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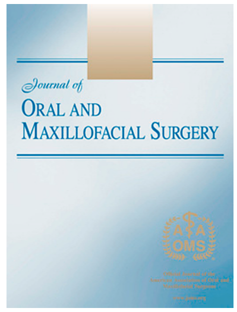

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Case report

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ABSTRACT

The main objectives of facial reanimation procedures include restoring facial symmetry at resting state and regaining facial mobility. Static procedures usually provide unsatisfactory results, especially in younger patients. For this reason, over the years, several different surgical alternatives based on autologous, locoregional, or muscle free flaps have been proposed. The gracilis muscle is the gold standard technique for dynamic reanimation of long standing facial paralysis. The excessive muscle bulk and the differences regarding the type of predominant muscle fiber compared to the zygomaticus major force reconstructive surgeons to search for alternatives to the gracilis as a potential free flap for reanimation. One of them is the sternohyoid muscle flap.

We report a patient with long-standing facial paralysis who underwent a dynamic facial reanimation by using a sternohyoid muscle free flap, thus proposing the procedure as an alternative to the conventional gracilis muscle flap.

Key words: facial paralysis; dynamic facial reanimation; free flap; sternohyoid muscle.

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INTRODUCTION

In long-term facial paralysis, the facial mimetic muscles, due to prolonged denervation, suffer from fibro-adipose metaplasia and irreversible atrophy. These histopathological phenomena develop, in most cases, between a year and a half and two years after the establishment of the paralysis, irrespective of its etiology. Surgical facial reanimation techniques must then seek a new objective: to provide new autologous muscle tissue to supply the atrophied facial muscles and thereby attempt to restore the mobility of the paralyzed face.

The main objectives of facial reanimation procedures include restoration of facial symmetry at resting state (static facial reanimation) and recovery of facial mobility (dynamic facial reanimation), in particular blinking and smiling. In achieving these objectives, static procedures, despite their usefulness and undeniable benefits as complementary methods, are deemed unsatisfactory, especially in younger patients. Therefore, a search for more ambitious facial reanimation techniques is required; such techniques which will attempt to restore mobility, ideally both spontaneous and symmetrical, to the paralyzed face. Although many different muscle flaps have been used over the years (pectoralis minor muscle, latissimus dorsi muscle), the gold standard for microvascularized free flaps in dynamic reanimation of long-term facial paralysis continues to be the gracilis muscle flap. The use of sternohyoid muscle has recently been proposed as an alternative in medical literature for its inherent advantages.

We report the case of a patient with long-standing facial paralysis in which a dynamic facial reanimation was carried out using the sternohyoid muscle as a free microvascularized flap, thus proposing the procedure as an alternative to the conventional gracilis muscle flap.

CASE REPORT

The patient was a 48-year-old woman with 31-month follow-up of a left peripheral facial paralysis resulting from neurosurgical resection of brain metastases of adenocarcinoma of unknown origin.

At initial assessment, from a static point of view, the patient presented resting asymmetry, with ciliary ptosis, enlarged eyelid fissure, scleral exposure without conjunctival ecchymosis, deleted nasogenian sulcus and moderately asymmetric but undescended commissure. From a dynamic point of view, the patient presented minimal eye closure, open-mouthed smile and lip pucker, showcasing great asymmetry when compared to healthy side. Complete paralysis in all other facial movements. Obvious, although not disfiguring, moderate synkinesis associated with eyebrow elevation was also observed. This initial physical examination corresponded to a grade VI on the House-Brackmann scale[1] and a score of 15 on the Sunnybrook scale[2] (Figure 1).

Given the amount of time elapsed and stable oncological baseline, dynamic facial reanimation with a free microvascularized flap of the left sternohyoid muscle was decided as the best course of action. Pre-thyroid musculature was exposed through a low anterior cervicotomy exploiting a natural skin fold. Once the omohyoid muscle was identified and sectioned, the descending loop of the hypoglossal nerve located in close proximity to the internal jugular vein via neurostimulation. The vascular pedicle of the sternohyoid muscle was dissected at the origin of the superior thyroid artery. Subsequently, the flap was sectioned distally together with the hyoid bone including the muscular sternohyoid insertion. The flap obtained was then inserted in the same position as the greater zygomatic muscle. The caudal end of the muscle was sutured to the modiolus, and the cephalic end, which included the hyoid insertion of the sternohyoid muscle, was fixed to the zygomatic bone using two 1.5 mm diameter and 12 mm long screws (Synthes Matrix Midface System®). The hyoid bone required morphological modification via bone milling obtaining a streamlined adaptation to the zygomatic arch. Anastomosis of ansa cervicalis to the left masseteric nerve was performed with perineural suture and application of Tissucol®, as well as vascular anastomosis between the superior thyroid vessels and the left superficial temporal vessels (Figure 2, Video 1). In addition, a 1.6-gram supratarsal gold weight was inserted in left upper eyelid.

After 4 days of hospitalization, during which no postoperative complications were present, the patient was discharged from hospital. At 6-month follow-up, the patient presented edema and redness of the left upper eyelid, with little response to topical corticosteroids. Epicutaneous tests were performed by the Department of Allergology, showing allergic reaction to sodium gold thiosulfate. The gold weight was therefore immediately removed and replaced with a platinum weight once the allergic and inflammatory reaction had been resolved.

Patient follow-up was performed at 1, 3, 6, 12, and 24 months postoperatively. Figure 3 and Videos 2 and 3 shows a pre and postoperative comparison made at 2-year follow-up.

DISCUSSION

The facial nerve (VII cranial nerve) provides motor innervation to the facial mimetic muscles. Injury to this nerve has special importance to the patient, its impact both physical and psychological. On the one hand, lagophthalmos secondary to palpebral incompetence increases the risk of development of ocular pathology (exposure keratitis, corneal ulcers, etc.), which can compromise the patient's vision. Lip incompetence can cause speech disorders as well as difficulty eating. On the other hand, the loss of facial expressiveness affects the patient's social interaction, deteriorating their mood, and may as a result trigger anxiety, depression or isolation.

Time (paralysis-reanimation interval) is the critical factor in deciding the ideal treatment in facial paralysis. This information, together with that provided by neurophysiological tests, mainly electromyography, allows us to evaluate the likelihood of spontaneous recovery and consequently propose different treatment options to the patient accordingly (Figure 4).

Facial paralysis of over 2 years presents a series of histopathological alterations to the facial mimetic muscles, which requires autologous muscle transplants to achieve the goal of restoring symmetry at resting state and restoring acceptable mobility. The objective is to try to restore the patient's natural facial expression as accurately as possible.

With this aim in mind, throughout the years several different surgical alternatives have been proposed: on the one hand, locoregional muscle transpositions (temporalis muscle, masseter muscle, etc.); and, on the other, microvascular free muscle flap transfers (pectoralis minor muscle, latissimus dorsi muscle, gracilis muscle, etc.)

In 1997, Daniel Labbé[3] described the lengthening temporalis myoplasty as a modification of the technique previously described by McLaughlin[4] in 1953. This technique consists of a regional muscle and tendon transfer in which the temporalis muscle tendon is transferred from its attachment on the coronoid process to the modiolus after complete mobilization of the temporalis muscle. Improvement in facial symmetry, particularly regarding the nasogenial sulcus, can be observed already during the immediate postoperative period, with orofacial rehabilitation being essential to achieve dynamic restoration of the smile. The minimal morbidity in the donor area as well as reasonably satisfactory esthetic results make this procedure a widely used treatment option.

The gracilis muscle is the first choice among microvascular free flaps. The first reference to the use of this muscle for facial reanimation corresponds to Harii et al[5] in 1976. Its versatility, the consistent anatomy of its vascular pedicle and the low postoperative morbidity of the donor area without causing any functional deficit are some of the advantages it offers. However, the use of this muscle is not without drawbacks. Its main disadvantage is the excessive bulk provided compared to the zygomaticus major muscle, creating an unacceptable esthetic deformity in the recipient site which, despite improving over the following months, remains very evident and problematic for the patient. This is especially relevant in older patients, where subcutaneous cellular tissue thickness decreases along with soft tissue elasticity. In these patients, any bulk excess will therefore be more evident, compared to younger patients. Biomechanical physiology is also a differentiating factor when comparing gracilis and facial muscles. The gracilis muscle is a slow-twitch muscle involved in maintaining balance and trunk stability. The zygomaticus major muscle, by contrast, requires very rapid movements for facial mimicry and has one of the highest proportions of fast-twitch muscle fibers found in the human body, just below those found in the orbicularis oculi muscle.

Taking into account these important differences mentioned, Alam et al proposed a novel dynamic facial reanimation technique using the sternohyoid muscle as a microvascular free flap in 2013, publishing the first clinical case in 2016.

The sternohyoid muscle arises from the posterior border of the medial end of the clavicle, the posterior sternoclavicular ligament, and the upper and posterior part of the manubrium sterni. Following an upward and medial trajectory, it then inserts into the inferior border of the body of the hyoid bone. It receives arterial supply from the superior thyroid artery, a branch of the external carotid artery; venous drainage is carried out by a vein of the same name, which empties into the internal jugular vein; motor innervation corresponds to the descending loop of the hypoglossal nerve.

The use of this muscle as a microvascular free flap offers several advantages that make it a valid and interesting option as an alternative to the gracilis muscle. First, it is located in an anatomical area far more familiar to the maxillofacial surgeon, which facilitates its dissection and extraction with minimal morbidity. It also has an easily identifiable vascular-nervous pedicle with few anatomical variations. Furthermore, the length of this nerve pedicle allows neurorrhaphy to be performed with the healthy facial nerve on the contralateral side without the need to interpose a complementary nerve graft. In this particular case, neurorrhaphy to the ipsilateral masseteric nerve was chosen, since it is a powerful nerve with a large number of axons that ensures initial contractile response at a 3-month follow-up, increasing as a result this technique’s predictability. Moreover, compared to the gracilis muscle, this free flap offers both a length and bulk, as well as a proportion of fast-twitch muscle fibres more similar to those of the zygomaticus major muscle[6,8]. This resemblance in dimensions of both muscles make the sternohyoid muscle particularly appealing in those patients with reduced skin thickness in the recipient site, whether due to their age, previous surgical or radiotherapy treatments, or any other cause. Finally, the superior length-contraction ratio due to the shorter length between origin and insertion achieves a greater facial symmetry during muscle contraction.

An anatomical peculiarity of the sternohyoid muscle flap is the separate locations of the vascular and nervous pedicle: while the blood vessels are located in the most cranial part of the flap, its motor nerve is in its most caudal. This can be a limiting factor when it comes to shortening the flap to its most ideal length, resulting in a looser positioning of the flap, and thereby reducing muscle contractile capacity. In addition, the inclusion of the hyoid bone to maintain original muscle insertion increases morbidity. Furthermore, hyoid adaptation to the zygomatic arch is difficult, requiring osteosynthesis material and can thus result in notable excess bulk.

In conclusion, improving quality-of-life in patients with facial paralysis continues to pose a challenge for reconstructive head and neck surgery. The search for new procedures and surgical techniques to achieve this has yielded promising results in recent years. One of these has been the incorporation of the sternohyoid muscle flap into our therapeutic arsenal. Its multiple advantages when compared the current gold standard, along with the promising esthetic and functional result it offers, mean that it should be considered a real alternative to the gracilis muscle when carrying out dynamic reanimation of patients with long-term facial paralysis.

However, randomized studies with larger sample sizes are necessary in order to accurately evaluate and compare both flaps in the long-term and definitively consider the sternohyoid muscle free flap as first choice in these patients.

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LEGENDS

FIGURE 1. Preoperative composite score of 15 on the Sunnybrook scale[2]

FIGURE 2. Dynamic facial reanimation using a microvascular free flap of sternohyoid muscle. A) Intraoperative layout of surgical approaches. The theoretical path of the descending loop of the hypoglossal nerve (black arrow) and the superior thyroid vessels (yellow arrow) are marked; B1) Identification of left sternohyoid muscle; B2) Muscle contraction after neurostimulation of its efferent motor nerve; C) Descending loop of left hypoglossal nerve; D) Placement of sternohyoid muscle according to anatomical position of zygomaticus major muscle; E) Macroscopic view of nerve anastomosis of ansa cervicalis to left masseteric nerve; F) Microscopic detail

of nerve anastomosis; G) Macroscopic detail of vascular anastomosis.

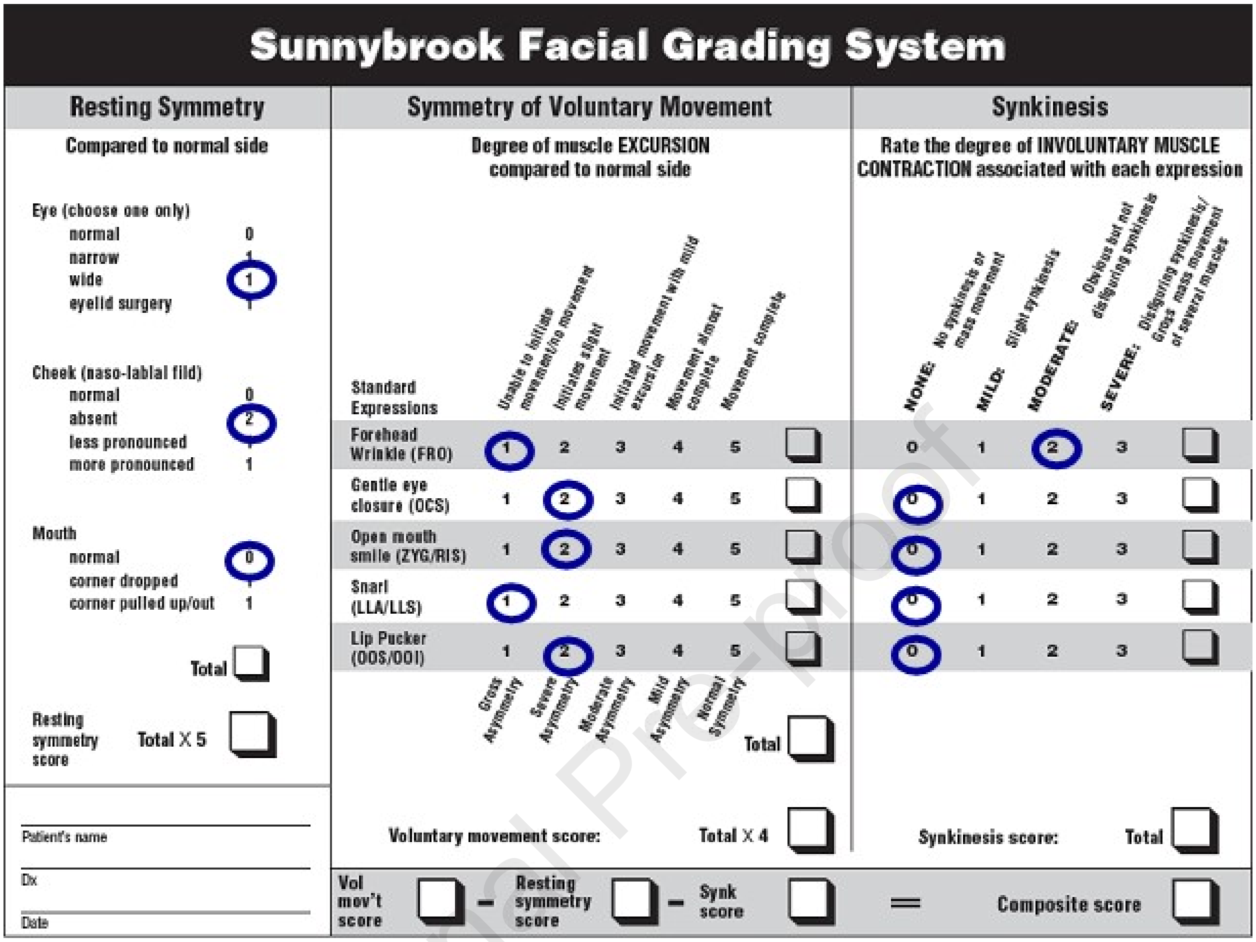
FIGURE 3. Comparison between preoperative (left) and postoperative (right) situation at two-year follow-up: A) Resting state; B) Forced eyelid closure; C) Zygomaticus major muscle (left), sternohyoid muscle (right).

FIGURE 4. Treatment options for facial paralysis depending on paralysis-reanimation interval.

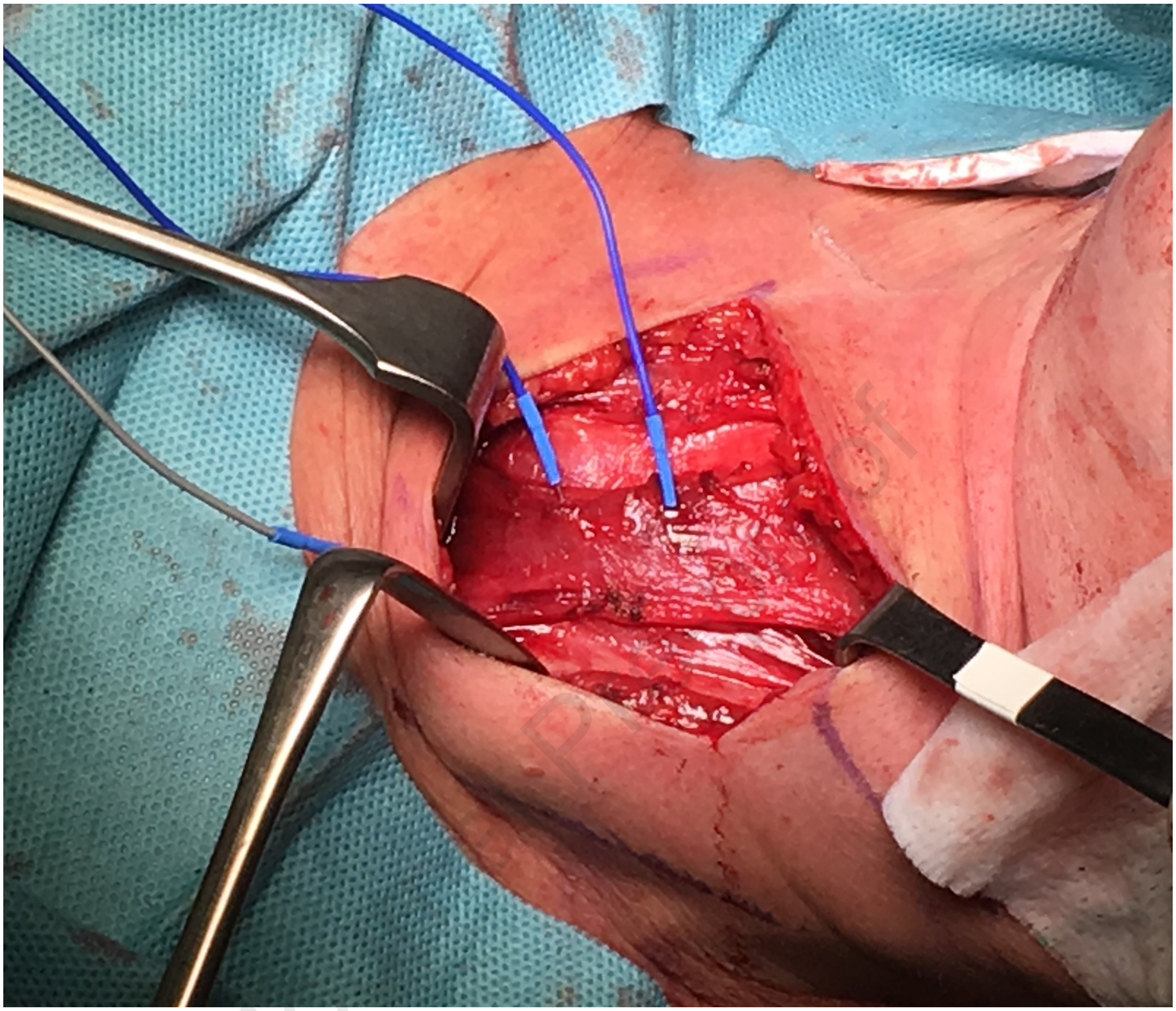
VIDEO 1. Dynamic facial reanimation with a free microvascularized flap of the left sternohyoid muscle

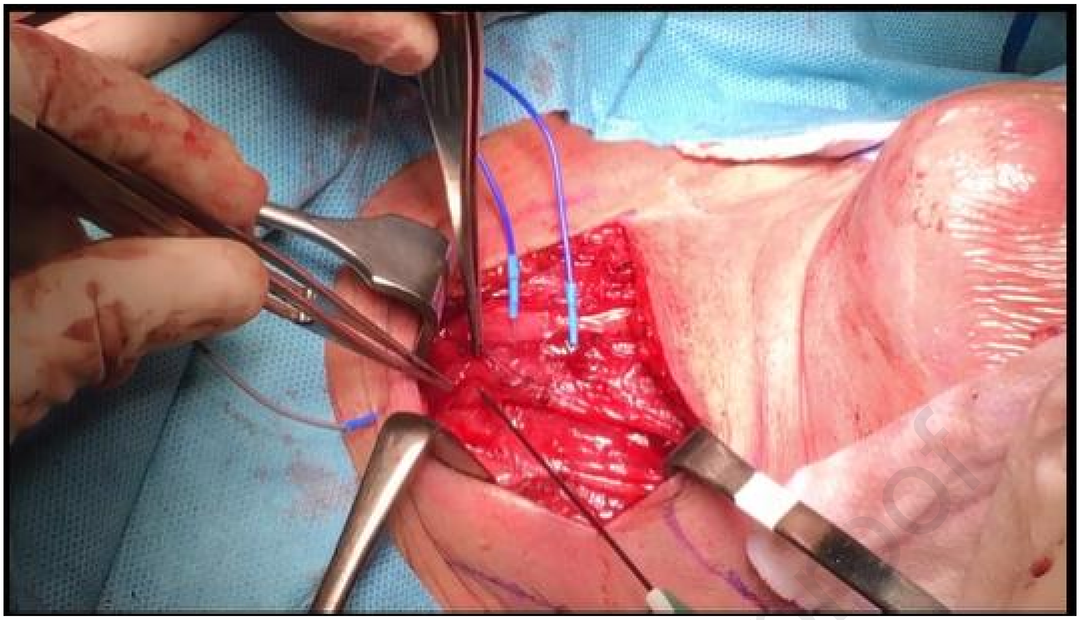
VIDEO 2. Preoperative patient status corresponded to a VI grade on House-Brackmann scale.

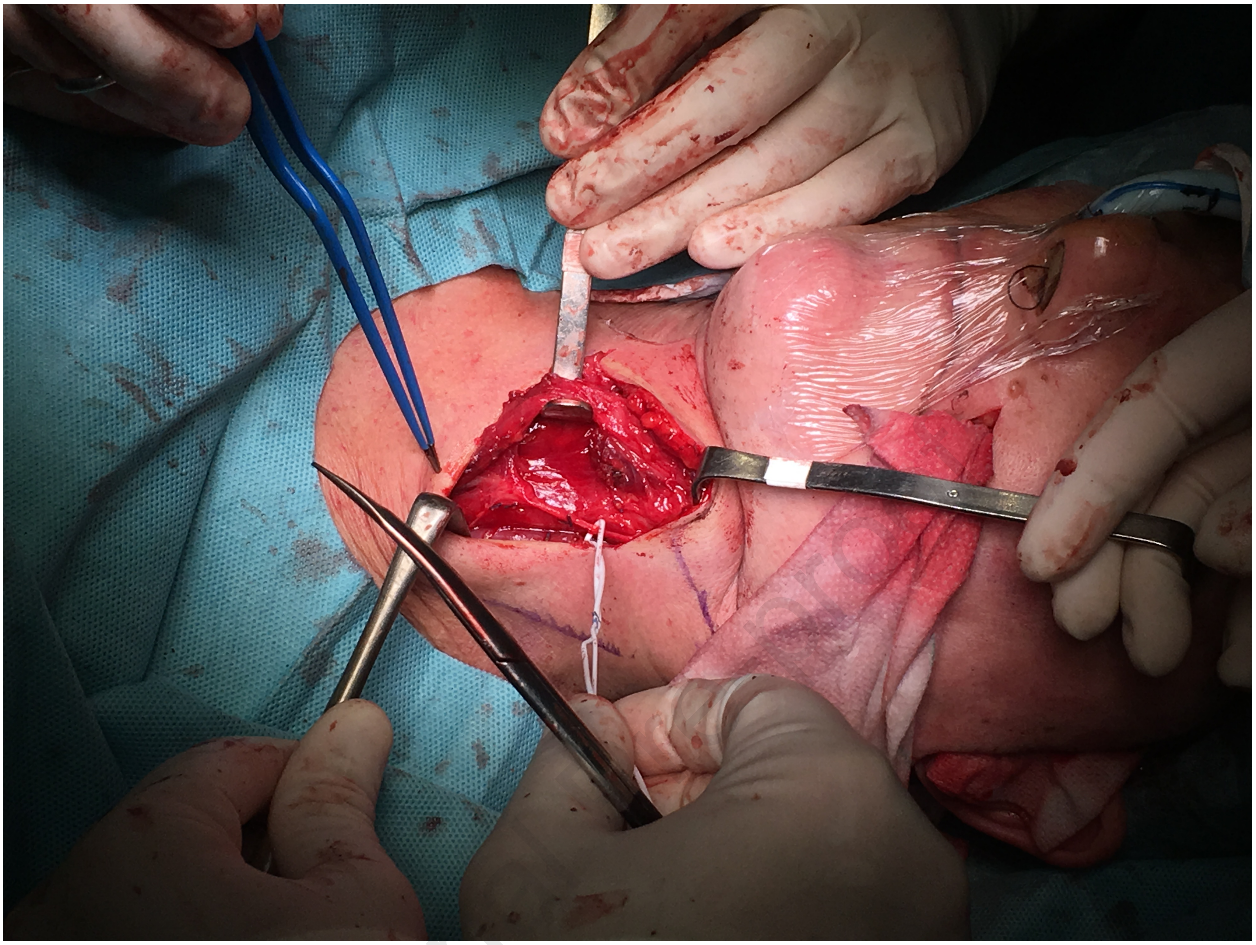
VIDEO 3. Postoperative situation of the patient at two-year follow-up.

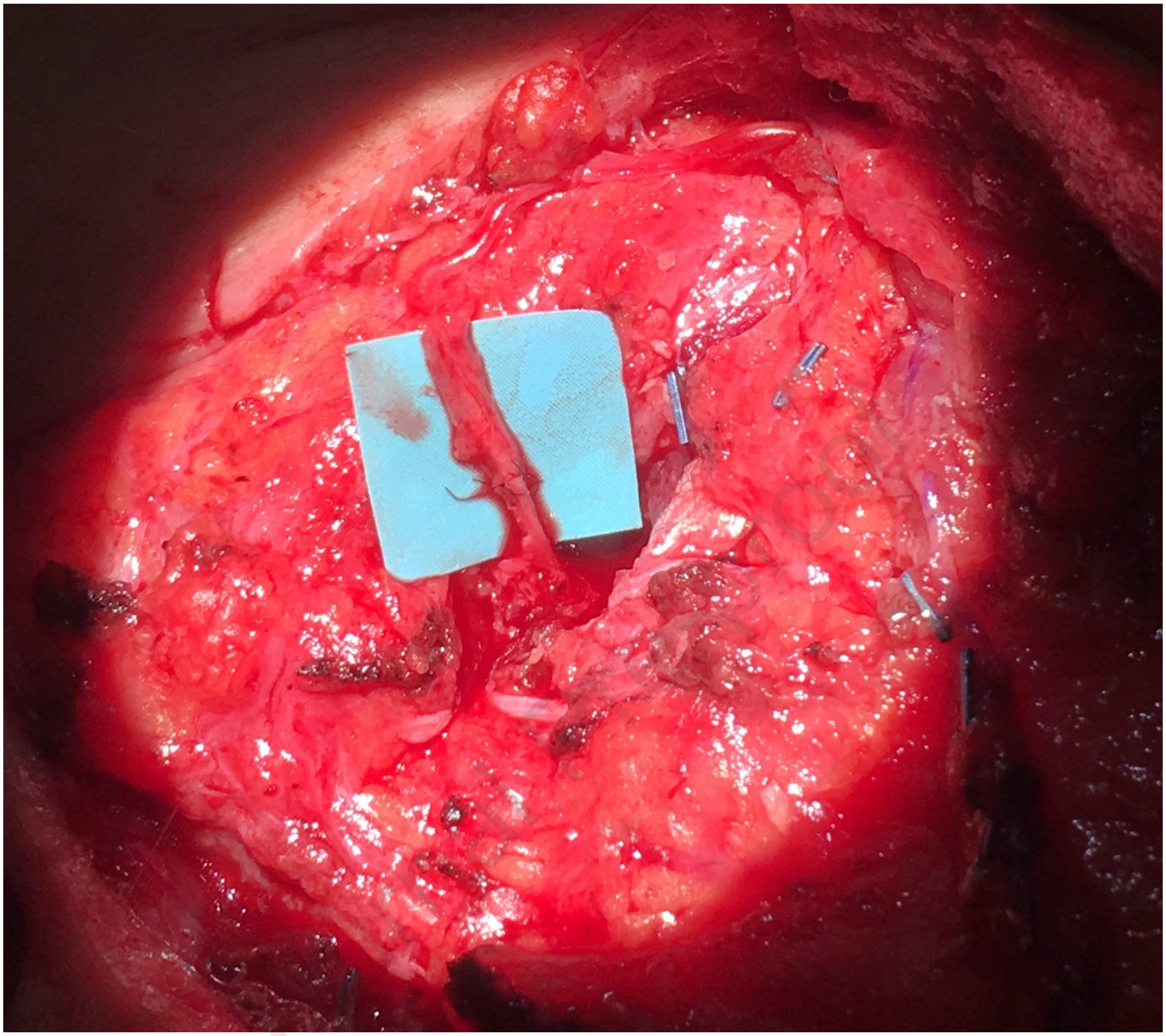

Sunnybrook Facial Grading System
Resting Symmetry
Compared to normal side
Eye (choose one only)
normal 0
narrow 1
wide 1
eyelid surgery 1
Cheek (naso-labial fild)
normal 0
absent 2
less pronounced 1
more pronounced 1
Mouth
normal 0
corner dropped 1
corner pulled up/out 1
Total
Resting symmetry score
Total X 5
Patient's name
Dx
Date
Symmetry of Voluntary Movement
Degree of muscle EXCURSION compared to normal side
Standard Expressions
Unable to initiate movement/no movement
Initiates slight movement
Initiated movement with mild excursion
Movement almost complete
Movement complete
Forehead Wrinkle (FRO)
Gentle eye closure (OCS)
Open mouth smile (ZYG/RIS)
Snarl (LLA/LLS)
Lip Pucker (OOS/OOI)
Gross Asymmetry
Severe Asymmetry
Moderate Asymmetry
Mild Asymmetry
Normal Symmetry
Total
Voluntary movement score:
Total X 4
Synkinesis
Rate the degree of INVOLUNTARY MUSCLE CONTRACTION associated with each expression
NONE: No synkinesis or mass movement
MILD: Slight synkinesis
MODERATE: Obvious but not disfiguring synkinesis
SEVERE: Disfiguring synkinesis/ Gross mass movement of several muscles
Synkinesis score:
Total
Vol mov't score
Resting symmetry score
Synk score
Composite score

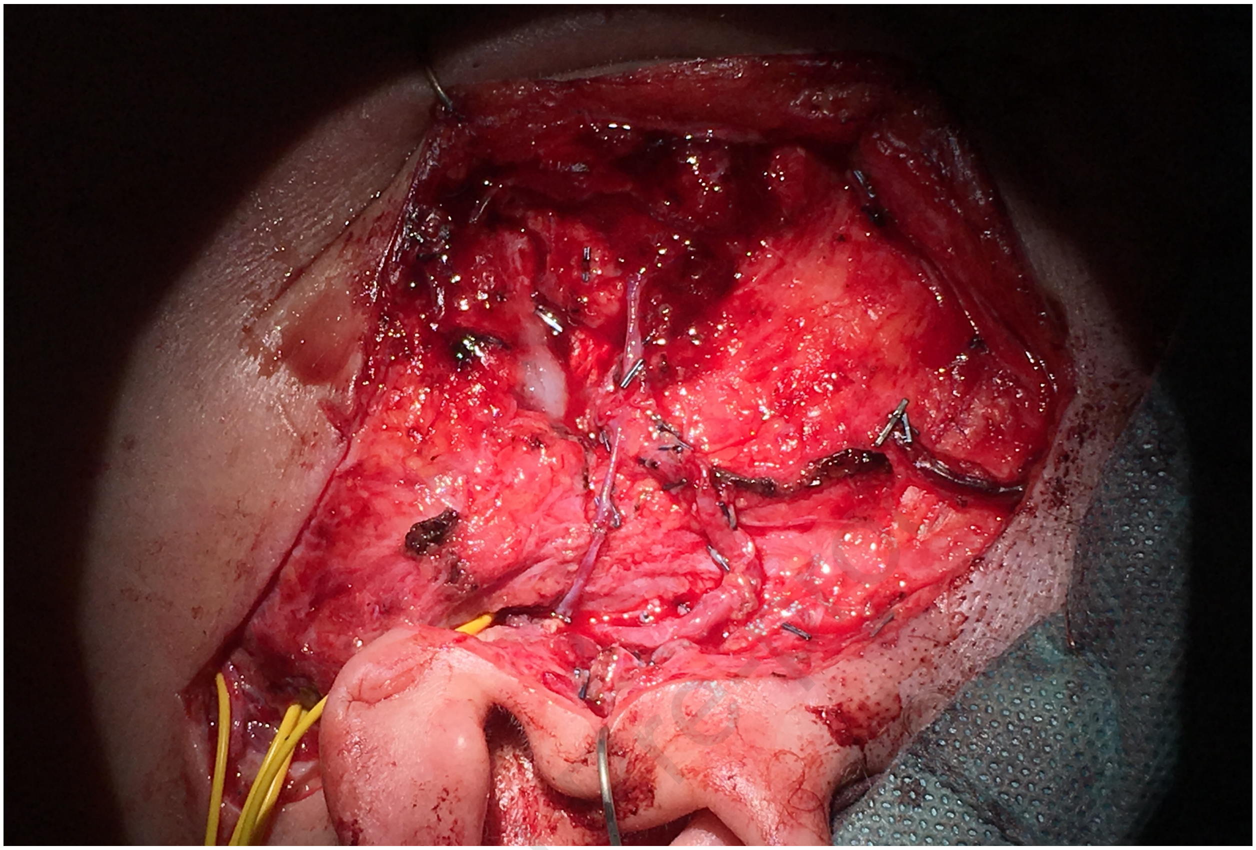

NM

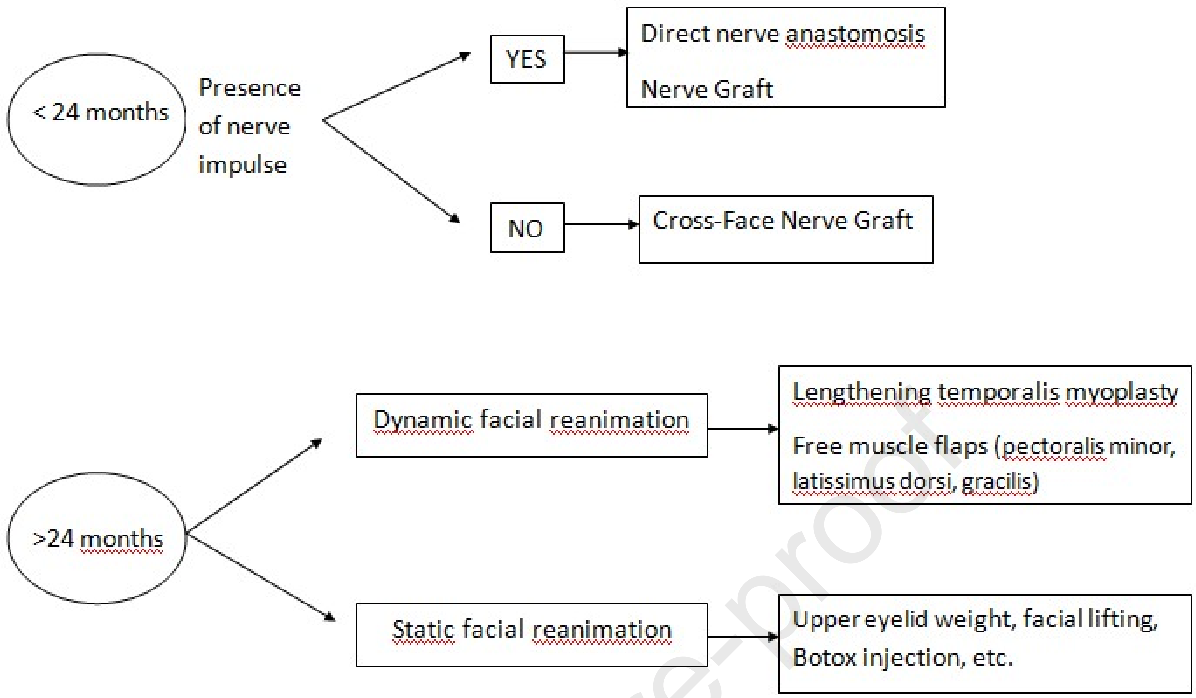












< 24 months
Presence of nerve impulse
YES
NO
Direct nerve anastomosis
Nerve Graft
Cross-Face Nerve Graft
>24 months
Dynamic facial reanimation
Static facial reanimation
Lengthening temporalis myoplasty
Free muscle flaps (pectoralis minor, latissimus dorsi, gracilis)
Upper eyelid weight, facial lifting, Botox injection, etc.