

Facial paralysis, etiology and surgical treatment in a tertiary care center in plastic and reconstructive surgery in Mexico

Parálisis facial, causas y tratamiento quirúrgico en un centro de referencia en cirugía plástica y reconstructiva en México

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Abstract

Background: Facial paralysis is a frequent disabling entity that causes a negative impact on the cosmetic, functional, social, psychological and economic aspects of the patient. Surgical treatment aims to restore the patient to her previous life with the fewest possible sequelae. **Objective:** Describe the experience of surgical management and propose a treatment algorithm. **Method:** A retrospective study was carried out from 2017 to 2019 of the records of patients with facial nerve involvement. The variables were age, sex, etiology, affected side and procedures performed. **Results:** 108 patients were obtained and the most frequent cause was development facial paralysis (41,8%), followed by resection of intracranial tumors (29%). A total of 225 procedures were performed, average per patient of 2.7. The most performed dynamic procedure was the gracilis-free flap (59%). The most frequent static procedures were the placement of a gold weight (24%) and the recreation of the nasogenian sulcus (13%). **Conclusions:** The surgical treatment algorithm will depend on the evolution time, etiology, donor nerves and state of the facial musculature. The gracilis-free flap continues to be the gold standard procedure in facial paralysis reconstruction. Static procedures are additionally required to achieve a satisfactory aesthetic and functional result.

Keywords: Facial paralysis. Developmental facial paralysis. Tertiary care center. Reconstructive surgery. Surgical treatment. Moebius syndrome.

Resumen

Antecedentes: La parálisis facial es una afección incapacitante que con frecuencia causa un impacto negativo en los aspectos cosméticos, funcionales, sociales, psicológicos y económicos. El tratamiento quirúrgico tiene como objetivo mejorar la calidad de vida dejando la menor cantidad posible de secuelas. **Objetivo:** Describir la experiencia del manejo quirúrgico y proponer un algoritmo de tratamiento. **Método:** Se realizó un estudio retrospectivo, de 2017 a 2019, de los expedientes de pacientes con afección del nervio facial. Las variables consideradas fueron la edad, el sexo, la etiología, el lado afectado y los procedimientos quirúrgicos realizados. **Resultados:** Se obtuvieron 108 pacientes y la causa más frecuente fue la parálisis facial del desarrollo

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sindrómica (42%), seguida de la resección de tumores intracraneales (29%). Se realizaron 225 procedimientos, con un promedio de 2.7 por paciente. El procedimiento dinámico más realizado fue el colgajo libre de gracilis (59%). Los procedimientos estáticos más frecuentes fueron la colocación de una pesa de oro (24%) y la recreación del surco nasogeniano (13%). **Conclusiones:** *La secuencia del tratamiento quirúrgico dependerá del tiempo de evolución, la etiología, los nervios disponibles y el estado de la musculatura facial. El colgajo libre de gracilis continúa siendo el procedimiento de elección en la reconstrucción de la parálisis facial. Adicionalmente se requieren procedimientos estáticos para lograr un resultado estético y funcional satisfactorio.*

Keywords: *Facial paralysis. Developmental facial paralysis. Tertiary care center. Reconstructive surgery. Surgical treatment. Moebius syndrome.*

Introduction

Peripheral facial palsy is a nervous disorder that has various etiologies and is characterized by involvement of the motor and sensory pathways of the seventh cranial nerve. Idiopathic facial palsy, or Bell's palsy, continues to be the most common cause of facial palsy in the world, with an incidence of 13 to 34 cases per 10,000 people per year in the United States of America.¹ and 20 to 30 cases per 100,000 people per year in Mexico². Other less common causes are traumatic, neoplastic, iatrogenic, developmental, and congenital facial paralysis.

The therapeutic approach to a patient with facial paralysis must be comprehensive and multidisciplinary. Classically, the diagnosis of facial paralysis, regardless of the etiology, has been clinical, including a thorough history taking and a complete physical examination. Several aspects should be emphasized in the anamnesis: possible cause, time of evolution, symptoms, and patient concerns. The physical examination should focus on oral competence, the condition of the cornea, and the pattern of facial mobility. Each branch of the facial nerve must be assessed individually:

- Frontotemporal: raised eyebrows.
- Zygomatic: eyelid closure.
- Mouth: smile and whistle.
- Mandibular-marginal: depression of the lower lip.

It should be complemented with the evaluation of other cranial nerves and an examination of extrinsic ocular motility (III, IV and VI nerves). There are various scales that classify the severity of facial paralysis, but the most accepted globally for considering only clinical aspects and being accessible and easy to reproduce is the House-Brackmann scale, which assesses the degree of dysfunction when performing voluntary movements; however, there are other scales that evaluate the state of the patient before and after surgery with videographic records, which are more objective^{3,4}.

Neurophysiological studies are an essential tool for making an accurate diagnosis and being able to determine the ideal surgical procedure for each patient.

They evaluate the degree of involvement of the facial nerve and the integrity of the facial musculature. Among the most accessible is electromyography, which determines the number of recruitable muscle fibers per territory by recording action potentials and electrical activity of facial muscles^{5,6}. It is useful in patients with facial paralysis of longer evolutionary time, when the denervation process has finished, and allows the identification of polyphasic motor unit potentials (reinnervation potentials). In all patients an electromyography should be performed prior to surgical procedures^{4,7}.

The surgical and multidisciplinary treatment of facial paralysis is based on the importance of facial expression for the development of the individual in all its psychosocial spheres. Facial paralysis is perceived negatively in the social aspect and affects essential functions such as corneal protection, nasal breathing, lip competence and speech. The smile constitutes a transcendental gesture and when it is affected it is directly associated with depression, isolation and a significant decrease in the quality of life^{8,9}.

In general, reconstruction techniques in facial paralysis are classified into static and dynamic procedures. Historically, static procedures were considered the first option in the surgical treatment of facial paralysis; they aim to reposition the soft tissues, counteracting the effects of gravity and having as a final result a facial symmetry at rest¹⁰. However, static procedures do not provide spontaneous mobility or symmetrical voluntary movements. For their part, dynamic procedures provide mobility, favor spontaneous voluntary movements and symmetrical facial expressions, and are currently the reference method for restoring movement in the paralyzed face^{10,11}.

Dynamic procedures tend to be more successful and fruitful than static ones, and should be offered to all patients considering reconstruction, unless there are health risk contraindications that prevent them from being performed. The most common approaches for dynamic reconstruction, in addition to neuroorrhaphy, nerve grafts, and nerve transfers, include regional muscle transfer and free muscle transfer.

In Mexico, the experience reported in reconstructive surgery for facial paralysis is scarce, since few centers in the country perform this type of procedure, in addition to the fact that there is no established management algorithm. The number of procedures, on average, that a patient requires is not described, nor are the most frequently performed for facial resuscitation. The objective of this article is to describe the experience of the peripheral nerve and facial paralysis clinic at the Dr. Manuel Gea González General Hospital, a reference center for plastic and reconstructive surgery in Mexico City, as well as to propose a surgical treatment algorithm.

Method

We designed a retrospective, cross-sectional and descriptive study in which all patients who underwent resuscitation surgery for facial paralysis in the period from January 2017 to December 2019 were included. The information was extracted from the clinical and photographic records of the patients, and was entered into a data capture sheet that included demographic variables of the patients, etiology of the paralysis, affected side, number and type of surgical procedures. A descriptive analysis of the characteristics of the population was carried out with the statistical package SPSS version 25, in which the categorical variables are reported in percentages and the continuous ones as average ($\pm$ standard deviation [SD]) or median (interquartile range) according to its distribution.

Results

108 patients were included, 63 (58%) women and 45 (42%) men. The average age at the time of surgery was 28.8 years (SD: 21), with a range from 1 to 89 years (Table 1). The most frequently affected side was the right, with 49 cases (45%); the left side represented 36 cases (33%) and involvement was bilateral in 23 cases (21%).

Regarding etiology, the most observed cause in our department was syndromic developmental facial paralysis, with 46 cases (42%); iatrogenic causes represented the second place, due to resection of intracranial tumors, with 32 cases (29%), and in third place, idiopathic facial or Bell's palsy, in 18 cases (16%).

Other less frequent causes were traumatic in six cases (6%), neoplasms that due to their location and growth compromised the facial nerve in three cases (3%), and infectious (Ramsay-Hunt, meningial tuberculosis) in four cases (4%). (Fig. 1).

Table 1. Demographic characteristics of the patients and affected half of the face

Variable	n (%)	Average
Sex:		
Male	45 (42)	-
Female	63 (58)	-
Age	Range: 1 to 89	29 (FROM: 21)
Affected half of the face		
Right	49 (45)	-
Left	36 (33)	-
Bilateral	23 (21)	-

SD: standard deviation.

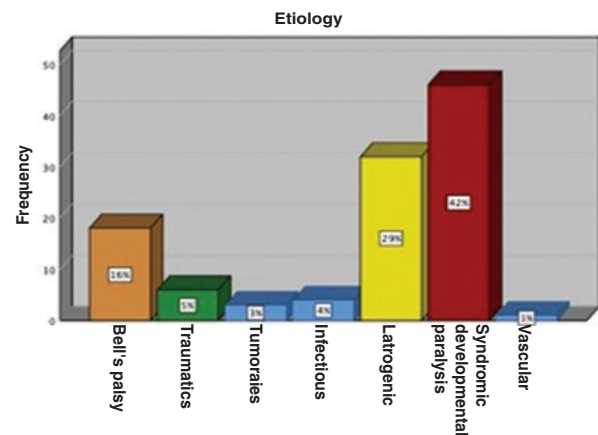


Figure 1. Etiology of facial paralysis.

Within syndromic developmental paralysis, Moebius syndrome represented the majority of cases, in 43 patients (88%), followed by hemifacial microsomia in three cases (6%) and other less frequent causes, such as Goldenhar syndrome, in two cases (4%) and CHARGE sequence (ocular coloboma, heart disease, choanal atresia, delayed growth or development, genital hypoplasia, and anomalies of the auricle or deafness) in one case (2%). Within the spectrum of Moebius syndrome, the classic or complete variant represented the majority, with 24 cases (56%), followed by the incomplete variant, with 13 cases (30%), and finally the Moebius-like, with six cases (14%) (involvement of other cranial nerves) (Figs. 2 and 3).

Iatrogenic causes include resections of intracranial and intratemporal tumors, of which the most frequent were schwannomas (38%), cholesteatomas resected by radical mastoidectomy (22%), acoustic neuromas (13%), meningiomas (13%), lymphangiomas (3%), paragangliomas (3%), g brainstem leomas (3%), neurofibromas (3%), and craniopharyngiomas (3%).

A total of 225 procedures were performed, of which 122 (54%) were dynamic and 103 (46%) were static.

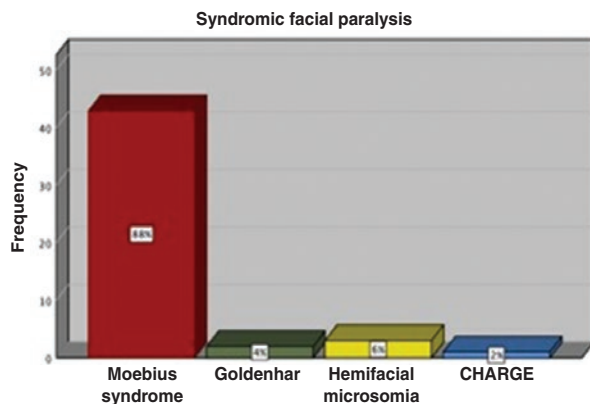


Figure 2. Syndromic developmental facial palsy.

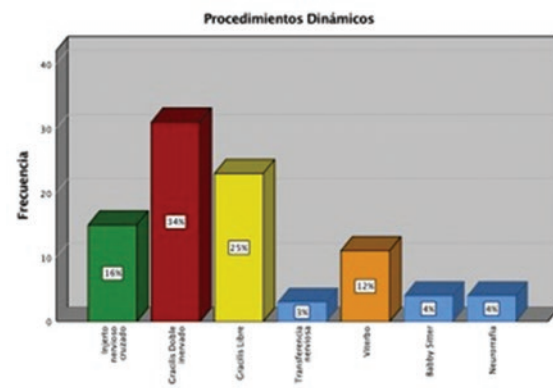


Figure 4. Dynamic procedures.

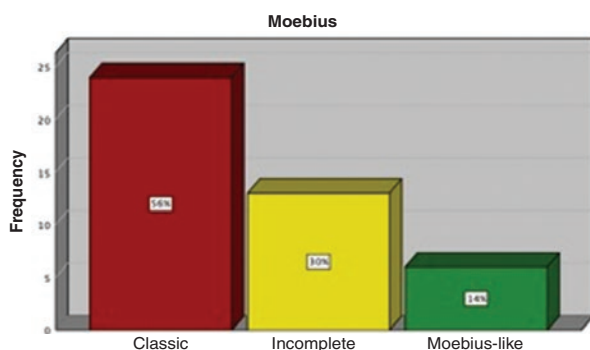


Figure 3. Moebius syndrome.

Table 2. Surgical procedures performed

Variable	Average	OF
Number of procedures	2.7	2.1
Dynamic procedures	1.8	0.6
Static procedures	2.1	2

SD: standard deviation.

The average number of procedures performed in each patient was 2.7 (SD: 2.1; range: 1-16) (Table 2).

The most frequently performed dynamic procedure was the *gracilis* muscle free flap, with 51 (59%) flaps performed, of which 31 (34%) were unilateral and 23 (25%) bilateral. The unilateral ones were performed in two stages: the first stage consisted of performing a crossed nerve graft from the healthy buccal nerve to the nasolabial fold of the affected side using the sural nerve as a graft, and in the second stage, 4 to 6 months later, a double innervated *gracilis* free flap was performed with end-to-end coaptation of the *gracilis* obturator to the crossed nerve graft and end-to-side

to the ipsilateral masseteric nerve. Most of the bilateral flaps were performed in two stages, with an average time between them of 1 to 6 months; in six cases it was done at one time.

Crossover nerve grafting represented the second most frequently performed dynamic procedure, in 15 cases (16%). The objective is to reanimate the affected side of the face in lesions with less than 6 months of evolution. The most frequent in this series was coaptation between the buccal-buccal nerves in nine cases (7%), followed by marginal-marginal coaptation in five cases (4%) and marginal-hypoglossal in one case (1%).

When free dynamic procedures fail, regional dynamic procedures are a valid alternative that is frequently performed. In our department, the Viterbo procedure was performed in 11 cases (12%) with failure of the *gracilis* flap. Other procedures performed less frequently were nerve transfers, in seven cases (8%), of which the *baby-sitter* procedure was the most frequent, in four cases, followed by masseteric-buccal transfers in two cases and the hypoglossal-marginal and spinal-marginal transfers in one case each. Primary neurorrhaphy was carried out in four cases (4%), when the patient presented within the first 72 hours after the injury, usually due to traumatic causes (Fig. 4).

The most frequently performed static procedures were, firstly, the placement of a gold weight in 25 cases (24%); secondly, the recreation of the nasolabial fold or commissuroplasty in 13 cases (13%); in third place, the tarsal strip in 11 cases (11%); and finally, the neurotization of depressor muscles in 10 cases (10%). Other less frequent procedures included eyebrow suspension, facial lipoinjection, lower eyelid suspension, asymmetric rhytidectomy, orbicularis muscle plication, frontalis muscle myotomy, and asymmetric

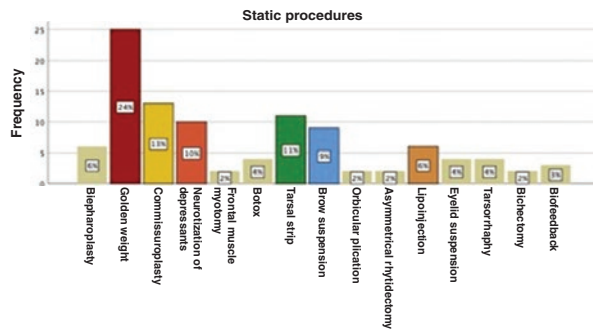


Figure 5. Static procedures.

blepharoplasty; and within the non-surgical, the application of botulinum toxin and rehabilitation with *biofeedback* therapy (Fig. 5).

Discussion

Currently, thanks to advances in surgical techniques for facial paralysis, in addition to restoring function, the main objective of surgical treatment includes the symmetrical, voluntary and spontaneous restoration of facial dynamics. Each procedure should be aimed at the affected area that is decided to be resuscitated: lower lip, oral commissure, middle portion of the face, ocular region or frontal portion. Timely and multidisciplinary treatment has considerably improved the quality of life of patients¹².

In our study, it was found that syndromic developmental facial palsy is the most frequent cause of facial paralysis, and within the syndromic etiology, Moebius syndrome was the most frequent cause, with the classic or complete variant being the most common. This contrasts with the information published in other series and is due to the fact that our hospital is the country's referral center for congenital craniofacial malformations¹³⁻¹⁵. Gousheh and Arasteh⁶ performed a retrospective study of 655 patients with facial paralysis that yielded similar results to ours, syndromic facial paralysis being the most frequent.

Terzis and Konofaos¹⁷, in a series of 166 patients with facial paralysis secondary to intracranial tumor resection, reported acoustic neurinoma as the main cause, followed by extratemporal tumors, such as hemangiomas, and lastly intratemporal tumors, such as cholesteatomas. In our study, resection of intracranial and extracranial tumors was the second most common cause of facial palsy. Schwannomas were the most common, followed by mastoidectomy to approach cholesteatomas, meningiomas, and acoustic neuromas.

The high incidence of facial palsy secondary to tumor resection in our center is possibly due to the interhospital referral made between the National Institute of Neurology and Neurosurgery.

Idiopathic facial palsy (Bell) continues to be the most frequent cause of facial paralysis in the world, and fortunately in 60-80% of cases there is a complete and spontaneous recovery after a couple of months¹⁸. However, patients with a torpid evolution or severe facial paralysis should be referred early to centers with experience in reconstructive surgery for facial paralysis, since most of them will require step-by-step surgical treatment. In most of the centers where facial paralysis surgery is performed, Bell's palsy is reported as the most frequent cause of facial paralysis that requires surgical treatment^{19,20}, in contrast to our results, in which Bell's palsy represented third place, probably because the majority of patients with sequelae are unaware of the existence of surgical treatment, since very few centers perform this type of surgery in the country. On the other hand, patients with acute facial Bell's palsy are referred to the otolaryngology service for initial medical management, and only cases with sequelae after 6 months are referred to our service for surgical approach.

Other not so frequent causes in our series were traumatic, mostly secondary to stab wounds or fractures of the facial mass, with partial or complete section of one of the branches of the facial nerve. Despite the fact that a large number of patients arrive with traumatic injuries¹³, facial nerve lesions are not as common in this series. In 20% of the patients who present late facial paralysis due to blunt trauma, there will be a complete recovery, since it is secondary to edema and they will have a good prognosis; conversely, if paralysis occurs at the time of the injury, it is likely that there will be no recovery, as occurs with penetrating trauma, and surgical treatment will be required²¹⁻²³.

All cases in this series underwent surgical procedures, except in two patients with Moebius syndrome in whom no procedure was performed due to their age, and one patient with Bell's palsy who was not a candidate for surgical treatment was sent to rehabilitation therapy with *biofeedback*. The average number of procedures performed on each patient was 2.7, including static and dynamic. In most published series, patients undergo an average of at least two surgeries to achieve satisfactory dynamic resuscitation; in this study, an average of 1.8 procedures were performed with a dynamic purpose^{4,15,17,19,24-26}. All patients undergoing

dynamic procedures received post-surgical rehabilitation with *biofeedback* therapy to improve coordination and voluntary movements.

The most frequent dynamic procedure in this study was the free *gracilis* flap, followed by crossed nerve grafts as the first procedure for the *gracilis* flap and as an isolated dynamic procedure for facial paralysis with an evolution of less than 6 months. Currently, dynamic procedures are the treatment of choice for the reconstruction of facial dynamics, since the results are more successful and fruitful than with static procedures, and they should be considered as the first option unless there is some contraindication or comorbidity that does not allow its realization. Limitations of these procedures when performing free muscle transfers include the need for a team with experience in microsurgery, the longer learning curve, and the higher cost. The dynamic procedure will be chosen according to the etiology of the facial paralysis, the time of evolution, the viable donor nerves and the viable facial musculature.

Static procedures consist of performing soft tissue suspension in order to achieve symmetry of the face at rest, but without allowing voluntary movements. They will be performed depending on the needs of each patient and as a complement to the dynamic procedures to obtain greater functional and aesthetic satisfaction. They have the advantages of requiring a low learning curve and lower cost^{27,28}. The main function of static procedures is to provide corneal protection and, to a lesser extent, to improve chewing and speech²⁹. In this study, an average of two procedures were performed for this purpose. Among the static procedures, the most performed was the placement of a gold weight, followed by commissuroplasty and the tarsal strip, similar to what has been published in other series, in which most of the procedures aim to restore function and the symmetry of the frontal, periocular and peribuccal zone^{16,17,19}. The static procedure should be chosen according to the aesthetic subunit to be reconstructed and individualizing the treatment for each patient.

Dynamic treatment algorithm of the General Hospital Dr. Manuel Gea González

Dr. Manuel Gea González General Hospital has the first multidisciplinary clinic for facial paralysis care in Mexico, made up of plastic surgeons, otolaryngologists, ophthalmologists, psychologists, geneticists, orthodontists and physiotherapists, and is a reference center for reconstructive surgery in the country.¹³

The objectives of the treatment consist of achieving four fundamental aspects:

- Facial symmetry at rest.
- Oral competence and palpebral closure.
- Voluntary facial movements with spontaneous facial expression.
- Minimal absence of synkinesias and mass movements.

In accordance with the service's experience in the treatment of facial paralysis, we propose the following modified algorithm from the one previously proposed by Terzis and Konofaos¹⁷ for dynamic resuscitation, depending on the etiology, the time of evolution, the available donor nerves and the state of the facial musculature (Fig. 6).

Acute presentation < 72 hours: traumatic or iatrogenic injury (direct neurorrhaphy)

Ideal when paralysis occurs in the first 72 hours after trauma or iatrogenic injury. Whenever possible, facial nerve injury should be identified at both ends and epineural neurorrhaphy attempted with two or three separate 9-0 nylon sutures when the gap is less than 17 mm. If this is not possible, nerve grafts should be used to perform tension-free neurorrhaphy. The rule indicates that any gap greater than 2 cm must be repaired with nerve grafts. The sural nerve is the main donor nerve due to its easy dissection and low complication rate. Other options are the greater auricular, medial antebrachial cutaneous, and lateral antebrachial cutaneous. The average recovery time is 12 to 18 months^{19,30,31}.

Late presentation: ipsilateral facial nerve missing or developmental facial palsy

After performing electromyography, surgical treatment will depend on the state of the facial musculature.

Viable musculature for reinnervation

When there is viable muscle for reinnervation, the treatment will depend on the evolution time:

- Lesion less than 6 months old: perform buccal-buccal or marginal-marginal crossed-nerve grafts.
- Lesion of more than 6 months and less than 2 years: perform crossed-nerve grafts and *baby-sitter* procedure (40% of the XII nerve ipsilateral to the affected VII) with or without nerve transfers (massetero-buccal and hypoglossal-marginal).

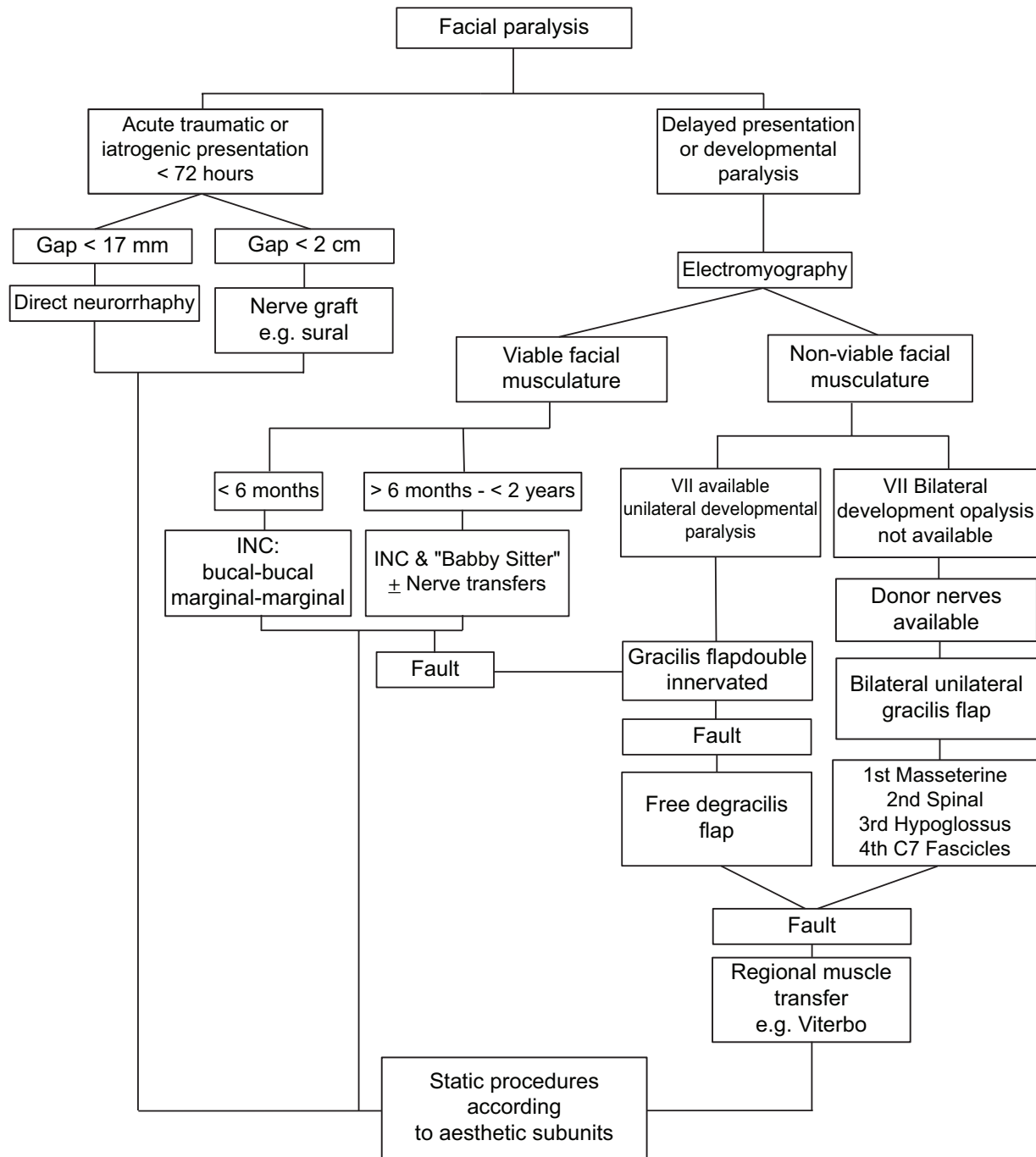


Figure 6. Surgical treatment algorithm. INC: crossover nerve graft.

Muscle not viable for reinnervation

In the event that the neurophysiological study shows data of absence of muscular activity, there is an injury of more than 2 years, unilateral or bilateral developmental paralysis, the surgical treatment will be a free muscle transfer and the donor nerve will be chosen according to availability.

Contralateral facial nerve available or unilateral developmental palsy

In our center we perform the double innervated *gracilis* flap for unilateral facial paralysis with the contralateral facial nerve available in two stages, as described by Cárdenas-Mejía et al.²⁵. The first phase consists of performing a crossed nerve graft from the healthy

buccal contralateral to the nasolabial fold of the affected side, using the sural nerve. The second stage is performed at 3-4 months when the nerve is viable, confirmed by neurophysiological studies, and consists of performing the free muscle flap coapting the obturator nerve to the contralateral facial in an end-to-end manner and to the ipsilateral masseteric nerve in an end-lateral manner. The average reinnervation time is 8.7 weeks, for visible movements it is 12.8 weeks and for total recovery from post-surgical edema it is 7.7 months. We prefer this technique over others in which the masseteric nerve is coapted with end-to-end anastomosis to the obturator *gracilis* and an end-to-side anastomosis to the contralateral facial is performed, because despite the fact that this nerve provides greater strength and generates a more symmetrical smile, rarely achieves the goal of spontaneity³². On the other hand, if only the contralateral facial crossed nerve graft is performed with end-to-end anastomosis to the *gracilis* obturator, greater spontaneity is achieved, but with a weak and rarely symmetrical smile^{33,34}. The double-innervated *gracilis* flap technique combines these two techniques by closely coapting the masseteric nerve to the *gracilis* muscle, guaranteeing a shorter reinnervation time, with a greater number of functional motor units, providing more power in muscle activation in less time, and simultaneously with a spontaneous and independent function, having better results than other described techniques. Despite the fact that in some series age over 60 years is a contraindication for performing this type of procedure, successful series of free flaps have been reported in people over 65 years of age³⁵.

Contralateral facial nerve missing or bilateral developmental palsy

In cases where the contralateral or bilateral facial nerve is not available, the procedure of choice will be the unilateral or bilateral *gracilis* free flap with micro-coaptation to the masseteric nerve with anastomosis of the circumflex femoral artery to the facial vessels. As a second option, coaptation to the spinal nerve, and when this is not possible, other feasible alternatives are the hypoglossal nerve or C7^{17,26}. For Moebius syndrome, between 4 and 15 years of age, surgical procedures will be initiated with the aim of dynamic, after performing electromyography, since in 7.5% of cases there are abnormalities²⁶. In most cases we perform the bilateral *gracilis* free flap in two times, with

an interval of 6 months^{24,36}. The implementation of a bilateral *gracilis* free flap in a single stage has been reported with good results; in our center we have also performed bilateral transfer with this technique and it represents a valid option when financial resources and the patient's state of health allow it³⁷.

Failure of free microsurgical procedures

When there is failure of free muscle transfers, regional transfers are a feasible alternative. The most commonly performed procedure in our center is the orthodromic transfer of the temporal muscle described by Viterbo and Paula Faleiros³⁸, which was performed in 11 cases (9%) in our series in which there was failure of the *gracilis* flap. Although acceptable results are obtained in the general appearance of the face, particularly at rest, the smile excursion is inferior compared to the result obtained by a free muscle transfer. Despite this last limitation, we have found temporalis muscle transfer to be a reliable salvage surgery^{38,39}.

Third stage or revision surgeries

It consists of performing revision surgeries to improve facial dynamics and statics. These interventions are individualized depending on the aesthetic subunit to be treated in each patient. To mention a few of them, gold weight placement, minitemporal flap, corneal neurotization, contralateral suppressor myomectomy, tarsal strip, brow suspension, asymmetric blepharoplasty, asymmetric rhytidectomy, and facial lipoinjection can be performed.

Limitations

This study has the limitations of being retrospective and not having long-term follow-up of the different procedures with validated postoperative evaluation scales, but it is the first study of global facial palsy in Mexico, which opens the way for future studies.

Conclusions

On average, two or three surgical procedures will be required to achieve an acceptable aesthetic and functional result. The dynamic procedure will be chosen based on the etiology, the time of evolution, the available donor nerves and the viable facial musculature. The *gracilis* flap continues to be the dynamic procedure

of choice for the reconstruction of facial paralysis; the double-innervated technique performed in cases of unilateral facial paralysis has provided us with excellent results so far. Procedures with a static purpose add functionality and provide harmony of the face at rest. Surgical treatment has managed to significantly improve the quality of life of patients and should be offered in all cases.

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Ethical disclosures

Protection of people and animals. The authors declare that no experiments were carried out on humans or animals for this research.

Data confidentiality. The authors declare that no patient data appears in this article.

Right to privacy and informed consent. The authors declare that no patient data appears in this article.

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Conflicts of interest

The authors have no conflicts of interest to declare in relation to the content of this article.

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