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DYNAMIC REANIMATION FOR FACIAL PARALYSIS – A REVIEW

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ABSTRACT

Facial nerve paralysis is a relatively common condition of the seventh cranial nerve affecting the population, causing esthetic, functional and psychological problems. With the advancement of technology many surgical techniques have been developed for treating patients with facial palsy. This article reviews about the surgical techniques in the management of patients with facial palsy for smile reconstruction. Also, it discusses about the etiology and clinical features of facial palsy, anatomy of smile, goals of reanimation, choosing the appropriate surgical option based on patient's condition and its outcomes.

KEYWORDS: **Facial Nerve, reanimation, facial paralysis, Nerve transfer, Free muscle transfer**

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INTRODUCTION

Facial palsy is the most common pathology of the cranial nerves with an incidence ranging from 20 to 30 cases per 100.000 people per year.[1] The facial nerve gives off several branches in the face which is responsible for providing the facial tone and movement necessary for ocular protection, nasal air- flow, articulation of speech and oral continence. If one or more facial nerve branches are paralyzed, the corresponding mimetic muscles lose their ability to contract. Damage to the facial nerve may cause imbalance of the face at rest as well as distorted, asymmetrical facial expressions (e.g. smiling, laughing, grimacing, etc.) Functionally, facial nerve injury affects chewing, fluid retention while drinking, nasal breathing, corneal exposure, speech patterns, and communication skills.[2] The term facial palsy summarizes incomplete loss (paresis) as well as complete loss (paralysis) of facial nerve function. Static reconstruction procedures aim to correct asymmetry at rest. Dynamic facial reanimation attempts to restore symmetry both at rest and while smiling.[3]

HISTORICAL BACKGROUND

The first known surgical repair of an injured facial nerve was performed by Drobnick in 1879. In 1971 Scaramella and Smith reported on the technique of cross facial nerve grafting (CFNG). Harii et al. for the first time used a free muscle transfer in combination with a nerve transfer in 1976. Eight years later, Terzis introduced the "babysitter" procedure. In 1989, Zuker et al. suggested the use of the masseteric nerve as possible donor nerve for innervation of the transplanted muscle in patients with Moebius syndrome.

ANATOMY OF SMILE

Functionally speaking, there are 18 paired muscles that participate in facial expression. There are certain muscles which play a larger role than others: the frontalis, orbicularis oculi, zygomaticus major, orbicularis oris, and the lip depressors. Functional elements that are scrutinized include the nasolabial fold (NLF) and the dynamics of the smile. The nasolabial fold is comprised of dense fibrous tissue, the upper lip levators, and the striated muscles originating in the fascia of the nasolabial fold. At its superior limit, the fold begins at the convergence of the ala nasi, cheek, and upper lip. The fold, then descends in a lateral course to end at the oral commissure. The nasolabial fold can assume varying shapes and depths and is unique to each individual. The nasolabial fold can appear straight, concave, or convex. Smile occurs in 2 stages. First, the upper lip levators contract along with the nasolabial fold musculature to elevate the nasolabial fold against resistance from the cheek. Next, the levator superior, zygomaticus major, and caninus muscles, raise the lip and NLF upward. There are 3 types of smile: Zygomaticus major smile, Canine smile, Full-denture smile

ETIOLOGY OF FACIAL PALSY[4]

CONGENITAL - mo'bius syndrome, birth trauma, mandibular division palsy

ACQUIRED

Traumatic - cerebral event, temporal bone fracture, facial laceration

Tumour – acoustic neuroma, cholesteatoma, parotid tumour

Inflammatory - bell's palsy, middle ear infection, myasthenia gravis Bell's palsy is an idiopathic paralysis and represents the most frequent acquired form in adults, with an incidence of 1 in 5000.[4] Three quarters of patients return to normal function, but a significant proportion suffer sequelae, such as weakness, hemifacial spasm, or synkinesis. Polymerase chain reaction analysis of viral DNA suggests it is caused by latent herpes viruses; thus, early treatment is centered on the use of corticosteroids and antiviral therapy to speed recovery and minimize residual deficit.[2]

CLINICAL FEATURES

Facial palsy can be unilateral or bilateral, partial or complete. Paralysis of the facial mimetic muscles causes loss of voluntary facial movement, loss of involuntary facial expression, dysfunction in facial tone, ocular dryness and tearing, speech difficulties, oral incontinence, impairment in mastication and obstruction of nasal airway, Significant emotional distress as a result of facial disfigurement, impaired communication, and social dysfunction.[5] In unilateral paralysis, there is usually weakening or loss of the nasolabial fold, deviation of the philtrum toward the normal side, commissure depression on the paralyzed side, and deviation of the entire oral sphincter toward the normal side. The sagging is due to gravity, and the deviation to the normal side is due to unopposed muscle action on the normal side. Movements of the commissure and the mid upper and mid lower lip are measured during animation. This gives the surgeon some information regarding the amount and direction of movement that is required for smile reconstruction. Synkinesis is the simultaneous contraction of two or more muscles that normally do not contract at the same time and is thought to be due to a misdirected sprouting of regenerating axons. A common synkinesis is eye closure with smiling. A particularly frustrating synkinesis occurs when there is a simultaneous contraction of the orbicularis oris and the retractors of the mouth. This grimacing appearance is brought on by attempts to smile or to purse the lips.

GOALS OF REANIMATION[6]

The goals of the reconstruction in facial paralysis include the following:

1.Facial symmetry at rest

2.Symmetrical smile

3.Voluntary, coordinated, spontaneous facial movements

4.Oral competence and eyelid closure with corneal protection

5.Absence or limitation of synkinesis and mass movement .

ASSESSMENT

A multidisciplinary approach should be employed, involving specialties such as ophthalmology, neurosurgery, and otolaryngology. In terms of the physical examination of the patient with a paralyzed face, the House-Brackmann scale is used to convey the extent of the injury[4]. The method of reconstruction for facial paralysis depends on several key parameters: the age and medical status of the patient; the extent, nature, and duration of paralysis; the availability of a functioning facial nerve branch and the desire of the patient. For older or high-risk patients, static reconstruction is considered safer than dynamic reanimation, due to slower and weaker nerve regeneration in older patients.

DYNAMIC REANIMATION

In cases where there is muscle atrophy due to long standing facial paralysis, in order to establish facial movements, viable muscles and nerves are detached from a donor site and transplanted to the paralysed area. This is called as facial Reanimation or dynamic reconstruction. Dynamic reanimation attempts to restore symmetry both at rest and while smiling. Three elements are required for the formation of a smile: neural input, a functional muscle innervated by the nerve, and proper muscle arrangement.[5] It is imperative to determine which of the elements is at fault. Perhaps the most significant unit for reconstruction, from a functional and aesthetic perspective, is the buccal-zygomatic muscle complex (BZMC), which is responsible for smiling and for the tone of cheeks. This complex of mimetic muscles includes the risorius, the zygomaticus major and minor, and the levator anguli oris muscles, and is normally innervated by tributaries of the zygomatic and buccal branches of the facial nerve. Reconstruction may be achieved by several methods.

1.NEURORRHAPHY

It is primary end to end suturing of facial nerve stumps.[done within 72 hours of facial nerve damage due to trauma or tumour surgery]. If tension free suturing is not possible, then an interpositional graft is required. Most commonly used grafts are sural nerve, greater auricular nerve and the median antebrachial cutaneous nerve [MACN].[4] This is indicated when both the proximal and distal branches of facial nerve along with facial musculature are intact.

2. CROSS FACIAL NERVE GRAFTING

Crossover techniques are most often used where there is irreversible facial nerve injury, intact facial musculature/distal facial nerve function, intact motor endplates, or intact proximal donor nerves are available. Ideally, this type of repair is performed within a year of the onset of facial paralysis so as to avoid distal muscle atrophy. Advantages to crossover techniques include low level of difficulty, the time interval until movement (4-6 months), avoidance of multiple sites of anastomosis, and the achievement of mimetic-like function with practice.[4] The most common techniques used in crossover grafting are the hypoglossal-to facial (most popular), and facial-to- facial crossover utilizing the sural nerve. Hypoglossal nerve,[7] may lead to ipsilateral atrophy of the tongue musculature with effects on speech and swallowing. It is best to use the motor nerve to masseter than hypoglossal nerve . The benefits of using the masseteric nerve include a single stage procedure, preservation of the contralateral facial nerve, and a greater axonal load that can be delivered to the muscle. This translates into a greater excursion of the commissure relative to cross-face nerve grafts, and should a patient have a strong contralateral smile, a cross-face nerve graft may not be sufficient to restore symmetry. Success of a nerve graft depends on many factors like the number of axons remaining in the nerve, potential for regeneration of axons and the status of the facial muscles.

3. MUSCLE TRANSPOSITIONS [DYNAMIC SLINGS]

They are used when: a) the facial neuromuscular system is absent b) facial nerve interruption of at least 2-3 years with loss of motor endplates and c) Crossover techniques are not possible due to donor nerve sacrifice d) neural techniques are unsuitable. The most reliable muscle transfers presently being used include the temporalis and masseter transfers. Although both of these techniques yield satisfactory results, extensive biofeedback/physical therapy is needed due to the unnatural movements that are needed to perform facial expression. For example, with the temporalis muscle transfer, patients must learn to smile by clenching the jaws. Muscle transpositions are usually unable to recreate a spontaneous dynamic smile, as activation of the muscle requires a specific maneuver (such as clenching the teeth).To overcome this, more sophisticated transpositions have been used in which the nerve to the muscle is coapted to the contralateral facial nerve.

4.FREE MUSCLE FLAPS / MICRONEUROVASCULAR TRANSFER

Indications for free muscle flaps/microneurovascular transfer are the same as those for muscle transfers. This technique requires viable muscle as well as innervation and is traditionally performed in 2 stages. The first stage involves performing a cross-face nerve graft from the nonparalyzed side of the face to the paralyzed side using a sural nerve graft. After approximately 1 year, long enough to allow for neural ingrowth of the graft, the free muscle transfer is performed. The “workhorse” flap for free muscle transfer is the gracilis. Other free muscle flaps used are: a. serratus anterior b. Latissimus dorsi c. Pectoralis minor. d. extensor digitorum brevis, e. rectus abdominis, f. tensor fascia lata, and g. abductor hallucis. Each person has a unique smile. The variables are the presence, extent, and position of the nasolabial fold, the shape of the smile as revealed by the shape and exposure of the red lip, the amount of teeth showing, the direction and amount of movement of the commissure and mid upper lip, and the presence or absence of depressor labii function pulling the lower lip downward. It is important to carefully analyze and measure the patient’s smile on the nonparalyzed side with and without finger support of the paralyzed corner of the mouth. This analysis gives the surgeon a chance to evaluate the shape of smile that is required on the paralyzed side and evaluate the strength of the smile. The muscle transfer is then designed for the individual patient. Most muscles need to be cut to the desired length for the reconstruction, which is about 10 to 12 cm. [8] The gracilis has the advantage that it is easily expendable, the incision is not readily visible, there is no functional problem when it is removed, and it is distant from the facial site so that two surgeons can work simultaneously. Usually 20 to 35 g of muscle is used in an adult and 10 to 20 g in a 5-year- child.[9] The extensor digitorum brevis [10] would seem an ideal muscle for transfer, being flat, small, and leaving minimal donor deficit, but the results are discouraging. The pectoralis minor [11] is a flat muscle that can be transferred without excessive bulk and minimal donor deficit. Although an excellent flap for reanimation, the vascular pedicle is variable. By contrast, the large latissimus dorsi [12] can be split into two independently innervated territories and has been advocated for single stage bilateral reconstruction in Mo¨bius patients. But it is bulky in the face, and as with the pectoralis minor, a two-team approach is difficult due to the proximity of the operative sites. The gracilis flap has a constant anatomy, is a simple dissection, and is of intermediate bulk but with minimal donor deficit and hidden scar. A two- team approach is feasible, and segmental dissection of the flap significantly reduces the bulk of the tissue. Dynamic facial reconstruction can be classified by two basic criteria: [5] 1.whether reconstruction is based on the facial nerve or on a different cranial nerve, and 2. whether the working muscle unit is the original BZMC or a transferred muscle flap. Facial nerve-based reanimation can be based on either an ipsilateral or contralateral facial nerve, depending on the presence of a functional branch or stump. Duration of paralysis is the principal determinant for the need for muscle transfer; if duration is less than 12 months, the BZMC is assumed to be viable. Muscles become irreversibly atrophic by 24 months, in which case muscle transfer is indicated.[6]

FACIAL REANIMATION FOR RECENT PARALYSIS

Primary facial nerve repair is possible in cases of recent trauma to the facial nerve. Within 72 hours from injury, direct suturing of the stumps may be achieved; otherwise, a sural cable nerve graft is used to interconnect the distal stumps of the zygomatico-buccal facial branches with an ipsilateral trunk of the facial nerve. In cases of recent paralysis in which a functional facial nerve branch is available only on the contralateral face, a cross-face sural nerve graft is used to relay facial nerve input across the face to the BZMC. Axons from the contralateral facial nerve regenerate through the sheath of the graft and innervate the muscle over 4 to 6 months.[5] Because muscle atrophy can develop while the facial nerve regenerates, an ipsilateral motor nerve (either masseter or hypoglossal) can be transposed to serve as a temporary innervator (“babysitter”)[13] to the muscle. Thus, muscle tone is preserved while spontaneous smiling is to be restored.

FACIAL REANIMATION FOR LONG LASTING PARALYSIS

Facial mimetic muscles can be reactivated with reasonable amplitudes if reinnervated before 2 years have elapsed from the time of injury. At 2 years, muscles reach a state of irreversible atrophy; thus, neural reconstruction alone is no longer suitable. Facial nerve-based reanimation for long-lasting paralysis necessitates both reinnervation and muscle transfer. When an ipsilateral nerve is available, a one stage free gracilis muscle flap transfer is performed. An innervated free gracilis muscle flap is harvested from the thigh and transferred to the paralyzed side of the face. The flap is inset subcutaneously in the paralyzed cheek. The blood vessels of the flap are anastomosed to facial vessels and its motor nerve is sutured to the available ipsilateral facial nerve branch. When a functional facial branch is only available on the other cheek, a two- stage cross-face sural nerve graft and free gracilis muscle transfer (two-stage procedure) [14, 15] is conducted. In the first stage, a sural nerve graft is harvested from the calf, coapted to a contralateral facial branch responsible for smiling stimulus, tunneled across the face to the paralyzed side, and banked in the upper buccal sulcus. The second stage is scheduled 9 months later, and consists of free gracilis muscle flap transfer as described, but in this case the nerve is coapted to the cross-face graft. Reinnervation of the muscle commences after 4 months and reaches full capacity within a year. Despite the need for two procedures, the two-stage cross-face nerve graft and gracilis muscle transfer has the highest rate of success and has the advantage of providing a spontaneous smile.[16, 17] Nonfacial nerve reanimation is based either on the ipsilateral motor nerve to the masseter or on the ipsilateral hypoglossal nerve. Thus, the stimulus to create smiling movement depends on voluntary actions such as teeth clenching or movement of the tongue. These efforts may become more natural over time. The need for muscle transfer depends on duration of paralysis. In cases of recent paralysis, a sural cable nerve graft can connect these nerves to the BZMC nerve stump. For long-lasting paralysis, one-stage free gracilis muscle transfer to masseter motor branch is performed.[18] Masseter-based reanimation achieves quicker and stronger contraction of the target muscle in elderly patients.[19, 20,21] Patients who are unsuitable or do not wish to undergo a microsurgical procedures may be reconstructed by transfer of local muscles flaps, namely the temporalis or masseter muscles. This is a simple, one stage procedure, which usually achieves fair static and dynamic results. However, it does not provide for a spontaneous smile and donor-site morbidity may be significant. Congenital palsy may suggest long-lasting absence of the facial nerve, necessitating muscle transfer for reanimation. In patients with Mobius syndrome (congenital paralysis of VII and VI nerves), two gracilis flap transfers to masseter nerves of each side of the face will provide excellent results.[22, 23, 24] When a single and reliable procedure is preferable because of poor general condition, age (patients over 50 years of age), or the wishes of the patient, the masseteric nerve may be used. It may also be used in the treatment of previously failed crossgraft procedures when a single-stage, reliable technique is required for rescue.[25] Double innervation of neuromuscular transplants with both facial crossgrafting and the masseteric nerve is a recently described procedure with encouraging results. For bilateral palsies the motor nerve to the masseter is the gold standard for reinnervation of neuromuscular transplants.[26, 18]

OUTCOME

All procedures in general show an improvement of symmetry of smile and patient satisfaction, although time of recovery differs between different approaches.[27] Primary neurorrhaphy has the best possible outcome, with a mean recovery time of 6 to 12 months. True spontaneity of a smile will not occur at the same rate in all dynamic smile reconstructions. The primary neurorrhaphy and free muscle transfer are the only options to restore a true spontaneous smile. Although the masseteric nerve transfer provides a strong smile within the range of normal, it never becomes truly spontaneous and emotional. But with practice, the majority of patients can provide a spontaneous smile some of the time due to the plasticity of the cerebral cortex.[28] Effective rehabilitation can also prevent biting whilst smiling, when using the masseteric nerve as nerve transfer.

COMPLICATIONS

Perineural fibrosis, synkinesis, facial abscess, hypertropic scars, haematoma, swelling of the face or muscle donor site due to infection, sensory deficit in donor nerve graft area, tongue atrophy [hypoglossal nerve as donor], inability to chew without smile [masseter nerve as donor].

REHABILITATION

After surgery, the rehabilitation of patients with facial paralysis necessitates electromyography (EMG) protocols, behavioral modification, and patient exercises. The patient needs to obtain voluntary control of facial regions. Another adjuvant therapy is the use of percutaneous electrical stimulation to stimulate motor function.

CONCLUSION

Review of literature shows that there is no current common opinion regarding the treatment for these patients. Although many surgical options are available, it is based on the surgeon's choice of treatment taking into consideration age and medical condition of the patient, duration of paralysis, type of paralysis, availability of nerve and prognosis of the patient. Treatment should be individualized for each and every patient. Doctors must have photographs, videographs taken pre operatively and after surgery in order to achieve patients' satisfaction. Many patients may need additional surgery for chronic palsy and must be informed regarding this during treatment planning. Outcomes from free muscle transfer are recognized as providing results superior to cranial nerve transfer or local muscle transposition,[29, 30] although secondary procedures are common to refine the aesthetic result.[31] Most importantly, it is important to match the patient's wishes to the reconstructive technique to achieve patient satisfaction.

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