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Facial reanimation with masseteric to facial nerve transfer: A three-dimensional longitudinal quantitative evaluation

Chiarella Sforza [a,*], Filippo Tarabbia [b], Andrea Mapelli [a,c], Valeria Colombo [b], Fernanda V. Sidequersky [a,c], Dimitri Rabbiosi [b], Isabella Annoni [a], Federico Biglioli [b]

[a] *Functional Anatomy Research Center (FARC), Laboratorio di Anatomia Funzionale dell'Apparato Stomatognatico (LAFAS), Laboratorio di Anatomia Funzionale dell'Apparato Locomotore (LAFAL), Dipartimento di Scienze Biomediche per la Salute, Facoltà di Medicina e Chirurgia, Università degli Studi di Milano, via Mangiagalli 31, I-20133 Milan, Italy*
[b] *Surgical Unit of Maxillo-Facial Surgery, San Paolo Hospital, Facoltà di Medicina e Chirurgia, Università degli Studi di Milano, Milan, Italy*
[c] *Department of Ophthalmology, Otorhinolaryngology, and Head and Neck Surgery, School of Medicine, Ribeirão Preto, University of São Paulo, São Paulo, Brazil*

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Summary Facial paralysis is a severe pathological condition, negatively affecting patients' quality of life. The altered tone and mobility of the mimetic musculature provoke both functional and morphological deficits. In the present study, we longitudinally measured facial movements in 14 patients (21–69 years) affected by unilateral facial paralysis not lasting longer than 23 months. The patients were analyzed before and after surgical masseteric to facial nerve neurorrhaphy. Examinations were performed at least 3 months after they had clinically started to regain facial mimicry. The displacement of selected facial landmarks was measured using an optoelectronic three-dimensional motion analyzer during: maximum smile without clenching (pre- and postsurgery), maximum smile by clenching on their posterior teeth (only postsurgery), and spontaneous smile (recorded during the vision of a funny video in both examinations). Before facial surgery, in all smiles facial landmarks moved more in the healthy than in the paretic side; after surgery, the differences decreased for both reduction of the healthy-side motion, and increment of the paretic-side motion (motion ratio before 52%, after 87%, $p < 0.05$, Students' *t*-test). The ratio between the paretic and healthy-side total motion (asymmetry) did not modify for maximum and spontaneous smiles, but significantly increased for the maximum smiles made with teeth clenching (asymmetry

* Corresponding author. Dipartimento di Scienze Biomediche per la Salute, via Mangiagalli 31I-20133–Milan, Italy. Tel.: +39 02 503 15407; fax: +39 02 503 15387.
E-mail address: chiarella.sforza@unimi.it (C. Sforza).

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before 32%, after 11%, $p < 0.001$). Spontaneous smiles were recorded only in a subset of patients, but their execution was modified by surgery, with more symmetrical movements of the rehabilitated-side landmarks (asymmetry before 33%, after 10%), and reduced motion of the healthy-side ones (motion ratio before 51%, after 83%). In conclusion, the significant asymmetry in the magnitude of facial movements that characterized the analyzed patients before surgery reduced after surgery, at least in those facial areas interested by the masseteric to facial nerve reanimation.
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Introduction

Medical and surgical treatments of craniofacial disorders have greatly improved, with a resulting longer life expectancy after traumas, tumor removals, infective diseases, and congenital malformations. In some patients, the original disorder or its treatment may provoke unilateral facial paralysis.[1–3] Facial paralysis is a severe pathological condition, negatively affecting patients' quality of life.[3,4] The worst functional deficit is the lack of lubrication of the cornea leading to superficial lesions, ulcers and, lastly, to visual loss. On the morphological point of view, there is generally an evident asymmetry of the face at rest due to the loss of tone of the mimetic musculature. Appearance further worsens during facial expressions, particularly when smiling. Reconstructive surgery attempts to address those two main drawbacks of the paralysis.

If the paralysis is recent, lasting <24 months, and mimetic musculature is still present (fibrillations are detected at electromyographic investigation), the facial nerve may be reactivated by connecting it to a new motor source. Several nerves have being proposed in literature for this purpose, with the hypoglossus being the most utilized.[5] This nerve source has the disadvantage to partially impair lingual function when anatomized end to end. If just a part of the hypoglossus nerve is taken, deficits are limited, but efficacy of the procedure as well. A further problem is represented by the difficulty to pair facial movements to lingual ones. A lot of physiotherapy is needed and results are variable among patients.

The other motor source that has been recently highlighted is the masseteric nerve.[6] The great advantage is the low morbidity: patients generally do not feel any deficit during mastication. Additionally, it is easier to couple smiling with teeth clenching compared to pushing the tongue toward them. Surgeons among the authors have been using a specific masseteric to facial nerve neurorrhaphy since October 2007, and some preliminary results of its effectiveness have been published.[6]

Indeed, there is not a widespread consensus about the best method for facial function assessments.[2,3,8] Although conventional clinical methods such as the House—Brackmann scale can be used everywhere and without any apparatus, they provide only qualitative assessments and are observer-dependent.[4,9,10] Some optical methods have been subsequently devised, providing quantitative information about the movements of selected facial landmarks and their trajectories.[3,4,10–15]

In our laboratory, we devised a computerized noninvasive method providing well-reproducible three-dimensional dynamic measurements that permit an objective assessment of facial movements.[7,14] The method was employed to assess both normal subjects[13] and patients with facial palsy.[7] In a preliminary report, mimicry impairment and surgical rehabilitation were analyzed cross-sectionally in two small groups of patients performing free smiles before and after facial surgery.[3,7] These cross-sectional data indicated that surgery reduced lip asymmetry during smile, but no definitive information about the total amount of labial movements was obtained.

In the present study, the same protocol was used with a longitudinal perspective; we quantitatively assessed facial movements in a group of patients before and after masseteric to facial nerve reanimation; the displacement of selected facial landmarks was measured in three dimensions during standardized animations (free smile, smile with teeth clenching, and spontaneous smile).

Materials and methods

Patients

Fourteen patients (five men, nine women; age range 21—69 years, mean 47 years, standard deviation (SD) 16) were analyzed. All patients were affected by unilateral facial paralysis not lasting longer than 23 months (between 1 and 23 months, mean 13 months, SD 5). Patients came from a consecutive series. All of them had signs of mimetic muscle fibrillations at preoperative electromyography and were candidates for surgical masseteric to facial nerve neurorrhaphy. Preoperatively, all patients had normal electromyographic masseteric nerve findings.

The patients were analyzed twice, at first just before surgery, and then after surgery and rehabilitation (between 11 and 25 months, mean 18 months, SD 4). In all but two patients who did not recover facial movements, examinations were performed at least 3 months after they had clinically started to regain facial mimicry (on average, 6 months, SD 3; maximum interval 12 months).

Data were also evaluated according to a modified House—Brackmann clinical classification specifically devised for patients with a facial paralysis or who had recovered from it.[16] By this way, a 6-grade subjective scale (Table 1) was coupled to data objectively acquired by optoelectronic instruments.

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