

Facial Contouring and Rejuvenation with the Use of Fat Injection

Gaye TOPLU ¹, Dincer ALTINEL ¹

ABSTRACT

Aim: Reversing the effects of facial aging is achieved through a combination of the best techniques. Minimizing the appearance of fine wrinkles is an important part of treatment, which can include skin resurfacing, intradermal filling injections, or a combination of the two. The search for the ideal filling material continues, but intradermal fat injections can be a cheap and safe alternative to classic intradermal fillers. This study aims to evaluate the feasibility, validity, and reliability of micrograft, nanofat graft, sharp needle intradermal fat grafting (SNIF) technique.

Material and Methods: In this retrospective study, the records of 13 consecutive patients treated over 3 years were reviewed to evaluate the results of the technique including panfacial rejuvenation, contouring, augmentation with fat injection, and its complications.

Results: The results were evaluated by clinical examination and patient photographs. Aesthetically good healing was achieved using microfat graft, nanofat graft, sharp needle emulsified fat with intradermal injection techniques, the results lasted more than 1 year, which exceeded the expected time for absorbable dermal fillers (typically 3 to 6 months). No major complications were encountered; the most common minor complications were bruising and swelling.

Conclusion: Microfat and nanofat grafts, SNIF, are a safe and effective alternative to conventional absorbable dermal fillers for patients who can accept minor discomfort from donor site fat harvesting. Fat harvesting and injection techniques should be done precisely to achieve proper results and prevent complications.

Keywords: Plastic surgery; esthetic surgery; cosmetic surgery.

Yağ Enjeksiyonunun Yüze Kontür Verme ve Yüz Gençleştirmede Kullanımı

ÖZ

Amaç: Yüz yaşlanmasının etkilerini tersine çevirmek en iyi tekniklerin bir kombinasyonu ile elde edilir. İnce kırışıklıkların görünümünü en aza indirmek, yüzey yenileme, intradermal dolgu enjeksiyonları veya ikisinin bir kombinasyonunu içerebilen tedavinin önemli bir parçasıdır. İdeal dolgu malzemesi arayışı devam etmektedir, ancak intradermal yağ enjeksiyonları klasik intradermal dolgulara ucuz ve güvenli bir alternatif olabilir. Bu çalışmanın amacı mikrogreft, nanogreft, keskin iğne intradermal yağ greftleme (SNIF) tekniğinin fizibilitesini, geçerliliğini ve güvenilirliğini değerlendirmektir.

Gereç ve Yöntemler: Çalışmamızda, 3 yıllık bir süre içinde tedavi edilen 13 ardışık hastanın kayıtları panfasial gençleştirme, kontür verme, augmented etme amaçlı yağ alma ve verme tekniğini ve komplikasyonlar dahil sonuçlarını değerlendirmek için gözden geçirildi.

Bulgular: Sonuçlar klinik muayene ve hasta fotoğrafları ile değerlendirildi. Mikroyağ grefti, nanoyağ grefti, keskin iğne ile emülsifiye edilmiş yağ ile intradermal enjeksiyon teknikleri kullanılarak estetik açıdan iyi iyileşme sağlandı, sonuçlar 1 yıldan fazla sürdü, bu da emilebilir dermal dolgu maddeleri (tipik olarak 3 ila 6 ay) için beklenen süreyi aştı. Hiçbir önemli komplikasyon oluşmadı; en sık görülen küçük komplikasyonlar morarma ve şişlikti.

Sonuç: Mikroyağ ve nanoyağ grefti, SNIF, donör bölgesinden yağ alımındaki küçük rahatsızlığı kabul edebilen hastalar için, klasik emilebilir dermal dolgu maddelerine güvenli ve etkili bir alternatiftir. Yağ alma ve enjeksiyon teknikleri

1 Istanbul Training and Research Hospital, Department of Plastic, Reconstructive and Aesthetic Surgery, Istanbul, Turkey

Corresponding Author: Gaye TOPLU, e-mail: gayetoplu@gmail.com
Received: 28.08.2020, Accepted: 13.11.2020

uygun sonuçlar elde etmek ve komplikasyonları önlemek için hassas bir şekilde yapılmalıdır.

Anahtar Kelimeler: Plastik cerrahisi; estetik cerrahisi; kozmetik cerrahisi.

INTRODUCTION

Fat autografts were prepared with different techniques in accordance with the needs of each patient. The use of these different sizes of fat grafts not only replaces the shortage of volume, but also the combination of deep injections or superficial injections with the help of the cannula, contributes to the reconstruction, rejuvenation and beautification of the entire facial area as a whole (1,2).

Fat grafts are widely used worldwide. While it was first used as a volume enhancer, it was also used in regenerative medicine because of the high amount of adult stem cells it contains (3). It is frequently preferred due to its easy and large amounts, adaptability to every structure and shape, easy application, and autologous texture. Fat grafts are used for aesthetic applications to refresh and support the skin and subcutaneous tissues.

Since fat grafting is an easy and effective application, its use in aesthetic surgery has become increasingly indispensable. The fat graft is autogenous and allergy/rejection is not observed. Despite the easiness of application and low risk for complications, undesired results can occur if the basic principles are not followed. Obtaining, processing, and application of the fat graft should be done with the appropriate technique to reduce the negative results by taking the necessary measures (4-8).

Fat grafts are harvested from the most suitable donor site by taking into consideration the patient needs. It is important to avoid any complications in the areas where the fat graft will be taken. The most commonly used donor areas in our application of fat graft injection to the face are the abdomen, inner thigh, inner-knee, flanks, and hip.

The first studies on fat grafting were in the early twentieth century (7, 9-11). In 1977, with the application of liposuction was introduced by Illouz (12). In 1986, fat injection application technique was standardized by Coleman. Following the introduction of adipose-derived stem cells, which were discovered in the first years of the 21st century, and its clinical application, has resulted in significant progress in recent years.(1-3, 13). Thus, the indications for fat grafting are gradually increasing, and currently, stem cell therapy applications from fat are extending far beyond the field of plastic surgery (14-21). We used these injections alone in some patients, while others combined with surgical (lower-upper blepharoplasty, facelift, temporal lift etc.) or non-surgical (such as Erbium, fractional CO2 laser, chemical peeling etc.) surface regeneration and rejuvenation techniques.

MATERIAL AND METHODS

In this retrospective study, the records of 13 consecutive patients treated between the years 2014 and 2019, were reviewed to evaluate the results of the technique including panfacial rejuvenation, contouring, augmentation with fat injection, and its complications. All the patients fitting the criteria were included in the

study. Patient consents were obtained from all patients prior to the procedure. The article complied with research and publication ethics. Ethical comity approval was obtained from Istanbul Training and Research Hospital (Date:07.10.2020,No:2473).

Physical examination

Initially, the patient is evaluated by inspection. If the patient has previously taken photographs, the skin/subcutaneous damage over the years can be evaluated better. Eyebrow position in the photos, eyelid contour height and malar fullness helps in evaluating. Physical examination generally evaluates the loss of facial fat compartments and bone tissue (such as temporals, eyebrow fat pads, tear troughs, pre-jowl sulcus, and mandibular edge.) Skin thickness is important. In patients with thin skin, the risk of visible lumps is higher if the fat is placed too superficially. Asymmetries of the face, volume losses, previous operations (swelling may take longer after fat injection of the patient with lower blepharoplasty), underlying bone and tooth problems, facial implants are noted. Areas suitable for fat transfer; forehead, temporal, eyebrow, lower and upper eyelids, zygoma, malar, buccal, cheek, chin, jawline, ear lobule, upper and lower lips.

Sun rays are considered to be the most important environmental factor that impairs skin quality and causes skin aging. This also affects the results of the applied technique. For this reason, we ask our patients to take protective measures from the harmful effects of sun rays after the application. We make suggestions to increase skin moisture.

Preoperatively, it is important to take photographs of the patient from certain standard angles. It is important to accurately identify the patient's upright position, voids, looseness, asymmetry, and bone changes during marking. With the combination of local tumescent infiltration anesthesia and oral premedication (anxiolytic etc.), the patient can safely and comfortably transfer fat. While different anesthesia techniques may be preferred, we used oral anxiolytic and local infiltration in our studies.

Fat harvesting procedure

1. The donor area is wiped with a chlorhexidine sponge.
2. The entrance hole of the cannula is injected with local anesthesia with 1% lidocaine.
3. Approximately 200 ml of tumescent solution is infiltrated with a 2 mm Coleman infiltration cannula with the fanning technique (Figure 1a).
4. Approximately 30-50 mL of fat is taken with a 2.4 mm Tulip Triport Harvesting cannula (Figure 1b).
5. After the syringes are filtered, the micronized fat is taken into the 10ml syringe and passed from the 2.4mm Tulip microadapter to the 1 ml luer lock syringe (Figure 1c).
6. Microfat grafts are transformed into nanografts 40-60 times back and forth from 1.2 mm Tulip nanoadapter of micronized fat taken with Tulip microcannula (Figure 1d).

Fat injection procedure

1. Face is wiped with chlorhexidine sponge.
2. Local anesthesia is applied to the areas to be injected on the face with 1% Lidocaine with Epinephrine.
3. Cannula entry holes are punctured with 19 gauge needles to the areas of the face to be injected. The

microfat and nanofat grafts, previously prepared, are injected with an insulin injector and a tulip cannula of size 0.7mm or 1.2mm depending on the depth, region, and purpose of the procedure. Nanofat is placed superficially (subdermally) in areas that require skinstrengthening (perioral lines, crow's feet). Nanofat is often preferred in the areas that require superficial application, while microfat is applied to areas that require deeper application (Figure 1e).

Post-operative care

The slightly yellowish color appearing immediately after the fat injection will disappear within one hour of erythema treatment. Ecchymosis can also as a result of puncture of superficial capillaries. Both erythema and ecchymosis can be easily closed with a concealer cream after 3 days. Postoperative treatment does not require specific skincare.

It can be used in combination with fractional CO₂ laser or medium depth chemical peels, skin rejuvenation processes, fat transfer.

Surgical procedures for facial rejuvenation can also be combined with fat transfer. In this case, we recommend performing the fat transfer procedure before blepharoplasty and / or facelift surgery. The combination of volume restorations of surgical procedures with fat increases the cosmetic result and provides the patient with a recovery time and ease for multiple procedures.

The surgeon needs to follow the preoperative drawings during fat transfer. Swelling from anesthesia and tissue trauma during the transfer may disrupt normal facial features and signs, leading to undesirable results. In our practice, it is routine to collect and freeze excessive amounts of fat to allow "retouching" in the first year.

Patients will have a variable swelling and bruising that gradually improves in the first 3 days, which improves in the next 7 days. They can continue applying cold for the first 4-6 hours, 15 minutes per hour.

It is recommended to continue supplementing bromelain (pineapple extract) 2 times a day for 10 days after the procedure. Corset application to the degreased area is recommended for 48-72 hours. Patients are re-evaluated at the postoperative 7th-day for general evaluation and in the 3rd, 6th, 12th months to see if additional fat grafts are required.

The injected stem cells enter a maturation period 6 months following the procedure. Successful results are obtained as a result of appropriate evaluations of each patient and application of techniques specific to patient's needs.

Statistical Analysis

Descriptive statistics were calculated using the GraphPad Prism 7.0 software (GraphPad Software, Inc., La Jolla, CA,USA).

RESULTS

In our study; 1 patient was male (7.7%) and 12 were female (92.3%). The mean patient age was 42.4 ± 5.9 years (35-53). A total of 34 fat grafts were applied to 13 patients (mean: 2.6 ± 0.5 treatment per patients). In this series, the most common injection sites were periorbital and perioral regions. Five of the 13 patients (38.5%) received an average of 12 months after the patient's request and a doctor's recommendation, and for the

second time, fat grafts were performed with microfat, nanofat and SNIF techniques. 13 (100%) microfat grafts, 10 (76.9%) nanofat grafts and 11 (84.6%) SNIFs were performed. In addition to fat injection, 12 (92.3%) botulinum toxins, 9 (69.2%) 3 sessions Fractional Radiofrequency (60%, 1-2.5mm, Fraxis Duo-IIlooda), 2 (15.4%) chemical peeling (TCA), 4 (30.8%) blepharoplasty, 3 (23.1%) temporal lifting and 1 (7.7%) Facelift was performed (Table 1-2).

Table 1. List of surgical and non-surgical procedures

	Number of patients	Percentage of patients
Botox	12	92.3%
Radiofrequency	9	69.2%
Chemical Peeling(TCA)	2	15.4%
Microfat graft	13	100 %
Nanofat graft	10	76.9 %
SNIF	11	84.6 %
Blepharoplasty	4	30.8 %
Temporal lift	3	23.1 %
Face lift	1	7.7 %

Sharp Needle Intradermal Fat Grafting

The mean follow-up was 23 months (12 months-36 months). No further treatment was performed on 13 patients for at least 1 year because either they were not considered appropriate by the physician or the patients didn't feel the need for additional procedures in this period.

None of the patients had serious complications such as asymmetry, lymphedema, contour deformity, irregularity, nodularity, induration, cyst, infection, necrosis, or fat embolism due to intravascular injection. The bruising of the treated area was observed in 1 (7.7%) of the patients. It declined in 1 week. 2 (15.4%) of the patients had mild swelling that lasted 5 days after the procedure. Although 1 patient lost a significant amount of weight in 1 year, the results remained stable (Figure 2,3,4,5).

Table 2. Summary of patient data

	Mean	Standard Deviation	Minimum-Maximum
Age (years)	42.4	5.9	34-53
Body mass index (BMI)	23	2.5	20-27
Microfat graft volume (ml)	9.76	4.4	4-17
Nanofat graft volume (ml)	2.4	0.5	2-3
SNIF volume (ml)	2.36	0.67	2-4
Total injection volume (ml)	13.2	6.2	5-21
Follow-up period (month)	23	7.7	12-36

Sharp Needle Intradermal Fat Grafting

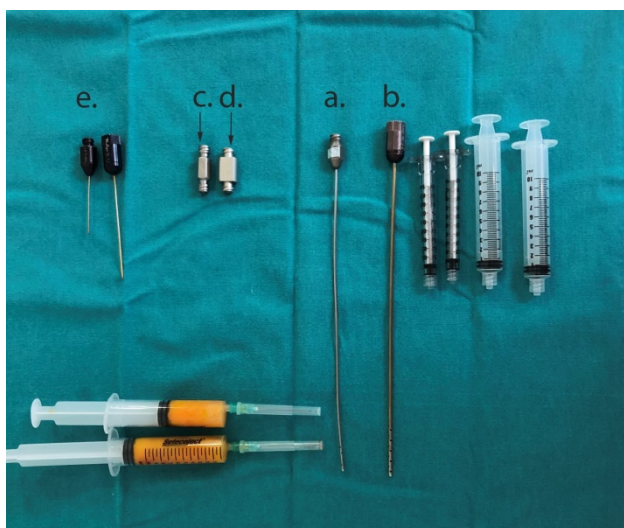


Figure 1. (a) Fat injection cannulas (0.7-1.2mm Tulip). Special blunt cannulas are required to safely perform fat grafting and poor outcomes are likely if sharp hypodermic needles are used. Sharp needle injection also poses a risk of fat embolization and related problems. (b) microfat graft adapter, (c) nanofat graft adapter. (d,e) Fat harvesting instruments. (d) 1.6-mm Coleman local anesthetic infiltration cannula, (e) 2.4-mm Tulip Triport harvesting cannula. 1mL and 10-mL Luer lock syringe.



Figure 2. Fat Injections. (a-e) A 48 year old patient before procedure. She has had no prior surgery. (f-k) Shaded areas show where the fat was placed. 2 ml microfat was placed in each upper orbit, 1 ml microfat graft was placed in each tear trough, 3 ml microfat graft and 1.5 ml nanofat graft was placed in each infra-orbital area, 1.5 ml SNIF was placed in each nasolabial crease and smoker line in each lip. 1 ml microfat graft was placed in each marionette. Total of 20 ml of fat injection was performed.

DISCUSSION

Subcutaneous fat loss, muscle atrophy and hypertrophy of the aging face, bone resorption and loss of skin elasticity create a cosmetically unpleasant appearance. In the face of this situation, the cosmetic surgeon should plan the rejuvenation program that best meets the needs of the patient.

In the past decade, there have been more publications on the elucidation of the subcutaneous facial structure and age-related changes (22). Rohrich and Pessa (23) have shown that the subcutaneous adipose tissue is not a single whole piece, but in the form of multiple fat compartments by muscles and muscles.



Figure 3. Fat Injections. (a-e) A 50 year old patient before procedure. She has had no prior surgery. (f-j: postoperative 6. month, k-o: postoperative 18. month.) Shaded areas show where fat was placed. 1 ml microfat graft was placed in each tear trough, 4 ml microfat graft and 1.5 ml nanofat graft was placed in each infra-orbital area, 1 ml SNIF was placed in each nasolabial, forehead and periorally deep wrinkles. 1 ml microfat graft was placed in each marionette. Total of 17 ml of fat injection was performed.



Figure 4. Fat Injections. (a-e) A 34 year old patient before procedure. She has had no prior surgery. (f-j: postoperative 12. month) Shaded areas indicate the fat injection locations. 1 ml microfat graft was placed in each tear trough, 5 ml microfat graft and 1 ml nanofat graft was placed in each infra-orbital area, 2 ml SNIF was placed in each nasolabial crease and glabella, perioral smoker line in each lip. 1 ml microfat graft was placed in each marionette. Total of 20 ml of fat injection was performed.

Superficial fat compartments; orbital fat compartments (superior, inferior, lateral), nasolabial, cheek fat compartments (medial, middle, lateral temporal), and deep fat compartments; sub-orbicularis oculi are defined as fat compartments (medial, lateral), deep cheek compartments (medial, lateral). This provides ease in locating and correcting the volume deficiency. Applying fat grafts to deep compartments provides contouring, lifting, and shallow applications to improve wrinkle and skin texture quality. Classical fat grafting is often used to create large amounts of volume, especially in breast reconstructive cases. In these cases, it is very important to

protect as many adipocytes as possible. Nanofat cannot create a significant fat volume. Therefore, the indications for nanofat injection are different compared to microfat grafting. Nanofat grafting is often combined with microfat grafting models, where nanofat grafting is used to improve the skin quality and improve atrophic skin areas. In our experience, unlike microfat, the effect of nanofat usually lasts with a delay of 4 weeks to 3 months. Since adipocytes do not survive the emulsification process, it can be questioned whether a nanofat transfer is a "fat grafting" procedure. The biggest effect of nanofat injection is probably a stem cell activity.

Skin aging is a multi-factor process. Skin aging occurs with the effect of multiple external and internal factors. The frequency and severity of these factors change the skin and subcutaneous tissues over time. We, physicians, frequently detect these changes in patients in the form of weakening of the skin quality, dryness, loss of elasticity, wrinkles and sagging. The purpose of our treatment planning is to replace the missing tissues that cause this appearance and refresh the skin.

The ideal dermal filler should have an efficacy that has been demonstrated by clinical studies and should be cost-effective. Dermal fillers with minimal side effects should be preferred. The longevity of the result of the filler must also be taken into account (8, 24). Filling materials can be obtained from different sources. Filling materials can be divided into two categories as the ones obtained from the patient's own body (autologous) and the ones from other biologically compatible sources (heterologous) (25). Sometimes, after a few months, delayed side effects can occur and appear as granulomas, sometimes permanent, under the skin. Although these late-period complications, they are often encountered after the application of fillings that are not obtained from the patient's own body, that is, obtained from heterologous sources despite being biologically compatible. Managing these complications is challenging for the physician. Examples of these kind of complications include superficial epithelization problems in the skin, regional swelling and lymph tissue involvement (26). In our study; Since autologous fat grafts are used as fillers, there are no problems with the use of heterologous fillers.

As a result of long years of studies, the histological and cellular effects of fat-derived stromal vascular fraction (SVF) have begun to be better understood. Clinical results obtained by nanofat grafting support the hypothesis that the use of the entire cell mixture and their natural scaffolds (extracellular matrix, structural tissues and intracellular messengers) may be more valuable than any of the SVF components used (7, 11).

With the nanofat grafting technique, the cells that we have prepared and made suitable for infiltration should be given to the recipient area as carefully as possible. In Coleman's classical macrophate graft technique, cannulas with wider ends and high probability of complications are used. Smaller cannulas have become popular for sensitive areas such as eyelids and lips. The small particle fat grafts, also known as microfat grafts, were used as a 23-gauge sharp needle intradermal fat graft published as SNIF technique of these small particle fat grafts by thinning and further thinning. Recently, it has been aimed to inject fat through smaller needles (27 gauge) into more

sensitive thin surface areas to ensure filling of very fine rhythms and improving the quality of the skin. To allow the fat graft to pass through these 27 gauge needles, microfats were mechanically emulsified and converted into nanofat. The surprising clinical changes in the quality and texture of the treated skin areas allowed us to use it in our patients. In this study, we share our results and experiences that we achieved with the combined use of microfat, nanofat, and SNIF technique.

Nanofat is a method mainly used to make the skin structure healthier. Although dermal fillers are often used to increase tissue fullness, our goal in using nanofat is to rejuvenate the skin rather than filling it. Nanofat is used in many clinical conditions and lesions (scar, atrophic and pigmented skin) that may cause skin aging. Nanofat application has become the main component of our procedure. At the same time, it was observed that better results were obtained by combining the nanofat technique with the microfat and SNIF technique in suitable patients in certain anatomical regions. This technique has proven to be applicable to almost every patient. Nanofat is usually applied in combination with SNIF for microfat or superficial rhythms to correct facial volume. Erbium can also be combined with chemical peeling surface resurfacing techniques such as fractional CO2 laser and trichloroacetic acid (TCA).

Areas in need of treatment vary from patient to patient, and planning an fat grafting procedure requires a different look at the face according to the needs of the patient and the doctor's experience; Any area that can be successfully treated with non-autologous injectable fillers, temporals, forehead, eyebrows, glabella, radix, supraorbital (upper eyelid), infraorbital (lower eyelid), malar, tear groove, nasolabial, geniomandibular groove, The jaw areas can potentially be treated with fat grafting (27,28). In our study, the full face evaluation of our patients, microfat, nanofat, and SNIF application were used in combination with the required areas and good results were obtained.

In our study; we detected positive changes in the quality, pigmentation and texture of patients' facial skin after the fat grafts were transferred to certain areas of the face in different emulsions and modifications (microfat, nanofat etc.). We used microfat grafts, nanofat grafts for the correction of atrophic skin damage caused by age and sun damage, healing of the lower eyelid hyperpigmentation, full face rejuvenation and beautification together with SNIF for enhancing skin quality.

Microfat, nanofat graft and SNIF are safe and effective alternatives to conventional absorbable dermal fillers for patients who can accept minor discomfort of fat intake from the donor area. Harvesting and injection techniques should be done precisely to achieve proper results and prevent complications.

Acknowledgement: We would like to thank Dr. Merdan Serin for his support in the planning of the study.

Authors' Contributions: Concept: T.G., A.D.; Design: T.G., A.D.; Data Collection and/or Processing: T.G., A.D.; Analysis and/or Interpretation: T.G., A.D.; Literature Search: T.G., A.D.; Manuscript Writing: T.G., A.D.

REFERENCES

1. Coleman SR. Structural fat grafting. *Aesthet Surg J*. 1998;18(5):386-8.
2. Coleman SR. Structural fat grafting: more than a permanent filler. *Plast Reconstr Surg*. 2006;118(Suppl 3):108S-20S.
3. Zuk PA. The adipose-derived stem cell: looking back and looking ahead. *Mol Biol Cell*. 2010;21(11):1783-7.
4. Li X, Kubiak CA, Yang X, Kemp SWP, Cederna PS, Ma J. Forehead fat grafting: Asian facial contouring and augmentation. *Plast Reconstr Surg*. 2019;144(5):1057-65.
5. Lindenblatt N, van Hulle A, Verpaele AM, Tonnard PL. The Role of Microfat Grafting in Facial Contouring. *Aesthet Surg J*. 2015;35(7):763-71.
6. Serra-Mestre JM, Serra-Renom JM, Martinez L, Almadori A, D'Andrea F. Platelet-rich plasma mixed-fat grafting: a reasonable pro-survival strategy for fat grafts? *Aesthetic Plast Surg*. 2014;38(5):1041-9.
7. Tonnard P, Verpaele A, Peeters G, Hamdi M, Cornelissen M, Declercq H. Nanofat grafting: basic research and clinical applications. *Plast Reconstr Surg*. 2013;132(4):1017-26.
8. Zeltzer AA, Tonnard PL, Verpaele AM. Sharp-needle intradermal fat grafting (SNIF). *Aesthet Surg J*. 2012;32(5):554-61.
9. Friji MT. Nanofat grafting: basic research and clinical applications. *Plast Reconstr Surg*. 2014;134(2):333e-4e.
10. Memar O, Nezamabadi A, Milani BY, Milani FY, Djalilian A. Nanofat grafting: basic research and clinical application. *Plast Reconstr Surg*. 2014;133(5):728e.
11. Tonnard P, Verpaele A, Carvas M. Fat grafting for facial rejuvenation with nanofat grafts. *Clin Plast Surg*. 2020;47(1):53-62.
12. Illouz YG. Body contouring by lipolysis: a 5-year experience with over 3000 cases. *Plast Reconstr Surg*. 1983;72(5):591-7.
13. Coleman SR. Long-term survival of fat transplants: controlled demonstrations. *Aesthetic Plast Surg*. 1995;19(5):421-5.
14. Fawzy El-Sayed KM, Dorfer C, Fandrich F, Gieseler F, Moustafa MH, Ungefroren H. Adult mesenchymal stem cells explored in the dental field. *Adv Biochem Eng Biotechnol*. 2013;130:89-103.
15. Oh JS, Park IS, Kim KN, Yoon DH, Kim SH, Ha Y. Transplantation of an adipose stem cell cluster in a spinal cord injury. *Neuroreport*. 2012;23(5):277-82.
16. Okura H, Saga A, Soeda M, Miyagawa S, Sawa Y, Daimon T, et al. Intracoronary artery transplantation of cardiomyoblast-like cells from human adipose tissue-derived multi-lineage progenitor cells improve left ventricular dysfunction and survival in a swine model of chronic myocardial infarction. *Biochem Biophys Res Commun*. 2012;425(4):859-65.
17. Puissant B, Barreau C, Bourin P, Clavel C, Corre J, Bousquet C, et al. Immunomodulatory effect of human adipose tissue-derived adult stem cells: comparison with bone marrow mesenchymal stem cells. *Br J Haematol*. 2005;129(1):118-29.
18. Toplu G, Ozcelik D, Serin M, Erdem H, Topacoglu AT. Adipose tissue-derived stromal vascular fraction increases osteogenesis in an experimental design zygomatic bone defect model. *J Craniofac Surg*. 2017;28(8):2179-82.
19. Turkseven A, Ozcelik D, Calis M, Celik HH, Yilmaz F, Onbas O, et al. Does periosteal graft combined with platelet-rich plasma enhance the healing of bone defect? *J Craniofac Surg*. 2018;29(4):1072-80.
20. Yoo KH, Jang IK, Lee MW, Kim HE, Yang MS, Eom Y, et al. Comparison of immunomodulatory properties of mesenchymal stem cells derived from adult human tissues. *Cell Immunol*. 2009;259(2):150-6.
21. Zhou B, Yuan J, Zhou Y, Ghawji M Jr, Deng YP, Lee AJ, et al. Administering human adipose-derived mesenchymal stem cells to prevent and treat experimental arthritis. *Clin Immunol*. 2011;141(3):328-37.
22. Obagi S, Willis C. Autologous fat augmentation of the face. *Atlas Oral Maxillofac Surg Clin North Am*. 2018;26(1):41-50.
23. Rohrich RJ, Pessa JE. The fat compartments of the face: anatomy and clinical implications for cosmetic surgery. *Plast Reconstr Surg*. 2007;119(7):2219-27.
24. Carraway JH. Commentary on: Sharp-needle intradermal fat grafting (SNIF). *Aesthet Surg J*. 2012;32(5):562-3.
25. De Bouille K. Management of complications after implantation of fillers. *J Cosmet Dermatol*. 2004;3(1):2-15.
26. Zhanqiang L. Fat grafting for pan-facial contouring in Asians: a goal-oriented approach based on the facial fat compartments. *Clin Plast Surg*. 2020;47(1):111-7.
27. Marten TJ, Elyassnia D. Fat grafting in facial rejuvenation. *Clin Plast Surg*. 2015;42(2):219-52.
28. Coleman SR. Facial augmentation with structural fat grafting. *Clin Plast Surg*. 2006;33(4):567-77.