Fat Grafting Volume Restoration to the Brow and Temporal Regions

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Abstract

Primary manifestations of facial aging are the reduction in subcutaneous tissue volume, especially the atrophy of fat as well as bone volume depletion which directly contribute to loss of support and laxity of the skin. Depressions and hollows develop with a visible disruption of the cosmetic facial aesthetic units resulting in harsh shadows. This is especially evident in the eyebrow and temporal regions which accentuate the appearance of brow ptosis and a hollow, almost cadaveric look to the temple. Restoration of volume to these areas has been shown to rejuvenate the upper face creating a softer, fuller, and more youthful appearance. Fat grafting by itself or in combination with upper facial surgical procedures plays a major role in the restoration of youthful facial qualities in this region.

Rejuvenation of the aging upper face is a complex and challenging endeavor for the patient emotionally and for the surgeon aesthetically. The goal is to obtain a youthful yet natural and soft-appearing result for the patient that is also age appropriate. There are three main categories that contribute to aging of the face: bony and soft tissue loss, tissue and skin laxity, and skin surface changes mostly due to environmental exposure.1,2 Facial fat compartments have also been identified that can atrophy at varying rates.3 Surgeons who perform facial rejuvenation procedures have increasingly recognized the importance of soft tissue volume enhancement of the face.

The brow and temporal regions have been relatively neglected areas for volume restoration in comparison to the midface and other regions of the face. The increasing popularity of soft tissue fillers and fat grafting has allowed surgeons performing upper facial rejuvenation procedures to enhance results that had been limited to traditional surgery by adding a three-dimensional augmentation component to the procedure.

Facial beauty in a youthful face consists of fullness, softness, symmetry, and proper proportions. There is a smooth distribution and transition of fat between aesthetic subunits of the face with a resultant balance between volume and shape. This can be demonstrated in a comparison of facial features between a mother and daughter (►Fig. 1A and B). There is a softness and fullness to the youthful face with smooth transitions between aesthetic units. Fat grafting, therefore, can play an important role in the restoration of these youthful qualities.

Autologous fat transplantation has been attempted for over a century with varying degrees of success; however, recent techniques have provided more predictable, reproducible, and long-lasting results. There are several reports in the literature with varying results using fat grafting.4–8 Great advances were made in the 1980s with the acceptance of liposuction and especially with low pressure syringe aspiration and reinjection (lipoplasty) pioneered by Pierre Fournier. He reported the integrity of lipocytes recovered by syringe aspiration and achieved more predictable outcomes with fat injection.9 Illouz also described that the human body is an excellent medium, and fat cells survive by intercellular lipolysis and osmosis until they are revascularized.10

Modern fat grafting was refined with the pioneering work of Sydney Coleman in the 1990s with his lipostructure technique.11 The concept of minimizing trauma during fat removal while injecting small fat parcels into multiple soft tissue tunnels resulted in better revascularization and more predictable outcomes. The success of fat grafting suggests that adipocytes can withstand periods of hypoxia until
revascularization is established. In 1996, Brandow and Newman showed that centrifugation of fat cells did not alter the microscopic structural integrity of lipocyte.12

Multiple modalities are required to give a natural improvement to the upper face with a resultant overall harmonious appearance. Some patients may benefit solely from upper eyelid skin resection, while others will require elevation of the ptotic brow to create a more youthful appearance. Great care must be taken to not overcorrect the ptotic brow in a patient that has always had a full brow and upper eyelid as this will distort the patient’s appearance to a greater extent than they were prepared for. A fine balance needs to exist with brow elevation, upper eyelid skin resection, and volume enhancement to the brow and temple complex. Too often we are asked by patients to overcorrect the eyebrow with lifting as the patient generally does not like the appearance of skin laxity to this area. These patients need to be educated on the benefits of volume enhancement in combination with surgical lifting to attain the most natural result. Obviously, each individual patient’s needs must be addressed differently as some will require more vertical lifting, while others need additional facial width. Therefore, a thorough and logical explanation to the patient with proper planning is imperative.

Experience has shown that the most important aspect of the fat grafting procedure is the proper placement and adequate volume of fat injected to attain long term and even permanent results. High-volume fat grafting to the overall face is performed, usually greater than 50 mL, and it is spread over most of the face and extending laterally into the temporal hairline. When discussing high-volume facial fat augmentation, it is very important to not think of fat grafting the same as a filler. One mL of filler does not equate to 1 mL of fat. Generally, one mL of filler is comparable to ~2 to 3 mL of fat. Fillers are more compact and have a greater lifting effect than fat, whereas fat is softer, compressible, and generally it is injected deeper and dispersed over a much wider area. Fat is used as a global, pan-facial volumizer in a deep and multilayered technique that follows the patient’s bone structure to soften the entire face proportionately.

**Planning**

The patient consultation provides the surgeon an opportunity to explain their philosophy for facial rejuvenation to the patient. Prospective patients are generally confused with all the information that is available to them and it is critically important to detail what the goals and expectations should be. Fat grafting has been misunderstood both by the lay public and practitioners and continues to be in the present. There are patients that may have had fat injected incorrectly for lines and wrinkles without long-lasting results. They are also afraid that they will end up with a fat appearing and distorted face. This process can be a difficult task for the surgeon, especially with patients that already have a heavy face. We have all seen the distorted female face with overly accentuated lips, perioral, nasolabial, and medial facial soft tissue from too many injected fillers creating the “simian appearance.”

The eyebrow and orbital bone need to be assessed with regard to thickness, bone and soft tissue atrophy, extent of ptosis, the degree and visibility of the superior eyelid crease, and the desired appearance following corrective options with the patient. A major component to the aging of the eyebrow is loss of support from volume loss and not descent of tissue. Loss of fullness in this area can result in a different appearance with the aging process in different people. Some may develop deep set upper eyelids, while others may appear to have significant sagging skin over the eyebrows. The temple is an extension of the lateral brow and a smooth transition between these aesthetic zones is ideal rather than a distinct depression. Experience has shown that temple and brow lifting procedures by themselves create long-term thinning of the soft tissue, which is contrary to the youthful softness desired. A lifted eyebrow and thinning temple can also be too altering for many patients. Careful preoperative planning by reviewing photographs of the patients in their youth is imperative. Patients that have always had a heavy brow and very little evidence of an upper eyelid crease may not desire an elevated brow and a deep upper eyelid sulcus.

Patients can generally be categorized into four basic groups for assessing the brow and planning the proper corrective procedure.

1. **Category I:** Severe brow ptosis (treated with brow lift, upper blepharoplasty, and fat grafting)
2. **Category II:** Mild-to-moderate brow ptosis (treated with conservative brow lift, upper blepharoplasty, and fat grafting)
3. **Category III:** No significant brow ptosis (treated with upper blepharoplasty and fat grafting)
4. **Category IV:** Atrophy only: natural or iatrogenic (treated with fat grafting) (**Figs. 2–5**).
Fat grafting by itself has limitations with regard to the amount of brow elevation that can be achieved but it is indicated in all four categories since bony and soft tissue atrophy exists.

Personal experience has shown that a combination of surgical treatment (brow lift and/or upper blepharoplasty) with simultaneous volume enhancement to the brow and temple will result in the most natural appearance for patients. If the desire is for a deeper superior eyelid crease without the appearance of skin excess, then upper eyelid skin resection is combined. It is important to not overfill the brow and temple areas as it may alter the patient’s appearance excessively with regard to the superior orbital sulcus.

The preoperative consultation is the time to educate the patient on the concepts of facial harmony and the youthful facial qualities that they are trying to attain. Spending time educating the patient and listening to what they desire will definitely result in happier outcomes.

**Technique**

The details and variations in fat grafting procedures have been discussed in previous publications by the author as well as others. In the preoperative dressing area, the patient’s face is marked with the patient in an upright position. The donor areas of fat excess are evaluated for quality and possible limitations because of previous liposuction or lack of sufficient quantity. These areas are marked in the standing position, and usually multiple areas are required to obtain adequate volumes. It is important to obtain fat from multiple sites, especially in thin patients, so that the potential for donor deformities from too much fat extraction from one location is limited.

The best quality donor fat in most patients is found in the lateral thighs because of the compactness of the adipocytes; but the medial thighs, the upper hips, the lower abdomen, and sometimes the medial knees are also utilized. No specific donor area has been found to be superior regarding the survival of the fat graft and fat is harvested where it is most readily available. The procedure is usually performed using conscious intravenous sedation with supplemental oxygen and the patient’s face, neck, and donor areas are prepped and draped in a sterile fashion. Blood is drawn from the patient to centrifuge and create platelet-rich plasma (PRP), which is often mixed with the fat graft. Generally, a ratio of 10% PRP is mixed with 90% fat graft by volume.

**Fat Harvesting**

The fat grafting procedure is performed before any other facial surgery. The tissue planes have not been violated and...
Fat can be placed in a more precise manner. The procedure takes at least 1 hour and is the most artistic aspect of facial rejuvenation. The patient remains in a supine position and is not turned for fat harvesting (►Fig. 6). A semitumescent local infiltration is performed in the donor areas using a mixture of 50 mL of 1% lidocaine, 1 mL of 1:1,000 epinephrine, and 12.5 mL sodium bicarbonate in 1 L of lactated Ringer’s solution. The anesthetic fluid is injected through entry sites made with a #11 blade first into the deep fat followed by the more superficial layer using 20 mL syringes and multiholed blunt infiltrating cannulas. This process results in some volume expansion of the adipocytes, which must be taken into account during facial infiltration. It is very important to wait at least 10 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. Several styles of 1.6 to 2.1 mm cannula tips (Tulip Corporation) are used on a 10 mL syringe for fat harvesting (►Fig. 7).

Approximately, 1 mL of lactated Ringer’s solution is placed in each syringe before fat aspiration, and a low negative volume pressure in the syringe is used, usually 3 to 5 mL, to limit the trauma to the harvested fat (►Fig. 8). The amount of fat and fluid aspirated during harvesting is measured to remove equal amount from the contralateral side. The donor access sites are closed with a 5–0 fast absorbing suture.

Fat Preparation

The fat is centrifuged (Hermle Labortechnik GmbH) for 2 minutes at 3,000 rpm in 10 mL syringes (►Fig. 9). The reports in the literature have been inconclusive regarding a superior method of fat preparation; therefore, this method has been the preferred approach for years and has resulted in consistent fat for grafting.19 There are 12 10 mL syringes that are placed in the centrifuge at one time and this can result in ~30 to 70 mL of usable fat. There are three distinct layers after centrifugation: the top layer which is the least dense and consists of oil from ruptured adipocytes; the bottom layer which is the most dense and contains lidocaine, lactated Ringer’s solution, and blood; and the middle layer which is made up of the usable fat. The bottom 20% of the usable fat layer portion contains the greatest percentage of adipose-derived stem cells (►Fig. 10). These cells tend to be more resistant to fragmentation, promote neovascularization, are theorized to attain greater long-term survival after being injected into a host area, and are a potential tool for regenerative therapies.20 Fat for injection should not contain any significant amount of blood because this can potentially 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, which are then used for the injection of fat into the face (►Fig. 11).

Fig. 6 Donor areas are marked for fat harvesting with the patient in the supine position.

Fig. 7 Fat harvesting (1.6–2.1 mm) cannula tips (Tulip Corporation).

Fig. 8 Low volume pressure fat aspiration.

Fig. 9 The fat is centrifuged (Hermle Labortechnik GmbH) for 2 minutes at 3,000 rpm in 10 mL syringes.
Facial Fat Injection

Local nerve blocks and local anesthetic soft tissue infiltration (1% lidocaine with 1:100,000 epinephrine) are used in the face. Skin puncture sites are created at strategic locations using an 18-gauge NoKor needle. Usually a total of ~10 mL of local anesthetic is infiltrated to the entire face for the fat grafting procedure using a blunt 22-gauge cannula to diminish the potential for ecchymosis. Care must be taken to not overinject local anesthetic and distort the area to be augmented with fat.

Generally, 0.9 mm blunt cannulas (Tulip Corporation) are attached to 1 mL syringes filled with the fat grafts and are used to smoothly inject the fat. The size of the cannula and the blunt design of the tip allow the cannula to glide through soft tissue creating minimal trauma. This results in very little postoperative edema, even with high volumes of fat injected. The injection technique is different than that of fillers and preferably the surgeon uses his or her palm to push the fat through the syringe rather than the thumb. This allows for much better control. The infiltration is first performed in the deepest tissue layer (usually at the periosteal level) and along the facial musculature and then followed by more superficial layers. The injection of fat is performed only on withdrawal of the cannula in linear noncontinuous tracts ultimately creating a weaving almost spider web pattern (Fig. 12). It is important to have the entire syringe, cannula, and hub prefilled with fat, so dead space is eliminated on injection.

Fat is injected prior to any surgical manipulation of the tissue and is usually injected in a deep plane. Once the tissue planes have been disrupted with a brow-lift procedure (endoscopic or open techniques), it is difficult to place fat in the desired level. The fat is injected in very small noncontinuous amounts rather than one long strand. The volume of fat injected varies for all individuals, but along the supraorbital rim, the volume should generally be limited to ~2 mL and should be in a pre-periosteal plane. If the desired effect is to reduce a very hollow upper eyelid sulcus, then the fat is injected along the inferior margin of the supraorbital rim. If the desired effect is to create elevation to the brow, then the fat is mainly injected along the upper body and superior to the supraorbital bony rim. Care must be taken when injecting near the eye and blunt cannulas, never sharp needles, are the only types used in this area and the nondominant finger should always be protecting the globe. In the temple, fat is injected at the level of the deep temporal fascia filling the temporal hollow and extending into the temporal hairline. This results in a volumetric lifting effect to the lateral brow and temples (Fig. 13). The volume of fat injected in each temple is usually between 5 and 7 mL. Some patients may also have an underlying bony asymmetry that fat grafting can improve by varying the quantities injected (Fig. 14).

It is important to feather the fat injected into adjacent aesthetic zones creating smooth transitional augmentation. The success of the technique is dependent on the injection of only small amounts of fat into many multilayered tunnels, which leads to improved revascularization and survival of the graft. The infiltration of fat is a diffuse process following the natural bony and soft tissue architecture of the patient. Facial fat grafting is a powerful procedure which can result in the elevation of the eyebrow, filling of the temple and is very complimentary with surgical eyebrow-forehead lifting and eyelid surgery.
Potential Complications of Fat Grafting

Complications are rare and are generally technique related. They can include infection, sensory or motor nerve damage, damage to underlying structures, prolonged ecchymosis, hemosiderin deposition of the dermis, prolonged edema, under correction or overcorrection, asymmetry, fat clumping or nodules, donor site soft tissue irregularities, and hypertrophic or hyperpigmented donor scars. Sharp needles should never be used to inject fat in any location of the face, especially the periorbital area. Intravascular fat injection may result in embolization and potential visual loss with the use of sharp needles or high-pressure injection in the periorbital region.\(^{19,21}\)

The main postoperative complication from fat augmentation is fat clumping or nodularity, which can be especially visible through the thin skin of the infraorbital and cheek junction. Over time, the fat irregularity becomes encapsulated and can feel firm, mobile, and nodular. This deformity is usually the result of excessive fat injection as well as the direction of injection. The eyelid–cheek junction can be an unforgiving area if overtreated, and conservative injection is recommended. If the soft tissue planes are distorted, either by excessive local anesthetic injection or significant bleeding, the surgeon cannot visualize how much fat is required for appropriate correction of the area. Bleeding will cause prolonged ecchymosis and can create a thick fibrous capsule around the injected fat. Sometimes, the fat graft will lodge in the cannula resulting in excessive pressure required to push the fat through. This is often seen with 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 from the injection site, the obstruction should be cleared, and then the injection can be continued.

Fat clumping should be treated at the time of injection if the surgeon realizes the irregularity is occurring. The fat can sometimes be manually compressed or aspirated. Unrealized overinjected and irregularly accumulated fat in the infraorbital region will persist and is difficult to eradicate. It becomes almost impossible to aspirate this fat once it is encapsulated. Excessive use of steroid injection to treat the irregularity in this region may also result in more soft tissue atrophy and a worsened appearance. Therefore, only diluted Kenalog should be used (~2–5 mg/mL) and combined with 5-fluorouracil solution. If this does not improve the appearance, direct surgical excision may be required. Overall, the complications with facial fat grafting in experienced hands are extremely rare, and the patient long-term satisfaction rate has been very high.

Conclusion

Success of facial fat grafting of the upper face is related to injecting an adequate volume of fat to areas where it will be of most benefit. This is a three-dimensional, artistic procedure which has a high learning curve (~7–10 years) to mastering the technique and obtaining predictable and consistent results. The surgeon must plan the augmentation accurately and spend the time to perform the procedure while minimizing trauma. In the upper face, fat grafting should be combined with surgical correction of a ptotic brow or eyelid skin resection and it will enhance the result.

Fig. 13  Fat is injected laterally and superiorly extending into the temporal hairline to give a volumetric lift to the face.

Fig. 14 Patient 1: (A) Before fat grafting (66 mL total to face) for facial asymmetry. (B) 7.5 years after. Patient 2: (C) Before fat grafting for upper facial asymmetry. (D) One year after.
Fat is an ideal tissue filler substance because there is usually an adequate supply, and since it is autologous, it is nonallergenic. There have been concerns, however, with the use of facial fat grafting including its unpredictable survival, the potential for irregularities and nodules, as well as the possibility of long-term overgrowth of fat. These concerns are mainly technique dependent and are usually not a problem in the hands of a skilled and experienced surgeon.

Although there is patient variability and some degree of unpredictability with fat survival, the areas of best retention are in the less mobile areas of the face such as the malar, mandibular, and temporal regions. The survival and longevity of fat grafting is less predictable in perioral locations mostly due to the muscular activity of this region with potentially a lower opportunity for revascularization of the grafts. Younger, healthier nonsmoking patients with better elasticity and blood supply retain fat to a greater degree than older patients who may have associated chronic diseases and less adequate blood supply to the face.

**Fig. 15** (A) A 57-year-old female with mild brow ptosis, dermatochalasis of upper eyelid skin, soft tissue atrophy, and aging face. She underwent endoscopic brow lift, upper blepharoplasty, fat grafting, fractional CO₂ laser resurfacing, and facelift procedure. (B) Nine months post-op.

**Fig. 16** (A) A 75-year-old female had previously undergone aggressive eyelid surgery. Fat grafting alone restored a more youthful appearance to the periorbital region. (B) 1.5 years post-op.

**Fig. 17** (A) A 52-year-old male had undergone previous upper blepharoplasty. Note the flattening of the eyebrow and excessive upper eyelid sulcus. (B) Two years after fat grafting to the periorbital region. Note the youthful appearance as a result of more fullness.

**Fig. 18** (A) A 72-year-old female with severe soft tissue atrophy of the temple. (B) One year after fat grafting to fill the temple hollows.
A true and accurate visual result with regard to the survival of the fat graft can be determined after ~6 months. Experience has shown that by this time the fat graft has stabilized and has been adequately revascularized by the host area blood supply. The facial contour as well as the overlying skin quality generally continues to improve 1 to 2 years following the procedure as the fat implant has firmly integrated in the soft tissue layers of the face. The effect of this change is not fully understood but has been postulated by many practitioners that perform fat grafting to be some type of stem cell phenomenon, although there are probably multiple factors that are just beginning to be understood. It is possible that with the greater volume of fat injected, there are a larger number of adipose-derived stem cells that may improve retention. Studies have shown that adipose-derived regenerative cells are capable of inducing angiogenesis and with minimally traumatic techniques as much as 90% of the lipoaspirate can result in viable cells.22,23 There is also histologic evidence of both survival of injected adipocytes and collagen and connective tissue replacement of ruptured fat cells.24 The implanted fat is not firm or nodular and it feels like normal fat when palpated. The skin and subcutaneous tissue have a thicker and firmer quality that is associated with youth.

**Patient Case Presentations**

> Figs. 15–21

Fig. 19 (A) A 50-year-old female with severe soft tissue atrophy of the temples and periorbital region. (B) Note the softness of these areas 3 months after fat grafting.

Fig. 20 (A) A 63-year-old female with periorbital and temporal soft tissue atrophy underwent upper and lower blepharoplasty, fat grafting, and fractional CO₂ laser resurfacing. (B) Six months post-op.

Fig. 21 (A) A 36-year-old female with brow ptosis and periorbital soft tissue atrophy. She underwent an endoscopic brow lift and periorbital fat grafting. (B) Six months post-op.

References

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