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CLINICAL ARTICLE

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# Comparison of symmetry after smile reconstruction for flaccid facial paralysis with combined fascia lata grafts and functional gracilis transfer for static suspension or gracilis transfer alone

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**Purpose:** Facial paralysis has a profound impact on functionality and esthetics of the oral region. In patients with strong skin laxity and soft tissue ptosis, functional smile reconstruction is challenging due to the accentuated asymmetry at rest. Thus, the purpose of the study was to analyze facial symmetry in this patient clientele following a combination of dynamic reanimation with fascial strips for static suspension compared to functional gracilis transfer alone.

**Methods:** In 2014, we altered the single-stage approach for microsurgical smile reconstruction in patients with significant soft tissue ptosis by adding fascia lata grafts for static support. We evaluated 6 patients (mean age 57.8 ± 5.2, group A) who underwent the combined procedure, and compared their results to 6 patients with flaccid facial paralysis who were treated before 2014 and received a functional gracilis transfer alone (mean age 52.5 ± 7.5, group B). To test the efficacy of the technique, we retrospectively analyzed the correction of the oral asymmetry as well as nasal and philtral deviation by computer-assisted photograph analysis 6 months postoperatively.

**Results:** The comparative analysis revealed a significant postoperative improvement of the oral asymmetry (A: 90.0 ± 5.0% relative correction at rest vs. B: 62.6 ± 17.2%, $P < .05$), nasal (A: 0.4 ± 0.2 vs. B: 0.7 ± 0.4 mm, $P < .05$), and philtral deviation (A: 0.5 ± 0.6 vs. B: 2.8 ± 1.8 mm, $P < .05$) in group A.

**Conclusions:** The combined procedure for dynamic facial reanimation allows for immediate correction of the oral asymmetry and improves overall outcome in patients with advanced soft tissue ptosis and oral asymmetry at rest.

## 1 | INTRODUCTION

Long-term facial paralysis has a devastating effect on patients. For dynamic reanimation of the oral commissure, microsurgical reconstruction with free functional muscle transfer has become the standard technique. The use of the contralateral facial nerve for innervation of the transferred muscle frequently produces pleasant results and potentially creates a spontaneous emotional smile (Terzis & Olivares, 2009). However, smile reanimation in facial paralysis patients with strong skin laxity possesses some unique challenges. First, drooping of the oral commissure of the affected side at rest is a common problem in patients with flaccid facial paralysis. The accentuated oral asymmetry at rest is difficult to correct with a free functional muscle transfer alone because the advanced physiological soft tissue ptosis often leads to lengthening of the muscle and lateral displacement of the ideal muscle insertion. Thus, the transferred muscle itself is not stable enough to correct the strong asymmetry permanently. Second, CFNG does not reliably result in an adequate axon count to trigger a sufficient muscle contraction for symmetric oral commissure excursion (Bae, Zuker, Manktelow, & Wade, 2006; Eisenhardt, Thiele, Stark, & Bannasch, 2013; Snyder-Warwick et al., 2015). This issue becomes more relevant in older patients because axon counts of facial nerve branches used as donor nerves for CFNG are decreasing with age (Hembd et al., 2017). Taken together, correction of the oral asymmetry in facial paralysis

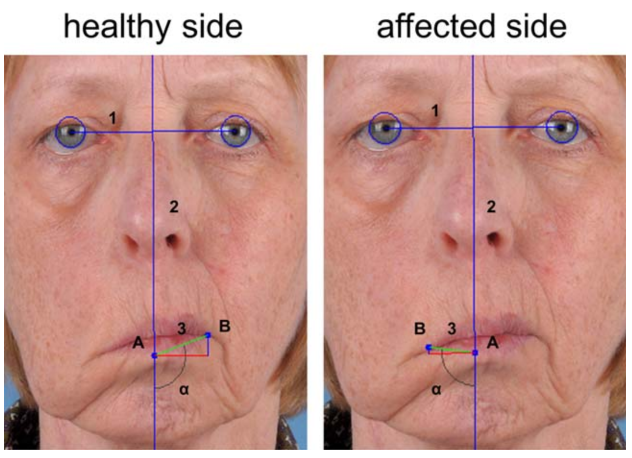



FIGURE 1 Analysis of the oral symmetry on preoperative photographs using the FACE-Gram software. **1.** Horizontal interpupillary line 1 (blue). **2.** Vertical line 2 (blue) bisecting and perpendicular to line 1. **A.** Intersection point of line 2 and the vermilliocutaneous border of the lower lip. **B.** Oral commissure. **3.** Line 3 (green) with distance spanning points A and B. **α.** Angle between line 2 and line 3

patients with significant soft tissue ptosis by using a free functional muscle transfer alone or two-staged procedure with CFNG frequently remain unsatisfactory.

Here, we addressed these challenging problems by combining dynamic smile reconstruction with fascia lata grafts for static suspension in patients with a flaccidly paralyzed face. The purpose of the study was to evaluate the improvement in facial asymmetry as well as nasal and philtral deviation when using the combined single-stage procedure compared to functional gracilis transfer alone.

## 2 | PATIENTS AND METHODS

In 2014, we changed the standard single-staged approach for microsurgical smile reconstruction in facial paralysis patients with significant soft tissue ptosis to improve the functional outcome and postoperative facial symmetry. To correct the strong drooping of the oral commissure as well as the nasal and philtral deviation, we optimized the technique for dynamic smile reconstruction using a functional gracilis transfer with masseteric innervation by implementing fascial strips for static support. We analyzed the outcome and efficacy of this procedure in patients with long-standing facial paralysis ($>$ 1 year) and significant oral and nasal asymmetry at rest due to strong skin laxity. In a retrospective chart review, we evaluated 6 patients (mean age $57.8 \pm 5.2$) who received the combined single-stage procedure (group A) for postoperative facial symmetry. To match group A, we further identified 6 patients (mean age $52.5 \pm 7.5$) who were treated before 2014 and underwent dynamic facial reanimation without additional fascia lata grafts for static suspension (group B). Patients were assigned to each treatment group based merely on the time point they presented in our clinic. We did not use the combined procedure with facia lata grafts for static suspension before 2014. Thus, all patients with flaccid facial palsy who opted for smile reconstruction before 2014 (group B) received a functional gracilis transfer alone. Exclusion criteria were bilateral facial paralysis, incomplete photo documentation and two-stage procedures using CFNG for dynamic facial reanimation. Demographic data


FIGURE 2 **(A)** The postoperative improvement of the nasal deviation was measured by the difference in vertical displacement of the nostrils in millimeter (green lines). A perfectly symmetric nasal base yields a symmetry score of zero mm. Patients who received dynamic facial reanimation with static fascia lata strips (group A) showed a significant correction of their nasal deviation compared to patients without an additional static support (group B). Bars indicate standard deviation (SD), significant differences between groups are marked with asterisks. **(B)** The philtral deviation was defined by the difference in horizontal displacement of the philtrum in millimeter. A perfectly symmetric philtrum yields a symmetry score of zero mm. By combining dynamic and static facial reanimation, philtral displacement was significantly improved (group A). Bars indicate standard deviation (SD), significant differences between groups are marked with asterisks

**TABLE 1** Patient demographics and operative characteristics

| | Group A | | Group B | | *P* value |
|---|---|---|---|---|---|
| Gender (f/m) | 5 | 1 | 5 | 1 | - |
| Age (time of gracilis transfer) [y] | 57.8 | | 52.5 | | .18 |
| Time since facial paralysis [y] | 3.2 [1.2–6.8] | | 7.3 [1.5–15.3] | | .15 |
| Charlson comorbidity index | 4.5 ± 1.5 | | 3.0 ± 0.6 | | <.05* |
| Operation time [min] | 428.5 ± 68.5 | | 428.3 ± 38.6 | | .99 |
| Surgeries per patient | 1.7 ± 0.5 | | 3.2 ± 1.7 | | .07 |
| Perioperative complications | 0 | | 0 | | - |
| Median follow-up [m] | 18.8 [12 - 25] | | 63.5 [32 - 106] | | <.05* |

*f* female, *m* male, *y* year(s), *m* month(s), *min* minute(s).

including age, gender, the cause of facial paralysis, and comorbidities were collected. The mean age of the study population was 55.2 years (range 44 to 67 years). All patients presented with a history of facial paralysis for at least 14 months and were followed up for at least 12 months postoperatively. In all cases, surgical resection of head and neck related neoplasms was the cause of facial paralysis. Furthermore, charts were reviewed for operation time, the incidence of complications, re-operations, the length of hospital stay, and wound complications.

Institutional review board approval was obtained from the local ethical committee prior to data acquisition (ethical approval #343/16). The clinical study was conducted in accordance with the Declaration of Helsinki (revised 59th General Assembly, Seoul, South Korea, 2008). Informed consent was obtained from every patient.

Standardized photographs were taken preoperatively and postoperatively to assess facial symmetry using the FACE–Gram software, both at rest and upon smiling. The software allows for an objective analysis of facial symmetry (Figure 1) (Hadlock & Urban, 2012). Here, the improvement of oral commissure positioning was assessed by calculating the corresponding ratio of the length of line 3 between both the healthy and affected side, and the corresponding angle $\alpha$. A perfectly symmetric smile yielded a symmetry ratio of one which was set to 100%. The nasal and philtral deviation was defined by measuring the difference in vertical displacement of the nostrils in millimeter (green lines, Figure 2A) and the difference in horizontal displacement of the philtrum in millimeter (green lines, Figure 2B), respectively. For both measurements, a perfectly symmetric result yielded a symmetry score of 0 mm. Additionally, standardized lateral photographs were taken for oral excursion analysis to assess the movement of the oral commissure upon smiling as described previously (Eisenhardt et al., 2013). Photos were taken at rest and when smiling with the patient positioned at a right angle to the camera. The projection of the tragion to commissure distance (T-C-distance) was measured and correlated to the resting value of healthy side at rest which was set to 100%. Relative shortening of the T-C-distance was assessed by subtracting the smiling T-C-distances from the resting values.

Postoperatively, all patients were seen in the outpatient setting after 3 and 6 months to document the clinical outcome of the surgical intervention. The postoperative assessment included the verification of a voluntary contraction of the transferred muscle and photo documentation. All outcome measurements were analyzed using the FACE–Gram software as described above (Bhama et al., 2014; Hadlock & Urban, 2012) except for the analysis of the oral excursion on standardized lateral photographs.

### 2.1 | Surgical procedure

The surgical technique for single-stage smile reconstruction with a free functional gracilis transfer innervated by the masseteric motor nerve has been described in detail elsewhere (Thiele, Bannasch, Stark, & Eisenhardt, 2015). In brief, we first prepared the pocket for the gracilis muscle segment and dissected the facial artery and vein. Then, the masseteric nerve was identified in its usual position and cut distally to allow for microsurgical nerve coaptation after inserting the muscle. In the next step, we performed an additional nasolabial incision mirroring the nasolabial fold on the healthy side to add precision to the perioral insertion of the fascial strips and gracilis muscle. For the combined approach, we then harvested 3 fascia lata strips of 1 cm in width and about 12–13 cm in length depending on the tragion to commissure distance. One fascia lata strip was fixed at the midline of the lower lip, one at the oral commissure and one at the upper lip 1 cm from the prospective nasolabial fold toward the philtral column. We fixed the strips on the layer of the atrophied facial musculature and evaluated the resulting smile by pulling on them. Care was taken to avoid any inversion or eversion of the lips and achieve a symmetric nasolabial fold. The fascia lata strips were then tunneled to the temporal region and fixed under slight overcorrection to the deep temporal fascia. After positioning of the fascial strips, the gracilis muscle segment was transferred to the face and fixed in the layer of the atrophied facial musculature over the fascial strips. In the combined procedure, the strong drooping of the oral commissure was compensated by the fascia lata grafts. Thus, any tension on the muscle, which could lead to overcorrection and muscle tightness postoperatively, was prevented. Finally, the microsurgical nerve coaptation and vessel anastomoses were performed.

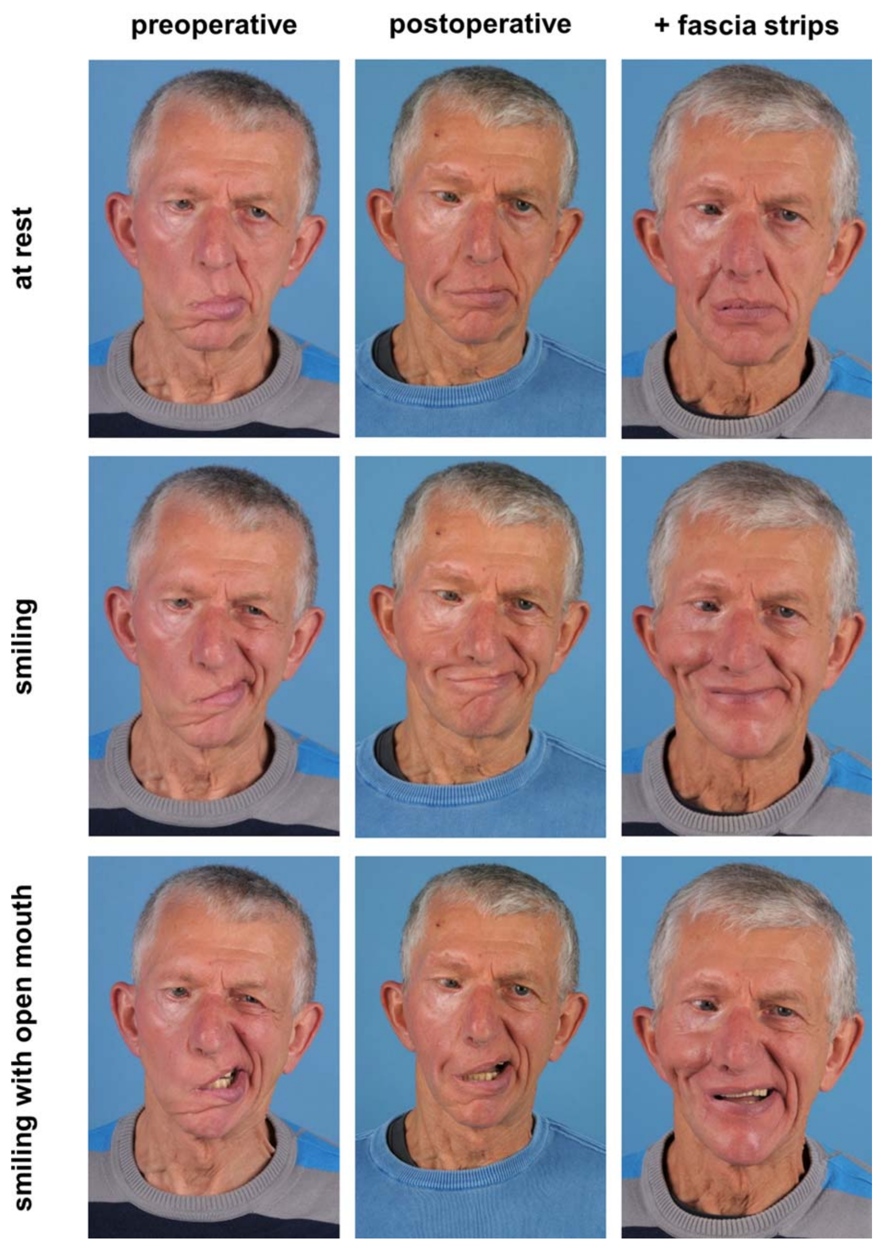



**FIGURE 3** 56-year-old woman with a complete facial paralysis of her right face after multiple resections of an endocrine adenoma of the middle ear. The patient underwent dynamic facial reanimation with a free functional gracilis muscle transfer coaptated to the masseteric nerve of the affected side and additional fascia lata strips for static support in a single-stage procedure. Photographs were taken preoperatively and six months postoperatively. The symmetry of smile was significantly improved after the single-stage reconstruction both at rest and upon smiling

### 2.2 | Statistical analysis

Statistical analysis was performed using the unpaired *t* test for normally distributed data and paired *t* test for normally distributed matched data. Data are presented as a percentage, mean values ± standard deviation, medians, and ranges. A *P* values of $<.05$ was regarded as statistically significant.

## 3 | RESULTS

All patients showed an uneventful postoperative course with the mean score for comorbid conditions being notably higher among patients of group A (4.5 ± 1.5 vs.3.0 ± 0.6 in group B, $P < .05$). The length of inpatient stay (6.9 ± 1.1 days in group A vs.7.1 ± 0.9 days in group B, $P = .99$) and the duration of the operation (428.5 ± 68.5 minutes in group A vs.428.3 ± 38.6 minutes in group B, $P = .99$, Table 1) were comparable in both groups. Thus, the harvesting of fascia lata strips did not prolong the duration of the surgical procedure significantly. In all patients, contraction of the transferred muscle when clenching the teeth was notable three to four months after surgery. After six months, all patients were able to smile voluntarily with an open mouth (Figure 3, Video 1). A spontaneous smile could be achieved by three patients in group A and two patients in group B. Overall, patients of group B tended to need more secondary procedures to achieve a pleasant smile

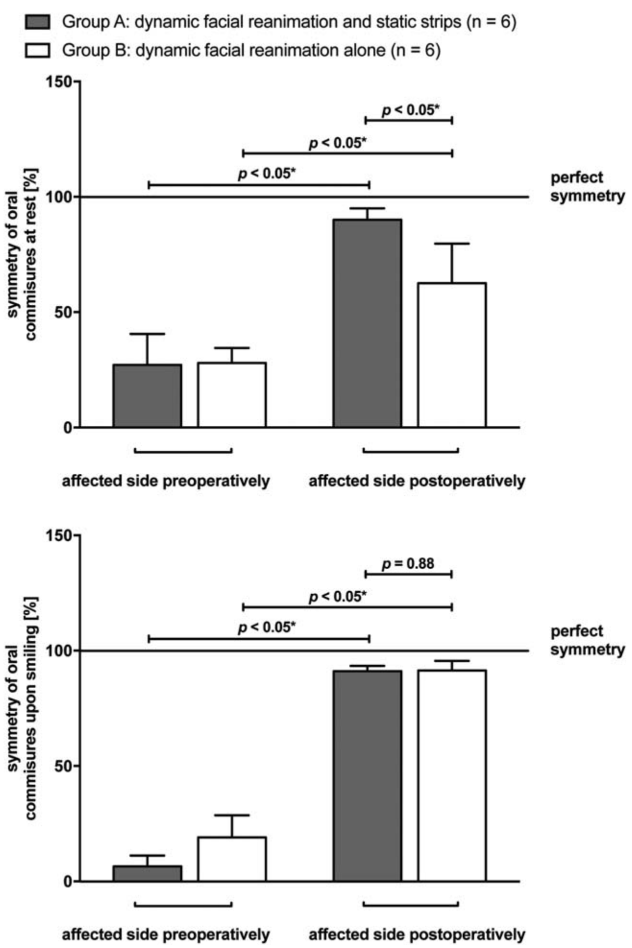



**FIGURE 4** 64-year-old man with a complete facial paralysis of his right face after resection of an acoustic neuroma. The patient underwent dynamic facial reanimation with a free functional gracilis muscle transfer alone. Postoperatively, a significant drooping of the affected side remained at rest and upon smiling with open mouth. The insertion of the gracilis muscle at the upper lip was too lateral due to secondary displacement. Therefore, the static symmetry was corrected with three fascia lata strips in a second procedure which could have been avoided when using static support in the first procedure. After this corrective procedure, the alignment of oral commissures both at rest and upon smiling are improved. However, the esthetic limitations of secondary touch-up procedures are evident when compared to the case presented in Figure 3

compared to group A (1.7 ± 0.5 procedures in total per patient in group A versus 3.2 ± 1.7 procedures in group B, $P = .07$, Table 1). The main reason for secondary touch-up procedures in group B was that the drooping of the oral commissure of the affected side at rest was not corrected adequately with dynamic facial reanimation alone (Figure 4, Video 2). Touch-up interventions included the secondary addition of fascial strips for static suspension, thinning and refixation of the transferred muscle, or weakening of contralateral fascial muscles contributing to facial asymmetry, such as the depressor labii inferioris muscle. For the comparative analysis, however, only photo documentation taken 6 months postoperatively was used, thus representing the results before any secondary touch-up procedures were performed.

In group A, the static symmetry of the smile at rest was significantly improved from 27.1 ± 13.5% preoperatively to 90.0 ± 5.0% postoperatively with 100% being set as a perfectly symmetric smile ($P < .05$, Figure 5, Table 2). The increase was less when dynamic reconstruction was performed alone as seen in group B (from 28.0 ± 6.5% to 62.6 ± 17.2%, $P < .05$). In comparison, patients of group A showed a significantly better alignment of oral commissures at rest ($P < .05$). Upon smiling, all patients developed an excellent oral symmetry ($P < .05$) without a significant difference between the treatment groups ($P = .88$, Figure 5).

Additionally, the vertical displacement of the nostrils decreased from 1.5 ± 1.1 mm preoperatively to 0.7 ± 0.4 mm postoperatively in group B and from 2.1 ± 1.1 mm to 0.4 ± 0.2 mm when fascial strips were used (group A). Thus, the symmetry of the nasal base could be significantly improved in treatment group A following surgery ($P < .05$, Figure 2A, Table 2). Patients who received dynamic facial reanimation alone did not show a significant correction of their preoperative nasal deviation ($P = .13$) and, therefore, tended to show a worse symmetric result compared with group A ($P = .08$). The difference in the horizontal displacement of the philtrum was also significantly improved in group A ($P < .05$, Figure 2B). Philtral deviation was corrected from 3.4 ± 2.1 mm preoperatively to 2.8 ± 1.8 mm postoperatively in group B, while it decreased from 5.6 ± 3.1 mm to 0.5 ± 0.6 mm in group A resulting in a significantly better symmetry of the philtrum for the latter group ($P < .05$, Figure 2B, Table 2).

Both surgical approaches proved to generate a symmetric oral excursion on the reanimated side compared to the healthy side indicating a sufficient contraction of the transferred muscle. Relative shortening of the T-C-distance in comparison to the respective healthy side was 85.3 ± 4.3% versus 87.9 ± 1.8% (healthy side) in group A ($P = .30$) and 86.1 ± 6.0% versus 88.9 ± 2.9% (healthy side) in group B ($P = .35$, Figure 6). However, all patients who did not receive additional static strips for smile reconstruction showed a significant drooping of the oral commissure on the affected side at rest at 6 months postoperatively (107.5 ± 1.7% versus 100%, $P < .05$). In contrast, the implementation of static strips to dynamic reanimation maintained the correction of the preoperative asymmetry at rest demonstrated by no notable difference in T-C-distance between both sides in group A (100.3 ± 1.7% versus 100%, $P = .70$, Figure 6). Thus, the assessment of the oral excursion on standardized lateral photographs underlined the FACE–Gram analysis of oral symmetry.

## 4 | DISCUSSION

We present a suitable single-stage procedure for optimization of the functional and esthetic outcome of smile reconstruction in flaccid facial paralysis patients. To our best knowledge, this is the first detailed description and analysis of the combination of static and dynamic techniques for functional facial reanimation found in the literature. The physiological soft tissue ptosis is disfiguring in the flaccidly paralyzed face and emphasizes the asymmetry at rest. In contrast, children, and younger adults without visible facial ptosis usually do not show any or

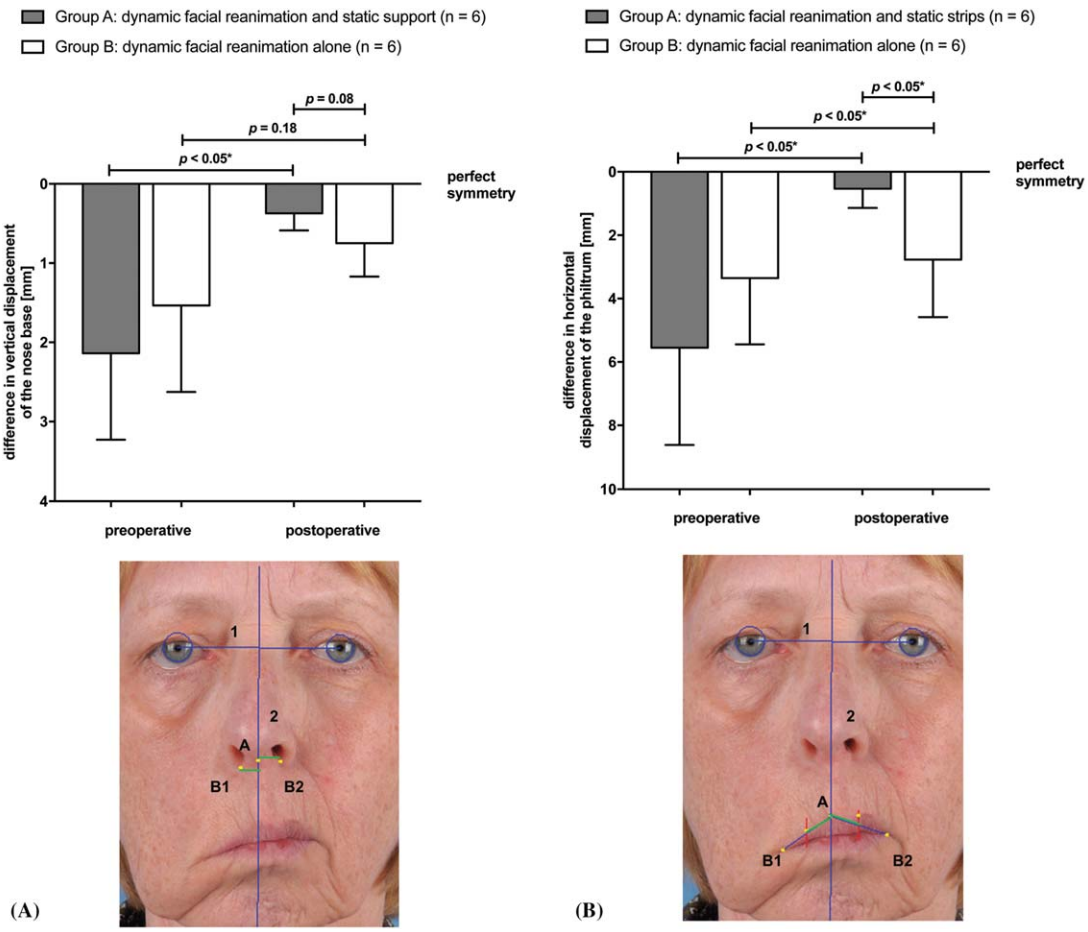



**FIGURE 5** The symmetry of the smile was measured by calculating the corresponding ratio of the length of line 3 between both the healthy and affected side, and the corresponding angle α between both sides. Perfect symmetry yields a symmetry ratio of one which was set as 100%. Postoperatively, static symmetry at rest was significantly improved in both groups ($P < .05$). Patients who received dynamic facial reanimation with additional fascia lata strips (group A) showed a significantly better alignment of oral commissures at rest than patients of group B ($P < .05$). Upon smiling, the symmetry of oral commissures was significantly improved in both treatment groups when compared with the preoperative photographs ($P < .05$). Bars indicate standard deviation (SD), significant differences between groups are marked with asterisks

only little oral asymmetry at rest. Thus, facial reanimation surgery in flaccid facial paralysis patients is challenging and the results in some aspects less predictable and often less satisfying than in the pediatric population (Snyder-Warwick et al., 2015).

The preoperative asymmetry at rest is hard to correct with the gracilis flap alone. However, putting excessive tension on the gracilis flap for compensation of the asymmetry at rest can lead to a lateral displacement of the insertion at the modiolus and upper lip. As a result, flaccid facial paralysis patients who received dynamic facial reanimation alone often retained a significant drooping of the oral commissure at rest. The use of static support resulted in immediate correction of the oral asymmetry and improvement of functional deficits such as loss of oral fluids or speech impairments. In our hands, patients treated with the combined technique demonstrated a significantly better alignment of the oral commissure at rest compared to patients who did not receive fascia lata grafts for static suspension. The additional nasolabial incision notably simplifies the procedure and provides precision by adding an esthetically negligible scar in patients with advanced soft tissue ptosis. Upon smiling, however, all patients in our study population developed a pleasingly symmetric smile. Thus, the combination of a free gracilis transfer and fascial strips helps to correct a strong asymmetry particularly at rest and generates a symmetric oral commissure excursion upon smiling at the same time.

The correction of the nasal deviation is challenging with dynamic smile reanimation. The nasal asymmetry is mainly due to the paralysis of the levator labii alequae nasi muscle which is not appropriately addressed when using a functional muscle transfer alone. Furthermore, a persistent displacement of the nose base can lead to impairment of nasal airway. By using fascial strips to the upper lip, nasal deviation could be significantly corrected as revealed by our detailed analysis. Patients also reported a subjective improvement in nasal breathing. As expected, patients who did not receive additional static strips tended to show a more unpleasant symmetric result of the nasal base and less improvement of the nasal airway. Additionally, the philtral deviation could be significantly corrected with the combination of dynamic and static techniques. As a result, the combined procedure was superior to

**TABLE 2** Outcome assessment

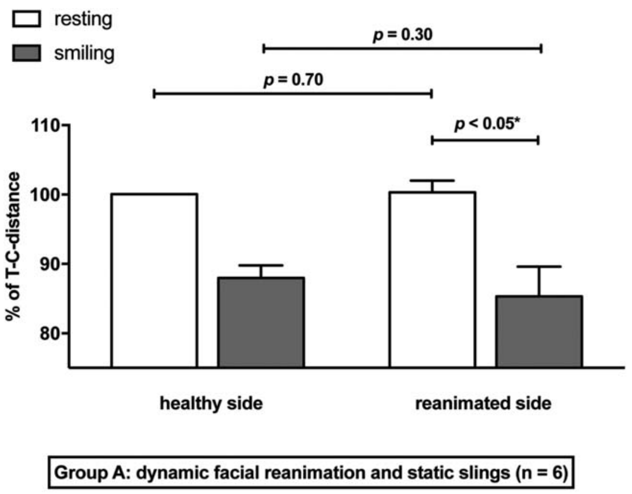
| | Group A | Group B | *P* value |
|---|---|---|---|
| Symmetry of oral commissure at rest (affected side) | | | |
| • Preoperatively | 27.1 ± 13.5% | 28.0 ± 6.5% | |
| • Postoperatively | 90.0 ± 5.0% | 62.6 ± 17.2% | < .05* |
| Symmetry of oral commissure upon smiling (affected side) | | | |
| • Preoperatively | 6.5 ± 4.7% | 19.1 ± 9.6% | |
| • Postoperatively | 91.2 ± 2.2% | 91.5 ± 4.2% | .88 |
| Nasal deviation [mm] | *P* < .05* | *P* = .13 | |
| • Preoperatively | 2.1 ± 1.1 | 1.5 ± 1.1 | |
| • Postoperatively | 0.4 ± 0.2 | 0.7 ± 0.4 | .08 |
| Philtral deviation [mm] | *P* < .05* | *P* = .62 | |
| • Preoperatively | 5.6 ± 3.1 | 3.4 ± 2.1 | |
| • Postoperatively | 0.5 ± 0.6 | 2.8 ± 1.8 | < .05* |
| Relative shortening of T-C-distance postoperatively | | | |
| • At rest | *P* = .70 | *P* < .05* | |
| ○ Healthy side | 100% | 100% | |
| ○ Affected side | 100.3 ± 1.7% | 107.5 ± 1.7% | < .05* |
| • Upon smiling | *P* = .30 | *P* = .35 | .80 |
| ○ Healthy side | 87.9 ± 1.8% | 88.9 ± 2.9% | |
| ○ Affected side | 85.3 ± 4.3% | 86.1 ± 6.0% | |

dynamic smile reanimation alone regarding facial symmetry, and is, therefore, our first choice for smile reconstruction in facial paralysis patients with significant soft tissue ptosis.

However, several limitations of our study need to be discussed. The overall small number of patients included in the retrospective analysis is a drawback which is a result of changing the general treatment approach for flaccid facial paralysis patients. From an ethical point of view, the conclusively superior esthetic and functional results achievable with the combined procedure prohibited the use of a free functional muscle transfer without static strips in this patient clientele. Thus, no facial paralysis patient with significant soft tissue ptosis received a dynamic smile reconstruction alone since introducing the combined technique into our clinical practice. Another limitation of the study is the software used for photographic analysis because it only allowed for a 2–dimensional measurement of different facial landmarks (Bhama et al., 2014; Hadlock & Urban, 2012). Because it failed to address Z-plane, the obtained value for the oral excursion in the frontal plane did not represent the total excursion. Thus, photo documentation had to be strictly standardized to avoid mistakes in the analysis. However, the assessment of oral excursion on standardized lateral photographs substantiated the FACE-Gram results. In the future, inaccuracy in the photographic analysis could potentially be avoided by obtaining 3 D-picture documentation and measurements (Frey et al., 2011; Sawyer, See, & Nduka, 2010) which was not available for this retrospective analysis.

One reason for inferior functional and esthetic outcome in flaccid facial paralysis patients is the fact that conventional donor nerves for CFNG such as the contralateral zygomatic branch of the facial nerve carry a lower axonal load with increasing age (Hembd et al., 2017). In comparison, the axonal load of the masseteric motor nerve is higher than the resulting axonal load of the CFNG (Snyder-Warwick et al., 2015). This higher axonal load, in turn, leads to a stronger muscle contraction (Bae et al., 2006; Eisenhardt et al., 2013; Snyder-Warwick et al., 2015) which is relevant in patients with a considerable oral commissure excursion of the healthy side preoperatively. While the use of fascial strips can also optimize oral symmetry at rest when performing a CFNG-innervated functional muscle transfer, the extent of oral commissure excursion upon smiling remains unpredictable in older patients. Because an exact cut-off point at which the expected axonal load of the CFNG is too weak to generate a symmetric smile is unknown, we recommend the masseteric-innervated combined procedure for older facial paralysis patients with significant soft tissue ptosis. In addition, smile reanimation using the masseteric nerve is a single-stage procedure with the first muscle contraction occurring earlier compared to two-staged procedures. Thus, the masseteric motor nerve has been used more frequently for facial reinnervation and dynamic smile reconstruction in the past years (Klebuc, 2011, 2015).

Three pitfalls must be taken into consideration when using the masseter-innervated combined procedure for smile reconstruction. First, the masseteric innervation will not produce a spontaneous smile in every case. In a retrospective study, Manktelow et al. have noted a spontaneous smile in 59% of their patients when using the masseteric nerve (Manktelow, Tomat, Zuker, & Chang, 2006). In our experience, developing a spontaneous smile is of high importance to a patient's long-term satisfaction. Therefore, we address this possible drawback in the patient counseling to determine the patient's preferences. If the ability to smile spontaneously is preferred, the combination of a CFNG-innervated functional gracilis transfer or double innervation of the transferred muscle are potential options to achieve an emotional smile in this patient clientele (Biglioli et al., 2012). Second, the transferred muscle innervated by the masseteric motor nerve does not show an entirely independent movement for all patients. Thus, involuntary movement of the cheek while biting might persist. Third, due to the resulting stronger muscle contraction, some patients require secondary



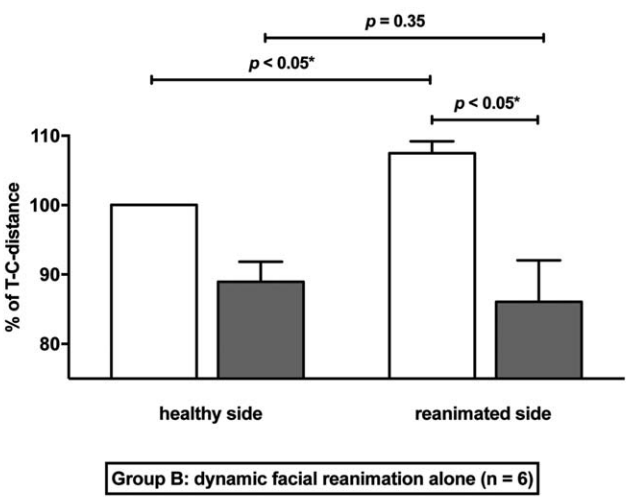




**FIGURE 6** Analysis of the projected tragion-commissure distance postoperatively (T-C-distance) by comparing lateral views of the patients. Values are given as a percentage with T-C-distance of the healthy side at rest set to 100%. After dynamic facial reanimation, the mean distance is significantly reduced on the reanimated side upon smiling in both groups ($P < .05$). At rest, patients of group B showed a significant difference in T-C-distance between the healthy and affected side ($P < .05$). In comparison, no notable difference was seen in patients of group A ($P = .70$). Empty columns represent resting and shaded columns smiling values. Bars indicate standard deviation (SD), significant differences between groups are marked with asterisks

touch-up procedures to optimize outcomes, such as flap thinning or repositioning (Braig, Bannasch, Stark, & Eisenhardt, 2017). With the use of fascial strips and growing experience of the surgeon performing facial reanimation, those secondary procedures tend to be less frequent.

The analysis of genuine spontaneity of the smile when using donor nerves other than the contralateral facial nerve remains to be investigated. Patients with long-standing paralysis are usually very pleased with the initial reconstructive results once muscle contraction starts. However, the long-term satisfaction in our personal experience is limited when a spontaneous smile, and sometimes even a smile with open mouth, cannot be achieved. Therefore, more work has to be done to optimize the surgical technique individually chosen for every patient and to reduce possible limitations.

## 5 | CONCLUSION

The addition of fascia lata strips to microsurgical smile reanimation proved to immediately correct oral asymmetry at rest and improve functional deficits such as loss of oral fluids or speech impairments. The combined single-stage reconstruction for facial paralysis is preferable in patients with significant soft tissue ptosis.

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### REFERENCES

Bae, Y. -C., Zuker, R. M., Manktelow, R. T., & Wade, S. (2006). A comparison of commissure excursion following gracilis muscle transplantation for facial paralysis using a cross-face nerve graft versus the motor nerve to the masseter nerve. *Plastic and Reconstructive Surgery*, *117*, 2407–2413.

Bhama, P. K., Weinberg, J. S., Lindsay, R. W., Hohman, M. H., Cheney, M. L., & Hadlock, T. A. (2014). Objective outcomes analysis following microvascular gracilis transfer for facial reanimation: A review of 10 years' experience. *JAMA Facial Plastic Surgery*, *16*, 85–92.

Biglioli, F., Colombo, V., Tarabbia, F., Pedrazzoli, M., Battista, V., & Giovanditto, F. (2012). Double innervation in free-flap surgery for long-standing facial paralysis. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *65*, 1343–1349.

Braig, D., Bannasch, H., Stark, G. B., & Eisenhardt, S. U. (2017). Analysis of the ideal muscle weight of gracilis muscle transplants for facial reanimation surgery with regard to the donor nerve and outcome. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. https://doi.org/10.1016/j.bjps.2016.12.005

Eisenhardt, S. U., Thiele, J. R., Stark, G. B. & Bannasch, H. (2013). [Comparison of cross face nerve graft with masseteric nerve as donor nerves for free functional muscle transfers in facial reanimation surgery]. *Handchir. Mikrochir. Plast. Chir. Organ Deutschsprachigen Arbeitsgemeinschaft Handchir. Organ Deutschsprachigen Arbeitsgemeinschaft Mikrochir. Peripher. Nerven Gefasse Organ V*, *45*, 223–228.

Frey, M., Tzou, C. H., Michaelidou, M., Pona, I., Hold, A., Placheta, E., & Kitzinger, H. B. (2011). 3D video analysis of facial movements. *Facial Plastic Surgery Clinics of North America*, *19*, 639–646.

Hadlock, T. A., & Urban, L. S. (2012). Toward a universal, automated facial measurement tool in facial reanimation. *Archives of Facial Plastic Surgery*, *14*, 277–282.

Hembd, A., Nagarkar, P. A., Saba, S., Wan, D., Kutz, J. W., Isaacson, B., Gupta, S., White, C. L., Rohrich, R. J., & Rozen, S. M. (2017). Facial nerve axonal analysis and anatomical localization in donor nerve: Optimizing axonal load for cross-facial nerve grafting in facial reanimation. *Plastic and Reconstructive Surgery*, *139*, 177–183.

Klebuc, M. (2015). The evolving role of the masseter-to-facial (V-VII) nerve transfer for rehabilitation of the paralyzed face. *Annales de Chirurgie Plastique Esthétique*, *60*, 436–441.

Klebuc, M. J. A. (2011). Facial reanimation using the masseter-to-facial nerve transfer. *Plastic and Reconstructive Surgery*, *127*, 1909–1915.

Manktelow, R. T., Tomat, L. R., Zuker, R. M., & Chang, M. (2006). Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: Effectiveness and cerebral adaptation. *Plastic and Reconstructive Surgery*, *118*, 885–899.

Sawyer, A. R., See, M., & Nduka, C. (2010). Quantitative analysis of normal smile with 3D stereophotogrammetry–an aid to facial reanimation. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, *63*, 65–72.

Snyder-Warwick, A. K., Fattah, A. Y., Zive, L., Halliday, W., Borschel, G. H., & Zuker, R. M. (2015). The degree of facial movement following microvascular muscle transfer in pediatric facial reanimation depends on donor motor nerve axonal density. *Plastic and Reconstructive Surgery*, *135*, 370e–81e.

Terzis, J. K., & Olivares, F. S. (2009). Long-term outcomes of free-muscle transfer for smile restoration in adults. *Plastic and Reconstructive Surgery*, *123*, 877–888.

Thiele, J., Bannasch, H., Stark, G. B., & Eisenhardt, S. U. (2015). Single-stage dynamic reanimation of the smile in irreversible facial paralysis by free functional muscle transfer. *Journal of Visualized Experiments JoVE*. https://doi.org/10.3791/52386

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