Micro-Autologous Fat Transplantation Combined With Platelet-Rich Plasma for Facial Filling and Regeneration: A Clinical Perspective in the Shadow of Evidence-Based Medicine

Kadri Ozer, MD and Ozlem Colak, MD†*

Abstract: Despite the popularity of lipofilling procedures in recent years, the presence of older habits still in fat graft harvesting and processing seems to be the biggest obstacle to the final better outcome of fat grafting. Our study is aimed to highlight some strategies what should be done in fat grafting in the shadow of evidence-based medicine and patient-reported outcomes which might be of interest to the clinicians. Between 2015 and 2017, 14 patients were included who underwent facial micro-autologous fat transplantation with platelet-rich plasma injection. The outcome was determined by the difference in presurgery and postsurgery FACE-Q modules, which were designed as patient-reported outcome instrument to evaluate the unique outcomes of patients undergoing facial cosmetic procedures. Surveys conducted were modules of satisfaction with facial appearance, satisfaction with cheeks, satisfaction with skin, psychological function, social function, aging appearance appraisal, and satisfaction with the outcome. All patients were followed up minimum 9 months. No major complications were recorded. The patient-reported FACE-Q satisfaction and FACE-Q quality-of-life presurgery and postsurgery results showed statistically significant improvement (<0.001). Overall satisfaction with the outcome was 87.6 ± 16.8 (range 55–100). A combination of platelet-rich plasma and micro-fat grafting with soft harvesting and processing could be seen a good surgical technique to restore volume and enhance skin quality in facial soft tissue augmentation. The authors believe that with minimum detrimental effect on fat grafting while harvesting, processing, and with the addition of platelet-rich plasma while applying may increase the surgeon's and patient's satisfaction with the outcome.

Key Words: Autologous transplantation, face, fat injections, platelet-rich plasma

From the *Aydin State Hospital, Plastic, Reconstructive and Aesthetic Surgery Clinic, Aydin; and †Istanbul Okmeydani Training and Research Hospital, Plastic, Reconstructive and Aesthetic Surgery Clinic, Istanbul, Turkey.

Received June 2, 2018.
Accepted for publication September 26, 2018.

Address correspondence and reprint requests to Kadri Ozer, MD, Aydin State Hospital, Plastic, Reconstructive and Aesthetic Surgery Clinic, 09100 Aydin, Turkey; E-mail: kadriozer@hotmail.com

The authors report no conflicts of interest.
Supplemental digital contents are available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jcraniofacialsurgery.com).

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000005122

(*J Craniofac Surg* 2019;30: 672–677)

Fat grafting has been known for many years; however, it is only since the mid-1990s that the Coleman's technique has become popular for facial fat grafting.[1] Fat is an autologous, inexpensive, abundant, readily available, host-compatible, and repeatedly accessible filler that restores volume. Additionally, fat naturally contains stem cells; thus, fat grafting potentially improves the quality of the overlying skin and repairs skin damage, thereby rejuvenating the face and is considered superior to conventional temporary fillers.[1,2] A major disadvantage of fat transplantation is uncertainty among surgeons regarding its use owing to unpredictable and variable graft survival rates. Owing to a better understanding of the components of adipose tissue over the last decade, surgeons can better predict the role of each component to modify techniques to improve the yield of targeted cell types and thereby improve patient outcomes. Although reports regarding fat graft survival in the recent literature support several newer techniques and/or modifications, clinically, surgeons continue with older approaches instead of using evidence-based medicine (which is even reflected in the published studies). Thus, no standardized protocol has been established for fat grafting.

Adipocytes secrete >100 proteins, which contribute to the expression of cytokines and growth factors including vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), insulin-like growth factor, and adiponectin, which induce angiogenesis.[3] VEGF, FGF-2, and platelet-derived growth factor (PDGF) are tyrosine kinase receptor-mediated growth factors that, in animal studies, have been shown to improve fat graft transplantation.[3] In our clinical practice, we have been combining micro-autologous fat transplantation (MAFT) with platelet-rich plasma (PRP), which contains multiple angiogenic growth factors including PDGF, transforming growth factor-beta (TGF-ß), epidermal growth factor (EGF), VEGF, and FGF.[4] This technique has been demonstrated enhanced proliferation of adipocyte-derived stem cells (ADSCs) in vitro and in vivo and improved overall graft survival.[4]

We aimed to establish a clinical perspective for an appropriate, feasible, and inexpensive approach (based on evidence-based medicine) to minimize fat graft resorption rates. Additionally, we have discussed our results of facial volume restoring and rejuvenation using objective scales based on patient satisfaction and quality of life. We have also highlighted strategies for fat graft harvesting and processing, which might be of interest to clinicians.

PATIENTS AND METHODS

We investigated 14 patients who underwent facial MAFT surgery with an additional PRP injection procedure between October 2015 and June 2017. These dates were selected because the procedure combining facial MAFT and PRP application was accepted and

implemented as a standard lipofilling protocol in our routine practice after October 2015. Patient demographics were evaluated using patients' medical records. All protocols used in this study were performed according to the recommended International Regulations and Declarations and complied with the Declaration of Helsinki. This study was approved by the local Medical Ethics Committee (local committee code no: 20180328-0040.407). All patients provided written informed consent.

Micro-Autologous Fat Harvesting and Processing

All operations were performed under sedation using local anesthesia and nerve blocks applied to the face. Using a multiholed infiltration spray cannula, a solution containing 0.04% lidocaine with 1:4,000,000 epinephrine was infiltrated until the tissues were adequately turgid by a simple pressure cuff. Fat graft harvesting was performed using a 10-mL syringe attached to a multiport cannula with a blunt tip, containing 24 side holes measuring 1 mm in diameter with alternating cutting edges in the proximal part of the holes. The harvesting cannula was 2 mm in diameter and 20 cm in length. Micro-fat was suctioned manually by withdrawing the plunger. The cannula was pushed through the harvest site, and the surgeon digitally manipulated and withdrew the plunger of the syringe to create gentle negative pressure as recommended by Coleman.[5] After the syringe was filled with harvested tissue, the cannula was removed from the syringe, and a new 10-mL syringe was attached to the cannula to repeat this procedure of micro-fat harvesting.

In our clinical practice (see Video, Supplemental Digital Content 1, http://links.lww.com/SCS/A387), we first cap the syringes containing harvested micro-fat grafts and leave them to stand in a cool environment for approximately 10 minutes to facilitate the separation of the liquid and solid components by gravity. After separation and fractionation of the contents of the syringe, the lower watery and bloody layer can be easily tapped by gently removing the plunger from the capped region. The remaining more condensed micro-fat is gently collected in 10-mL syringes, which are plugged carefully with their own plunger seals for centrifugation. All fat-filled 10-mL syringes were centrifuged at 300g for 4 minutes. After centrifugation, the lipoaspirate in the syringe was divided into 3 layers: the oily upper layer, fatty tissue in the middle layer, and the aqueous portion at the bottom. We initially removed the plug to equalize the pressure, and the fluid at the bottom was easily drained out once the cap was removed. Subsequently, the upper oily layer was gently poured out without disturbing the middle layer. The middle layer in all syringes comprising condensed micro-fat was gently collected in new sterile syringes. The concentrated fat in the main syringe was transferred to 1-mL syringes (a 1-mL syringe demonstrates lesser resistance to the injection of fat grafts) for the injection of fat into the face using a 3-way stopcock.

Platelet-Rich Plasma Preparation

On the day of the surgery, 11 mL of whole blood was drawn into standard tubes containing anticoagulant citrate dextrose solution-formula A (ACD-A) with a blood to anticoagulant ratio of 9:1. We obtained 12 tubes for each patient (a mean of 132 mL of fresh blood from each patient). The 12 tubes were centrifuged for only 1 spin at a standard relative centrifugal force of 1650g for 5 minutes using a multipurpose centrifuge (NF 800; NUVE Industrial Materials Manufacturing and Trading Co, Ankara, Turkey). Blood components were separated into the plasma, buffy coat, and erythrocyte layers. In our technique, the plasma layer formed after centrifugation is divided into approximately 3 equal portions, and the uppermost two-thirds is removed.[6] One-third of the plasma at the bottom and the buffy coat layer were collected without mixing these with the erythrocyte layer. Using this method, we obtained a mean of 1.2 mL of PRP from each tube (we collected approximately 14.4 mL of PRP from all 12 tubes without using any commercial kit systems). As a result of our previous clinical studies, baseline platelet concentrations increased 4-fold in the PRP using this manual technique.[6] We do not activate PRP with calcium or thrombin because nonactivated platelets present in PRP get gradually activated and secrete orchestrated growth factors up to 10 days.[7]

Surgical Technique

Micro-autologous fat transplantation was injected in the superficial planes on each side of the face. Injection areas are selected to recreate the curves and the projection of the face. Micro-autologous fat transplantation was performed using a small cannula. After completing the MAFT injections, PRP injections were performed intra- and/or subdermally. Platelet-rich plasma is not mixed with micro-autologous fat at the beginning of the operation because such mixing interferes with accurate assessment of the volume of the injected autologous filler material secondary to a pseudo-filling effect. Therefore, we prefer to inject PRP into the selected areas immediately after fat injection has been completed.

Assessment Using FACE-Q Scales

The FACE-Q is a revolutionary patient-reported outcome instrument that evaluates specific outcomes in patients undergoing facial cosmetic procedures.[8] It uses several assessment scales to evaluate satisfaction with facial appearance, health-related quality of life, and satisfaction with the process of care. The FACE-Q satisfaction scales consist of questions relating to patient satisfaction with regard to facial appearance, appearance of the cheeks, and other such parameters. Rating is performed based on the following scales: 1 = very dissatisfied, 2 = somewhat dissatisfied, 3 = somewhat satisfied, and 4 = very satisfied. Quality of life scales are rated as: definitely disagree, somewhat disagree, somewhat agree, or definitely agree.[8]

A presurgery FACE-Q was administered including the following modules:

1. Satisfaction with facial appearance: This 10-item scale assesses the overall facial appearance using items including: "How your profile (side view) looks," "how fresh your face looks, and "how your face looks under bright lights."[9]
2. Satisfaction with cheeks: This 5-item scale assesses the appearance of the cheeks using items including: "How attractive your cheeks look," "how smooth your cheeks look."[8]
3. Satisfaction with skin: This 12-item scale assesses facial skin in mind with items such as: "How your facial skin looks when you first wake up," "how the tone (color) of your facial skin looks."[8]
4. Psychological function: This 10-item scale includes a series of positively worded statements that respondents are invited to agree/disagree, for example, "I feel good about myself," "I feel confident," "I feel attractive."[9]
5. Social function: This 8-item scale includes a series of positively worded statements that measure social confidence. Respondents are invited to agree/disagree with statements such as: "I make a good first impression," "I am relaxed around people that I don't know well."[9]
6. Aging appearance appraisal: This 7-item scale includes statements about how the patient feels about the age his–her face looks. Respondents may agree/disagree with statements such as: "I look older than I want to look," "When I see my reflection, I am reminded of how old I look."[8]

All patients included in this study completed a postsurgery FACE-Q at least 9 months postoperatively. This questionnaire included the same modules as were assessed during presurgery evaluation but with the addition of a 6-item satisfaction-with-outcome module. Each FACE-Q scale was scored using a lookup conversion table approach. Scores range from 0 to 100 with higher scores indicating greater satisfaction and/or quality of life.[8] Results were grouped to obtain the mean presurgery and postsurgery results.

Statistical Analysis

The SPSS (Statistical Package for Social Sciences, Chicago, IL) 15.0 Data Analysis System was used for data analysis. Normal distribution and homogeneity tests were performed on all data. Data are expressed as mean ± standard deviation. Statistical significance was calculated using the paired *t* test. Two-sided values of $P < 0.05$ were considered statistically significant.

RESULTS

The mean age of the 14 patients included in this study was 44.9 ± 11.9 years (range, 33–65 years) and all were women. All patients were followed-up over a minimum 9 months. No major complications (eg, infection, skin necrosis, nodulation, fibrosis, calcification, asymmetry, or vascular insults) were recorded. The mean volumes amount of 35.6 mL of micro-autologous fat for overall face and PRP used overall for the face were 35.6 and 14.4 mL, respectively, of PRP for overall face. Thus, the PRP:micro-fat ratio was approximately 1:2.5. The patient-reported FACE-Q satisfaction (Fig. 1) and FACE-Q quality of life scores (Fig. 2) presurgery and 9 months postsurgery results before the operation and 9 months after the last intervention showed a statistically significant improvement in all the FACE-Q modules assessed. Satisfaction with overall facial appearance improved from scores of 28.4 ± 23.3 to 90.3 ± 17.5 ($P < 0.001$, paired *t* test) whereas satisfaction with the cheeks and the skin improved from scores of 34.6 ± 20.1 to 92.3 ± 16.1 and from scores of 33.7 ± 18.1 to 88.0 ± 20.3, respectively (for both, $P < 0.001$, paired *t* test). Aging appearance appraisal improved from scores of 45.1 ± 25.1 to 91.7 ± 8.3 ($P < 0.001$, paired *t* test). The scores of overall satisfaction with outcome were 87.6 ± 16.8 (range 55–100). A few patients with facial MAFT combined with PRP are illustrated in Figures 3 to 6.

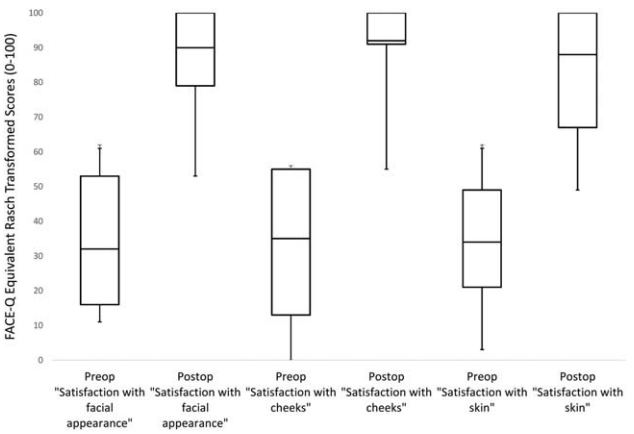

FIGURE 1. Graphic analysis of FACE-Q scores comparing preoperative and postoperative satisfaction of overall face, cheeks, and skin ($P < 0.001$). Data represent group means with minimum and maximum scores. Lower scores represent a less satisfaction in the life with the face, cheeks, and skin. Changes in grading after the procedure can be seen. MAFT, micro-autologous fat transplantation; PRP, platelet-rich plasma.

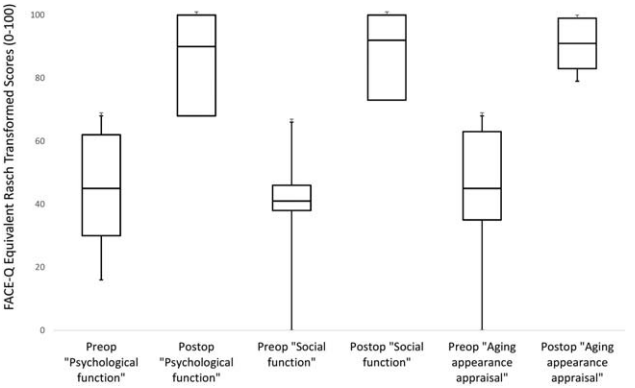

FIGURE 2. The result of FACE-Q scores of quality of life comparing preoperative and postoperative psychological function, social function, and aging appraisal ($P < 0.001$). Data represent group means with minimum and maximum scores. Lower scores represent a less quality of life with facial appearance. Increased scores show the positive effects of the applied procedure on the social and psychological aspects of the patients' lives.

FIGURE 3. Preoperative anterior (A), oblique (B, C), lateral (D, E) views and preoperative design (F) of a 44-year-old woman presented for facial recontouring with fat grafting to increase the youthful appearance. Results of 1-year postoperative views from MAFT + PRP are shown (G–K). Malar lipofilling and skin rejuvenation with decreased wrinkles can be seen primarily in lateral views which could not be explained by only lipofilling. MAFT, micro-autologous fat transplantation; PRP, platelet-rich plasma.

FIGURE 4. Preoperative lateral (A) and oblique (B) views of a 33-year-old woman presented for facial recontouring. Nine months postoperative views are shown (C and D) after MAFT + PRP procedure. Primarily contouring of cheeks and the mandibular area could be seen with excellent results. MAFT, micro-autologous fat transplantation; PRP, platelet-rich plasma.

FIGURE 5. Preoperative lateral (A) and oblique (B) views of a 37-year-old woman presented for facial recontouring. Fifteen months postoperative views are shown (C and D) after MAFT + PRP procedure. The excellent youthful appearance was obtained with a good well-rounded cheek despite longer period. MAFT, micro-autologous fat transplantation; PRP, platelet-rich plasma.

DISCUSSION

Fat transplantation was first reported by Neuber in 1893.[10] Until the end of the twentieth century, owing to patients with inconsistent volume retention, fat grafting had largely fallen out of favor in plastic surgery. Following Coleman's report regarding the key factors associated with harvesting and application, the history and popularity of fat transplantation has undergone a radical change, and over the last decade, this technique has become an essential component of facial rejuvenation and harmonization.[11] A thorough understanding of mechanisms affecting adipocyte survival is crucial to optimize long-term results. Per Coleman, ''Successful fat transplantation demands that every step is practiced with attention to this fragile nature of living tissue that must be in close proximity to a nutritional and respiratory source to survive.''[12] In the past several years after Coleman, many studies have been published regarding harvesting and processing methods, contents of the injected fat and the results of lipofilling. Each study can be viewed as part of a complementary puzzle. Several issues associated with fat grafting might become clearer after closely evaluating these studies as a whole.

Carpaneda and Ribeiro[13] reported a graft survival rate of only 40% at 1.5 ± 0.5 mm from the edge of the graft. Kato et al[14] transplanted an autologous inguinal fat pad under the scalp of mice and reported 3 zones based on histopathological examination. The most superficial zone closest to the surface showed survival of all adipocytes, the middle regenerating zone showed adipocyte death, although small new adipocytes were observed to appear a week later with their numbers peaking at 4 weeks following stem cell proliferation, and a central necrotizing zone showed no adipogenesis with several inflammatory cells observed after 2 weeks with marked necrosis, oil cysts, and fibrosis.[10,14] Demarcation of the surviving outer zone and the regenerating middle zone was observed at 1 to 300 μm and 600 to 1200 μm from the surface, respectively.[10] Therefore, it can be concluded that larger fat lobules are associated with a greater degree of fat necrosis. We performed fat graft harvesting using a multiport cannula containing several side holes measuring 1 mm in diameter with alternating cutting edges. The disadvantages of conventional fat transplantation including the risks of irregular fat accumulation and visible lumpiness can be avoided with the transplantation of small fat parcels.

Another important point in harvesting fat grafts is the amount of negative pressure used during suctioning. We follow the recommendations of most authorities on fat grafting including Pu, Coleman, Katzel, and James, who all recommend that the cannula should be pushed through the harvest site, and the surgeon should digitally manipulate and withdraw the plunger of a 10-mL syringe to provide slight negative pressure while the cannula is advanced and retracted through the harvested site.[2,5,15,16] Coleman has reported that a combination of slight negative pressure and the curetting action of the cannula through the tissues allows fat parcels to move through the cannula into the barrel of the syringe.[5] Several studies have reported the negative effect of high pressure on fat harvesting. It has been suggested that conventional liposuction may produce a more detrimental effect on fat cells than syringe aspiration for fat graft harvesting.[17] Pu et al observed significantly impaired adipocyte cellular function in conventional liposuction aspirates compared with fresh fatty tissue samples and syringe-aspirated fat.[15,18] The Coleman technique yields a greater number of viable adipocytes

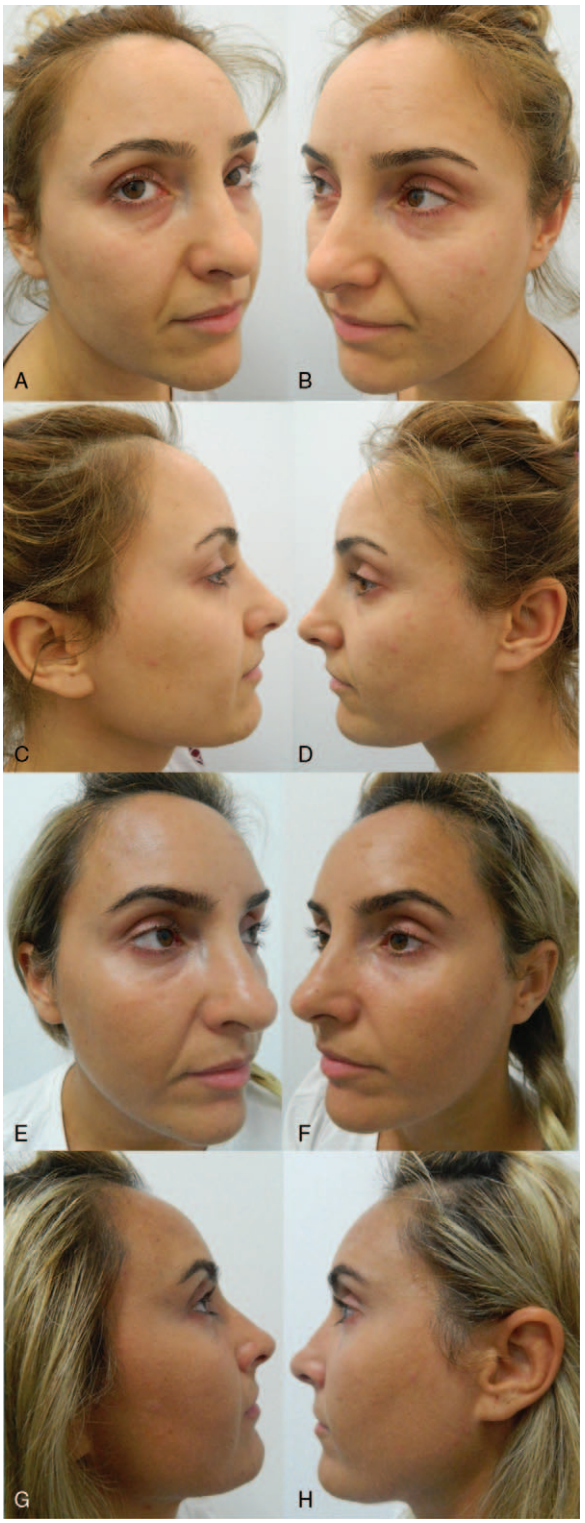

FIGURE 6. Preoperative anterior oblique (A, B) and lateral (C, D) views of a 37-year-old woman presented for facial recontouring and decreasing wrinkles with fat grafting to increase the youthful appearance. Results of 13 months postoperative views from MAFT + PRP are shown (E–H). Despite a rapid weight loss due to the patient's intense and stressful period in her life after the operation, malar lipofilling, and skin rejuvenation with decreased wrinkles can be seen primarily in lateral views which could not be explained by only lipofilling. Besides that the pigmentation of lower orbital palpebras has been decreased after the operation. MAFT, micro-autologous fat transplantation; PRP, platelet-rich plasma.

and sustains a more optimal level of cellular function within fat grafts and has been considered superior to conventional liposuction as a method of choice for fat graft harvesting over the last decade. However, the speed of centrifugation used by the Coleman technique may harm adipocyte cellular function.[19,20] Ferraro et al[20] have reported that high centrifugal forces such as those used in the Coleman technique (3000 revolutions per minute [rpm]) significantly damage fat cells with low cell viability, whereas very low centrifugal forces (500 rpm) show little effect on adipose tissue density, resembling fat decantation. Hoareau et al[19] reported that strong centrifugation (900g, 1800g) which is commonly used in the Coleman technique (3 minutes at 3000 rpm/900g) is harmful for adipose tissue because it causes a 3-fold higher rate of adipocyte death than that with low centrifugation (100g, 400g) and at speeds >400g, centrifugation causes irreversible damage and adipocyte death. It is recommended to remove the unnecessary and/or harmful components for adipose tissue engraftment/regeneration to reduce the graft volume without reducing the number of viable adipocytes and ADSCs for condensation of adipose tissue for grafting.[21] Condensation can be achieved without damaging adipocytes by initially performing gravity aided separation in a cool environment followed by gentle/slow centrifugation (300g over 4 minutes). Thus, the first application primarily removes water and red blood cells, and more condensed fat can be collected for the second application to generate further condensed fat with minimally damaged viable cells.

Platelet-rich plasma has become increasingly popular in all fields of plastic surgery since the 2000s. Platelet-rich plasma is an autologous concentration of platelets in a small volume of plasma. Platelet-rich plasma is useful in fat transplantation owing to its rich supply of cytokines and growth factors particularly TGF-β, PDGF, VEGF, FGF-2, and EGF that are known to play critical roles in cell proliferation, chemotaxis, cell differentiation, angiogenesis, and tissue remodeling.

Based on in vitro and in vivo studies, ADSCs have recently been demonstrated to secrete cytokines and growth factors including EGF, VEGF, PDGF, TGF-β, and basic FGF, among others, which demonstrate angiogenic, immunosuppressive, anti-inflammatory, and antioxidative properties.[22] These ADSCs secrete bioactive levels of angiogenic and antiapoptotic growth factors, and their secretion significantly increases under hypoxic conditions. Adipocyte-derived stem cells can potentially enhance fat grafting. Given this property of ADSCs, their combination with PRP may theoretically produce an additive effect. Addition of PRP to ADSCs causes the secretion of a variety of growth factors that affect surrounding tissues and cells because it is hypothesized that the combination promotes proliferation and differentiation of stem cells and maturation of preadipocytes into mature adipocytes.[22] Among the studies on PRP mixed with autologous fat for grafting, Cervelli et al observed that patients treated with reconstruction of a 3-dimensional projection of the face using fat grafting concomitant with PRP, showed 70% contour restoration and a 3-dimensional volume after 1 year as opposed to only 31% in control patients treated with only fat grafting.[23] Gentile et al[24] observed that patients treated with PRP added to autologous fat grafts showed a 69% rate of contour restoration and 3-dimensional volume after 1 year as opposed to 39% in controls treated with only centrifuged fat grafting for breast lipofilling. By contrast, a few authors have reported no effect of PRP addition on fat grafting. The study reported by Fontdevila et al[25] demonstrated a significant bias because the study evaluated facial lipofilling in patients with the human immunodeficiency virus infection treated with triple therapy—a treatment that is known to alter the physiology of fatty tissue because it evaluated the facial lipofilling in HIV patients under triple therapy, a treatment known to alter the physiology of fatty tissue. Hersant et al[26] also commented on the study because this patient group usually demonstrates thrombocytopenia and alteration in

platelet morphology and function. Willemsen et al[27] studied the use of PRP for facial lipofilling and concluded that the addition of PRP does not improve patient outcome. However, the authors admitted that their study was potentially biased and weakened with a fat:PRP ratio of 12:1 mL.[27] A study published by the same authors reported that ADSCs respond to PRP in a dose-dependent manner. This study compared the efficacy of 15%, 5%, and 1.7% PRP and concluded that PRP-stimulated cell proliferation was nearly 8-fold higher with PRP at a 15% concentration. Their study used 4.5 mL of PRP in a 25.5 mL lipograft.[28] Their observation regarding the dose-dependent effects of PRP on proliferation and ADSC function can explain the varying clinical results that have been observed thus far.[28]

An acknowledged limitation of the study is the lack of a control group of micro-autologous fat grafting without PRP. A prospective study including patients undergoing facial lipofilling with addition either saline or PRP could be possible; however, it could be argued that particularly when comparing a treatment modality with a no treatment response control group would be unwise and unethical. We performed MAFT + PRP surgery to all of our patients because we believe that this technique is the most acceptable surgery for our patients and while we perform this surgery method, we could not perform any other surgical modalities. If a retrospective study was designed to compare fat grafting with and without PRP groups, there would be the lack of standardization in collection methods and sample analysis which can be seen as another limitation. Another limitation of the study could be seen as using the FACE-Q scales which can be argued as subjective assessments. We believe that any surgical technique made on a patient should be combined with a specific questionnaire to assess the actual result on the patient to better understand the recovery process, quality of life impact of facial aesthetic procedures. So that, recently developed and validated FACE-Q which was can be smoothly incorporated into research and/or routine clinical practice.[29]

The FACE-Q module, which measures patient-reported outcomes of facial cosmetic treatments in a scientifically sound manner, confirmed marked post-treatment satisfaction with image perception in terms of its impact on social life and relationships. A combination of PRP and micro-fat grafting with soft harvesting and processing can be viewed as a useful surgical technique to restore volume and enhance skin quality in facial soft tissue augmentation. Per Coleman's statement in his famous article, "Fat can fill large and small soft-tissue defects of the face and body, with every indication of permanence. However, fat grafting does not seem to work equally for every technique, for every area of the body, for every patient, or for every surgeon."[5] We are of the view that minimal damage during harvesting the fat graft, appropriate processing, and the addition of PRP in combination with the fat graft may increase patient and surgeon satisfaction related to outcomes.

REFERENCES

1. Pu LLQ. Fat grafting for facial rejuvenation and contouring: a rationalized approach. *Ann Plast Surg* 2018;81(suppl 1):S102–S108
2. Coleman SR, Katzel EB. Fat grafting for facial filling and regeneration *Clin Plast Surg* 2015;42:289–300
3. Diepenbrock RM, Green JM. Autologous fat transfer for maxillofacial reconstruction. *Atlas Oral Maxillofac Surg Clin North Am* 2018;26:59–68
4. Liao H-T, James IB, Marra K, et al. The effects of platelet-rich plasma on cell proliferation and adipogenic potential of adipose-derived stem cells. *Tissue Eng Part A* 2015;21:2714–2722
5. Coleman SR. Structural fat grafting: more than a permanent filler. *Plast Reconstr Surg* 2006;118(suppl):108S–120S
6. Ozer K, Kankaya Y, Çolak O. An important and overlooked parameter in platelet rich plasma preparation: the mean platelet volume. *J Cosmet Dermatol* 2018. [published ahead of print June 3, 2018] doi: 10.1111/jocd.12682
7. Atashi F, Jaconi MEE, Pittet-Cuénod B, et al. Autologous platelet-rich plasma: a biological supplement to enhance adipose-derived mesenchymal stem cell expansion. *Tissue Eng Part C Methods* 2015;21:253–262
8. Klassen AF, Cano S, Pusic AL. A revolutionary patient-reported outcome instrument by Memorial Sloan-Kettering Cancer Center: FACE-Q. 2010. Available at: https://eprovide.mapi-trust.org/instruments/face-q2#online_distribution. Accessed October 13, 2018.
9. East C, Badia L, Marsh D, et al. Measuring patient-reported outcomes in rhinoplasty using the FACE-Q: a single site study. *Facial Plast Surg* 2017;33:461–469
10. Gause TM, Kling RE, Sivak WN, et al. Particle size in fat graft retention: a review on the impact of harvesting technique in lipofilling surgical outcomes. *Adipocyte* 2014;3:273–279
11. Shue S, Kurlander DE, Guyuron B. Fat injection: a systematic review of injection volumes by facial subunit. *Aesthetic Plast Surg* 2018;42:1261–1270
12. Coleman SR. Facial recontouring with lipostructure. *Clin Plast Surg* 1997;24:347–367
13. Carpaneda CA, Ribeiro MT. Study of the histologic alterations and viability of the adipose graft in humans. *Aesthetic Plast Surg* 1993;17:43–47
14. Kato H, Mineda K, Eto H, et al. Degeneration, regeneration, and cicatrization after fat grafting: dynamic total tissue remodeling during the first 3 months. *Plast Reconstr Surg* 2014;133:303e–313e
15. Pu LLQ, Coleman SR, Cui X, et al. Autologous fat grafts harvested and refined by the Coleman technique: a comparative study. *Plast Reconstr Surg* 2008;122:932–937
16. James IB, Coleman SR, Rubin JP. Fat, stem cells, and platelet-rich plasma. *Clin Plast Surg* 2016;43:473–488
17. Davis K, Rasko Y, Oni G, et al. Comparison of adipocyte viability and fat graft survival in an animal model using a new tissue liquefaction liposuction device vs standard Coleman method for harvesting. *Aesthetic Surg J* 2013;33:1175–1185
18. Pu LLQ, Cui X, Fink BF, et al. The viability of fatty tissues within adipose aspirates after conventional liposuction: a comprehensive study. *Ann Plast Surg* 2005;54:288–292
19. Hoareau L, Bencharif K, Girard AC, et al. Effect of centrifugation and washing on adipose graft viability: a new method to improve graft efficiency. *J Plast Reconstr Aesthetic Surg* 2013;66:712–719
20. Ferraro GA, De Francesco F, Tirino V, et al. Effects of a new centrifugation method on adipose cell viability for autologous fat grafting. *Aesthetic Plast Surg* 2011;35:341–348
21. Kuno S, Yoshimura K. Condensation of tissue and stem cells for fat grafting. *Clin Plast Surg* 2015;42:191–197
22. Picard F, Hersant B, La Padula S, et al. Platelet-rich plasma-enriched autologous fat graft in regenerative and aesthetic facial surgery: technical note. *J Stomatol Oral Maxillofac Surg* 2017;118:228–231
23. Cervelli V, Gentile P, Scioli MG, et al. Application of platelet-rich plasma in plastic surgery: clinical and in vitro evaluation. *Tissue Eng Part C Methods* 2009;15:625–634
24. Gentile P, Di Pasquali C, Bocchini I, et al. Breast reconstruction with autologous fat graft mixed with platelet-rich plasma. *Surg Innov* 2013;20:370–376
25. Fontdevila J, Guisantes E, Martínez E, et al. Double-blind clinical trial to compare autologous fat grafts versus autologous fat grafts with PDGF: no effect of PDGF. *Plast Reconstr Surg* 2014;134:219e–230e
26. Hersant B, Picard F, Meningaud JP. Double-blind clinical trial to compare autologous fat grafts versus autologous fat grafts with PDGF: no effect of PDGF. *Plast Reconstr Surg* 2015;135:787e–788e
27. Willemsen JCN, Van Dongen J, Spiekman M, et al. The addition of platelet-rich plasma to facial lipofilling: a double-blind, placebo-controlled, randomized trial. *Plast Reconstr Surg* 2018;141:331–343
28. Willemsen JCN, Spiekman M, Stevens HPJ, et al. Platelet-rich plasma influences expansion and paracrine function of adipose-derived stromal cells in a dose-dependent fashion. *Plast Reconstr Surg* 2016;137:554e–565e
29. Tenna S, Cogliandro A, Barone M, et al. Comparative study using autologous fat grafts plus platelet-rich plasma with or without fractional CO_2 laser resurfacing in treatment of acne scars: analysis of outcomes and satisfaction with FACE-Q. *Aesthetic Plast Surg* 2017;41:661–666