Facial Reanimation Surgery With Micro-vascular Gracilis Free Flap for Unilateral Facial Palsy

Ivan Doménech Juan, Jordi Tornero, Paula Cruz Toro, Nuria Ortiz Laredo, Jorge Vega Celiz, Josefina Junyent, Manel Maños Pujol

Servicio de Otorrinolaringología, Hospital Universitario de Bellvitge, Barcelona, Spain
Servicio de Rehabilitación, Hospital Universitario de Bellvitge, Barcelona, Spain
Agrupació Màdica i Quirúrgica (AMiQ), Unidad Funcional de Otorrinolaringología y Alergia, Hospital Universitario Quirón Dexeus, Barcelona, Spain

Received 19 April 2013; accepted 24 June 2013

KEYWORDS
Facial palsy; Facial reanimation; Gracilis muscle free flap

Abstract

Introduction and objectives: Micro-neurovascular free muscle flap transfer is currently the procedure of choice for long-standing facial paralysis. We present a case series of patients treated with gracilis muscle free flap with motor innervation by the masseteric nerve. We discuss the surgical technique and quantify the movement granted by the muscle, the improvement in quality of life and aesthetic results.

Materials and methods: We report ten patients with unilateral facial paralysis who underwent free gracilis muscle flap, between the years 2010 and 2012 in two tertiary hospitals.

Results: Any failure of the microsuture with survival of all flaps is not reported. The muscle movement was quantified by vectors at rest and contraction with an average of 1.7 cm that initiated around the fourth month after surgery. Patients also reported a significant improvement in symmetry at rest as well as oral and ocular competition.

Conclusion: As currently presented in literature, microvascular free flaps are the technique of choice for facial reanimation. In our experience, we believe that gracilis muscle flap innervated by the masseteric nerve is a reliable and secure technique that provides adequate functional and aesthetic results.

© 2013 Elsevier España, S.L. All rights reserved.


Corresponding author.

E-mail addresses: paulitacruz@hotmail.com, paucruztoro@gmail.com (P. Cruz Toro).

2173-5735/$ - see front matter © 2013 Elsevier España, S.L. All rights reserved.
PALABRAS CLAVE
Parálisis facial; Reanimación facial; Colgajo muscular libre microvascularizado gracilis

Cirugía reparadora de la parálisis facial mediante colgajo libre microvascularizado de músculo gracilis

Resumen

Introducción/objetivos: La transferencia de colgajo libre muscular microneurovascular es actualmente el procedimiento de elección para la parálisis facial de larga evolución. Presentamos una serie de casos de pacientes tratados con colgajo libre de músculo gracilis con inervación motora por el nervio maseterino. Se analiza la técnica quirúrgica y cuantificamos el movimiento otorgado por el músculo, así como la mejoría en la calidad de vida y los resultados estéticos obtenidos.

Materiales y métodos: Se analizan 10 pacientes con parálisis facial unilateral, quienes fueron intervenidos con colgajo muscular libre gracilis, durante los años 2010 y 2012 en 2 centros hospitalarios de tercer nivel.

Resultados: No encontramos fallo de la microsutura con supervivencia de todos los colgajos realizados. El movimiento muscular se cuantificó mediante vectores en reposo y contracción, con un promedio de 1,7 cm, se inició aproximadamente hacia el cuarto mes después de la intervención. Se demuestra también una mejora significativa de la simetría en reposo, así como de la competencia oral y ocular.

Conclusiones: Como se presenta actualmente en la literatura los colgajos libres microvascularizados son la técnica de elección para la reanimación facial. En nuestra experiencia consideramos que el colgajo con músculo gracilis inervado por el nervio maseterino es una técnica fiable y segura, que ofrece adecuados resultados tanto funcionales como estéticos.

© 2013 Elsevier España, S.L. Todos los derechos reservados.

Introduction

Facial paralysis is characterised by the interruption of the nerve supply to the muscles of the face, consequently leading to a weakness or absence of facial mimicry. This anomaly involves important sequelae, not only aesthetic but also functional and psychological.

Over approximately the last 3 decades, facial reanimation surgery has evolved significantly. From the initial static techniques that attempted to provide symmetry at rest, dynamic techniques have been developed, which offer the possibility of movement, giving patients their smiles back.

The various dynamic techniques have in turn evolved from the treatments of nerve reinnervation using hypoglossal–facial anastomosis, transpositions of the masseter and temporal muscles, or the Labbé lengthening temporalis myoplasty, up to the most recent techniques of microvascular free muscle flaps. The use of the gracilis free flap with its different innervation techniques by trigeminal or contralateral facial muscles stands out among these. Such surgeries have become more and more present according to the specialised literature given their great versatility, reliability and functional results, growing into the technique of choice in the treatment of facial paralysis for most surgeons.¹

Materials and Methods

We analysed a total of 10 patients with facial paralysis that had surgery between 2010 and 2012 in 2 third-level centres. The technique used in all the cases was a microvascularized gracilis free flap innervated by masseteric branch of the trigeminal nerve.

All patients received a preoperative assessment with photographic and video documentation. During the postoperative period, the muscle flap movement was studied and the patients evaluated the results subjectively by means of a questionnaire.

Surgical Technique

The procedure is performed in a single surgical step under general anaesthesia with 2 fields at once. At the facial level, a Blair incision is made and then the skin flap over the parotid-masseteric fascia is dissected from the entire hemiface affected up to the orbicular muscle of the lips. The facial vessels are identified and prepared, as is the V3 motor branch (trigeminal nerve) in the deep face of the masseter muscle. Simultaneously, in the inner face of the leg, the gracilis muscle is identified and dissected with its vascular pedicle, as well as the branch of the obturator nerve. A muscle segment of only approximately 10–12 cm is required, depending on the facial characteristics of the patient. Next, the muscle is transposed to the paralysed half of the face, placing anchor sutures around the peri-buccal muscle. After that the microvascular anastomosis of the muscle pedicle with the facial vessels is carried out, normally with 8 equidistant sutures of 9/0 Ethilon®. Obturator-masseter nerve microanastomosis is performed using 2 7/0 Prolene® stitches. We always associate a superficial musculoaponeurotic system (SMAS) technique lifting, leaving 2 Penrose-type drains (1 in the area of the vascular microsuture and another under the gracilis in the parotid region).

In the immediate postoperative period, the patients are monitored to review the surgical wound at the first, second and fourth week. This last revision is performed together
Reconstructive surgery of facial paralysis: gracilis muscle free flap

Quantification of Movement

Facial movement is quantified using a method that is easy, simple, objective and quick to perform in the consultation. We use the establishment of 2 vectors and their angle of disposition for each patient and, consequently, we obtain a vector result (VR) of movement in centimetres to study the dynamics or movement provided by the gracilis muscle flap. In the affected half of the face, we establish 2 vectors with different movement directions measured at rest and during contraction (smiling). These measurements are: Vector 1, from the corner of the mouth to the outer edge of the eye, and Vector 2, from the corner of the mouth to the central part of the tragus. The difference between distance at rest and during contraction for each vector quantifies the movement of the muscle in centimetres. Based on these differences and on the angle obtained for each patient, a VR is drawn to give us the movement and true projection of the corner of the mouth (Figs. 1 and 2).

Patients carried out a subject assessment using the Face Scale survey, developed by Kahn et al. and validated in 2000, at 3 months after initiating muscle movement. This is a patient-based system to measure the deterioration and impairment caused by the facial paralysis, evaluating functional items such as facial mobility and pain, eye problems and chewing, as well as social development and behaviour; points are given on a scale from 1 to 5 (with 1 being the worst classification and 5, the best). The survey was carried out in the preoperative consultation and at 3 months after the operation.

Results

A total of 10 facial reanimation operations using microvascularized gracilis free flap were performed on 7 women and 3 men, with a mean age of 44 years (38–52 years). Of the 10 patients, 7 presented facial paralysis as a result of the removal of a vestibular schwannoma, 2 patients presented Bell’s paralysis and in 1 patient the paralysis was secondary to a neurectomy for Ménière’s syndrome. All of them had a Grade VI on the House–Brackmann scale. The average time between facial paralysis and surgery was 65 months (10 months–20 years). Among prior antecedents it is especially relevant that 4 patients presented previous facial operations: 3 had had a failed hypoglossal–facial anastomosis, 2 of them were associated with a palpebral weight and the other 1 with a tarsorrhaphy; likewise, a cross-face technique with sural nerve and face lift had been performed on 1 patient in another centre.

There were no serious intra- or perioperative complications. Mean hospital stay was 9 days (8–10 days). In the case of the patient with the prior hypoglossal–facial anastomosis, vascular anastomosis could not be performed because the facial vein had been ligated before. Of the 9 remaining operations, there was no microvascular suture failure, with a viability of 100% of the muscle flaps. With respect to the nerve suture, we can report 1 patient in which we consider that deficient nerve anastomosis was produced due to delayed and limited commencement of movements.

In the postoperative period, 1 patient presented a haematoma, which was revised surgically without later incidents. As minor complications, we can report 2 seroma of the facial surgical wound, 1 with later superinfection and 1 infection of the surgical wound of the lower member; all of these cases resolved appropriately with conservative treatment (Table 1).

Analysis of Muscle Movement

Of the 9 patients in which the surgery was performed, we can report movement characteristics for 8 of them, given that the patient operated most recently still does not present movement (after 2 months).

The muscle initiated its contractile capacity at 4 months on average, ranging from a minimum of 2 months to a maximum of 9 months. No relationship was found between the onset of muscle contraction and the time lapse between
facial paralysis and surgery. Neither was it possible to relate onset with the ensuing functional result.

In the case of the deficient nerve suture, we found that movement began with a long delay (9 months). In addition, movement was slight for each vector (less than 4 mm). However, the tone of the flap is adequate, conserving symmetry at rest and appropriate facial balance.

We obtained the muscle movements of the remaining 7 cases with the vectors previously mentioned, with their difference at rest and during contraction. Mean movement in centimetres for Vector 1 (corner of the mouth to outer edge of the eye) was 0.9 cm and that of Vector 2 (corner of the mouth to tragus) was 1 cm (Table 2). The third vector (the result of adding SV1 and SV2), which measures the movement of the corner of the mouth to the temporalis area, had a mean of 1.7 cm (Table 3).

**Table 1** Demographic Results from the Series of Patients.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Cause of FP</th>
<th>Antecedents</th>
<th>FP-SI time</th>
<th>Postoperative complications</th>
<th>SI-movement time</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>F</td>
<td>Bell’s FP</td>
<td>No</td>
<td>5 years</td>
<td>Haematoma (revision)</td>
<td>4 months</td>
</tr>
<tr>
<td>42</td>
<td>M</td>
<td>Neurinoma (VIII)</td>
<td>Hypoglossal-facial anastomosis. Tarsorrhaphy</td>
<td>3 years</td>
<td>–</td>
<td>5 months</td>
</tr>
<tr>
<td>40</td>
<td>F</td>
<td>Neurinoma (VIII)</td>
<td>Face lift 2011</td>
<td>10 m</td>
<td>Seroma. Infection of surgical wound of the lower member</td>
<td>9 months</td>
</tr>
<tr>
<td>45</td>
<td>F</td>
<td>Neurinoma (VIII)</td>
<td></td>
<td>20 m</td>
<td>–</td>
<td>4 months</td>
</tr>
<tr>
<td>40</td>
<td>F</td>
<td>Neurinoma (VIII)</td>
<td></td>
<td>11 m</td>
<td>Seroma, superinfection</td>
<td>3 months</td>
</tr>
<tr>
<td>51</td>
<td>F</td>
<td>Neurinoma (VIII)</td>
<td></td>
<td>3 years</td>
<td>No</td>
<td>3 months</td>
</tr>
<tr>
<td>52</td>
<td>F</td>
<td>Neurinoma (VIII)</td>
<td>Hypoglossal-facial anastomosis. Weight</td>
<td>2 years</td>
<td>Facial vein tied off. No anastomosis</td>
<td>–</td>
</tr>
<tr>
<td>44</td>
<td>M</td>
<td>Neurinoma (VIII)</td>
<td>Hypoglossal-facial anastomosis. Weight</td>
<td>2 years</td>
<td>No</td>
<td>3 months</td>
</tr>
<tr>
<td>61</td>
<td>F</td>
<td>Neurinoma (VIII), Ménière’s disease</td>
<td>Cross-face grafting (sural nerve).</td>
<td>16 years</td>
<td>No</td>
<td>4 months</td>
</tr>
<tr>
<td>59</td>
<td>M</td>
<td>Bell’s FP</td>
<td>Face lift</td>
<td>20 years</td>
<td>No</td>
<td>–</td>
</tr>
</tbody>
</table>

F, female; FP, facial paralysis; M, male; SI, surgical intervention.

**Table 2** Results of Measuring Vector 1 (Corner-outer Edge of the Eye) and Vector 2 (Corner of the Mouth–Tragus) in Centimetres.

<table>
<thead>
<tr>
<th>Measurements at rest (cm)</th>
<th>Contraction (cm)</th>
<th>Movement (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>V1: 7.5</td>
<td>V1: 6.7</td>
</tr>
<tr>
<td>Patient 2</td>
<td>V1: 9</td>
<td>V1: 7.8</td>
</tr>
<tr>
<td>Patient 3</td>
<td>Slight</td>
<td>–</td>
</tr>
<tr>
<td>Patient 4</td>
<td>V1: 8.5</td>
<td>V1: 7.4</td>
</tr>
<tr>
<td>Patient 5</td>
<td>V1: 7.5</td>
<td>V1: 6.5</td>
</tr>
<tr>
<td>Patient 6</td>
<td>V1: 8</td>
<td>V1: 7</td>
</tr>
<tr>
<td>Patient 7</td>
<td>V1: 9</td>
<td>V1: 8.5</td>
</tr>
<tr>
<td>Patient 8</td>
<td>V1: 8.9</td>
<td>V1: 8.2</td>
</tr>
</tbody>
</table>

The third column indicates the difference of the vectors at rest and during contraction.

**Face Scale**

As for the subjective questionnaire on functional evaluation, the global mean score increased from 45 to 62 points. All the patients that had difficulties with oral competence reported a significant recovery, with decrease in spontaneous drooling and improvement in chewing and in ability to control liquids. With respect to ocular competence, all patients reported reestablishment of corneal moisture with decrease in the use of artificial tears, due to the tone the gracili provided to the lower lid; the score on the scale in that section increased from 7.8 to 9.7. Likewise, except for the patient with muscle movement delay, all of the patients indicated that they were content with the static results, as well as with the new facial movement achieved, with good production of smiles.

It should be noted that items such as pronunciation were added to the functional section of the survey. In this, 6 of
the patients with movement reported an improvement in the sound of the "b" and "p", as well as clearer and more understandable speech. Likewise, all patients reported an increase and improvement in nasal breathing.

### Discussion

Denervation of the seventh cranial nerve and its consequent facial paralysis represents a significant functional and aesthetic deterioration for the patient that also involves an important loss of quality of life. The great challenge of surgery over the last several years has been creating techniques that not only offer functional improvement, but also return dynamism and symmetry to the face.

At present, dynamic procedures (whether by nerve graft or by local or free muscle transfer) are the procedures of choice for facial reanimation. Static techniques should be considered as aids to obtain functional results for the eye, forehead, eyebrow and nasal valve. They are also an alternative for elderly patients and for those with a combination of diseases, who are not candidates for dynamic procedures but could benefit from restoration of facial symmetry.\(^1,14\)

Hypoglossal–facial reinnervation was one of the most defended techniques in the past;\(^1,4\) however, one of its main weaknesses is seen in the consequences of denervation of the twelfth cranial nerve; it involves tongue hemi-atrophy with the speech and swallowing difficulties reported in up to 50%–60% of patients and the important deficiencies that dyskinesia between the different muscle groups provoke in patients, even in spite of the multiple modifications of the original technique (nerve interposition, end-to-side anastomosis, etc.).\(^3-7\) Likewise, the low efficacy of this reinnervation procedure in long-standing facial paralysis cases has been shown, with asymmetry at rest and poor results in muscle movement.\(^1\)

Because of this, muscle transposition became the techniques of choice for reconstructing long-standing facial paralysis. The gracilis muscle is probably the flap most often used, having demonstrated postoperative complication rates for both the receptor and donor sites, without any functional deficit presented to date.\(^9\) It is also a reliable technique; with success in our series in all the cases without microsurgery failure and flap necrosis, corroborating the great reliability of this technique, as indicated in the literature.\(^5,10-13\)

In contrast to other authors, we did not perform a control postoperative Doppler sonogram. However, based on our own experience we believe that it is a useful technique that should possibly be obligatory in previously operated patients to ensure the viability of receptor vessels and consequently prevent the impossibility of technical execution such as in the patient reported in our series.\(^14\)

There are large groups with more extensive series in the literature that have managed to computerise the pre- and postoperative measurements, laboriously quantifying data, images and very sophisticated computer programmes.\(^11,13,15,16\)

We, not having such resources available, propose an easy, simple, reproducible, inexpensive and rapid method that has made it possible for us to detect our movement results clearly through the VR. Although a precise comparison cannot be made, we see agreement with previous series such as that of Gousheh and Araste,\(^9\) who reported movement of the corner of the mouth at 1.5–2 cm in 76% of their patients; Manktelow et al.,\(^17\) with 1.3 cm;±4.7 mm; Bianchi et al.,\(^12,16\) approximately 16 mm; Frey et al.,\(^11\) a range of 14±9 mm; Schliephake et al.,\(^10\) with the flap reaching 65% of the movement on the non-paretic side; and Hadlock et al.,\(^12\) who reported movement of 8.8±5 mm in a paediatric population. Likewise, we see a clear similarity in the onset of muscle movement in our series with that of other authors, with a global period of between 4 and 6 months.\(^5,10-13,17\)

As far as nerve suture and movement onset and quality, in our series we present 1 case of deficient movement as defined by its late appearance. However, as in the rest of our cases and in large series such as that of Gousheh et al.,\(^5,16-18\) (who reported only 2% of flaps with poor recovery), the mesenteric nerve has been shown to be considered a safe, strong donor that provides movement similar to that of the non-impaired half of the face.

The effectiveness of this muscle contraction muscular over time has often been questioned. However, Terzis and Olivares\(^19\) showed that the scale and recruitment of motor units did not alter or decrease with time, thus maintaining prolonged muscle function.

Hontanilla et al.,\(^15,16\) recently compared the results of hemi-hypoglossal facial anastomosis and gracilis free flap with the 2 innervation techniques. The results demonstrated little variability in the displacement of the corner of the mouth between the 2 groups; however, the operation with the muscle flap presented greater facial symmetry, quicker onset of movement and greater patient satisfaction.

As for the alternative of gracilis flap reinnervation using healthy facial nerve with interposition of the sural nerve (cross-face technique), we appreciate the virtue of a spontaneous and involuntary smile but it has the disadvantage of requiring 2 operations with time between them, which delays the functional result by approximately 1 year. In contrast, the trigeminal nerve technique can be performed in a single surgery, yielding functionality in a mean of about 4 months and, although voluntary muscle movement is initiated using a stimulation of chewing, it has been observed that over time some patients manage with rehabilitation to achieve a spontaneous and involuntary smiling.\(^17\)

It seems that there is a cerebral adaptation, or plasticity, that leads to cortical reorganisation, producing new connections between the nuclei of the cranial nerves V and VII.

### Table 3: Measurements of the Vector Result, in Centimetres, Obtained From the Differences Between Vectors 1 and 2.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Vector result (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>1.6</td>
</tr>
<tr>
<td>Patient 2</td>
<td>2.6</td>
</tr>
<tr>
<td>Patient 3</td>
<td>Very limited</td>
</tr>
<tr>
<td>Patient 4</td>
<td>1.7</td>
</tr>
<tr>
<td>Patient 5</td>
<td>1.8</td>
</tr>
<tr>
<td>Patient 6</td>
<td>1.9</td>
</tr>
<tr>
<td>Patient 7</td>
<td>1</td>
</tr>
<tr>
<td>Patient 8</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Studies are currently being carried out by means of functional MRI that show different cortical areas of activation of smiling and chewing for the contraction of the gracilis before and after performing this technique.\(^\text{17}\)

To obtain an appropriate functional result, we think that rehabilitation in the postoperative period plays a key role, which in our case we initiate at 1 month after the operation as protocol. When muscle movement is started, an active programme of personal, directed exercises (in front of a mirror, interpersonal conversations, etc.) should be started to create positive feedback. It is in this way that you can achieve adequate muscle strength, without hypertonia or muscle bulges, obtaining appropriate facial symmetry as the final result (Figs. 3 and 4).\(^\text{1,17,18}\)

**Conclusion**

As the literature has been making clear, with the most recent articles on facial reanimation surgery, the techniques of microvascular gracilis muscle free flaps have become the treatment of choice in facial paralysis. In our experience, they provide adequate movement of the corner of the mouth while improving facial symmetry. We see how they not only give the patient back the ability to smile, they improve aspects such as speech and chewing and the nasal breathing function as well. The patient obtains great physical, mental and emotional improvement, as the results obtained in the Face Scale show.

**Conflict of Interest**

The authors have no conflicts of interest to declare.

**References**

Reconstructive surgery of facial paralysis: gracilis muscle free flap


