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Qualitative and Quantitative Analysis of Smile Excursion in Facial Reanimation: A Systematic Review and Meta-analysis of 1- versus 2-stage Procedures

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Background: Free functional muscle transfer has become a common treatment modality for smile restoration in long-lasting facial paralysis, but the selection of surgical strategy between a 1-stage and a 2-stage procedure has remained a matter of debate. The aim of this study was to compare the quantitative and qualitative outcomes of smile excursion between 1-stage and 2-stage free muscle transfers in the literature.

Methods: A comprehensive review of the published literature between 1975 and end of January 2017 was conducted.

Results: The abstracts or titles of 2,743 articles were screened. A total of 24 articles met our inclusion criteria of performing a quantitative or qualitative evaluation of a free-functioning muscle transfer for smile restoration. For the purpose of meta-analysis, 7 articles providing quantitative data on a total of 254 patients were included. When comparing muscle excursion between 1-stage and 2-stage procedures, the average range of smile excursion was 11.5 mm versus 6.6 mm, respectively. For the purpose of systematic review, 17 articles were included. The result of the systematic review suggested a tendency toward superior functional results for the 1-stage procedure when comparing the quality of smile.

Conclusions: The results of this review must be interpreted with great caution. Quantitative analysis suggests that 1-stage procedures produce better excursion than 2-stage procedures. Qualitative analysis suggests that 1-stage procedures might also produce superior results when based on excursion and symmetry alone, but these comparisons do not include one important variable dictating the quality of a smile—the spontaneity of the smile. The difficulty in comparing published results calls for a consensus classification system for facial palsy. *(Plast Reconstr Surg Glob Open 2017;5:e1621; doi: 10.1097/GOX.0000000000001621; Published online 28 December 2017.)*

INTRODUCTION

Facial paralysis is associated with the inability to produce normal facial expressions, and this can have significant social implications for patients. Smile restoration is thus one of the priorities in reconstruction of the paralyzed face.[1] Since the pioneering work of Harii et al.[2] in 1976 using free functioning muscle transplant (FFMT) in facial paralysis, this procedure has become one of the most common techniques for smile restoration in patients with long-standing facial paralysis.

In facial reanimation using FFMT, the selection of both the donor muscle and donor motor nerve is of critical importance. Several muscles have been used as donor tissue, including the pectoralis minor, latissimus dorsi, serratus anterior, ext. digitorium brevis, rectus abdominis, and the gracilis.[3] The selection of the donor nerve for neurotization of the FFMT is critical, and this is what defines the surgical strategy as a 1-stage or 2-stage facial reanimation. Traditionally, the 2-stage method combines a first-stage cross-facial nerve grafting from the contralateral facial nerve followed by a second-stage free muscle transfer. The main advan-

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tage of this approach has been the prospect of obtaining a synchronized, coordinated, and spontaneous emotional expression.[4–6] However, this procedure necessitates 2 operations; it has a long regeneration time,[7] and the use of a nerve graft is associated with possible sequelae such as hypoesthesia or paresthesia depending on the donor nerve.[8] To overcome the drawbacks of the 2-stage method, a 1-stage FFMT has been described and has become increasingly popular. In the 1-stage procedure, the motor nerve of an FFMT is coapted directly to an ipsilateral nonfacial cranial nerve (eg, the masseter nerve, spinal accessory nerve, or hypoglossal nerve) or the contralateral facial nerve by including a long nerve in the muscle flap. This procedure provides more reliable and faster muscle neurotization. The distance from the site of coaptation to the motor endplates is shorter when using an ipsilateral cranial nerve, and this also avoids the use of a nerve graft. In addition, spontaneity has been reported in a number of patients when using the ipsilateral masseter nerve due to cerebral adaptation, but using this nerve might also cause involuntary motion.[9,10]

It has been previously reported that 1-stage FFMT provides stronger smile excursion than 2-stage procedures, and this is likely related to the increased axonal load and decreased loss of axons due to the reduced number of coaptations in the 1-stage procedure.[11–13] However, there is no current consensus for objectively evaluating postoperative smile outcomes. Different measurement systems have been described with wide variation in the reporting of results, making it difficult to compare outcomes of different surgical techniques.[14]

The aim of this literature review was to compare the outcome of smile excursion both quantitatively and qualitatively between 1-stage and 2-stage procedures involving FFMT.

MATERIALS AND METHODS

Data Sources

Searches of PubMed and the Cochrane Library were conducted for all publications from 1975 until the end of January 2017. The following medical subject heading search terms and keywords were used, either individually or in combination: "smile reanimation," "facial reanimation," "facial animation," "free functioning muscle transfer," "gracilis flap," "masseter nerve transfer," "cross-face nerve graft," and "cross-facial nerve graft."

Study Selection

Articles/abstracts were included if they met the following criteria:

- Population: humans, both children and adults.
- Intervention: 1-stage or 2-stage procedures with free muscle transfer.
- Outcomes: smile excursion in millimeters or other reanimation scoring system that evaluated the smile (eg, teeth exposure, patient satisfaction).

The study selection was performed through 2 levels of screening. In the first screening, abstracts were reviewed for the following exclusion criteria: case reports, meeting abstracts, reviews, editorials, preclinical studies, studies with dual innervations or multiple muscle transfers, languages other than English, and animal or cadaveric studies. In the second screening, all articles were read in their entirety, and the same inclusion and exclusion criteria were applied. Only studies that passed both levels of screening were included in our analysis and were critically assessed.

Data Extraction

The following data were extracted from each primary article and used for statistical and/or descriptive comparisons: author, journal, year of publication, sample size (number of patients and number of FFMTs), partial/total paralysis, retrospective or prospective data collection, age (range, mean), gender, type of surgery (1-stage or 2-stage), muscle used as the FFMT, donor nerve, months until second surgery (for 2-stage procedures), results, and percentage of patients with spontaneous smiles after surgery.

Data Analysis

Quantitative Data—Statistical Analysis

Statistical analysis of the mean, SD, and weighting calculations were performed with Stata SE for Mac OS (Version 12.0, StataCorp, 4905 Lakeway Dr., College Station, Tex.). Basic calculations were performed using Microsoft Excel for Mac 2011 (Version 14.0.0, 100825 Microsoft Redmond Campus, Redmond, Wash.). Meta-analysis comparing 2 independent groups and the creation of forest plots was done using OpenMetaAnalyst for Sierra (Version 10.12, Wallace et al 2014, Center for Evidence Synthesis in Health, Brown University). A P value less than 0.05 was considered statistically significant.

Qualitative Data—Descriptive Analysis

Due to the lack of uniformity in the selection of the grading system for smile evaluation, it was difficult to make comparisons of the results presented in the different studies. In an effort to make the qualitative data more uniform and to be able to analyze the qualitative data, we translated the results from the studies into our own 7-type ordinal categorical scale with relatable nomenclature that we created for the purpose of this study. The grades for smile restoration were as follows: Failed/absent, Unsatisfactory/poor, Satisfactory, Fair/average, Good, and Excellent (Fig. 3). Three studies showed only the number of successful cases of all cases, and therefore a category named Unknown but not good/excellent was created. Only the electromyography (EMG) score and not the qualitative facial smile grading was reported in 1 study, and this study was added due to grading similarities with other included studies.[15] Translation criteria were held as strict as possible, but some variability was unavoidable. Eleven studies were omitted from because the data were not presented in ordinal categories or were only reported as descriptive statistics.

RESULTS

Selection of Articles

Titles or abstracts of 2,743 articles were screened according to Figure 1. After removal of duplicates and cohort overlap and the application of the inclusion and exclusion criteria, 24 articles were deemed relevant and included in the final analysis. All the selected articles had relatively poor validity, and none of the studies were randomized controlled trials. Fourteen of the 24 included studies were retrospective case-control studies. Very few studies reported baseline characteristics in detail, and only Hayashi and Maruyama[16] and Terzis and Olivares[17] described the patients individually.

Seventeen of the 24 included articles presented results for 1-stage procedures, and 14 of the 24 included articles presented results for 2-stage procedures. Seven of the 24 articles presented quantitative results of commissure excursion in millimeters and were included in the meta-analysis (Tables 1 and 2). Five studies presented quantitative results for both 1-stage and 2-stage procedures. The study by Gousheh and Arasteh[18] did

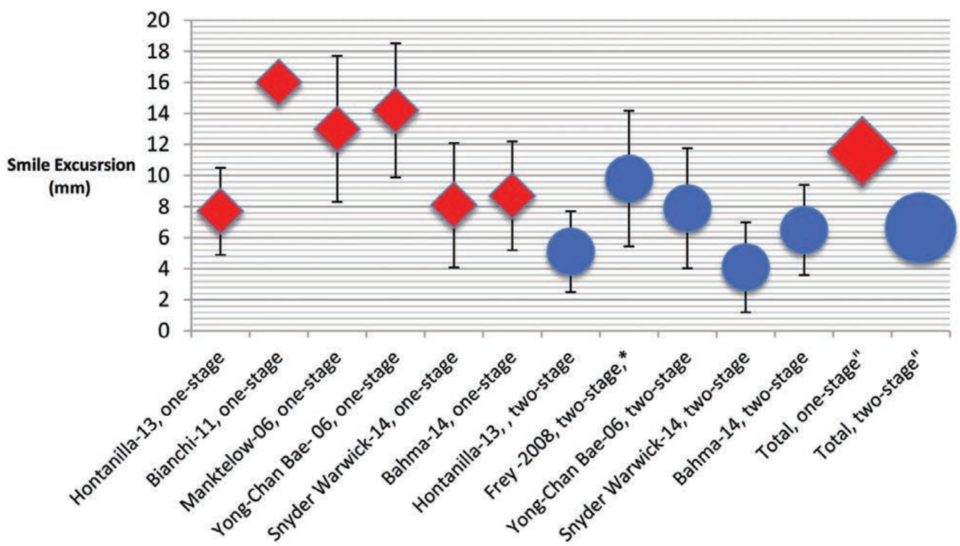

Fig. 1. Diagram showing the mean difference of postoperative oral commissure excursion in 1-stage (in red) and 2-stage (in blue) procedures.

Table 1. Description of Quantitative Studies for 1-stage Procedures

Author	Study Type	Patients (No)	FFMT (No)	Age (Range, Mean) Gender	Muscle	Donor Nerve	Grading System
Snyder-Warwick—14 (11)	Prospective	13	13	Mean: 9.6	Gracilis	Masseter	
Bhama—14 (19)	Retrospective	43	43	Range: 6–80; mean: 35	Gracilis	Masseter	FaCE score
Hontanilla—13 (18)	Prospective	27	27	Range: 27–55; mean: 40.7; 12 M/15 F	Gracilis	Masseter	FACIAL CLIMA system
Bianchi—11 (36)	Retrospective	21	31	Range: 7–60; mean: 21; 11 M/10 F	Gracilis	Masseter	Terzis score
Manktelow—06 (9)	Retrospective	19	31	Range: 16–61; mean: 34.4; 9 M/18 F	Gracilis	Masseter	
Yong-Chan Bae—06 (6)	Retrospective	32	32	Mean: 8.9; 21 M/29 F	Gracilis	Masseter	

Table 2. Description of Quantitative Studies for 2-stage Procedures

Author	Study Type	Patients (No)	FFMT (No)	Age (Range, Mean) Gender	Muscle + Donor Nerve	Second Surgery (mo)	Grading System
Snyder-Warwick—14 (11)	Prospective	12	12	Mean: 10.2	Gracilis + Sural	5–20	
Bhama—14 (19)	Retrospective	35	35	Range: 6–80; mean: 35	Gracilis + Sural	6–9 m	FaCE score
Hontanilla—13 (18)	Prospective	20	20	Range: 32–53; mean: 42.4; 7 M/13 F	Gracilis + Sural	7.9 m	FACIAL CLIMA system
Frey—08 (37)	Prospective	12		Range: 13–60; mean: 40.3	Gracilis + Sural	10 m	3D video analysis
Yong-Chan Bae—06 (6)	Retrospective	20	20	Mean: 10; 29 M/41 F	Gracilis + Sural	12.6 m	

Table 3. Description and Results of Qualitative Studies for 1-stage Procedures

Author	Study Type	Patients (No)	FFMT (No)	Age (Range, Mean) Gender	Muscle	Donor Nerve	Spontaneous Smile	Results
Takushima—13 (38)	Prospective	344	351	Range: 5–75; mean: 41.2; 1 33 M/211 F	LD	Contralateral facial nerve	N/A	Grade 0 = 21, 1 = 18, 2 = 7, 3 = 23, 4 = 101, 5 = 181
Chuang—13 (39)	Retrospective	36	42	Range: 4–63; mean: 22; 19 M/17 F	Gracilis	Accessory nerve	19/42 = 45%; Chuang cortical adaption stage	Smile excursion scoring system 0–4; average 3.45 ± 0.739
Biglioli—12 (40)	Prospective	50	50	Group 1= 40 patients, range: 6–77, mean: 47.4, 28 M/12 F; group 2 = 10 patients, range: 16–63, mean: 42.3, 8 M/2 F	Group 1 = LD; group 2 = Gracilis	Contralateral facial nerve; ipsilateral masseter nerve	100% if recovered muscle function; 10%	*Terzis and Noah system*: Excellent 14, Good 15, Average 5, Poor 3, Failed 3; group 2 = Excellent 3, good 5, average 2.
An-Tang Liu—12 (41)	Prospective	41	41	Range: 17–61; mean: 32.6; 24 M/21 F	Abductor hallucis	Contralateral facial nerve = 38; mylohyoid branch of ipsilateral trigeminal nerve = 3	N/A	Toronto facial grading system. Facial nerve function index. TFGS = 54.8 ± 6.9; FNFI = 79.4 ± 9.6%
Gousheh—11 (17)	Retrospective	14	14	Range: 3–72; mean: 25.7	LD	Contralateral facial nerve	100%	Excellent: > 2 cm = 0; Good: 1.5–2 cm = 12; Satisfactory: 1–1.5 cm = 2; Failed: < 1 cm = 0
Faria—07 (30)	Prospective	33	Group 1 = 11; group 2 = 22	Group 1 = range: 10–70; mean: 41.9; 4 M/7 F; group 2 = range: 9–58; mean 26.5; 9 M/13 F	Group 1= LD; group 2 = gracilis	Contralateral facial nerve; trigeminal nerve	45%; 0%	Absent 1, poor 1, fair 3, good 5, excellent 1; fair 3, good 6, excellent 13
Sajjadian—06 (42)	Prospective	5	5	Range: 11–64	Rectus abdominis	Contralateral facial nerve	N/A	Facial grading system improved from a mean 16 ± 9 to 39 ± 16 (25–55). Average improvement 186%.
Hayashi—05 (15)	?	7	7	Range: 30–80; mean: 57; 2 M/5 F	Biceps femoris	Contralateral facial nerve	N/A	Excellent = 2; Good = 3; Fair = 1; No evaluation = 1
Kumar—02 (25)	Prospective	10	10	Range: 10–60; mean: 39.9; 2 F/8 M	Gracilis	Contralateral facial nerve	N/A	O’ Brien: Good 6, fair 3, poor 1
Wang Wei—99 (24)	Retrospective	86	86	Range: 7–52	LD	Contralateral facial nerve	N/A	Clinical and patient questionnaire. Satisfactory results 80/86 patients
Harii—98 (7)	Retrospective	24	24	Range: 14–70; mean: 41.5	LD	Contralateral facial nerve	N/A	Grade 0–5, 5 = 11, 4 = 10, 3 = 1, 1 = 1, 0 = 1

LD, Latissimus dorsi; N/A, not applicable; TFGS, Toronto facial grading system; FNFI, facial nerve function index.

not present exact numerical results for either 1-stage or 2-stage procedures, and it was therefore excluded from the meta-analysis and was only included in the systematic review.

The characteristics and results of the qualitative studies are shown in Tables 3 and 4 for the 1-stage and 2-stages procedures, respectively. The evaluation and grading method of the results in the qualitative studies are shown in Tables 5 and 6 for the 1-stage and 2-stage procedures, respectively.

Meta-analysis of the Quantitative Data

The mean difference in oral commissure muscle excursion was 11.5 mm for 1-stage procedures and 6.6 mm for 2-stage procedures (Fig. 1).

A forest plot with odds ratios was created comparing the mean smile excursion in millimeters after surgery between 1-stage and 2-stage procedures (Fig. 2). Only 4 studies[6,11,19,20] were included that met the criteria of using both procedures and presenting full descriptive statistics. A P value less than 0.05 was considered statistically significant.

Systematic Review of the Qualitative Data

In our systematic review of the qualitative data, 17 different studies were included with 14 different grading systems. Eleven studies presented results for 1-stage procedures, and 9 studies presented results for 2-stage procedures. Due to the wide difference between the evaluation systems, translation of the results into our own categorical scale was necessary, see Figure 3. The result has to be interpreted with great caution, but Figure 3 does indicate better results for the 1-stage procedures.

DISCUSSION

FFMT for facial reanimation can be performed as a 1-stage or 2-stage procedure depending on age, etiology, facial morphology, weight, patient preference, or surgeon preference. In 1980, O'Brien et al.[21] described a 2-stage operation using a cross-face nerve graft acting as a conduit between the contralateral facial nerve and the transferred neurovascular graft. The main advantage of such a 2-stage approach is the prospect of obtaining synchronized, coordinated, and spontaneous emotional expression.[4–6] However, the 2-stage procedure has drawbacks such as the need for 2 surgeries, a long regeneration time, and potential sequelae depending on the donor tissue. Furthermore, Momeni et al.[22] point out that there can be additional patient morbidities in the 2-stage procedure in which weakening of the involved facial nerve branches affects the normal side of the face; however, in our opinion, this is very rare. A 1-stage procedure using a long nerve pedicle coapted to the contralateral face has also been proposed by several authors using a number of different muscle donors with long nerves such as the abductor hallucis, latissimus dorsi, and gracilis.[7,23,24] The 1-stage procedure with the contralateral facial nerve as the neurotizer allows for quicker recovery period and overcomes the potential sequelae involved with nerve harvesting and nerve bridging. Kumar

Table 4. Description and Results of Qualitative Studies for 2-stage Procedures

Author	Study Type	Patients (No)	FFMT (No)	Age (Range, Mean) Gender	Muscle	Nerve/Origin	Second Surgery (mo)	Spontaneous Smile	Results
Harrison—12 (43)	Retrospective	561	561	Range: 4–64; mean: 25.4; 245 M/316 F	Pectoralis minor = 528; LD = 28; Gracilis = 3; EDB = 2	CFNG/Sural	6–36 m mean 9 m	N/A	Hay's score +++ 354; ++ 159; +31; Nil 17
Terzis—12 (44)	Retrospective	30	30	Range: 20–63; mean: 40.7	Gracilis	CFNG	9–12 m	N/A	Terzis score: excellent 9, good 13, moderate 3, fair 5, poor 0
Gousheh—11 (17)	Retrospective	505	505	Range: 3–72; mean: 25.7	Gracilis	CFNG/Sural	12 m adults; 9 m children	98%	Excellent: > 2 cm = 71; good: 1.5–2 cm = 384; satisfactory: 1–1.5 cm = 40; failed: < 1 cm = 10
Terzis—09 (16)	Retrospective (Overlap with Terzis -12??)	23	26	Range: 17–53; mean: 30.71 ± 10.5; 18 F/6 M	Gracilis = 20; pectoralis minor = 5; rectus abductor = 1	CFNG/Sural = 15; babysitter = 6; interpostional graft = 1	6–24 m	N/A	Terzis score 5-1; 70% were graded good or excellent results
Chuang—08 (3)	Retrospective	249	252	N/A	Gracilis	CFNG/Sural	6–9 m	N/A	50% have satisfactory results
Faria—07 (30)	Prospective	58	58	Range: 5–63; mean: 28.6; 16 M/42 F	Gracilis	CFNG		34%	Absent 4, poor 10, fair 13, good 24, excellent 7
Takushima—04 (20)	Retrospective	24		Range: 5–65; mean: 34.2	Gracilis	CFNG/Sural	12 m	N/A	EMG-score; grade 5 = 10, 4 = 10, 3 = 2, 1 = 2
Kumar—02 (25)	Prospective	15		Range: 7–49; mean: 24; 13 F/2 M	Gracilis	CFNG/Sural	8–17 m mean 12.1 m	N/A	O' Brien: good 11, fair 3, poor 1.
O' Brien—90 (29)	Retrospective	32		Range: 6–65; mean: 33		CFNG/Sural	4–20 m, mean 8.4 m	N/A	O'Brien: excellent 1, good 14, fair 14, poor 3

CFNG, cross-facial nerve graft; EMG, electromyography.

Table 5. One-stage Procedures—Evaluation of Results

Author	Evaluation of Results
Takushima et al. (2013) (38)	5-graded scale based on a combination of clinical and EMG findings
Chuang et al. (2013) (39)	"Chuang´s smile excursion score," "the cortical adaptation stage" and questionnaire to evaluate patient satisfaction
Biglioli et al. (2012) (40)	Results classified of standardized photographs according to the 5-stage system developed by Terzis and Noah
An-Tang Liu et al. (2012) (41)	Toronto facial grading system and the Facial Nerve Function Index
Faria et al. (2007) (30)	5-graded scale, based on intensity and shape, without consideration of motivation (voluntary or emotional smile)
Sajjadian et al. (2006) (42)	The Facial grading system, a 100-point evaluation assessing impairments in resting symmetry, symmetry during voluntary movement and synkinesis of voluntary movement
Hayashi et al. (2005) (15)	Patient evaluation results varying from excellent to fair, unfortunately without specifying what it was based on
Kumar et al. (2002) (25) (29)	Results graded using a modification of the point system suggested by O'Brien et al.
Wang Wei et al. (1999) (24)	Clinical examination and patient questionnaire for facial appearance at rest and during voluntary and involuntary movements and muscle tone. The results were poorly presented, divided into satisfactory or not
Harii et al. (1998) (7)	5-graded evaluation scale based on EMG-results, facial tonus and muscle power contraction

EMG, electromyography.

Table 6. Two-stage Procedures—Evaluation of Results

Author	Evaluation of Results
Takushima et al. (2004) (20)	5-grade evaluation criteria based on EMG-results
Faria et al. (2007) (30)	Graded as above.
Kumar et al. (2002) (25) (29)	Graded as above.
Harrison et al. (2012) (43)	Surgeon's score method and the Hay's score.
Terzis et al. (2009 and 2012) (16) (44)	Evaluated smile symmetry and function using a 5-category scale ranging from poor to excellent, Terzis score
Chuang et al. (2008) (3)	Only presented their results as "more than 50% of patients have satisfactory results with few patients having severe complications"
O'Brien et al. (1990) (29)	Patient evaluation of results and physician examination results, ranging from excellent-good-fair-poor

EMG, electromyography.

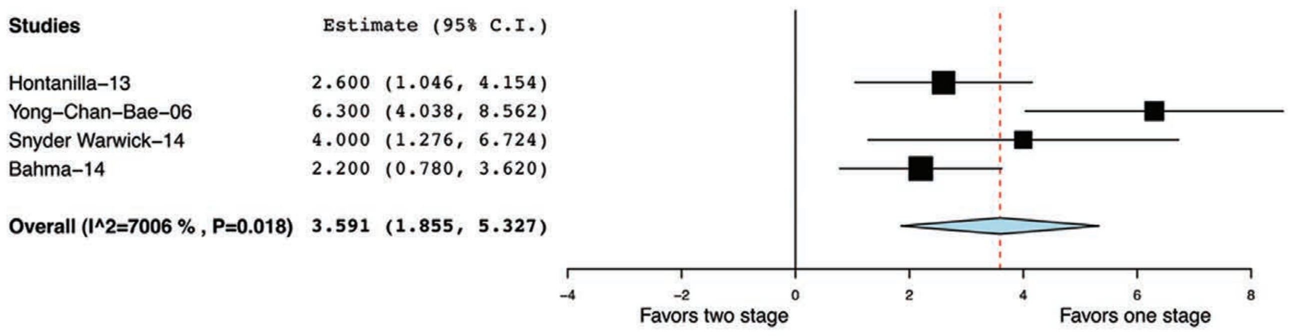

Fig. 2. Forest plot comparing 1-stage and 2-stage procedures.

and Hassan[25] showed in their comparative study of 1-stage and 2-stage procedures that there were similar functional outcomes between the 2 methods, but there were quicker beneficial effects of surgery, and no donor-site complaints with the 1-stage procedure. However, in 1-stage muscle transfer using the contralateral facial nerve, the insetting of the muscle can be compromised in order to allow the nerve to reach to the other hemiface for direct coaptation, therefore compromising the final quality of the smile.

To overcome some of these obstacles, the 1-stage procedure using an ipsilateral cranial nerve as the neurotizer, such as the masseter nerve and less commonly the spinal accessory or hypoglossal nerves, has gained popularity. It has been noted by some authors that 1-stage procedures provide stronger smile excursion if a neurotizer such as the masseter nerve is used due to more robust innervation.[11] The masseter nerve also has a high density of myelinated motor fibers that correspond favorably to the axon counts in the native zygomatic and buccal branches of the facial nerve. Electron microscopy evaluation has demonstrated approximately 2,700 myelinated motor axons in the main trunk of the nerve and 1,500 in the descending branch. This dense population of motor fibers is responsible for the strong commissure excursion seen when using the masseter nerve as a motor donor.[12,13]

The main drawback of using the masseter nerve has been the lack of spontaneity. However, cortical plasticity and cerebral adaptation are phenomena that might change this view. Manktelow et al.[9] demonstrated in a long-term follow-up of 45 functional free muscle flaps in-

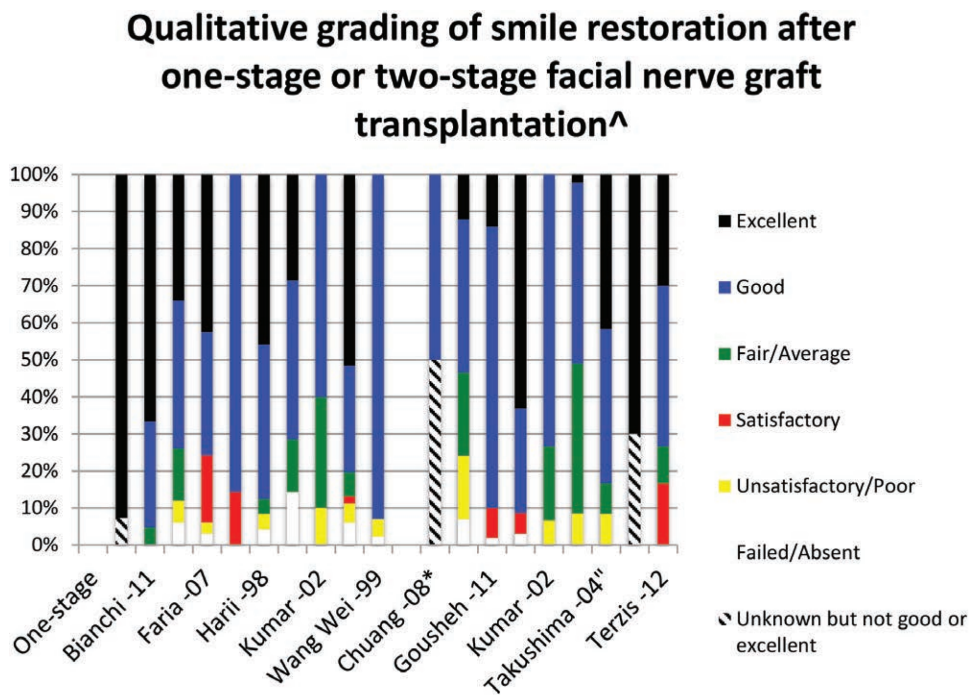

Fig. 3. Diagram showing the results of categorical data in qualitative grading of smile restoration between 1-stage (on the left) and 2-stage (on the right) procedures and the translation to our artificial grading system.

nervated by the motor nerve branch to the masseter that 85% of the patients could smile without biting and that 59% smiled without conscious effort. However, based on personal discussion with the senior authors of that article, the criteria for spontaneity were less stringent than those used today.[9]

Another explanation for the spontaneity seen in masseter-produced smiles is given by Schaverien et al.[26] who show that activation of the motor nerve to the masseter occurs during normal smile production in around half of the normal population. It seems likely that this phenomenon might be a significant contributory factor to the observed high frequency of patients achieving a spontaneous smile following free gracilis to masseter nerve transfer. It was suggested that EMG might help in the preselection of patients that are likely to develop a spontaneous smile following reanimation procedures where the masseter nerve is used as the donor.[26]

The purpose of our study was to evaluate the restoration of the smile both quantitatively and qualitatively in order to provide additional information that could be considered with other factors when deciding on a 1-stage or a 2-stage procedure. The first challenge we encountered when trying to perform such an analysis was the lack of uniformity in the evaluation of the studies, and no universally accepted grading system exists to measure the outcomes of these surgeries. Within the literature, the scoring system can be broken down into either subjective or objective systems. We encountered 14 different grading systems in our review. In a recent article, Niziol et al.[27] reviewed the current scoring methods for facial reanimation surgery and called for a consensus in the grading system of facial palsy restoration. Traditionally, the House-Brackmann scale has been used for evaluation of total facial function; however, that scale lacks qualitative measures, is observer dependent, and cannot be applied to patients after microsurgical reconstruction.[27,28] The lack of current consensus for objectively evaluating postoperative smiling outcomes has resulted in the introduction of a variety of classification systems, thus making comparisons between centers and surgical techniques increasingly difficult.[4,25,29–31] Manktelow et al.[14] advocate the use of a handheld ruler, and the FACE-gram program quantifies average excursion of the oral commissure by examining postoperative photographs.[32] The FACIAL CLIMA quantifies commissure displacement based on information provided from 3-dimensional data,[33] while Chuang´s Smile Excursion Score is based on the number of teeth exposed when smiling.[34] The Terzis Facial Grading System is based on a 5-step scale of judgment, evaluating facial symmetry at rest and the quality of smile.[4] Hay developed a simple scoring system initially used to assess cosmetic rhinoplasty in which scores are assigned by looking at pictures ranging from perfect to a very marked imperfection.[27]

In our meta-analysis, we found that 1-stage reanimation procedures using the ipsilateral nonfacial nerve globally produce a stronger smile excursion based on objective analysis and also suggest a better smile by qualitative analysis, although we would strongly refrain from drawing conclusions from the latter because spontaneity has a significant contribution to smile quality and was not always taken into appropriate consideration. The mean oral commissure muscle excursion was 11.5 mm for 1-stage procedures and 6.6 mm for 2-stage procedures. Only 4 of these articles met the criteria of using both procedures, and presenting full descriptive statistics and were thus included in the forest plot analysis.[6,19,35] The studies of Hontanilla et al.[19] and Snyder-Warwick et al.[11] presented *P* values less than 0.05. The meta-analysis showed an advantage in excursion when using 1-stage procedures, but the difference was not statistically significant.

In our systematic review of the qualitative data, 17 different studies were included, and we encountered 14 different grading systems, which made comparisons of the results very difficult. Eleven studies presented results for 1-stage procedures, and 9 studies presented results for 2-stage procedures. Due to the wide difference between the evaluation systems, translation of the results into our own categorical scale was necessary. The result has to be interpreted with great caution, but the illustration in Figure 3 does indicate better results for the 1-stage procedures. Furthermore, the choice of whether to have a small smile excursion that is spontaneous versus a balanced smile that needs to be initiated is a matter of patient preference, and it is the responsibility of the surgeon to determine this together with the patient.

Several limitations to this analysis should be noted. None of the studies included were randomized controlled trials, and many of the studies mixed results from adults and children. Many different muscle flaps were also used in the included studies, and this contributed to the heterogeneity of the compared cohorts. Additionally, in the qualitative group, patients with incomplete and complete paralysis were mixed, possibly creating a bias for better results in patients with incomplete paralysis. Moreover, the differences in excursion measurement techniques used in the different studies also introduce bias. Our own ordinal categorical scale has not previously been used in facial reanimation studies, and this also contributes to the results of this study being difficult to evaluate and is another limitation of this study.

CONCLUSIONS

The results of this review should be interpreted with great caution. Although our results suggest that 1-stage facial reanimation using FFMT provides better quantitative outcomes in smile reanimation when compared with 2-stage procedures, it is not possible to reliably compare the 2 on a qualitative basis due to the subjectivity of the quality measurements and because spontaneity was not taken into account in most of the studies. The difficulty in comparing the published results calls for a consensus classification system for facial palsy, and further randomized control trials with the 2 procedures are recommended.

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