Microfat and Nanofat

When and Where These Treatments Work

Jordan Rihani, MD

KEYWORDS

• Nanofat • Microfat • Facial volumization • Facial rejuvenation
• Adipose-derived mesenchymal stem cells • Fat grafting • Injectable filler

KEY POINTS

- Newer fat-grafting techniques have decreased many of the original drawbacks of fat-grafting procedures.
- Adipose tissue contains large stores of mesenchymal stem cells that are showing great promise in bioregenerative medicine.
- Injection of nanofat combined with microfat seems to offer improvement in skin texture as well as structural volumization.
- Basic principles of microfat and nanofat are reviewed, as well as a description of injection technique.

INTRODUCTION

Although fat and dermal-fat grafting has been performed for over 50 years[1] and the injection of fat grafts have been performed nearly 30 years,[2] the popularity of facial fat grafting has remained relatively stable. On the contrary, since U.S. Food and Drug Administration approval, the hyaluronic acid filler market has seen an explosive, upward climb.[3] Behind this trend is an increasing awareness by both patients and providers about the important role of volume loss in facial aging. Bone, fat, and muscle loss share equal roles with loss of skin elasticity in the aging process.[4]

The injectable filler market today is a 3 billion dollar industry and includes a variety of products including hyaluronic acid (HA), poly-L-lactic acid, calcium hydroxylapatite, and polymethyl methacrylate. With the ease of use of these products, lack of donor site morbidity, predictable outcome, and the reversibility of HA fillers, it is easy to see why this market has grown so much over the last 13 years. However, many patients are searching for longer-lasting, more natural solutions than the 9 to 12 month results afforded by most fillers currently available on the market. For these reasons, many have returned to using fat grafting as a solution for many of those shortcomings.

The theoretic draw to fat transfer is easy to see—it seems more "natural" to patients as an autologous graft, it is not price restricted at high volumes, and it is capable of producing long-term results. However, we also must consider the potential downsides, which include: donor site morbidity, unpredictability of graft survival,[5,6] graft hypertrophy,[7,8] and exposure to local or general anesthesia for the procedure.[9] When weighted into the discussion, patients tend to sway less often in the direction of fat transfer. However, recent evolution in fat transfer may have sidestepped many of the shortcomings of the original procedure. Discovery of adipose-derived mesenchymal stem cells

Disclosure Statement: The author has nothing to disclose.
Facial Plastic Surgery Institute, 521 West Southlake Boulevard, Suite 175, Southlake, TX 76092, USA
E-mail address: Jordan@rihanimd.com

Facial Plast Surg Clin N Am 27 (2019) 321–330
https://doi.org/10.1016/j.fsc.2019.03.004

(AD-MSCs) and the elucidation of fat survival patterns following grafting have provided insights for improved outcomes. As a result, the original dermal-fat grafts and microlipoinjection techniques[2,10] have been advanced by current techniques of microfat and nanofat,[11,12] which are showing promising results.

It is known that fat undergoes changes in mass throughout the course of our lives. As fat undergoes these changes, the surrounding blood supply and extracellular matrix must be accommodated—a process mediated, not by the adipocytes themselves, but by signaling of the surrounding stromal vascular fraction (SVF) and its interaction with adipocytes. This nucleated cell fraction includes smooth muscle cells, endothelial cells, blood cells, stem cells, and extracellular matrix. The discovery of large quantities of mesenchymal stem cells present in adipose tissue is likely responsible for most of the signaling in these instances.[13] Signaling of vascular endothelial growth factor, for example, in the creation of new endothelial cells and blood vessels is one example. Several studies have shown that these adult stem cells contain multipotent lineages capable of forming other tissues including bone and muscle.[14–16]

Our understanding of adult mesenchymal stem cells and their multipotent capabilities has combined with ease of methods of enzymatic and mechanical harvest from adipose tissue. The excitement has seen an increase in applications of bioregenerative medicine, especially in facial rejuvenation. Most of these precursor cells are found mixed within the adipocyte population in a typical fat harvest. Isolation of these cells occurs in two ways—either enzymatically or mechanically. Although enzymatic isolation of these cells is most efficient in terms of the concentration of cells harvested, the additional time and requirements of this procedure are not always practical in a surgical setting. The second method for obtaining these is through mechanical isolation. Through techniques of fracturing cell bonds and filtration, the SVF can be isolated from harvested fat in acceptable concentrations.[17]

The mechanical isolation of these adult mesenchymal stem cells, popularized by Tonnard,[11] seems to complement our current methods of structural fat grafting with microfat in a way that addresses many of the needs of volume replacement without many of the drawbacks of the original fat-grafting techniques. Furthermore, combining surgical skin excision with volume replacement has created a “sweet spot” for surgeons creating a look that is natural and not overly pulled, on one end of the spectrum, or overly filled, on the other.

WHAT IS MICROFAT AND NANOFAT?

Fat harvested from the body has a multitude of cells. Adipocytes comprise approximately 30% to 70% of the total cells of harvested fat. Other cells include extracellular matrix, endothelial cells, mural cells, fibroblasts, adipose-derived stem cells, and blood cells.[18] These cells provide the surrounding stroma that support and assist growth of adipose tissue and new blood vessel formation. These AD-MSCs are integral during the grafting process and many believe play a more important role in the fat-grafting process than the adipocytes themselves—demonstrated by the debate between host replacement versus cell survival theories.[19]

The debate regarding whether the host replaces all grafted fat cells (host replacement theory) or whether cells survive the grafting process and remain alive to provide the effect of fat grafting (cell survival theory), seems to show evidence for both mechanisms.[20] Arguments include lack of correlation between surviving adipocytes and final grafted volume and presence of necrosis and fibrosis in histologic sections following fat grafting.

Taking these concepts into consideration, the development of methods of isolating the adult mesenchymal stem cells, or SVF, without living adipocytes has been achieved enzymatically and mechanically. Although the focus of this article is on the mechanical isolation of SVF, the reader should also be familiar with the concept of enzymatic isolation. Enzymatic processing uses the addition of proteolytic enzymes that enable in vitro separation of fat cells from the SVF. Enzymatic digestion allows for the isolation of the SVF pellet of AD-MSCs that can be injected in highly concentrated form.

When the process is performed mechanically, adipocytes are fractured through mechanical emulsification and filtration, leaving the viable SVF intact.[17] Although a misnomer, because there are no viable fat cells, the byproduct of this process is known as “nanofat.” This method, described by Tonnard, includes mechanical disruption through small-bore luer lock connectors, followed by filtration through a 500-μm filter.[21] This relatively quick process allows isolation of the SVF as well as some nonviable adipocyte cell components.[22,23] The active component, the SVF, promotes endothelial proliferation, collagen creation, and new cell differentiation and creation.

Conversely, microfat, compared with nanofat, does contain whole and viable adipocytes with their surrounding cell milieu. When injected, these adipocytes act like traditional fat grafts—incorporating into the sites of injection. The term "microfat" refers to the small 1-mm holes in the sides of the liposuction cannula, which allows for smaller grafts than the traditional larger fat-harvesting cannulas, usually 2 to 3 mm in size.

Injection of microfat and nanofat is done in conjunction with one another in my practice. Microfat provides the structural support and volumization, whereas nanofat delivers improvement in fine facial rhytids and neocollagenesis in more cosmetically sensitive areas. Preoperative planning and assessment allow volumes that will be set aside for microfat injections and nanofat injections. After setting aside the appropriate volumes of the harvested microfat to be injected, the remainder undergoes a mechanical isolation process to become nanofat. That mechanical isolation method is described in more detail below.

INDICATIONS FOR FAT TRANSFER

Patients needing generalized volume improvement for multiple regions of the face *with adequate supply of donor fat* are candidates for fat transfer. Regions of volume loss are assessed as follows: forehead and glabella, temples, medial and lateral supraorbital region, outer cheek (including the zygoma and preauricular area), infraorbital and medial cheek, nasolabial folds and upper lip, pyriform aperture, anterior chin and prejowl sulcus, and lateral jawline. Patients undergoing facial rejuvenation surgery with adequate donor supply are considered ideal candidates for fat transfer. In some patients with low body mass index, the adequacy of their donor fat volume is a concern and I will typically discuss alternative methods of volumization—such as poly-L-lactic acid.

CONTRAINDICATIONS

Patients who have undergone multiple rounds of previous liposuction to the donor sites from body-contouring procedures may have little usable fat and tend to have a very fibrous composition to harvested fat, making mechanical isolation of nanofat difficult. I also do not typically offer fat transfer to patients under 40 years because of concerns of hypertrophy later in life.

TECHNIQUE

Marking

Preoperative assessment begins in a stepwise fashion through analysis of patient photographs. Volume changes are assessed in the abovementioned facial regions. Before surgery, areas of volume deficit are carefully marked in the preoperative room with the patient in the sitting position. This allows assessment before loss of landmarks with the patient lying supine. The chin is carefully marked using the patient's dentition to help delineate the midline to avoid any asymmetry of the chin with volumization and ensure that the maximal volume is achieved at the midline (**Fig. 1**). The iliac crest is also marked and areas of fat harvest are outlined.

Harvest is typically performed from the lateral thigh in female patients, because this tends to be a common location for fat deposition. Additional advantage of the lateral thigh donor site is that it is well tolerated, is safe to harvest, and shows minimal irregularities following harvest. The abdomen and medial thigh can also be used as donor sites, but they are not the first choice, in my opinion. In men, the abdomen tends to be a more reliable source of donor fat.

The patient is positioned supine with arms outward at 45° from the body to allow access to the donor site. Bilateral thigh and hip are prepped from the iliac crest down to the midthigh, which allows access to the fat pad in that region (**Fig. 2**). Tumescent solution is mixed using a 100-mL bag of 0.9% normal saline with 2 mL of 1% plain lidocaine and 0.1 mL of 1:1000 epinephrine. Tumescent is infiltrated using a tumescent infusion cannula affixed to a 60-mL syringe, and the fluid is instilled and equally distributed between both sides. It is recommended that the tumescent solution sit for 15 minutes after injection and before harvest.

Fat harvesting is performed using 60-mL BD syringes with a Tonnard fat harvester cannula

Fig. 1. Preoperative markings.

Fig. 2. Lateral thigh harvest site.

with 1-mm side ports. Approximately 40 to 50 mL of aspirate is typically harvested per side using manual suction, assisted by the use of a “Johnnie Lok” to maintain adequate negative pressure. After harvest of the fat, the donor site is closed using a simple Steri-Strip closure of the entry point.

Syringes are allowed to settle by gravity allowing separation of fat from supranatant and infranatant, which are discarded (**Fig. 3**). The 2 syringes now contain microfat given the presence of viable fat cells harvested from small-bore cannulas. Approximately 24 mL of microfat is transferred to 3-mL syringes for the microfat injection (**Fig. 4**). The remaining fat is set aside for continued processing into nanofat.

Fig. 3. Harvested microfat before removal of supranatant and infranatant.

Fig. 4. Microfat ready for injection.

Mechanical processing of nanofat for isolation of AD-MSCs, is performed using the Tulip nanofat system. A set of luer lock connectors is used to emulsify the fat, first with a 2.4-mm luer lock for a total of 40 passes, then a 1.2-mm luer lock for another 40 passes (**Fig. 5**). Any fibrous tissue that obstructs the passage through the luer lock is extracted to prevent clogging of the filter in the following step. The emulsified fat takes on a finer texture and lighter color (**Fig. 6**).

The final step involves a single pass through the nanotransfer filter allowing the final isolation of AD-SVF without surviving adipocytes (**Fig. 7**). This nanofat is also transferred to 3-mL syringes for injection. The nanofat is capable of being injected through small blunt microcannulas (25- or 27-gauge) or 30-gauge needles for superficial intradermal injections.

INJECTION OF MICROFAT

Microfat is injected through 3-mL syringes using a 2-inch 0.7-mm injection cannula. An 18-gauge needle is adequate to create entry points for passage of the 0.7-mm cannula. Injection of microfat proceeds in a top down fashion (**Fig. 8**).

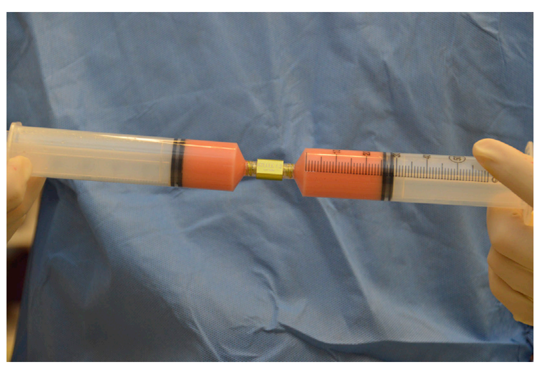

Fig. 5. Luer lock emulsification of fat.

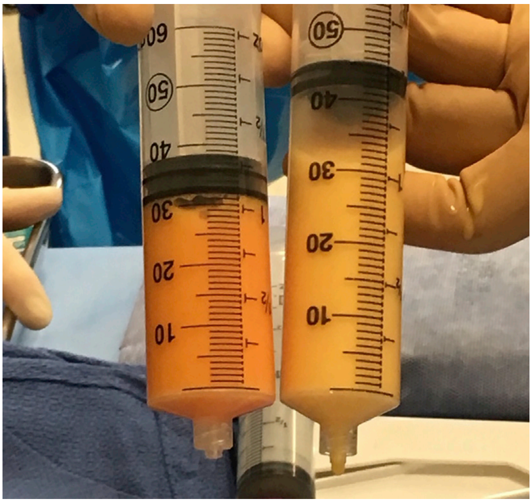

Fig. 6. Comparison of microfat and nanofat.

Approximately 10 to 16 mL of microfat is used per side of the face (total of 20–32 mL of microfat) injected in a deep fashion along the periosteum in all areas except the temple. Care is taken not to overfill these areas to avoid an overfilled or cherubic appearance.

Temple

Temples are addressed with an entry point above the zygomatic arch at the hairline. This allows access to almost the entirety of the temporal fossa from the lateral orbital rim to the superior temporal line and back into the hair-bearing temporal fossa.[24] Approximately 2 to 3 mL of microfat is deposited in small linear aliquots with a fanlike approach and massaged gently.

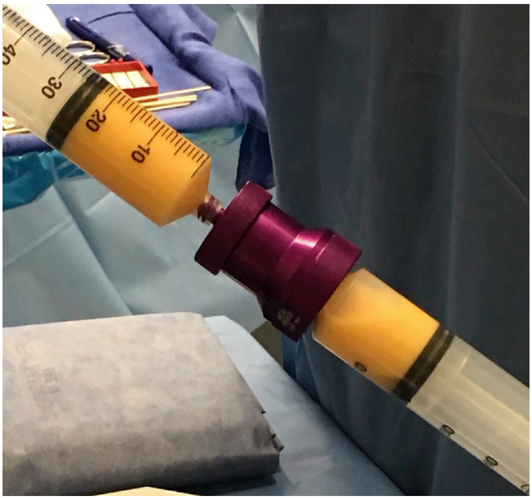

Fig. 7. Processing through the nanofat filter.

Zygomatic Arch and Lateral Cheek

An entry point along the zygoma is used to create a smooth transition from the temple down through the lateral cheek. Approximately 3 mL of microfat is injected into this location, again in small linear aliquots. The injections are performed deep along the periosteum for this injection.

Buccal Space

An entry point lateral to the buccal space allows volumization of the inferior cheek if there is buccal space hollowing. This also helps to improve the transition from the midface to the submalar area. Approximately 1 to 2 mL is used in this region.

Pyriform Aperture

An entry point lateral to the pyriform aperture allows placement of microfat along the periosteum of the lateral and inferior borders of the pyriform aperture.

Chin and Marionette Lines

An entry point is made at the level of the mandibular border anterior to the mandibular ligament and another one more anterior to allow volumization of medial chin. A fanning approach deep along the periosteum is used to volumize this area with a total of 3 to 4 mL per side and in the midline.

Gonial Angle

An entry point superior to the gonial angle allows a fanning technique for volumization of this region. The fingers of the opposite hand are used to guide the inferior extent of the injection to ensure a sharp delineation of the posterior mandible.

INJECTION OF NANOFAT

Nanofat is injected with different techniques depending on the location. For subcutaneous injections, a 25-gauge microcannula is used. A 23-gauge needle is used for creation of the entry points for the microcannula. Use of a smaller cannula is possible; however, the rigidity of the 25-gauge microcannula allows easier injection into the desired areas. For intradermal injections of fine rhytids, a 30-gauge needle is used. Typical volumes of nanofat are 8 to 10 mL per side of the face or a total of 16 to 20 mL (**Fig. 9**).

Upper Face

The glabella, forehead rhytids, and supraorbital/lateral brow region are injected typically with 1 to

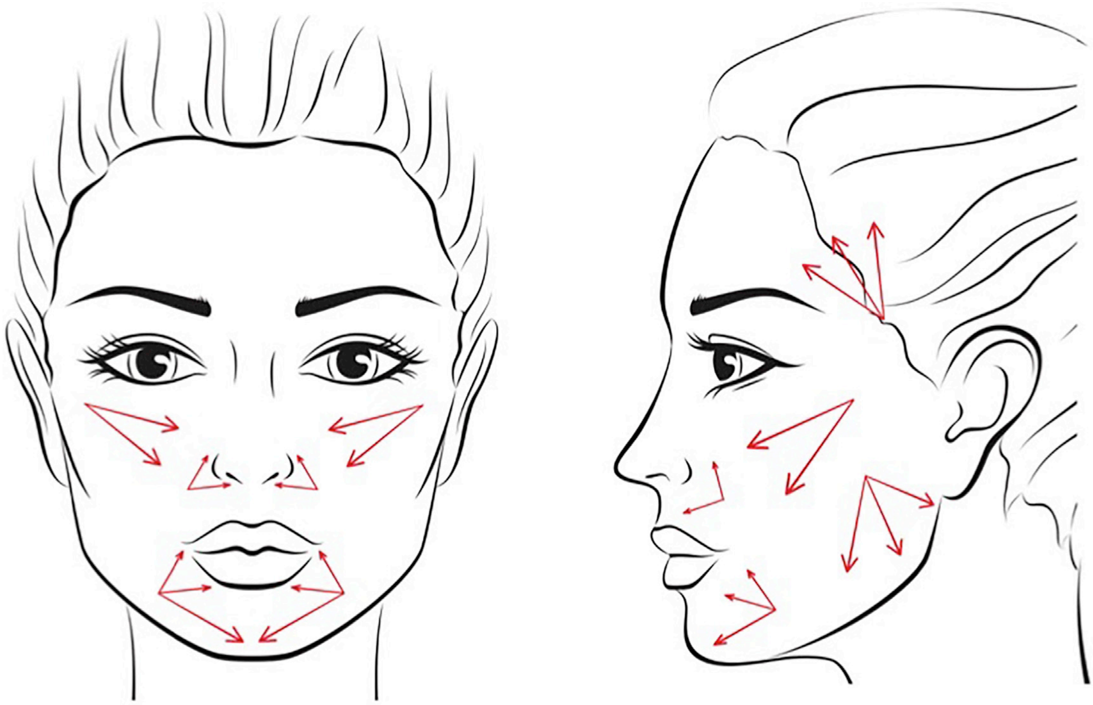

Fig. 8. Location of microfat placement. (*Courtesy of* J. Rihani, MD, FACS, Southlake, TX.)

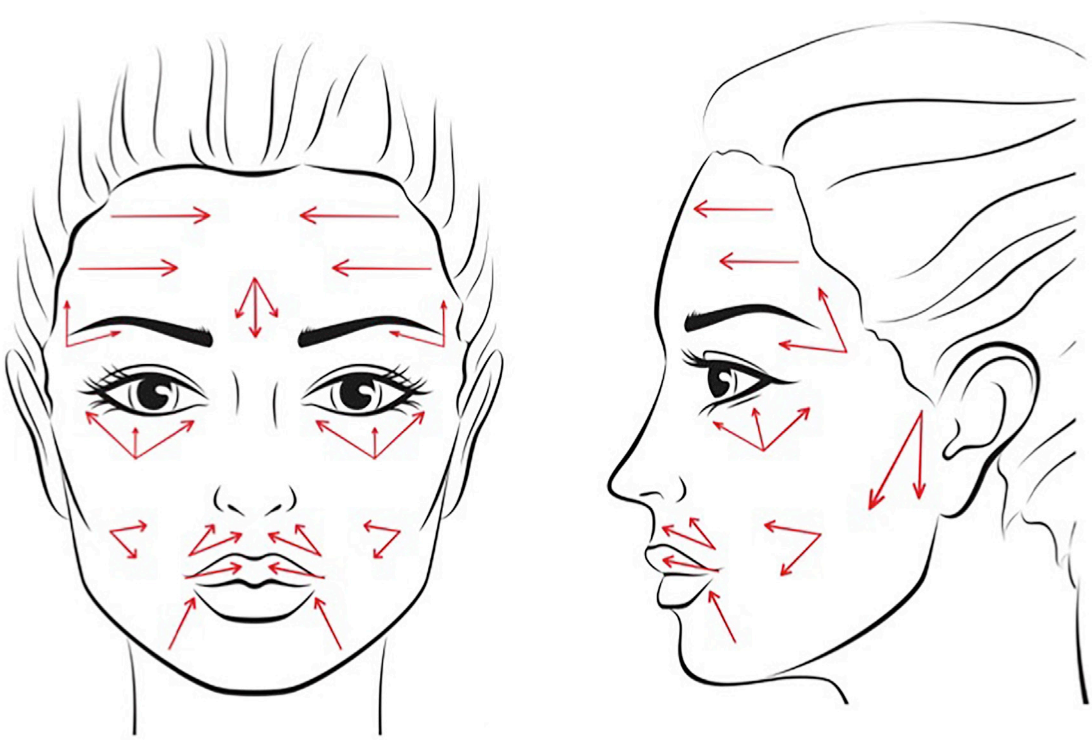

Fig. 9. Location of nanofat placement. (*Courtesy of* J. Rihani, MD, FACS, Southlake, TX.)

2 mL per site using the 25-gauge cannula. The medial upper eyelid can also be addressed, if necessary, in a similar fashion.

Midface

Microcannula injection is used for nanofat placement in the tear trough and lower eyelid, usually in a supraperiosteal location, similar to hyaluronic filler placement. A total of 1 to 2 mL is typically used per side for adequate volumization. If a lower blepharoplasty is simultaneously performed, I typically perform my lower blepharoplasty with fat repositioning before fat injection to avoid movement or suctioning of the nanofat. In this situation, the direction of injections is in a linear, vertical fashion, instead of parallel to the orbital rim (see **Fig. 8**).

Lower Face

The upper lip, nasolabial folds, perioral rhytids, and marionette lines are excellent targets for nanofat injection. A 30-gauge needle is used for subcision and intradermal injection of nanofat into perioral rhytids, allowing a slight wheal to be formed in the skin. Fat injections should be performed carefully using a retrograde threading technique of the cannula to avoid any intravascular complications.

Postoperative Course

Typical swelling and bruising is expected after fat-grafting procedures. Cool compresses are used for the first 3 days and may be accompanied by light facial massage, if not performed in conjunction with another surgical procedure. In areas of intradermal injections or in areas of thin skin, such as the lower eyelid, a slight yellow discoloration can be expected and may persist for a month or 2 following injections, but does resolve. Final volumes are assessed at the 6-month and 1-year time points. Patients are counseled preoperatively that an additional round of fat transfer may be required to achieve desired volumes and optimal correction (**Figs. 10** and **11**).

DISCUSSION

Over the last 30 years, advances in fat grafting have allowed for the fine-tuning of techniques and the art of volumization.[21,25] Volume loss in the face, as we know, does not simply occur through the loss of fat volume, but involves the loss of bone and muscle volume, as well as skin elasticity. These new fat-grafting techniques have decreased the limitations initially seen with traditional fat grafting, while exploring the new frontiers of neocollagenesis for reversing the signs of aging.[26–28]

We are currently in an era of unprecedented popularity of injectable fillers, thanks in part to social media and corporate marketing of HA fillers. Patients and physicians alike now appreciate the role of volume, because it relates to the aging process and facial rejuvenation. Fear of being overfilled, however, is a common concern of many patients who have seen the effect of facial distortion produced by overuse and abuse of many of these synthetic fillers or previously used fat-grafting techniques. As surgeons, however, we

Fig. 10. Combination of microfat and nanofat and cheeklift for improvement in marionette lines.

Fig. 11. Combination of microfat and nanofat with facelift for improvement in overall cheek and jawline appearance.

bring a unique perspective that allows for full facial assessment and treatment algorithms that can combine surgical procedures with volume restoration to achieve optimal results.

As knowledge of the role of AD-MSC grows, so do the possibilities of facial rejuvenation. The future holds the ability to not only volumize using fat cells but also to promote new cell and collagen formation through the injection of stromal cells.[29] The promising field of bioregenerative medicine and its applications for facial rejuvenation is still in its early stages and will likely continue to see refinements in the near future. Current techniques that allow for the mechanical isolation of nanofat are simple and easy to perform in either an office or operating room setting, and have been shown to produce viable AD-MSCs as byproducts of the procedure.[17] This has opened the door for new applications of neocollagenesis in patients wanting autologous solutions for facial aging concerns.

Limitations of this procedure include the need for multiple rounds of treatment. Patients are counseled regarding the possibility that a second procedure may be necessary to achieve optimal results and to avoid overfilling during a single treatment. However, given that many patients undergo HA filler treatments annually, I have not found this to be a limitation in my practice. One benefit for patients is the lower cost of fat grafting given the amount of volume afforded by this process without the product cost of the injectable fillers.

Future directions for microfat and nanofat injections include new methods for the efficient harvest of AD-MSCs, standardization of AD-MSC harvest, and expansion of the uses of these products in the clinical setting. For example, one such method was described by Mashiko and colleagues[17] that compared the emulsification technique described here with a “squeeze” technique of cutting adipocytes sharply, which may have reduced the number of damaged mesenchymal stem cells. As clinicians, the idea of expanding the uses of nanofat is quite exciting. One such method is small-volume clinical applications. For example, instead of the larger-volume harvests described, harvesting 10 to 20 mL of nanofat for the improvement in perioral rhytids can also be achieved as an isolated procedure. The results of this procedure have a high patient satisfaction in my practice, with follow-up greater than 2 years.

SUMMARY

The search for the perfect filler remains a long, ongoing one. Facial assessment should begin with an understanding of the changes occurring not only in fat volume but also in muscle and bone volume and skin quality. By using the tools at our disposal, the treating doctor should be able to combine both surgical intervention with volumization to avoid overly pulled or overly filled results. The combination of deeper, structural microfat grafting for volume replacement with more superficial, collagen-forming nanofat provides an optimal solution to produce excellent results.

SURGICAL PEARLS

1. Candidate selection is critical for the procedure. Generally, patients over 40 years of age with adequate donor fat and needing large volumes for replacement of 2 or more regions of the face.
2. Set appropriate patient expectations by discussing the possibility of additional fat transfer sessions at 6 to 12 months.
3. Mark patients preoperatively while sitting upright to avoid the loss of landmarks while they are supine.
4. The lateral thigh is a safe donor site with an adequate fat supply in most women. Abdominal fat may be targeted in men or women without adequate thigh fat.
5. Injections should be performed slowly with small aliquots, injecting only while withdrawing the cannula, to avoid vascular complications.
6. Fat grafting can be combined with other surgical procedures to achieve optimal results.

REFERENCES

1. Peer LA. Loss of weight and volume in human fat grafts. Plast Reconstr Surg 1950;5:217–30.
2. Fournier PF. Facial recontouring with fat grafting. Dermatol Clin 1990;8(3):523–37.
3. American Society for Aesthetic Plastic surgery, procedural Statistics. 2017. Available at: https://www.surgery.org/media/statistics. Accessed September 2018.
4. Pessa JE, Slice DE, Hanz KR, et al. Aging and the shape of the mandible. Plast Reconstr Surg 2008;121:196–200.
5. Canizares O Jr, Thomson J, Allen R Jr, et al. The effect of processing technique on fat graft survival. Plast Reconstr Surg 2017;140:933–43.
6. Pinski KS, Roenigk HH Jr. Autologous fat transplantation. Long-term follow-up. J Dermatol Surg Oncol 1992;18(3):179–84.
7. Latoni JD, Marshall DM, Wolfe SA. Overgrowth of fat autotransplanted for correction of localized steroid-induced atrophy. Plast Reconstr Surg 2000;106(7):1566–9.
8. Miller JJ, Popp JC. Fat hypertrophy after autologous fat transfer. Ophthalmic Plast Reconstr Surg 2002;18(3):228–31.
9. Coleman SR, Lam S, Cohen S, et al. Fat grafting challenges and debates. Atlas Oral Maxillofac Surg Clin North Am 2018;26:81–4.
10. Asken S. Facial liposuction and microlipoinjection. J Dermatol Surg Oncol 1988;14(3):297–305.
11. Tonnard P, Verpaele A, Peeters G, et al. Nanofat grafting: basic research and clinical applications. Plast Reconstr Surg 2013;132(4):1017–26.
12. Lindenblatt N, van Hulle A, Verpaele A, et al. The role of microfat grafting in facial contouring. Aesthet Surg J 2015;35(7):763–71.
13. Bourin P, Bunnell BA, Casteilla L, et al. Stromal cells from the adipose tissue-derived stromal vascular fraction and culture expanded adipose tissue-derived stromal/stem cells: a joint statement of the International Federation for Adipose Therapeutics and Science (IFATS) and the International Society for Cellular Therapy (ISCT). Cytotherapy 2013;15:641–8.
14. Zuk PA, Zhu M, Ashjian P, et al. Human adipose tissue is a source of multipotent stem cells. Mol Biol Cell 2002;13:4279–95.
15. Zuk PA, Zhu M, Mizuno H, et al. Multilineage cells from human adipose tissue: implications for cell-based therapies. Tissue Eng 2001;7:211–28.
16. Li H, Zimmerlin L, Marra KG, et al. Adipogenic potential of adipose stem cell subpopulations. Plast Reconstr Surg 2011;128:663–72.
17. Mashiko T, Wu SH, Feng J, et al. Mechanical micronization of lipoaspirates: squeeze and emulsification techniques. Plast Reconstr Surg 2017;139(1):79–90.
18. Eto H, Suga H, Matsumoto D, et al. Characterization of structure and cellular components of aspirated and excised adipose tissue. Plast Reconstr Surg 2009;124(4):1087–97.
19. Harrison BL, Malafa M, Davis K, et al. The discordant histology of grafted fat: a systematic review of the literature. Plast Reconstr Surg 2015;135(3):542e–55e.
20. Eto H1, Kato H, Suga H, et al. The fate of adipocytes after nonvascularized fat grafting: evidence of early death and replacement of adipocytes. Plast Reconstr Surg 2012;129(5):1081–92.
21. Fournier P. Fat grafting: my technique. Dermatol Surg 2000;26:1117–28.
22. Chaput B, Bertheuil N, Escubes M, et al. Mechanically isolated stromal vascular fraction provides a valid and useful collagenase-free alternative technique: a comparative study. Plast Reconstr Surg 2016;138:807–19.
23. Banyard D, Sarantopoulos C, Brovikova A, et al. Phenotypic analysis of stromal vascular fraction after mechanical shear reveals stress-induced progenitor populations. Plast Reconstr Surg 2016;138:237e.
24. Rihani J. Aesthetics and rejuvenation of the temple. Facial Plast Surg 2018;34(02):159–63.
25. Marten T, Elyassnia D. Fat grafting in facial rejuvenation. Clin Plast Surg 2015;42:219–52.
26. Wei H, Gu SX, Liang YD, et al. Nanofat-derived stem cells with platelet-rich fibrin improve facial contour remodeling and skin rejuvenation after autologous structural fat transplantation. Oncotarget 2017;8(No. 40):68542–56.

27. Xu P, Yu Q, Huang H, et al. Nanofat increases dermis thickness and neovascularization in photoaged nude mouse skin. Aesthetic Plast Surg 2018;42:343–51.
28. Uyulmaz S, Macedo NS, Rezaeian F, et al. Nanofat grafting for scar treatment and skin quality improvement. Aesthet Surg J 2018;38(4):421–8.
29. Rigotti G, Charles-de-Sá L, Gontijo-de-Amorim NF, et al. Expanded stem cells, stromal-vascular fraction, and platelet-rich plasma enriched fat: comparing results of different facial rejuvenation approaches in a clinical trial. Aesthet Surg J 2016;36(3):261–70.