Dynamic Muscle Transfer in Facial Nerve Palsy: The Use of Contralateral Orbicularis Oculi Muscle

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The prevention of visual loss secondary to exposure keratopathy and corneal ulceration is the main objective in patients with facial nerve palsy. Initial treatment includes frequent administration of lubricants and nocturnal eye lid taping to prevent corneal exposure and trauma while sleeping.\textsuperscript{1} The height of the palpebral aperture can be reduced to minimize the corneal exposure, and this can be achieved with a simple suture tarsorrhaphy, levator aponeurosis recession, and/or upper eye lid loading.\textsuperscript{1–3} Lower lid spacers can provide upward support.\textsuperscript{4,5} Transferring muscle fibers from one region to another with its own nerve supply is the principle of dynamic facial reanimation. Temporalis muscle transposition is the most commonly performed muscle transfer procedure in facial palsy.\textsuperscript{6} Transferring temporalis muscle fibers to the eyelids allows eye lid closure during mastication. However, at night, lagophthalmos remains a problem as the eye lid closure relies on conscious efforts by the patient to chew.\textsuperscript{7} Free muscle grafts with microneurovascular anastomosis have

The aim of the study is to describe the results of dynamic muscle transfer with an orbicularis oculi muscle flap from the contralateral side to the paralyzed side in patients with House-Brackmann grade 6 facial nerve palsy. This case series included six patients who underwent dynamic muscle transfer with a flap of healthy orbicularis oculi muscle fibers from the contralateral side into the paralyzed orbicularis oculi muscle. All patients had a House-Brackmann grade 6 facial nerve palsy. They all had previous multiple surgical procedures to improve the eyelid function. In spite of this, they were all symptomatic in terms of corneal exposure before orbicularis muscle transfer. All patients had postoperative follow up in excess of 2 years after the procedure. All patients improved symptomatically and had clinically reduced lagophthalmos postoperatively. Five patients who had an absent blink reflex showed a significant improvement in their blink reflex postoperatively. No complications occurred at the donor site. All patients showed a significant improvement of their symptoms and their lagophthalmos reduced postoperatively. Most importantly, the blink occurred involuntarily at the same time as the blink on the normal side. The authors propose that a dynamic muscle transfer using the contralateral orbicularis muscle may be considered to improve the voluntary lid closure and spontaneous blink reflex to improve corneal exposure in patients with grade 6 facial palsy who have not benefited from conventional surgical procedures.
also been tried. Cross-face nerve grafts such as the gracilis muscle transplant use the innervation from the contralateral healthy side to allow dynamic movements of the affected side. Other microvascular free grafts used are taken from pectorals minor, latissimus dorsi, trapezius, and internus abdominis muscles. Although all of the above can be successful in restoring static and/or dynamic movement, they do not restore the involuntary blink. In our multidisciplinary facial function treatment service, the patients have undergone transfer of the contralateral orbicularis oculi muscle fibers since 2009 to re-create an involuntary blink and improve medial eyelid support, this being a natural extension of the previously used muscle techniques described above. The authors present their results of contralateral orbicularis oculi muscle transposition in complete facial nerve palsy (House-Brackmann grade 6) nonresponsive to conventional treatment modalities.

Method
Six consecutive patients who underwent orbicularis oculi muscle transfers from the contralateral side and a postoperative follow-up of in excess of 24 months were included in this study. The eye lid function was carefully assessed and patients’ symptoms were monitored. The return of the orbicularis function is demonstrated by clinical neurophysiology in one patient. The authors have followed internationally accepted ethics standards.

Surgical Procedure
After informed consent has been obtained (including an explanation of the risks to the fellow eye), the preseptal orbicularis from the unaffected upper eyelid was exposed via an upper lid skin blepharoplasty, and the skin edges were undermined. A flap of healthy orbicularis muscle was raised, remaining attached medially via a wide pedicle not to interfere with its nerve and vascular supply (Fig. 1A). Then a subcutaneous supra-nasal tunnel was fashioned, through which the orbicularis flap was passed to the affected side (Fig. 1B). This healthy orbicularis muscle flap was then divided into superior and inferior slips (Fig. 1C) prior to being sutured into paralytic orbicularis on the paralyzed side in the upper (via an upper lid skin crease incision) and lower eye lids (via a subciliary incision). The orbicularis oculi of the paralyzed eyelids was incised about one-third along the eyelid length and the muscle transposed from the functioning side sutured into a gap in it with 6/0 Vicryl. The incisions were closed with 7.0 Vicryl suture (Fig. 1D) and chloramphenicol 1% antibiotic ointment was applied to the wounds. The patient was discharged home and follow-up arranged in the clinic 2 weeks after surgery.

Results
A total of six patients with grade 6 facial nerve palsy on the House-Brackmann scale were treated with orbicularis muscle transfer. The male:female ratio was 2:1. All patients tolerated the surgical procedure well and the scar of the upper lid skin incision healed well and was hidden at the upper lid skin crease. The lower lid subciliary skin incision also healed well with minimal scar formation. The surgical incision on the side of the nose resembles the surgical incision made during an
external dacryocystorhinostomy (DCR) procedure and also healed well. In all patients, the symptoms of ocular exposure improved postoperatively, and all were satisfied with the experience of the surgical procedure. Blink quality showed a significant improvement after orbicularis surgery, and the signs of improvement were seen as early as only 2 days postoperatively. In five of these patients there was no blink reflex preoperatively and all these patients showed signs of a returned blink response on the paralyzed side in coordination with the normal sidepostoperatively. Pre- and post-op photographs (Figs. 2 and 3) and pre- and post-op videos (Videos 1 and 2) of the same patient in Fig. 1 demonstrate a reduction in the right palpebral aperture height on both involuntary and voluntary eye closure after surgery. The lagophthalmos was found to be markedly improved postoperatively and the improvement ranged from 1 to 5 mm (Table 1). Although the lagophthalmos was only partially reduced, this improvement was sufficient enough to improve the symptoms and signs of exposure keratopathy. No symptoms or complications were noted on the donor side eyelid.

**Electromyographic Studies**

Facial motor studies were performed on the same subject in Figs. 1–3. The facial nerve of both sides at the tragus was stimulated and recordings were made over the orbicularis oculi muscle on the affected side with surface electrodes. On stimulation of the ipsilateral facial nerve and recording over the right (paralyzed) orbicularis oculi (grafted side) showed active denervation changes with no response (Fig. 4, R1 and R2). However, with stimulation of the left (contralateral) facial nerve a response is recorded from the right (ipsilateral) previously paralyzed orbicularis oculi muscle. Three recordings were recorded by reference electrodes over the medial (L1), central (L2), and lateral (L3) upper lid on the recipient orbicularis muscle to ensure that the evoked response did not represent a far-field response from the left-sided facial muscles. All these three surface electrodes recorded a positive response. A concentric needle EMG examination was also performed. This showed voluntary activation of motor units of normal morphology although recruitment patterns were reduced. These findings indicated that the grafted orbicularis oculi muscle segment is functioning with continuity of the facial nerve motor fibers.

**Discussion**

All our patients had their facial nerves sacrificed during surgical treatment for either cerebellopontine angle or parotid gland tumors leaving them with severe (House-Brackmann grade 6) facial nerve palsies. All patients had been subjected to multiple oculoplastic procedures to treat lagophthalmos and corneal exposure. However,
<table>
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<th>Pt. no.</th>
<th>Gender</th>
<th>Age at surgery</th>
<th>Cause of facial palsy</th>
<th>Grade of weakness</th>
<th>Previous surgery</th>
<th>Pre-op: symptoms and signs</th>
<th>Pre-op: blink</th>
<th>Post-op: blink</th>
<th>Pre-op: lagophthalmos (mm)</th>
<th>Post-op: lagophthalmos (mm)</th>
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<td>Partial blink</td>
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<td>1</td>
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<td>M</td>
<td>51</td>
<td>Right acoustic neuroma</td>
<td>6</td>
<td>PP, brow suspension, LR</td>
<td>discomfort</td>
<td>Markedly reduced blink</td>
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<td>6</td>
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<td>No blink</td>
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<td>F</td>
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<td>Right parotidectomy</td>
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<td>Epiphora, discomfort</td>
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<td>Partial blink</td>
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<td>0</td>
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<tr>
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<td>M</td>
<td>66</td>
<td>Right acoustic neuroma</td>
<td>6</td>
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<td>Discomfort</td>
<td>No blink</td>
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<td>Discomfort, redness and irritation</td>
<td>No blink</td>
<td>Partial blink</td>
<td>4</td>
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</table>

Abbreviations: BL, brow lift; F, female; GW, gold weight; LR, levator recession; LT, lateral tarsorrhaphy; LTS, lateral tarsal strip; M, male; MC, medial canthoplasty; post-op, postoperative; PP, punctal plugs; pre-op, preoperative.
despite multiple surgeries, all these patients remained symptomatic with absent blink and lagophthalmos preoperatively. Surgery was only offered for patients who had grade 6 facial nerve palsies so as not to jeopardize any residual facial function in patients with lesser grades of facial nerve palsy. After surgery, all patients required tear supplements less frequently and reported a subjective improvement in ocular comfort with symptomatic relief. There was no exposure keratopathy postoperatively in any of our patients (minimum follow-up of 6 months). Blink of the upper lid improved in all cases, along with improved lower lid support. The return of the blink to the upper lid was seen as early as 2 days postoperatively. Unfortunately the lower lid was noted to have minimal movement in our experience.

Fig. 4 The results of EMG examinations. R1 and R2. (A) Stimulation of the right (affected) facial nerve at the tragus elicited no recordable ipsilateral orbicularis muscle response medially (R1) or laterally (R2). (B) Stimulation of the left (contralateral) facial nerve at the tragus elicited good responses from the affected (right) orbicularis muscle confirming muscle graft continuity consistent with the clinical findings of improved eyelid function. L1, L2, and L3 responses were obtained from the surface electrodes placed at the medial, central, and lateral upper eye lid. All three recordings showed a positive response.
All these patients had no blink/orbicularis function preoperatively. Although no patient recovered a complete blink, even a mild to moderate blink improved the exposure keratopathy and ocular discomfort significantly in all subjects. Most importantly, the postoperative blink reflex on the paralytic side occurred in coordination with the normal side, and did not require a conscious effort on the part of the patient to initiate eye closure. In addition, the improved static support and position of the paralytic lower lid ectropion was very beneficial for ocular comfort and reducing the exposure keratopathy. None of our patients reported any symptoms related to the orbicularis function of the fellow eye (donor site). Though it is difficult to objectively assess the improvement due to the effect of multiple previous surgeries, all patients showed a significant improvement of the orbicularis muscle function on the affected side following orbicularis transfer surgery. The surgical incisions healed well with good cosmetic outcome with the upper lid scars hidden in the upper lid skin crease.

Other facial reanimation procedures include various transpositions and free grafts. Facial reanimation using muscle transposition should be considered when the distal neuromuscular unit is either absent, nonviable due to fibrosis (>2-year-old injury), or in congenital facial paralysis. Additionally, there may be significant soft tissue defects after tumor extirpation that are amenable to defect repair with a regional muscle or microneurovascular free tissue transfer that acts secondarily to reanimate the face. A classic dynamic facial sling, the temporalis muscle transposition, is often considered for the eyelids to achieve reanimation. The temporalis muscle is innervated by the trigeminal nerve and is unresponsive to emotion without extensive retraining. The blood supply arises from the deep temporal branch of the internal maxillary artery. Disadvantages of the temporalis transposition includes the lack of spontaneous movement, chronic temporal-mandibular joint dysfunction, and tissue bulk over the zygomatic arch.17 Classically, the temporalis muscle is attached to the orbicularis muscle at the nasolabial fold or oral commissure with sufficient tension (overcorrection) to compensate for normal postoperative attenuation. An interesting paper by Sherris18 described a refinement of the temporalis muscle transposition technique by using only the middle one-third of the muscle to reanimate the oral commissure. Free muscle transfer was first described for facial reanimation in 1976 by Harii et al.19 Free muscle transfer is most useful for dynamic reanimation of the paralytic face when a concomitant soft tissue defect needs reconstruction. Free flaps are often not the first choice in facial reanimation due to the length of operating time and necessity of microvascular expertise. Reinnervation of the muscle restores facial tone at around 4 to 5 months, and movement can be expected after 7 to 8 months.11 The free flaps most frequently used have been the gracilis, latissimus dorsi, and pectoralis minor. Bove et al20 assessed cadaveric dissections of these flaps in terms of microsurgical (suitability, diameter, vascular pedicle size), anatomic (thickness, modeling possibilities, direction of fibers), and functional characteristics (extensibility, power, regenerative capacity). Based on these criteria, Bove et al found the most suitable flap to be the latissimus dorsi followed by the gracilis.20 The gracilis muscle is a long, thin muscle originating at the anterior margin of the pubic symphysis and ramus of the ischium and inserting onto the medial surface of the tibia. Chuang et al21 reported their experience in eight patients with complex facial paralysis, using a gracilis muscle free flaps and its associated skin paddle.

The first successful human face transplant was performed in France by a team led by Devauchelle and Lengele. This represents an important example of the balance of bioethics and transplantation technology. The complexity of facial transplantation has highlighted the importance of a health care team composed of psychologists, transplant physicians, and surgeons.22

In our case series, all patients' symptoms improved with cosmetically more acceptable lid positions and a reduction in lagophthalmos (~Table 1). All patients required less frequent lubrication following orbicularis muscle transposition. An improved spontaneous and forced blink on the affected side, with neurophysiologic confirmation of orbicularis contraction upon stimulation of the contralateral facial nerve was also demonstrated. We propose that the orbicularis muscle transposition flap cross transfer be considered in patients with complete facial nerve palsy and persistent symptoms of exposure keratopathy where it may be useful to have a return of blink and/or improved lower lid support.

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