6 Management of Facial Paralysis

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INTRODUCTION

Significant functional, aesthetic and psychosocial sequelae accompany facial paralysis. Dysfunctional lacrimation, palpebral fissure widening, loss of blink reflex and orbicularis function can lead to exposure keratopathy and corneal ulceration. Lagophthalmos is potentiated by paralytic eyelid, ectropion, and upper and lower lid retraction. The absent lower lid and nasal twist further exaggerates epiphora.[1]

The loss of oral competence leads to drooling and articulation difficulty. Nasal alar collapse, nasolabial flattening and nasal valve dysfunction add further to the social stigma associated with the induced nasal speech. The psychological impact of facial disfigurement and unwelcome attention is profound resulting in depression, agoraphobia and social isolation.[2]

Rehabilitation of the paralysed face presents a complex and challenging management problem. Potential for nerve regeneration varies widely and as yet, accurate prognostic indicators of spontaneous recovery do not exist. This directly influences the decision regarding reanimation as certain techniques interfere with or even preclude the normal recovery process. Facial function and appearance can be improved with physical therapy, botulinum toxin injection and surgery. Surgical options include primary neurorrhaphy, interpositional nerve grafts, nerve substitution techniques, static resuspension and/or dynamic reanimation. The cause of paralysis and degree of functional impairment, as well as the patient's age and medical history must be considered before any intervention. Adequate observation time from onset of paralysis, and appropriate patient and procedure selection is paramount to achieve the best surgical outcome.

During the past century, approaches to reanimation of the paralysed face have seen the development and refinement of surgical techniques to restore dynamic function via regional muscle transposition,[3] free muscle transfer[4,5] and more recently, muscle lengthening procedures.[6,7]

Long-term goals of facial reanimation are to achieve normal appearance at rest, symmetrical movement and restoration of voluntary muscle control.[8]

NEURAL TECHNIQUES

Primary Neurorrhaphy

Primary end-to-end anastomosis of the facial nerve at the time of injury is the most effective method of rehabilitating the paralysed face. This is relevant in iatrogenic injury during oncological resection or prompt surgical intervention after temporal bone fracture or sharp trauma to the branchiomotor division. The repair is best achieved at, or within 30 days of, the primary ablative operation. The limiting factors for primary neurorrhaphy are access to the intracranial facial nerve and sufficient neuronal length.

The present neurorrhaphy technique uses a microscope, specialised microinstrumentation and the use of 8-0/10-0 monofilament suture. When the ends of the injured facial nerve have been identified, they are trimmed, and the epineurium is peeled back to expose the endoneurium. One percent methylene blue is applied to the exposed nerve ends with a cotton-tipped applicator. The epineural sheath stains dark blue whilst the endoneurial surface stains a lighter blue facilitating accurate approximation.[9] One or two perineural sutures between the proximal and distal nerve trunks usually suffice. A tension-free anastomosis is essential to prevent scar formation and subsequent disruption of axonal regeneration.[10] If tension-free neurorrhaphy cannot be achieved, mobilisation of the neural segments or interpositional grafts may be necessary.

Interpositional Grafts

When a tension-free anastomosis cannot be achieved with primary neurorrhaphy, or facial nerve length has been sacrificed to obtain tumour clearance in oncologic resection, several donor nerves are available for interpositional grafting. The greater auricular and sural nerves, however, are most suitable for facial nerve repair in terms of their availability, axonal content and length.[28] They are also readily accessible, and the area of sensory deficit created by their harvest is acceptable to the patient. The length of the graft should be at least 1–2 mm longer than the gap it is to bridge to ensure a tension-free anastomosis. In the adult, upto 10 cm of the greater auricular nerve can be harvested. It is found by bisecting at right angles, a line drawn between the mastoid tip and angle of the mandible, and is easily accessible at neck dissection. The sural nerve has three advantages over the greater auricular nerve. First, a greater length can be obtained (upto 40 cm), second, it has a greater number of neural fascicles, and third, it will not be involved in the primary oncological resection. The sural nerve lies between the lateral malleolus and the Achilles tendon, 1 cm lateral and deep to the saphenous vein. Nerve harvest using multiple transverse incisions decreases postoperative pain on ambulation and avoids the unsightly scar that follows long vertical incision. The technique for neuronal anastomosis

is as described above, and the expected rate of axonal regeneration is 1 mm/day. Patients can expect to have adequate facial tone after 6 months and restoration of motion 1–3 months thereafter.[10]

Cranial Nerve Crossover

Using other cranial nerves for facial reanimation should be considered when the proximal central stump is unavailable, primary nerve grafts are not possible, and surgery can be performed within 2 years of injury. This is most commonly seen following nerve sacrifice, cerebellopontine angle tumour surgery, radical oncologic resection of the temporal bone, parotid and skull base, and severe temporal bone brainstem trauma. Various options include classic hypoglossal facial anastomosis, hypoglossal facial jump grafting and facial nerve cross facial anastomosis. The main disadvantage of donor nerve techniques is the inevitable sacrifice in donor cranial nerve function. Complete transection of the hypoglossal nerve leads to ipsilateral paralysis and hemitongue atrophy, causing difficulty with mastication, speech and swallowing. Functional disability is variable. Pensak et al noted that 74% of patients reported some difficulty with eating, whilst only 21% found it debilitating. Rarely was swallowing significantly disturbed, and although articulation was affected in all patients initially, rarely was this disabling and improvement was significant over time. Interestingly, whilst mid and lower facial reanimation was satisfactory to the patient, 75% reported incomplete eye closure, and of these, 21% developed ophthalmic sequelae.[11] It is therefore advisable to combine this technique with ophthalmic reanimation and/or protection as discussed later. May and Drucker described the hypoglossal-facial interposition jump graft[12] for use in patients with bilateral facial paralysis, other cranial nerve deficits (a combined X and XII deficit risks aspiration on swallowing), in those with neurofibromatosis Type 2, and in those who refuse to accept the sequelae of unilateral hypoglossal palsy. This procedure involves partially incising rather than transecting the hypoglossal nerve. Sufficient numbers of hypoglossal axons remain to spare tongue function whilst axonal regeneration can occur across an interposition end-to-side 'jump' graft anastomosed to the distal ipsilateral facial stump to reanimate the paralysed face (an indirect hypoglossal-facial anastomosis). Manni et al[13] followed up 39 patients who underwent indirect hypoglossal-facial anastomosis. All patients had normal tongue function, and most achieved House Brackman grade III (44.6%), II (20.9%) or IV (24.1%) (House Brackman grading is the globally accepted facial palsy grading scale).

Whilst this technique preserves ipsilateral tongue function with two anastomoses, the return of facial nerve motor function is inevitably slower and weaker when compared with direct hypoglossal-facial anastomosis. To address this, Atlas and Lowinger[14] modified the technique in three patients by connecting the distal facial nerve directly to a partially incised hypoglossal nerve. Sufficient length was achieved by removing the mastoid tip. The facial nerve was mobilised in the temporal bone, sectioned at the second genu, and following transposition from the mastoid segment, an end-to-side hypoglossal anastomosis was performed. Although only small numbers have been described, all patients achieved a highly satisfactory cosmetic and functional outcome.

Cross-face grafting (facial-facial anastomosis) was originally described by Scaramella.[15] A crossed facial nerve graft is used to extend the buccal nerve branch of the animated facial nerve across the upper lip by the alar base (Fisch's modification)[16] to the contralateral distal facial nerve. The obvious disadvantage of this procedure is the sacrifice of normal facial function for the potential benefit to the paralysed side. The more distal the donor branched used, the less axonal flow; the more proximal, the greater the donor deficit. May and Schaitkin, therefore, suggest that cross-face grafting should not be used as a primary procedure, but should be used to power a free muscle graft or to augment other procedures that are performed to restore facial function.[17]

REGIONAL MUSCLE TRANSPOSITION

There are three regional muscles available for reanimation. The temporalis muscle, used for perioral reanimation (upper/lower lip, melolabial fold and alar base) is the most popular due to its length, location, contractility and vector of pull to restore the position of the corner of the mouth to create a lateral smile. The masseter muscle is less frequently used because it provides an unphysiological horizontal action on the lip commissure, an unaesthetic depression over the mandibular angle and longer-term mastication difficulty. It may be useful as an adjunct to temporalis muscle transposition or following radical parotid surgery. The digastric muscle is transposed to partially restore function following the loss of depressor anguli oris innervated by the marginal mandibular branch of the facial nerve.

The temporalis muscle is animated by the trigeminal nerve, and is unresponsive to emotion without extensive retraining. The voluntary, balanced lateral smile therefore, may be achieved only in the well-motivated patient willing to work, often for a long period, with a specialist physiotherapist. A major advantage of temporalis muscle transposition is the possibility to reanimate partial facial function, or in those patients where some facial nerve recovery is expected. The facial nerve lies deep to the superficial musculoaponeurotic system (SMAS), so the muscle can be transposed through a tunnel superficial to the SMAS without disturbing the facial nerve fibres. The procedure therefore, can be performed at the same time as a nerve repair or XII-VII crossover to give an immediate improvement, that in no way compromises the outcome of the nerve repair. The main disadvantages of temporalis transposition are lack of spontaneous

movement, chronic temporomandibular joint dysfunction and tissue bulk over the zygomatic arch.[18]

An exciting recent development, the lengthening temporalis myoplasty, described by Labbé[6] addresses several disadvantages. In his article, Labbé improves on McLaughlin's original technique[19] by transferring the temporalis tendon, still attached to the coronoid process, directly to the lips. He performs a true myoplasty without the need for an intermediate fascia lata graft. The fixed temporal point is preserved on the anterior temporal crest, and the lengthened temporalis passes deep to the zygomatic arch, thereby eradicating the unaesthetic zygomatic bulge/temporal hollow previously seen. Stretching the muscle results in an immediate overcorrection, which is necessary to allow for normal muscle attenuation. Intraoral contralateral myectomies may afford better symmetry;[20] however, this can be achieved with Botox® injection. Byrne et al recently reviewed their experience with this technique and concluded that patient satisfaction was high; the procedure was relatively easy to perform, minimally invasive and eliminated the facial asymmetry typical of temporalis transfer.[7]

FREE MUSCLE TRANSFER

The aim of free muscle transfer for facial reanimation is to achieve a natural and subconscious smile. It is indicated when native facial muscles are absent, denervated for greater than 2-years duration, or when regional muscles have been damaged by oncologic resection or tumour. Harii et al in 1973 successfully transferred the gracilis to the face with both neural and vascular anastomoses, and demonstrated subsequent functional reinnervation.[4] Since then, a variety of muscles have been used for free tissue transfer, but the most popular in descending order of frequency are the gracilis, pectoralis minor and latissimus dorsi. The criteria for selection of a muscle include fibre length commensurate with zygomaticus major, 6–8 cm in length, suitable vascular architecture, location and structure of suitable tendinous anchor points and a donor nerve of sufficient length to reach the ipsilateral hypoglossal nerve or previous cross-face nerve transfer. The sacrifice of the donor muscle must not lead to significant donor site morbidity. In a study of various muscles available, Terzis found that the pectoralis minor was most suitable for these criteria. The pectoralis minor also has a high density of motor nerve axons available for reanimation—a 'smart muscle'.[21] This preference for pectoralis minor is supported by Harrison,[5] but in a recent cadaveric study, Bove et al assessed suitability of flaps in terms of microsurgical (vascular pedicle size and diameter), anatomical (thickness, fibre direction) and functional characteristics (power, extensibility), and concluded that the most suitable to flap was the latissimus dorsi, followed by gracilis then pectoralis minor.[22] Whichever donor muscle is used, reinnervation restores facial tone at 4–5 months and movement can be expected after 7–8 months.[23]

Selection of the donor nerve to innervate the free graft depends on the aetiology of facial paralysis, availability of functioning ipsilateral facial nerve, previous facial surgery and patient preference. Options include using the original proximal facial nerve after oncologic resection (often from within the fallopian canal), the contralateral facial nerve via a cross-face sural nerve graft in a two-stage procedure, and the ipsilateral hypoglossal nerve. The latter may achieve some degree of voluntary smile by pressing the tongue on to the hard palate, but will not achieve the involuntary mimetic innervation of the free graft seen when the facial nerve is used.

OPHTHALMIC PROTECTION AND REHABILITATION

Orbital protection and subsequent rehabilitation are mandatory in facial palsy. A comprehensive review of oculoplastic techniques, such as that published recently by Rahman and Sadiq,[24] falls outside the scope of this chapter, but the common interventions have been discussed.

Conservative Orbital Protection

Protection of the exposed cornea, and close monitoring and treatment of corneal complications is the primary concern. The lower-third of the cornea is most often affected dependent on the degree of lagophthalmos. If recovery of facial function is expected, conservative measures are best adopted with meticulous monitoring.

Lubrication with methylcellulose preparations is necessary, drops during the daytime and more viscous ointment at night, with taping or patching to prevent nocturnal inadvertent trauma. Moisture chambers have been used with good effect. Patients lubricate the eye before applying a Cartella shield with an overlying cellophane dressing. This acts as orbital ‘greenhouse’ retaining moisture within the pocket. In patients with reduced tear production or in whom lubrication and patching fails to address corneal exposure, punctal occlusion with punctal plugs may be successful.

Botulinum Toxin

Botox® (Allergan, Berks) provides good corneal protection by inducing a protective ptosis by temporarily paralysing levator palpebrae superioris. In one series of 21 patients, the induced ptosis was sustained for a mean of 46 days following onset after 4 days.[25] Another study reported a 45% rate of temporary diplopia, but advocated Botox® use as eyelid scarring is avoided, topical therapy may be continued and corneal examination was possible.[26]

Corneal Protective Surgery

These days, surgical measures to ensure corneal protection in the acute phase are less frequent employed. Tarsorrhaphy has been superceded by other rehabilitative procedures such as suborbicularis oculi fat lifts (SOOF lifts), lid loading and canthoplasty. Tarsorrhaphy has been criticized for its lack of peripheral vision, poor cosmesis and ineffectiveness. It is best reserved for those patients in whom medical therapy is difficult, lacrimal gland function is lost, or in combined V/VII nerve paresis where corneal sensation is impaired. Upper lid loading was first introduced in the 1950s,[27] and has stood the test of time. Weighting of the upper lid results in an increased gravitational pull of on the lid, and aided by levator palpebrae relaxation, the paralysed eyelid may close passively, greatly reducing lagophthalmos. Gold, first suggested in 1966, is now standard, but Berghaus et al[28] suggest that linked platinum may have superior characteristics. A smaller volume is required due to the greater density of platinum (21.5 g/cm^3) when compared with gold (19.4 g/cm^3); the flexible chain linkage allows for better contour to the tarsal plate, and on histological examination of the peri-implant capsule, less inflammation was observed.

In the longer term, after an initial waiting period for return of normal facial function, oculoplastic surgery in the form of canthoplasty, lid shortening procedures and lower lid spacers (with conchal[29] or auricular cartilage[30] grafts) should coincide with correction of the ptotic mid-facial region. Lisman demonstrated superior lower lid reanimation once the paralytic mid-facial region had been elevated.[31] The extent of gravitational ectropion is dependent on the laxity allowed by the tarsal plate and the medial and lateral canthal tendons. The procedure of choice, therefore, requires an individualised approach to obtain the best functional and cosmetic result.

ADJUNCTIVE TECHNIQUES

Botulinum toxin is the simplest method of providing symmetry by paralysing the contralateral hyperfunctioning muscles. This is most marked in isolated marginal mandibular paralysis with chemical denervation of the contralateral depressor labii inferioris (DLI). Hussain et al[32] reported a 93% (39/42) success rate with contralateral DLI resection resulting in improved aesthetic lower lip symmetry at rest and on animation. The effect was mimicked preoperatively with selective DLI Botox® injection. Care needs to be taken to avoid oral incompetence to fluids or food, which has been reported to occur as frequently as 50% and 17%, respectively in a recent study.[33]

Facial slings can improve facial symmetry and function in those who are medically unfit, or wish to undergo reanimation surgery. Whilst donor site morbidity and foreign body reactions with autologous fascia lata have been reduced with the advent of synthetic expanded polytetrafluoroethylene (Gore-Tex, WL Gore, Flagstaff AZ), and allografts such as human acellular dermis (Alloderm, Lifecell Corp. Branchberg NJ), late complications leading to revision surgery are not uncommon.[34] All are used successfully to lift the mid-and lower-atonic facial musculature. A multivectored suture sling technique has recently been described.[35] Perioral and perialar 3/0 permanent sutures are passed deep to midfacial soft tissues with a Keith needle and anchored through lateral orbital wall drill holes. The procedure has distinct advantages over standard static sling techniques; however, the medium- and long-term resilience of this technique has not been demonstrated. The multivector system accounts for the different vectors of pull of normal facial musculature, the technique requires small incisions and can therefore be performed under local anaesthesia enabling patient assistance by contralateral facial movement, and small changes and adjustments can be made in the outpatient clinic.

Facial rejuvenation surgery, including SMAS and MACS (Minimal Access Cranial Suspension) rhytidectomy, blepharoplasty and endoscopic browlift techniques, can improve the functional and cosmetic deficit in facial paralysis patients. The lateral pull of rhytidectomy has been shown to improve nasal valve function on acoustic rhinometry.[36]

THE FUTURE

It is an exciting time in the realm of facial paralysis management. Technological advances in digital photography and laser facial mapping are enabling development of tools to objectively evaluate facial movement and function.[37] Once this tool is available and standardised, a web-based data archive will provide quantitative validated outcome measures for current treatment strategies and enable a global consensus.[38] Research progresses in the field of nerve regeneration. Future work is likely to focus on improving axonal growth along nerve grafts and improving target accuracy.[39] High efficiency transmission of axons through nerve grafting material is likely to involve 'smart' biomaterials in which both polymeric substances and biologically relevant agents are combined to create living bioartificial nerve conduits.[40]

CONCLUSION

Whilst there have been significant advances in, and refinement of surgical technique for rehabilitation of the paralysed face in recent years, we have yet to achieve a consensus for surgical management. The cause of this is multifactorial and includes patient specific factors and physician preference. What is agreed upon, however, is that the facial paralysis patient requires a detailed physical, functional and psychological evaluation. The treatment choices are based on the cause and duration of paralysis, and the patient's condition and expectations of outcome. The choice of therapy can be overwhelming to the patient, but it is essential that they are engaged in the decision making process. Any intervention undertaken, be it surgery or physiotherapy, will require absolute dedication, compliance and endurance to achieve the best outcome.

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