the food bolus in the oral phase of swallowing. Nerve crossover using CN XI results in shoulder girdle weakness, reduction in range of motion and occasionally chronic shoulder pain. Modifications of these techniques have been described in an attempt to minimize donor site morbidity. This would include splitting the hypoglossal nerve distally so that some nerve fibers are preserved to the tongue or using the branch of the accessory nerve to the sternocleidomastoid while preserving the branch to the trapezius. Synkinesis or mass movement results from the loss of individualized innervation of specific facial muscles. Instead, all muscle groups receive stimulation simultaneously, resulting in an unnatural mass contraction of all facial muscles. Hypertonia of the facial muscles results in a grimace expression and is due to the fact that the regenerating axonal fibers from the donor nerve can actually be greater in number than in the native facial nerve. This causes an increase in baseline neural input and increased resting muscle tone. Finally, the unpredictability of the functional outcome complicates preoperative patient counseling. Two patients with essentially identical clinical pictures, treated with identical crossover procedures, could have two very different results in terms of voluntary facial movements. The explanation for this type of variability is unclear. However, it is clear that intensive physical therapy and training exercises will result in improved voluntary function. Despite these disadvantages, nerve crossover techniques are widely utilized and large outcome studies report up to 80% of patients achieving “good” results, defined as a House-Brackman score of III.

The cross-facial nerve grafting technique involves the sacrifice of some distal nerve branches on the normal side of the face with placement of a sural nerve interposition graft to the corresponding facial nerve branch on the paralyzed side. The idea of using the normal facial nerve to rehabilitate the paralyzed nerve has the theoretical advantage of providing symmetric voluntary facial movements. It also, in many cases, has been shown to reestablish good resting tone and symmetry while producing minimal donor site deformity. However, it has the disadvantage of a significantly reduced number of regenerating neurons compared to other

crossover techniques, resulting in much weaker facial muscle contraction. This procedure is not typically used on its own, but rather in combination with a subsequent free muscle grafting procedure which will be discussed in more detail later.

Replacement of Nonfunctional Facial Muscles

Indications for muscle transfer techniques in facial rehabilitation include long-standing paralysis (greater than 3-4 years) with a small chance of recovery using nerve grafting procedures, lack of intact facial neuromuscular units due to fibrosis, atrophy or congenital absence and patient contraindications to nerve crossover techniques. Options for muscle transfer include regional muscles pedicled on their native neurovascular supply or free muscle transfers with microvascular anastomosis.

Regional muscle transfers utilize the temporalis and masseter muscles. Prior to undertaking one of these procedures, the normal strength of the muscles and function of the motor supply from the trigeminal nerve must be confirmed. The transfer of either of these muscles primarily addresses paralysis in the lower third of the face and the resultant drooping of the oral commissure. Patients with a complete facial paralysis who choose to undergo a regional muscle transfer will require additional procedures to correct the paralysis of the upper face.

Temporalis muscle transposition has the advantage of being a technically straightforward procedure that provides immediate restitution of midface symmetry. It can be performed through a hemicoronal incision or preauricular incision that is extended superiorly. A 2cm strip of muscle is harvested from the middle third of the muscle body and elevated off of the underlying skull inferiorly to the superior aspect of the zygomatic arch. A tunnel is created over the zygomatic arch, taking care to preserve the frontal branch if facial nerve recovery is possible, and the muscle is rotated over the arch, through the tunnel toward the oral commissure. If additional length is required, the superficial layer of the deep temporal fascia can be elevated off of the underlying muscle from inferior to superior, leaving it attached to the superior extent of the muscle. An alternative to this would be to harvest a strip of pericranium with the muscle. A second incision is created in the nasolabial fold or along the vermilion border to allow access to the orbicularis oris muscle. The muscle or fascia is then sutured to the orbicularis with permanent suture and the oral commissure elevated in an overcorrected position. The disadvantages of this technique include the bulkiness of the muscle where it crosses over the zygomatic arch, the temporal depression that results from muscle harvest and the potential for chronic TMJ pain from loss of support of the temporalis. The voluntary movement that can be achieved with the temporalis transposition is not spontaneous like the normal side of the face. The patient will require training exercises to learn to produce a smile by biting or clenching the teeth.

Masseter muscle transposition can be used in place of the temporalis if for some reason that muscle is unavailable. Perhaps more commonly it is used in conjunction with a temporalis transfer to improve reanimation of the lower lip at the corner of the mouth. This muscle can be harvested through an incision along the inferior border of the mandible or an intraoral incision along the sulcus of the mandible. The anterior aspect of the masseter is elevated and incised at its insertion along the inferior border of the mandible. The muscle is rotated anteriorly toward the oral commissure and secured to the orbicularis oris in a similar fashion to that described

above. The disadvantage of the masseter transposition is that less muscle mass is available compared to the temporalis and the vector of pull is more lateral than superior resulting in a less desirable position of the oral commissure.

Microneurovascular free muscle transplantation is another option for the rehabilitation of long standing facial paralysis and has recently gained popularity in use for patients with congenital facial paralysis and complete lack of normal facial neuromuscular units. In the past, this procedure was performed with neural reanastomosis but without microvascular reanastomosis. Experience has shown that this will result in significant muscle atrophy with weakening of muscle contraction. Today these free muscle flaps are harvested with their native nerve and blood supply and both are reanastomosed in the recipient site.

Several donor muscles have been described for facial reanimation including the extensor digitorum brevis, gracilis, latissimus dorsi, pectoralis minor, rectus abdominis and serratus anterior. An ideal donor muscle has a single dependable vascular pedicle of sufficient length to allow for harvesting and reanastomosis. The muscle body needs sufficient bulk without being overly bulky and the excursion of the muscle in contraction should be as close to that needed in the face as possible. Additionally, harvest of the donor muscle should result in minimal morbidity. Unfortunately, none of the above-mentioned options for donor muscles display all of these characteristics, so the choice of one versus the others will be dictated by each individual patient.

The most commonly used recipient vessels are the facial or superficial temporal arteries and veins. These most often will be of an adequately matched caliber to the donor pedicle. The choice of recipient nerve will be dictated by the status of the ipsilateral facial nerve. Most often native facial nerve is not available, but if it is, it should be utilized either by direct anastomosis or interpositional grafting. Crossover grafting from the hypoglossal or accessory nerves to the nerve stump of the muscle graft is another option. As mentioned previously, this leads to donor site morbidity and has the disadvantages of mass movement and movement that is not coordinated with the other side of the face. The most commonly utilized recipient nerve is the facial nerve from the nonparalyzed side of the face via the placement of a cross-facial sural nerve interposition graft. This technique is most often described as a staged procedure with the initial placement of a cross-facial sural nerve graft followed by muscle transplantation after 10-12 months, although recent reports have found that this can be performed in a single stage with similar outcomes.

The advantages of the free muscle graft over the use of a regional muscle transfer include its ability to be reinnervated with input from the native facial nerve if it exists, its ability to augment soft tissue defects in the face if necessary, and its potential for coordinated movement with the contralateral face if a cross-facial sural nerve graft is used. Disadvantages of this technique include its technical difficulty and long operating room time, the extended time commitment required for a staged procedure and the potential for unsatisfactory results despite a well-performed procedure.

Static Resuspension of Facial Tissues

Patients who do not desire extensive rehabilitative surgery, those with a poor prognosis or those who are unable to undergo the previously mentioned techniques may be candidates for static resuspension procedures. Although, as the name implies, these techniques do not restore facial movement, they can be very effective in improving facial symmetry by elevating the corner of the mouth or a ptotic brow. The elevation of the oral commissure results in functional improvement as well by reestablishing oral competence and preventing drooling. Static slings also tighten the cheek against the teeth, an action which benefits the oral preparatory phase of swallowing and speech articulation. Elevation of a ptotic brow can reverse lateral visual field defects caused by drooping facial tissue.

The majority of static sling procedures address the paralyzed lower face, specifically the oral commissure. However, as mentioned some authors are also beginning to use these same techniques to improve the paralyzed forehead with a ptotic brow. Fascia lata had been the most commonly used material in the past. It had the advantage of being a native tissue, which reduces the chances of infection or extrusion. However, its disadvantages included donor site morbidity, increased operating time and the tendency for the tissue to stretch over time, leading to recurrence of facial drooping and need for revision. Synthetic suspension materials are widely utilized today and include Gore-Tex and Alloderm. Both of these materials are safe, easy to work with, available in a variety of sizes, exhibit good tensile strength with little stretch over time and avoid the increased time and morbidity of harvesting fascia. Advantages of facial suspension using Gore-Tex include the technical ease of the operation, which can often be performed under local anesthesia, the avoidance of a donor site and the ease of revision or reversal if needed. Additionally, the effect of improved facial symmetry is immediate and this technique can be used in conjunction with neural grafting procedures while awaiting axonal ingrowth. The two primary disadvantages of Gore-Tex include the potential for stretch with loss of suspension requiring revision and the fact that it is a foreign material and therefore at higher risk for infection or extrusion.

The technique for resuspension of the corner of the mouth, as mentioned previously, is technically straightforward. The process is quite similar to that described for temporalis or masseter transfer only with the use of fascia or synthetic materials instead of muscle. And, unlike muscle transfer in which the muscle is pedicled from its origin, the sling is fixed to the zygomatic arch and this serves as the support for the suspension. The corner of the mouth is elevated into a desirable position with a small amount of overcorrection to offset any early stretch of the sling.

Forehead suspension with Gore-Tex employs essentially the same idea. An incision is made in a natural skin crease in the forehead between .5 and 1.0cm superior to the lateral aspect of the brow. From this incision, the superior fibers of the orbicularis oculi are identified. A vertical incision is made behind the hairline, through the galea and a tunnel is dissected in a subgaleal plane toward the first incision. The sling is then sutured to the orbicularis, placed under tension until the brow is elevated to the desired position and then secured to the skull with titanium screws.

Adjunctive Procedures

Numerous additional procedures have been described to augment the major rehabilitative procedures outlined above or to address specific defects not repaired with those procedures. Except for the reinnervation techniques, the other surgeries often will correct only a portion of the paralyzed face and for optimal rehabilitation, more than one procedure will be required.

Adjunctive procedures to correct the lagophthalmos and ectropion that occur in the upper third of the paralyzed face will often be performed in conjunction with muscle transfers, free muscle grafts or static slings which are primarily helpful in addressing the lower third of the face. The loss of function of the orbicularis oculi muscle leads to an unopposed action of the levator palpebrae and subsequent inability to close the upper lid. Inadequate eye closure puts the cornea at risk for exposure, drying, and ulceration, possibly leading to irreversible damage. For these reasons, reestablishing complete upper lid closure is of utmost importance. Several techniques have been described to achieve this goal, but the most commonly utilized is the gold weight implant. This is a technically easy procedure that consistently results in correction of lagophthalmos. The disadvantages of a gold weight include its visibility beneath the thin upper lid skin and the occasional occurrence of extrusion. An alternative technique to improve upper lid closure is the palpebral spring. Although this is technically more challenging, it may be a better option for those concerned about the visibility of the gold weight or for patients that have compromised levator function with ptosis in addition to loss of orbicularis function.

Ectropion of the lower lid follows paralysis of the orbicularis as the tissues become more lax and fall away from the globe with the pull of gravity. This deformity can be satisfactorily repaired with a variety of techniques. The wedge resection and lateral canthopexy is probably the quickest and easiest to perform although a tarsal strip procedure is also very straightforward. A bit more complex form of ectropion repair is the temporalis fascia sling. In this case, a strip of deep temporal fascia is harvested, placed through a tunnel in the lower lid and secured to the medial and lateral orbital periosteum. The sling is tightened, thereby pulling the lower lid against the globe.

Tarsorrhaphy had been the procedure of choice to address the eye in facial paralysis. This has largely been replaced with the techniques mentioned above, however should remain in the armamentarium of the reconstructive surgeon. The benefit of tarsorrhaphy is that it is simple, effective and addresses both the upper and lower lid problems with one procedure. Disadvantages include the narrowing of the palpebrae fissure with visual field restriction and the potential for lid deformity after release of the tarsorrhaphy.

Drooping of the lower lip may persist after other rehabilitation procedures and can be addressed with a wedge resection of the redundant, drooping orbicularis oris. This can be performed alone, in a standard V or W shaped excision, or in conjunction with transposition of the opposite, nonparalyzed orbicularis. In this technique, a tunnel is created from the wedge excision to the modiolus on the paralyzed side. The normal orbicularis is then advanced across the wedge defect and through the tunnel where it is secured to the modiolus. The direction of pull can be directed more laterally or superiorly as directed by the individual patient's deformity.

Many cosmetic procedures designed to rejuvenate the aging face can also be quite helpful in rehabilitating the paralyzed face as well. Brow ptosis, as previously mentioned, may be corrected with a Gore-Tex sling. Other options include a formal brow lift performed via a direct, mid-forehead or pretrichial incision. Endoscopically assisted lifting procedures have also been described as useful adjuncts and have the benefit of being able to address both the ptotic brow and midface in the same setting. The classic rhytidectomy with SMAS plication is a reasonable adjunct to improve the appearance of the lower third of the face, while deep plane rhytidectomy with subperiosteal dissection can provide lifting of the upper lip and midface as well.

Finally, the use of botulinum toxin injection after reinnervation techniques can be very beneficial in the treatment of synkinesis or hypertonia. Overactive muscles can be treated with Botox to reduce resting tone. Mass facial movements can be improved by selectively targeting those muscles contributing to the abnormal expression for chemical denervation. The benefits of Botox therapy for these purposes include its ease of administration, its temporary effect if the patient is unhappy with the result and its ability to selectively target abnormal muscles. The disadvantages are the need for repeat treatments every 3-4 months and the potential for over-injection with the recurrence of the facial paralysis that was the issue to begin with.

Summary

There are many possible treatment options for the patient desiring facial rehabilitation. No single procedure will address the cosmetic and functional deficits of every patient. Therefore, carefully tailoring the treatment plan to each individual's clinical picture will facilitate successful rehabilitation and lead to satisfied patients.

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