Autologous Fat Grafting for Midface Rejuvenation

Thomas L. Tzikas, MD

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Soft tissue atrophy has recently gained more acceptance among facial plastic surgeons as being one of the most critical elements of facial aging. This atrophy is most evident with aging in the midface, where tissue involution creates hollow infraorbital crescent depressions and shadowing most often described by patients as dark circles. The progressive thinning of the lower eyelid skin also allows the underlying blood vessels and muscle to be visualized. The smooth transition of soft tissue in the junction between the eyelid skin and cheek that is present in the youthful face is interrupted, drawing attention to the area. Facial aging is caused by overall deflation of tissue with subsequent ptosis of the skin and supporting structures. Loss of support in the midface occurs owing to malar soft tissue loss and inferior migration of the malar fat pad. The result is a flattening and hollowing of the midface with the appearance of pseudohermated lower eyelid fat pads and a tear trough deformity.

Facial beauty in the youthful face consists of fullness, softness, symmetry, and proper proportions. The youthful esthetics of the midface include a smooth distribution of fat overlying the malar bone with a soft transition into the temple, lateral eyebrow, and submalar, buccal, and infraorbital regions. As facial aging continues, the outline of the malar bone can become visible. This change is a result of overlying soft tissue atrophy as well as atrophy of the facial skeleton and musculature, which can create a skeletonization of the face. Loss of soft tissue volume results in the appearance of anatomic structures that were not visible previously, such as the orbital fat pads, orbicularis muscle, and orbital bony rim. Evaluation of a mother and daughter can reveal many signs of facial aging (Fig. 1). The youthful face of the daughter has a soft, convex, smooth appearance with one esthetic region blending into the next. All areas of the mother's face show soft tissue atrophy with resultant thinning of the skin and shadowing. In the periorbital region, the radial fullness of the eyebrow is lost, with the patient developing ptosis of the brow and dermatomalasis of the upper eyelid. Dynamic rhytids are noted in the lateral orbital region with pseudohermated lower eyelid fat pads and nasojugal depressions.

Three-dimensional augmentation using fat grafting, especially in the infraorbital zone, can create a supportive structure for the lower eyelid and can improve scleral show (Fig. 2). Rather than removing significant amounts of lower eyelid fat and using vertical vector suspension of tissue, the addition of three-dimensional soft tissue fat grafts creates a more healthy, natural, and harmonious appearance. In my opinion, cheek augmentation with implants limits the area of enhancement and results in an overprojected malar region that is often out of proportion with other facial features.
Fat grafting has the major advantage of allowing the surgeon to be more creative and artistic. One can sculpt the region with feathering into adjacent areas without leaving a disproportionate appearance. A high learning curve is necessary to obtain esthetically pleasing and consistent long-term results, especially in the periorbital area.

History

Fat has been used for filling facial defects for over 100 years. A written report by Neuber [1] in 1893 described using 1-cm pieces of fat to reconstruct facial scars owing to tuberculosis. In 1910, Lexer [2] noted greater than 3 year survival of blocks of autologous fat when used for reconstruction of zygomatic arch fractures, and he emphasized minimizing the trauma to the implant to improve viability. There are several reports in the literature with varying results using fat grafting [3–8]. Great advancements were made in the 1980s with the acceptance of liposuction and especially with low pressure syringe aspiration and reinjection (lipoplasty) pioneered by Fournier [9]. Fournier demonstrated the integrity of lipocytes recovered by syringe aspiration and achieved more predictable outcomes with fat injection [9]. Ilouz [10] also reported that the human body was an excellent tissue medium and found that fat cells survived by intercellular lipolysis and osmosis until they were revascularized. Contemporary fat grafting was taken to a whole different level with the pioneering work of Coleman [11] in the 1990s with his lipoinjection procedure. The concept of minimizing trauma

Fig. 1. (A) Photograph of the 23-year-old daughter of a patient. Note the smooth overall structure of her face with thick skin and soft tissue fullness. (B) Photograph of her 54-year-old mother. Note the thinner skin and soft tissue with atrophy to all areas of her face. The soft tissue atrophy creates the appearance of brow ptosis with dermatochalasis.

Fig. 2. (A) A 47-year-old woman pictured preoperatively with bilateral scleral show of the lower eyelids and loss of soft tissue volume in the midface. She desired facial and eyelid rejuvenation. (B) Appearance 9 months after undergoing minimal upper eyelid skin removal, fat grafting to the face (66 mL), cervicofacial rhytidoplasty, and chemi cal peel to the lower eyelid and upper lip skin. Note the improvement of the scleral show following fat grafting to the midface (approximately 10 mL to each side).
during fat removal while injecting small fat parcels into multiple tunnels in soft tissue for better revascularization resulted in more predictable and long-term results [11]. The success of fat grafting suggests that adipocytes can withstand periods of hypoxia until revascularization is established. In 1996 Brandow and Newman [12] showed that centrifugation of harvested fat cells did not alter the microscopic structural integrity of lipocytes. Amar [13] has also popularized his method of autologous fat grafting muscle injection.

**Overview of fat grafting**

The fat grafting surgical technique used by the author is a multilayered full facial augmentation using volumes generally between 60 and 120 mL of fat. Full facial rejuvenation is performed most often to maintain or establish normal facial proportions. If fat grafting is combined with other facial rejuvenation surgery, such as rhytidoplasty, blepharoplasty, or endoscopic brow-lift, fat is infiltrated only in areas that have not been dissected by surgery to allow the fat grafts to anchor in the desired region. Fat that is not used in the initial procedure is frozen in sterile syringes, labeled with the patient’s identification, and stored in frozen storage at −20°C for 12 months. Frozen fat is used at a later date to fill areas not previously treated or if the patient requires a minor touch-up. When fat grafting is performed for regional augmentation, such as in the midface, smaller volumes of fat are injected to this area as compared with the volume that would have been used if the grafting was a part of full facial augmentation. The smaller volumes of fat maintain proper facial proportions with adjoining esthetic zones. With full facial augmentation, larger volumes are injected to each region, because adjacent areas are also treated.

Key regions of the face must be augmented with fat to create a more youthful appearance. The most important area comprises the midface, upper malar, and infraorbital region, which is the major support area of the eyelid and face. Proper augmentation of this primary arc, which also blends into the lateral eyebrow, the anterior and inferior temple, and the submalar regions, creates a rejuvenated appearance in all patients and is always the centerpoint of the procedure (Fig. 3). Other key regions of augmentation are the lateral jawline to establish the mandibular angle, the temporal fossa and lateral eyebrow, the perioral region (lips, nasolabial fold, and prejowl), and the glabella.

The author’s experience with this procedure has evolved over 13 years and more than 2000 patients (fat grafting alone or in combination with other surgery). Patient ages have ranged from 18 to 88 years in females and males. Autologous fat grafting can be performed on a patient before face-lift or blepharoplasty and may prolong the need for such procedures. In the author’s opinion, fat grafting should be used in combination with every face-lift, blepharoplasty, or skin resurfacing procedure. Fat augmentation can also significantly enhance the appearance of patients who have undergone previous facial surgery that has left behind an obvious unnatural appearance and who are in need of more facial volume, especially in the midface.

The most successful areas of fat grafting are in the more static regions of the face, such as the tear

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**Fig. 3.** (A) Preoperative photograph of a 45-year-old female patient. She had undergone unsuccessful fat grafting to the midface by another physician twice previously. (B) Primary midface arc of augmentation. (C) Appearance 14 months after 76 mL fat augmentation. Note the fullness and elevation of her midface.
trough deformity, midface, upper malar region, jawline, temporal fossa, mandible, and lateral eyebrow. Fat grafts placed in the perioral region are viable, but the result is less predictable owing to mobility. This movement results in sheering forces that limit the angiogenesis of the graft. Repeat treatments with frozen fat or other filler materials are used by the author, especially in the lips and marionette regions. The popular myth that autologous fat grafting is a temporary filler is primarily the result of surgeons injecting fat into mostly mobile areas such as the lips or nasolabial grooves, using poor technique, and not injecting adequate volumes. This misconception is a hurdle the clinician must overcome when dealing with patients questioning the viability of fat grafting and long-term results.

Because the results achieved from fat grafting are sometimes more subtle than those from traditional face-lifts, detailed preoperative patient counseling is imperative. Patients need to be educated on the effects of three-dimensional volume enhancement using pre- and postoperative fat grafting photographs as well as youthful photographs of the patients themselves. Once patients understand the effects of volume loss on their aging face, they will be accepting of the procedure. Realistic expectations are emphasized to all patients, and they need to have a clear understanding of the limitations of the procedure. The distortion of the face in the weeks following the soft tissue infiltration must also be fully understood by patients. Preoperative surgical planning is mainly performed by reviewing high-quality facial photographs of the patient and comparing them with photographs taken in his or

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**Fig. 4.** Photograph of a 2.1 mm × 12 cm three-hole fat aspiration cannula used for fat harvesting (Tulip Corp., San Diego, California).

**Fig. 5.** Note the layering of the centrifuged syringe on the right. The syringe on the left was not spun.

**Fig. 6.** Photograph of 0.9 mm (top) and 1.2 mm (bottom) fat injecting cannulas (Tulip Corp., San Diego, California).

**Fig. 7.** Periorbital fat augmentation is performed by injecting fat from entry points at the lateral eyebrow, the lateral orbit, and the inframalar region. Multiple tunnels and passes are required to achieve adequate augmentation.
her youth from several angles. Three-dimensional photography will be extremely useful for all aspects of the facial rejuvenation consultation when this technology becomes more commercially available.

The best candidates for fat grafting are younger (less than 50 years old), healthy, nonsmokers with thicker skin and good overall skin elasticity. Smoking decreases the revascularization potential for the grafts, and these patients should be warned preoperatively that their results will be limited. Thinner inelastic skin in older patients also does not contain an optimal vascular supply and may require more than one treatment session for adequate results. As is true for any facial plastic surgery procedure, the patient must stop aspirin, non-steroidal anti-inflammatory medications, vitamin E, herbal supplements, cigarette smoking, as well as alcohol consumption at least 2 weeks before the procedure. He or she is started on a vitamin B complex and 2000 mg of vitamin C daily. The patient is also evaluated with appropriate blood studies, electrocardiography, and medical clearance if he or she is aged more than 50 years.

**Surgical technique**

The patient’s donor areas of fat excess are evaluated for quality and possible limitations of removal owing to previous liposuction or lack of sufficient quantity. For facial plastic surgeons, there is a learning curve to achieve a comfort level for the procedure of removing fat from different parts of the body. I would recommend starting in areas of significant fat excess and removing small amounts of fat. The technique is similar to neck liposuction, but a 10-mL syringe is used with limited negative pressure rather than a machine. Patient donor areas are marked in the standing position, and multiple...

**Fig. 8.** (A) Photograph of a 67-year-old woman who has undergone previous face-lift surgery. She has flatness of the midface and lack of mandibular definition. (B) Appearance 1 year following facial fat grafting using 72 mL. Note the overall improvement to the midface, with a rounder more elevated appearance.

**Fig. 9.** (A) Preoperative photograph of a 59-year-old patient desiring facial augmentation. She is extremely thin and has a hollow appearance to the malar and submalar regions. (B) Appearance 1 year following fat grafting to her face using 91 mL of fat and 3 mL of Radiesse to the nasolabial folds. The fat injected has created a fuller appearance to the midface.
areas are required to obtain adequate volumes. Fat should be obtained from multiple regions, especially in thin patients, so that the potential for donor deformities from too much fat extraction from one location is limited.

Key regions of the face, most notably the infraorbital depressions, are also carefully marked in the standing position. The best quality donor fat in most patients is found in the lateral thighs owing to the compactness of the adipocytes, but the medial thighs, upper hips, lower abdomen, and sometimes the medial knees are also used. The procedure is usually performed with conscious intravenous sedation with local nerve blocks and local anesthetic soft tissue infiltration (1% lidocaine with 1:100,000 epinephrine) in the face. A semi-tumescent local infiltration is performed in the donor areas using a mixture of 50 mL of 1% lidocaine, 1 mL of 1:1000 epinephrine, and 12.5 mL of sodium bicarbonate in 1 L of lactated Ringer's solution. The anesthetic fluid is injected through entry sites made with a No. 11 blade first into the deep fat followed by the more superficial layer using 20 mL syringes and multi-holed fine infiltrating cannulas. This process results in some volume expansion of the adipocytes, which must be taken into account during facial infiltration. One should wait at least 15 minutes for the local epinephrine effect to occur before fat harvesting. The quality and quantity of fat harvested will be significantly enhanced after this waiting period. A 2.1-mm cannula with three serial openings (Tulip Corp., San Diego, California) is used on a 10-mL syringe for fat harvesting (Fig. 4). Approximately 2 mL of lactated Ringer's solution is placed in each syringe before harvesting, and a minimal negative volume pressure on the syringe is used, usually 2 to 3 mL, to limit the trauma to the harvested fat. The amount of fat and fluid aspirated

Fig. 10. (A) Photograph of a 44-year-old man desiring facial rejuvenation. Note the retracted midface and maxillary region. (B) Appearance 18 months after autologous fat grafting to the face with 70 mL of fat. Note the enhancement of the overall face and especially the periorbital, midface, and upper lip.

Fig. 11. (A) Photograph of a 22-year-old woman with pseudoherniated lower eyelid fat. There is also a soft tissue depression at the infraorbital rim. (B) Appearance 1 year following lower transconjunctival blepharoplasty and fat grafting to the infraorbital region (3 mL of fat was injected on each side).
during harvesting is measured to remove equal amounts from the contralateral side. The donor access sites are closed with a 5-0 fast absorbing suture, and the area is dressed with a light pressure dressing.

The fat is centrifuged for 2 minutes at 3000 rpm in the 10-mL syringes, which results in three distinct layers (Fig. 5). The top layer is the least dense and consists of oil from ruptured adipocytes. The bottom layer is the most dense and contains lidocaine, lactated Ringer’s solution, and blood. The middle layer is made up of the usable fat. Fat for grafting should not contain any significant amount of blood, because it will stimulate macrophage activity in the recipient site and may decrease fat survival. The fatty layer is separated from the other layers by decanting the fluid from the syringes. The usable fat is ultimately transferred into 1 mL syringes that are used for injection. The face is marked in the upright sitting position, and local anesthetic infiltration (1% lidocaine with 1:100,000 epinephrine) is performed as nerve blocks and regional soft tissue infiltration. Care must be taken not to overinject local anesthetic and distort the area to be augmented with fat. In the infraorbital region, it is sometimes preferable to infiltrate the local anesthetic solution using a blunt cannula to prevent trauma to the venous plexus and to limit the tissue distortion.

Fat infiltration of the face begins by making skin puncture sites at strategic locations using an 18-gauge NoKor needle. Sutures are not required in the facial access sites, only Steri-strips for 24 hours, and the sites will heal without any visible marks. Generally, 0.9 mm and 1.2 mm cannulas (Tulip Corp.) are attached to 1 mL syringes filled with the fat grafts and are used to inject the fat (Fig. 6). The 1-mL syringes allow for a smoother transfer of fat grafts while minimizing force. The size of the cannula and the design of the tip allow it to glide through soft tissue, creating minimal trauma that results in much less postoperative edema than some of the blunt cannulas currently available. The infiltration is first performed in the deepest tissue

Fig. 13. (A) Photograph of a 73-year-old woman who desires facial and eyelid rejuvenation but does not want to undergo a facelift. (B) Appearance 9 months following lower transconjunctival blepharoplasty, fat grafting to the midface, and CO2 laser resurfacing to the lower eyelid and upper lip skin. The patient has a significant rejuvenation to the midface. A total of 9 mL of fat was injected to each side.
layer (usually at the periosteal level) and along the facial musculature and then followed by infiltration into more superficial layers. The injection of fat is performed only on withdrawal of the cannula in linear tracts, ultimately, creating a weaving pattern. The entire syringe, needle, and hub should be prefilled with fat so that dead space is eliminated on injection.

Fig. 14. (A) Photograph of a 49-year-old woman who desires facial rejuvenation. Note the irregularity of the eyelid and cheek owing to soft tissue atrophy. (B) Appearance 10 months following fat grafting to the face along with endoscopic brow-lift, upper and lower blepharoplasty, and cervicofacial rhytidoplasty. The contour of the midface has been improved significantly.

Fig. 15. (A) Preoperative photograph of a 48-year-old woman who desires facial rejuvenation. The patient has significant fat atrophy of the entire face. Note the hollow appearance of the temple and submalar region as well as the bony outline of the zygoma. (B) Appearance on postoperative day 3 following fat grafting to the entire face (102 mL of fat was injected). The patient has only mild ecchymosis and edema of the entire face, even with a large volume augmentation. (C) Appearance 14 days postoperatively. The significant edema has mostly subsided. The patient is able to return to most of her normal activities at this time. (D) Photograph taken 3 months postoperatively. Note the overall softness of her face.
limited to approximately 2 mL. The overall malar region can accept 7 to 20 mL of fat spread over a wide area. One should feather the fat into adjacent esthetic zones by injecting the anterior temporal region as well as the lateral eyebrow. This technique creates a soft transition when performing midface augmentation. The success of the technique is dependent on the injection of small amounts of fat into many multilayered tunnels, which leads to improved revascularization and survival of the graft. One should not overfill the anterior malar and infraorbital region, because this will create excessive fullness and skin wrinkling upon smiling. Fat should be tapered as the injection is continued toward the eyelid so that a resultant ledge of fat or sunken eye appearance can be avoided. The infiltration of fat is a diffuse process following the natural bony and soft tissue facial architecture of the patient (Figs. 8, 9, and 10).

Midface augmentation is frequently combined with lower transconjunctival blepharoplasty fat removal and chemical resurfacing for treatment of rhytids in appropriate patients (Figs. 11, 12, 13, and 14). The fat is generally injected first in the infraorbital region before any significant tissue distortion. Fat is then removed from the lower eyelid using a standard transconjunctival approach in conservative quantities followed by a light Baker-Gordon phenol peel to the lower eyelid skin. The peel is applied using a cotton-tipped applicator that has been squeezed of most of the chemical solution and then feathered to the edge of the infraorbital esthetic unit. Long-term results in my hands have been better with the chemical peel versus laser resurfacing, with a recovery time of less than 1 week. If a patient is not a candidate for chemical peeling owing to the natural pigmant of his or her skin and skin redundancy is a concern, a conservative skin pinch technique is used to excise extra skin. Fat grafting to the infraorbital region will support the lower eyelid and improve scleral show. It will also frequently correct some dermatochalasis of the lower eyelid, necessitating less skin excision.

For full facial rejuvenation, the areas of augmentation are usually the same in all patients; however, the volume injected to each region is individualized. The amount of fat grafted during a typical procedure can range from 60 to 120 mL. The most important aspect of the injection procedure is to maintain proper esthetic proportions of the face. The postoperative care is minimal, but the patient must be prepared for edema and distortion of the face, especially in the first 1 to 2 weeks. Ice gel masks are used for at least 48 hours with head elevation for 1 week. The patient is instructed to limit extreme facial movements and talking for the first 72 hours as well as refrain from exercise for 10 days.

**Fig. 16.** Direct excision of a persistent fat irregularity in the infraorbital region. These incisions heal surprisingly well.

**Fig. 17.** Soft tissue atrophy of the infraorbital region caused by excessive steroid injection for the treatment of a irregular fat accumulation. This defect was later treated by injecting stored fat with a good result.
This limitation will reduce shearing forces on the fat grafts and allow angiogenesis to take place. Warm compresses are used starting on the third or fourth day, and a Medrol Dosepak and Simenc (homeopathic Arnica montana) have been beneficial. Patients have minimal discomfort in the donor areas and no discomfort in the face. Because of the decreased tissue trauma associated with the fine canulas, significant edema subsides within 7 to 10 days, even with the large volumes injected (Fig. 15).

Approximately 10% to 15% of the harvested fat is preserved in sealed syringes at a temperature of $-20^\circ$C for 12 months labeled with the patient's name, social security number, and the date the fat will be discarded. Studies have shown that an adequate percentage of adipose cells is preserved by freezing [14,15], and this fat can be used for minor touch-up procedures.

Potential complications are generally technique related but can include hematoma, infection, herpetic outbreak, sensory or motor nerve damage, damage to underlying structures, prolonged ecchymosis, hemosiderin deposition of the dermis, prolonged edema, undercorrection, overcorrection, fat clumping, donor site soft tissue irregularities, hypertrophic or hyperpigmented donor scars, asymmetry, tattooing of the infiltration sites, fat necrosis, and fat migration. Sharp needles should never be used to inject fat in any location of the face, especially in the periorbital area. Laceration or intravascular fat injection may result in embolization and potential visual loss with the use of

Fig. 18. (A) Preoperative photograph of a 53-year-old man desiring an improved appearance to the midface. (B) Appearance 1 year following fat grafting to the face with a total of 55 mL of fat injected. Note the improved appearance to the midface. (C) Five year result without any additional treatment. The fat has persisted and even appears fuller owing to a slight weight gain by the patient.

Fig. 19. (A) Preoperative photograph of a patient desiring facial rejuvenation. (B) Appearance 2.5 years following autologous fat grafting to the face using a total of 85 mL of fat. Note the overall improvement to her face.
sharp needles or high pressure injection in the peri-orbital region [16,17].

The main postoperative complication from midface fat augmentation is fat clumping, which can be visible through the thin skin. The fat irregularity can be firm and nodular. This clumping is a result of excessive fat injection with each pass of the cannula. If the soft tissue planes are distorted by excessive local anesthetic injection or significant bleeding, the surgeon cannot visualize how much fat is required for appropriate correction of the area. Bleeding causes prolonged ecchymosis and sometimes will create a thick fibrous capsule around the fat graft. Sometimes the fat graft will lodge in the cannula, resulting in excessive pressure required to push the fat through. This event is common in thin patients who have more fibrous tissue mixed with the fat. In this situation, one must never force the fat through the cannula. The cannula should be removed, the obstruction cleared, and the injection continued. Fat clumping should be treated at the time of injection if the surgeon realizes this has happened. The fat can be manually compressed or aspirated with the same cannula used for injection. Unrealized fat clumps will persist, are difficult to eradicate, and may require direct excision (Fig. 16). Excessive use of steroid injection to this region may result in more soft tissue atrophy and a worsened appearance (Fig. 17). Only diluted Kenalog should be used in this area (approximately 4 mg/mL or less). In actuality, the complications with this technique in experienced hands are extremely rare, and the patient long-term satisfaction rate has been very high.

Summary

Soft tissue augmentation with fat grafting is becoming a more common procedure but is technique dependent with a high learning curve. The surgeon must master a precise minimally traumatic harvesting, preparation, and infiltration technique using a diffuse multilayering method of fat infiltration that follows the patient’s facial contour. The main benefit of fat is that it is a natural filler that can augment all areas of a face. It is especially beneficial in the midface because it is pliable and can be sculpted smoothly over a wide area.

The results of autologous fat grafting can be extremely satisfying for the patient and the surgeon as long as expectations are realistic. Excellent serial photographic documentation of patient results is mandatory because simple clinical evaluation is unreliable. Small amounts of fat grafted into multiple tunnels undergo revascularization and become incorporated into normal subcutaneous tissue. Grafted fat feels like normal soft tissue to the touch and cannot be palpated like other facial implants. The results at 5 or 6 months usually persist for many years, although normal soft tissue volume loss continues with natural aging (Figs. 18 and 19). Grafted fat will also fluctuate in size with general weight loss or weight gain. Some individual patient variability will be noted, with younger patients retaining a greater percentage of fat using smaller volumes. This difference may be explained by better vascularity and tissue elasticity in younger patients.

Autologous fat grafting produces subtle yet significant results, with the face appearing softer, healthier, and more youthful and without an “operated look.” The resultant facial contour has a natural appearance with a gentle transition between one facial zone and the next. The fat infiltration technique is an artistic three-dimensional procedure, and patient outcomes improve with greater experience by the surgeon. Once the technique is mastered, the results are long-term and predictable and can compliment most other facial surgical procedures (Fig. 19).

References


