OPEN

PRS GLOBAL OPEN

IDEAS AND INNOVATIONS

Reconstructive

Fat Grafting in Facial Palsy: A Secondary Revision Technique to Improve the Facial Aesthetics

Marco Pappalardo, MD, PhD*†
Kerry Davies, MD*
Stephen Morley, MD, FRCS (Plast)*

Summary: We report our experience of using autologous fat grafting (AFG) as an adjunct to dynamic and static facial reanimation surgical techniques in patients with facial palsy. A consecutive series of patients with facial palsy (congenital or acquired) treated by AFG between September 2007 and October 2017 were reviewed. Multiple strategies for initial dynamic facial reanimation have been utilized. Indications for AFG included asymmetry, volume deficiency, and visible muscle tethering. Standard AFG technique was used with fat harvested from the lower abdomen or thigh and injected into multiple affected areas. Fat grafting was repeated as necessary. Two-dimensional analysis was performed using standardized pre- and postoperative photographs to assess facial symmetry. Patient, surgeon, and independent evaluator satisfaction was recorded using a five-point Likert scale (0–4). Thirty-two patients with a mean age of 43±15.5 years were treated with AFG following facial reanimation. A mean of 1.7±1.4 secondary procedures were performed following initial dynamic reanimation before fat grafting. The average number of AFG episodes was 2.2±1.4 with a mean volume of 12.9±6.0 ml. Minimal complications were seen in either the donor or the recipient sites. There was significant improvement ($P \leq 0.001$) of postoperative quantitative facial symmetry following fat grafting. At one-year follow-up, surgeon, patient, and independent evaluator were mostly satisfied (3.06±0.62, 3.31±0.59, and 3.16±0.57, respectively). We report a positive experience of correction of facial asymmetry, contour abnormality and visible muscle pull with fat transplantation following dynamic facial reanimation. The procedure has been shown to be quick and simple, with few complications. *(Plast Reconstr Surg Glob Open 2022;10:e4572; doi: 10.1097/GOX.0000000000004572; Published online 19 October 2022.)*

INTRODUCTION

Facial palsy (FP) is a disabling condition caused by a dysfunction of the VII cranial nerve, with significant morbidity with both aesthetic and psychological implications.[1] The incidence of FP is estimated to be about 20–25 per 100,000 people per year.[2–4] Patients may experience facial asymmetry, impaired emotional expression, and difficulties performing basic daily functions.

*From the *Canniesburn Plastic Surgery Unit, Glasgow Royal Infirmary, NHS Scotland, United Kingdom; and †Division of Plastic and Reconstructive Surgery, Department of Medical and Surgical Sciences, Policlinico University Hospital, University of Modena and Reggio Emilia, Italy.*

Received for publication November 30, 2021; accepted August 9, 2022.

DOI: 10.1097/GOX.0000000000004572

Treatment of FP requires a multidisciplinary collaboration.[1] Plastic surgery has a prevalent role in reanimation using static or dynamic procedures, and their purposes are to restore functional impairment and provide facial symmetry at rest and in dynamic, spontaneous movements.[5] Over the last 30 years, dynamic reconstruction has been considered the best option for facial reanimation.[6–17] A single dynamic procedure can also improve bulk and contour in facial deformities, but irregularities often persist; hence, secondary revisions are often required.[12,18–20] Nowadays, one of the most promising and useful reconstructive techniques is autologous fat grafting (AFG),[21] but to date, there is a lack of data regarding its utility in patients with FP, and only a few studies have been published.[22,23] Over the years, AFG has been used for facial re-contouring in aesthetic surgery with good long-term results,[24–27] and its use has progressed to the treatment of

Disclosure: *The authors have no conflicts of interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

congenital, traumatic, connective tissue disease,[28] postoncological,[29,30] and postsurgical craniofacial volume deficits.[31–36] The aim of this study was to evaluate the use of serial AFG in FP patients as a revision technique following facial reanimation procedures to improve facial aesthetics.

Takeaways

Question: Is autologus fat grafting (AFG) a useful procedure to improve the aesthetic appearance of patients with facial paralysis previously treated by dynamic facial-reanimation procedures?

Findings: A significant improvement of postoperative quantitative facial symmetry following fat grafting was obtained. At one-year follow-up, surgeon, patient, and independent evaluator were mostly satisfied.

Meaning: AFG is a useful secondary-revision technique to address facial asymmetry, contour abnormality, and visible muscle pull following dynamic facial reanimation.

METHODS

A total of 32 patients with a diagnosis of FP were identified between September 2007 and October 2017 at our institution. Patients were treated by dynamic facial reanimation procedures as first-stage followed by secondary procedures. AFG was used as the final revision technique. All surgical procedures were performed by the senior author (S.M.). This article conforms to the Declaration of Helsinki.

AFG Preoperative Workup

A preliminary clinical examination of each patient in upright position was conducted requiring patients to smile, to open and close the eyes, and to perform several other facial expressions to better assess the recovery post-facial reanimation procedures, and to evaluate the facial asymmetry or contour defects. Preoperative marking of facial contour irregularities was performed.

AFG Technique

Standard Coleman technique of structural fat grafting was used in this study.[21,24]

Postoperative Care and Follow-up

The grafted side of the face was immobilized with steri-strips for five days. Patients were instructed to reduce movement of facial muscles whenever possible. Follow-up included clinical examinations at 1, 6, and 12 months post-AFG.

Quantitative Analysis

Standardized two-dimensional full-face frontal analysis was performed on pre- and postoperative photographs.[37] Postoperative photographs were taken 1 year after the last AFG procedure. Two-dimensional analysis of facial symmetry analysis was performed using Image J (version 1.44, National-Institutes-Health, Bethesda), a reliable freeware medical imaging processing software able to delineate and calculate irregularly shaped areas.[38,39] The upper boundary of the face was considered a horizontal line through the nasion. To divide the face in half, a vertical line was done from the nasion through the center of Cupid's bow. Both surface area of each hemiface and total facial area were measured. All of the measurements were performed by one blinded investigator. Post-AFG facial area treated has been divided by pre-AFG facial area to determine the change ratio for each half of the face.[40] The quantitative facial symmetry score in percentage was calculated as AFG-treated side surface area × 100 divided by nontreated side surface area.

Surgeon, Patient, and Independent Outcome Satisfaction

Patient, surgeon, and independent evaluator satisfaction was assessed using a five-point Likert scale based on facial symmetry, contour volume, and overall appearance from 0, very dissatisfied to 4, very satisfied.

Statistical Analysis

Descriptive data were presented as means ± SD. Comparison of pre- versus postoperative facial symmetry measurements were obtained using the Friedman and Wilcoxon test. Values were considered significant at a P value less than < 0.05.

RESULTS

There were 32 patients included in the study: 30 with unilateral and two with bilateral FP. There were five men and 27 women with a mean age of 43 ± 15.5 (range, 17–67) years. Several initial dynamic facial reanimation procedures have been employed, including temporalis transfer (n = 3), facial nerve graft (n = 3), dynamized latissimus-dorsi flap motored onto contralateral branch facial nerve (n = 4), masseter-to-facial nerve transfer (n = 2), single-stage gracilis flap motored onto nerve to masseter (n = 10) or two-stage CFNG/gracilis flap (n = 8), and digastric transfer (n = 2). A mean of 1.7 secondary procedures have been performed following initial dynamic reanimation before AFG. The mean follow-up after final fat graft was 1.9 years. The number of AFG episodes was 2.2 ± 1.4. Fifteen (46%) patients had only one AFG episode, seven (22%) had two injections, four (12%) had three injections, two (6%) had four injections and four (12%) patients had five AFG episodes (Figs. 1, 2). The median interval between serial AFG was 6.5 months. The average amount of fat injected was 12.9 ± 6.0 ml. In SDC1, we recorded the reanimation and revisions procedures, indications for secondary AFG, site injected, episodes of AFG required, and volume transferred. (**See table, Supplemental Digital Content 1,** which shows surgical details of patients undergoing first stage of dynamic facial reanimation, secondary revision procedures, and autologous fat grafting, including indications, site injected, and number of fat grafts required. **http://links.lww.com/PRSGO/C186.**) There was no postoperative bleeding, major infection, subcutaneous cysts, or hematomas. Fat graft re-absorption occurred primarily within the first three months with no obvious further absorption of injected fat after this period. Computerized-photogrammetric quantitative facial surface area

Fig. 1. A 52-year-old woman presented with fairly dense left facial paralysis associated with a significant contour defect affecting the left cheek and persistent sinus following surgery to remove an infected malar implant. She underwent one-stage facial reanimation with a free gracilis flap motored onto the nerve to masseter muscle and removal of some dead bone fragments at the inferior aspect of her sinus (A). At 3 months, her facial reanimation was working well; she had a discernable smile with movement of about 5 mm at the left modiolus, and her sinus had been successfully sealed over. To improve the contour deformity of her left cheek, five Coleman AFG procedures were performed. Under general anesthesia, a tumescent solution containing 0.5% lidocaine and 1:200.000 adrenaline was infiltrated into the donor-sites. Fat was harvested using a disposable two-hole 15-cm blunt-tipped Coleman cannula, 3 mm in diameter connected with a 10 ml Luer-Lock syringe. Three millimeter incisions were made to insert the cannula. Once the fat had been harvested, each 10 ml syringe was placed into a sterilized sleeve in a centrifuge and spun at 3000 rpm for 3 minutes. Fat was harvested with an average of 75 ml from the abdomen and lateral thigh with a volume of usable fat cells of 25 ml. When all AFG had been processed, the purified fat was transferred to 1-ml Luer-Lock syringes. Blunt 1-hole infiltration cannulas, 17 gauge, were used to inject the fat into the receiving area. Approximately 0.1 ml of fat was injected with each pass of cannula, into multiple tissue areas within the subcutaneous tissue using multiple tissue planes and tunnels. Incisions were sutured and harvest sites were not closed to facilitate postoperative drainage. Results following five episodes of AFG at 1-year follow-up. Cosmetic results following AFG have been very pleasing and have significantly improved the facial symmetry (B).

measurements showed an average of 10.9% improvement in postoperative quantitative facial symmetry that was statistically significant ($P \leq 0.001$). The satisfaction surveys were done after 1 year following the last AFG according to the comparison of pre- and postoperative photographs for degree of improvement. (**See figure, Supplemental Digital Content 2,** which shows satisfaction surveys taken by the patients, surgeon, and independent evaluator after 1 year following the last fat injection according to the comparison of pre- and postoperative photographs and videos. **http://links.lww.com/PRSGO/C187**.) The mean surgeon, patient, and independent evaluator satisfaction was 3.06 ± 0.62, 3.31 ± 0.59, and 3.16 ± 0.57 (ranging from 2 to 4 in all evaluations), respectively.

DISCUSSION

Restoration of facial symmetry and correction of contour irregularities are a challenging problem in FP patients. In particular, when established unilateral facial palsies are treated, restoration of symmetry and volume correction are the real goals.[41] We used AFG as a tissue filler to address facial asymmetry, contour abnormality and visible muscle pull as a secondary revision technique in FP patients previously treated by dynamic facial reanimation procedures. The likelihood of revisional AFG following reanimation procedures have been mentioned to all patients to improve the facial aesthetic. Indications for AFG include (a) facial asymmetry due to volume loss involving contour of lower-eyelid, cheek, chin, nasolabial fold or brow–temple

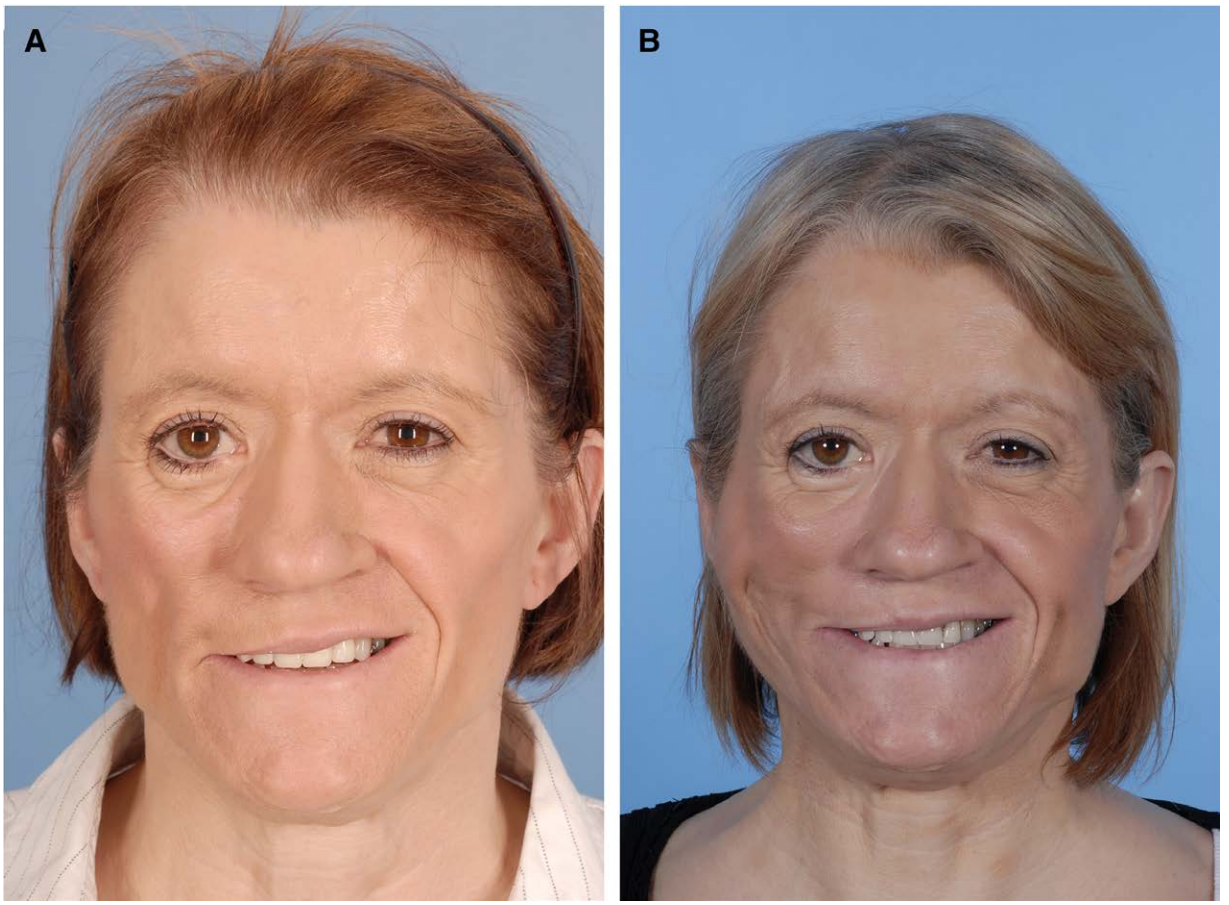

Fig. 2. A 50-year-old woman presented with right-sided FP as a sequela of surgery (free groin flap) to treat her Romberg's disease. She underwent a free gracilis flap motored onto the nerve to masseter for smile regeneration to improve both her facial weakness and the contour deficit on the right side (A). Seven months postoperative, which was complicated with an infected hematoma, she had nice movement but significant contour irregularities on both cheeks. The fat was harvested from the abdomen and both thighs and infiltrated into both cheeks to correct the deformity. For each of the three procedures, the total amount of fat harvested was an average of 75 ml, of which 21 ml was usable for the injection. At 1-year follow-up after the last AFG injection, she had a fairly pleasing result and has improved symmetry (B).

junction; (b)inversion of upper/lower-lip at the free-muscle fixation points; and (c) muscle-pull in cheek region.

The results of this study showed a significant improvement in facial symmetry at 12-months follow-up following AFG. Indeed, patients, surgeon, and independent evaluator were mostly satisfied after serial AFG.

AFG is a relatively fast and easy procedure[21,42,43]; however, FP patients are very different from those who simply require cosmetic corrections.[44] Biglioli et al successfully used AFG in unilateral FP patients as an ancillary procedure after dynamic reanimation, to restore volumetric loss of the atrophied lip, increasing aesthetic volume and the ameliorated lip competence.[22] Then, Siah et al reported the use of AFG to achieve periorbital symmetry in FP patients.[23] The authors showed significant improvement in temple hollowness, tear trough visibility, and lower eyelid–cheek-junction symmetry. However, variable rate of resorption of the grafted fat over time suggested the procedure may require repeating in some patients. In our series, graft re-absorption was the main complication, and in five patients, multiple episodes of AFG were necessary to achieve volumetric restoration. Of note, we did not observe different degrees of re-absorption of fat in different anatomical locations. Many studies reported that the absorption rate of transplanted fat can reach 70% of the volume; therefore, overcorrection and repeated operations are often needed.[45,46] To overcome this shortcoming, techniques for adipose-derived regenerative cell(ADRC)-enriched fat grafting are gaining more attention.[47–49] Since ADRCs contain multiple types of stem-regenerative cells, a cooperative interaction among these cells and the factors that they produce may allow ADRCs to enhance graft survival and quality.[50] We plan to use ADRCs in our current protocol for secondary injection of AFG in FP patients.

We acknowledge that this study presents some limitations, including (1) the retrospective study-design, (2) the effect of each type of dynamic facial reanimation and static procedure before AFG, (3) the quantitative assessment of facial symmetry using two-dimensional instead of three-dimensional imaging,[51–54] and (4) that the patient's self-reported satisfaction may not be ideal even using a designed Likert-type scale questionnaire. Despite these limitations, we believe that the reported data are robust and warrant further investigation to evaluate them further.

CONCLUSIONS

In this article, we wish to demonstrate that serial AFG is a very useful secondary revision technique following facial reanimation for achieving long-term improvements in facial contour and symmetry in FP patients. This technique could provide symmetrical, aesthetically pleasing results, fewer complications, less overall operating theater time, and increased quality-of-life for patients who have undergone dynamic facial reanimation.

Marco Pappalardo, MD, PhD
Division of Plastic and Reconstructive Surgery
Department of Medical and Surgical Sciences
Policlinico University Hospital
University of Modena and Reggio Emilia
Via del Pozzo, 71
Modena 41124
Italy
E-mail: marco.pappalardo@unimore.it

PATIENT CONSENT

The patients provided written consent for the use of their images.

REFERENCES

1. Fattah A, Borschel GH, Manktelow RT, et al. Facial palsy and reconstruction. *Plast Reconstr Surg.* 2012;129:340e–352e.
2. Finsterer J. Management of peripheral facial nerve palsy. *Eur Arch Otorhinolaryngol.* 2008;265:743–752.
3. Holland NJ, Weiner GM. Recent developments in Bell's palsy. *BMJ.* 2004;329:553–557.
4. Westin LM, Zuker R. A new classification system for facial paralysis in the clinical setting. *J Craniofac Surg.* 2003;14:672–679.
5. Zuker R, Manktelow R, Hussian G. Facial Paralysis. In: Rodriguez E, Neligan P. *Pediatric Plastic Surgery.* Vol 3. London: Elsevier; 2018.
6. Manktelow RT, Tomat LR, Zuker RM, et al. Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: effectiveness and cerebral adaptation. *Plast Reconstr Surg.* 2006;118:885–899.
7. Labbé D, Huault M. Lengthening temporalis myoplasty and lip reanimation. *Plast Reconstr Surg.* 2000;105:1289–1297; discussion 1298.
8. Mackinnon SE, Dellon AL. Technical considerations of the latissimus dorsi muscle flap: a segmentally innervated muscle transfer for facial reanimation. *Microsurgery.* 1988;9:36–45.
9. Woollard AC, Harrison DH, Grobbelaar AO. An approach to bilateral facial paralysis. *J Plast Reconstr Aesthet Surg.* 2010;63:1557–1560.
10. Rodríguez Lorenzo A, Morley S, Payne AP, et al. Anatomy of the motor nerve to the gracilis muscle and its implications in a one-stage microneurovascular gracilis transfer for facial reanimation. *J Plast Reconstr Aesthet Surg.* 2010;63:54–58.
11. Ferguson LD, Paterson T, Ramsay F, et al. Applied anatomy of the latissimus dorsi free flap for refinement in one-stage facial reanimation. *J Plast Reconstr Aesthet Surg.* 2011;64:1417–1423.
12. Terzis JK, Noah ME. Analysis of 100 cases of free-muscle transplantation for facial paralysis. *Plast Reconstr Surg.* 1997;99:1905–1921.
13. Terzis JK, Kalantarian B. Microsurgical strategies in 74 patients for restoration of dynamic depressor muscle mechanism: a neglected target in facial reanimation. *Plast Reconstr Surg.* 2000;105:1917–1931; discussion 1932–1914.
14. O'Brien BM, Pederson WC, Khazanchi RK, et al. Results of management of facial palsy with microvascular free-muscle transfer. *Plast Reconstr Surg.* 1990;86:12–22; discussion 23–14.
15. Ferreira MC, Marques de Faria JC. Result of microvascular gracilis transplantation for facial paralysis-personal series. *Clin Plast Surg.* 2002;29:515–522, vi.
16. Morley SE. Combining an end to side nerve to masseter transfer with cross face nerve graft for functional upgrade in partial facial paralysis-an observational cohort study. *J Plast Reconstr Aesthet Surg.* 2021;74:1446–1454.
17. Cotrufo S, Hart A, Payne AP, et al. Topographic anatomy of the nerve to masseter: an anatomical and clinical study. *J Plast Reconstr Aesthet Surg.* 2011;64:1424–1429.
18. Terzis JK, Olivares FS. Secondary surgery in adult facial paralysis reanimation. *Plast Reconstr Surg.* 2009;124:1916–1931.
19. Frey M, Giovanoli P. The three-stage concept to optimize the results of microsurgical reanimation of the paralyzed face. *Clin Plast Surg.* 2002;29:461–482.
20. Takushima A, Harii K, Asato H, et al. Revisional operations improve results of neurovascular free muscle transfer for treatment of facial paralysis. *Plast Reconstr Surg.* 2005;116:371–380.
21. Coleman SR. Structural fat grafting: more than a permanent filler. *Plast Reconstr Surg.* 2006;118(3 Suppl):108S–120S.
22. Biglioli F, Allevi F, Battista VM, et al. Lipofilling of the atrophied lip in facial palsy patients. *Minerva Stomatol.* 2014;63:69–75.
23. Siah WF, Litwin AS, Nduka C, et al. Periorbital autologous fat grafting in facial nerve palsy. *Ophthalmic Plast Reconstr Surg.* 2017;33:202–208.
24. Coleman SR. Facial recontouring with lipostructure. *Clin Plast Surg.* 1997;24:347–367.
25. Rohrich RJ, Afrooz PN. Finesse in face lifting: the role of facial fat compartment augmentation in facial rejuvenation. *Plast Reconstr Surg.* 2019;143:98–101.
26. Coleman S. *Structural Fat Grafting.* St. Louis, Mo.: Waulity Medical Publishing; 2004.
27. Coleman SR. Hand rejuvenation with structural fat grafting. *Plast Reconstr Surg.* 2002;110:1731–1744; discussion 1745–1737.
28. Starnoni M, Pappalardo M, Spinella A, et al. Systemic sclerosis cutaneous expression: Management of skin fibrosis and digital ulcers. *Ann Med Surg (Lond).* 2021;71:102984.
29. Ho OA, Lin YL, Pappalardo M, et al. Nipple-sparing mastectomy and breast reconstruction with a deep inferior epigastric perforator flap using thoracodorsal recipient vessels and a low lateral incision. *J Surg Oncol.* 2018;118:621–629.
30. Herly M, Ørholt M, Larsen A, et al. Efficacy of breast reconstruction with fat grafting: a systematic review and meta-analysis. *J Plast Reconstr Aesthet Surg.* 2018;71:1740–1750.
31. Clauser L. Optimizing maxillofacial and craniofacial results. In: Coleman S, Mazzola R. *Fat Injection from Filling to Regeneration.* St. Louis, Mo.: Quality Medical Publishing, Inc.; 2009.
32. Clauser L, Polito J, Mandrioli S, et al. Structural fat grafting in complex reconstructive surgery. *J Craniofac Surg.* 2008;19:187–191.
33. Tanna N, Wan DC, Kawamoto HK, et al. Craniofacial microsomia soft-tissue reconstruction comparison: inframammary extended circumflex scapular flap versus serial fat grafting. *Plast Reconstr Surg.* 2011;127:802–811.
34. Clauser LC, Tieghi R, Consorti G. Parry-Romberg syndrome: volumetric regeneration by structural fat grafting technique. *J Craniomaxillofac Surg.* 2010;38:605–609.
35. Guerrerosantos J, Chicas M, Rivera H. Palatopharyngeal lipoinjection: an advantageous method in velopharyngeal incompetence. *Plast Reconstr Surg.* 2004;113:776–777.
36. De Santis G, Pinelli M, Benanti E, et al. Lipofilling after laser-assisted treatment for facial filler complication: volumetric and regenerative effect. *Plast Reconstr Surg.* 2021;147:585–591.
37. Romeo M, O'Reilly B, Robertson BF, et al. Validation of the Glasgow Facial Palsy Scale for the assessment of smile reanimation surgery in facial paralysis. *Clin Otolaryngol.* 2012;37:181–187.

38. Heike CL, Stueckle LP, Stuhaug ET, et al. Photographic protocol for image acquisition in craniofacial microsomia. *Head Face Med.* 2011;7:25.
39. Dello SA, Stoot JH, van Stiphout RS, et al. Prospective volumetric assessment of the liver on a personal computer by nonradiologists prior to partial hepatectomy. *World J Surg.* 2011;35:386–392.
40. Lim AA, Fan K, Allam KA, et al. Autologous fat transplantation in the craniofacial patient: the UCLA experience. *J Craniofac Surg.* 2012;23:1061–1066.
41. Bhama PK, Weinberg JS, Lindsay RW, et al. Objective outcomes analysis following microvascular gracilis transfer for facial reanimation: a review of 10 years' experience. *JAMA Facial Plast Surg.* 2014;16:85–92.
42. Baccarani A, Pappalardo M, Starnoni M, et al. Plastic surgeons in the middle of the coronavirus disease 2019 pandemic storm in Italy. *Plast Reconstr Surg Glob Open.* 2020;8:e2889.
43. Starnoni M, Baccarani A, Pappalardo M, et al. Management of personal protective equipment in plastic surgery in the era of coronavirus disease. *Plast Reconstr Surg Glob Open.* 2020;8:e2879.
44. Bianchi B, Ferri A, Ferrari S, et al. Ancillary procedures in facial animation surgery. *J Oral Maxillofac Surg.* 2014;72:2582–2590.
45. Moseley TA, Zhu M, Hedrick MH. Adipose-derived stem and progenitor cells as fillers in plastic and reconstructive surgery. *Plast Reconstr Surg.* 2006;118(3 Suppl):121S–128S.
46. Zhu M, Zhou Z, Chen Y, et al. Supplementation of fat grafts with adipose-derived regenerative cells improves long-term graft retention. *Ann Plast Surg.* 2010;64:222–228.
47. Kakudo N, Tanaka Y, Morimoto N, et al. Adipose-derived regenerative cell (ADRC)-enriched fat grafting: optimal cell concentration and effects on grafted fat characteristics. *J Transl Med.* 2013;11:254.
48. Di Stefano AB, Pappalardo M, Moschella F, et al. MicroRNAs in solid organ and vascularized composite allotransplantation: potential biomarkers for diagnosis and therapeutic use. *Transplant Rev (Orlando).* 2020;34:100566.
49. Pappalardo M, Montesano L, Toia F, et al. Immunomodulation in vascularized composite allotransplantation: what is the role for adipose-derived stem cells? *Ann Plast Surg.* 2019;82:245–251.
50. Pérez-Cano R, Vranckx JJ, Lasso JM, et al. Prospective trial of adipose-derived regenerative cell (ADRC)-enriched fat grafting for partial mastectomy defects: the RESTORE-2 trial. *Eur J Surg Oncol.* 2012;38:382–389.
51. Sigaux N, Ganry L, Mojallal A, et al. [Stereophotogrammetry and facial surgery: Principles, applications and prospects]. *Ann Chir Plast Esthet.* 2018;63:62–68.
52. Koh KS, Oh TS, Kim H, et al. Clinical application of human adipose tissue-derived mesenchymal stem cells in progressive hemifacial atrophy (Parry-Romberg disease) with microfat grafting techniques using 3-dimensional computed tomography and 3-dimensional camera. *Ann Plast Surg.* 2012;69:331–337.
53. Heike CL, Upson K, Stuhaug E, et al. 3D digital stereophotogrammetry: a practical guide to facial image acquisition. *Head Face Med.* 2010;6:18.
54. Gibelli D, Dolci C, Cappella A, et al. Reliability of optical devices for three-dimensional facial anatomy description: a systematic review and meta-analysis. *Int J Oral Maxillofac Surg.* 2020;49:1092–1106.