ORIGINAL ARTICLE

Advanced Aesthetic Facial Rejuvenation: Sculptural Fat Restoration by Autologous Fat Transfer With Adipose-Derived Stem Cell Therapy

Peter Michael Schmid, DO

Introduction: The aging process uniquely challenges facial aesthetics by inherent variable soft-tissue and structural remodeling. Rejuvenation of the aging face by autologous fat transfer (AFT) enriched with adipose-derived stem cells (ADSCs) remains a treatment option for volume restoration and contour deficiencies, establishing facial harmony and beauty. Successful outcomes incorporate artistic principles and sound fat-grafting techniques.

Materials and Methods: The author presents a review of current scientific PubMed literature and sculptural resources on facial aging, aesthetics, and autologous fat and stem cell grafting and describes advanced fat-grafting techniques for facial rejuvenation.

Results: Improved clinical fat graft survivability and aesthetic outcomes have been observed in 50 patients treated by the proposed techniques of autologous fat graft and stem cell recipient bed preparation administered by sculptural fat transplantation.

Conclusions: Sculptural fat restoration integrated with AFT and selective ADSC seeding is an important key to facial rejuvenation, producing aesthetically pleasing and lasting results.

Sculpting expresses life in its individualized form. —J. Dewey (1987)

Facial aesthetic beauty is manifest in youth, gender, and genetics. Attractiveness is an esteemed extrinsic quality that is a complex interplay of facial features and anatomical structures composed of volumes and planes, proportions, and degrees of symmetry. Aging uniquely challenges qualities of beauty by disrupting facial harmony and balance. Essentially, the aging face becomes volume deplete as the cutaneous envelope expands and to a varying degree descends. The challenge to the cosmetic surgeon is to master the art of restoration of the facial aesthetic through soft-tissue manipulation, modification, or refinement. Success is grounded in artistic and proficient application of reliable cosmetic surgical techniques. It is imperative to achieve natural-appearing results.

Beautification of the face has intrigued cosmetic and plastic surgeons for centuries. Autologous fat grafting is the ideal complement to facial rejuvenation, administered solely or as an adjunctive procedure in the cosmetic armamentarium. Enduring 30 years of application for soft-tissue enhancement, there remains great disparity in fat transplantation techniques and graft survival outcomes. With an ongoing professional commitment to scientific studies on aging and tissue engineering, researchers continue to pave the way to improved understanding of the biophysiology behind adipose tissue and adipose-derived stem cells (ADSCs) as applied to volume replacement therapy. The author presents a personal approach to structural volume restoration of the aging face by sculptural fat restoration with selective ADSC seeding.

Autologous Fat Transfer and Stem Cells: Background and Science

Since Neuber1 innovatively pioneered the technique of fat transplantation by inserting small aliquots of fat into the scarred face of a patient suffering from tuberculosis osteitis in 1893, a new era in soft-tissue augmentation was established. Withstanding years of application and scrutiny, adipose tissue to date has

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From the Institute of Aesthetic Plastic & Reconstructive Surgery, Longmont, Colo, and Rocky Vista University College of Osteopathic Medicine, Parker, Colo.
Corresponding author: Peter Michael Schmid, DO, Institute of Aesthetic Plastic & Reconstructive Surgery, 1305 Sumner St, Suite #100, Longmont, CO 80501 (e-mail: drs@iaprs.com).
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proven to be the ideal soft-tissue filler for cosmetic and reconstructive purposes. It is cost-effective, readily accessible, typically donor site abundant and easily extracted, manipulated, and returned to a recipient bed. As a safe autologous implant, it is biocompatible, lacking in immunogenicity, biofilms, or teratogenicity. It provides a permanent reconstructive option to patients, replacing “like with like” native tissue, and can re-create a natural cosmetic appearance.

In 1989, Billings and May reported the “unpredictable behavior of free fat autographs.” Fat graft survivability as reported by various authors has ranged from 20–90%, with recent reports relaying improved transplant longevity in excess of 50%. The patient still remains the critical variable to the success of autologous fat transfer (AFT). To date, scientific evidence for autologous fat grafting in cosmetic surgery has been composed mostly of expert opinion and patient case studies instead of high-quality, controlled randomized trials or systematic reviews. Cosmetic surgeons often find themselves adjusting or refining their techniques based on practice preferences and patient outcomes. The unfolding promise to contemporary fat-grafting techniques is the presence of the ADSCs inherent to the fat graft.

Scientific evidence supports adipose tissue as a rich resource of mesenchymal stem cells. These ADSCs demonstrate high proliferative capacity and can potentiate cellular dedifferentiation, cell preservation capability, angiogenesis, neovascularization, and adipogenesis. ADSCs contain and release growth factors, hormones, and other products that can communicate and function at a localized site of tissue injury or systemically. ADSCs consist of a heterogeneous population of stromal cells with variable adipogenic potential to include endothelial mature, endothelial progenitor, pericyte, and preadipocyte cells possessing reparative and regenerative capabilities. Preadipocytes, when environmentally induced, can accumulate lipids and differentiate into adipocytes and contribute to the regeneration of adipose tissue. Adipose tissue as a donor resource contains 100 to 1000 times more pluripotent stem cells per cubic centimeter basis than bone marrow, and it can be harvested by routine liposuction. Various authors report that 1 g (cubic centimeter) of human adipose tissue contains 1 million adipocytes, 1 million adipose-derived stem/progenitor cells, 1 million endothelial cells, and 1–2 million blood-derived cells.

When transplanted, adipocytes, ADSCs, and cell subpopulations are devascularized and initially exposed to severe ischemic and hypoxic recipient environments. Peer’s cell survival theory of fat transplantation emphasizes the importance of transplanting a high count of viable adipocytes to the recipient bed in vivo, with graft survival dependent initially on inosculation and nutrient diffusion and later by neovascularization within 4–8 days triggered by angiopoietins. Ischemia-induced necrosis, apoptosis (adipocytes, blood-derived cells, and vascular endothelial cells), and cell death occur within 24 hours of devascularization (with adipocytes susceptible to cell death as early as 12 hours) after transplantation, with ADSCs remaining viable up to 72 hours. Damaged fat grafts can serve as tissue scaffolds upon which ADSCs and preadipocytes activate and grow. ADSCs can be used to fortify adipose tissue grafts for transplantation.

Carpeneda and Ribiero studied the histological alterations and viability of fat grafts transplanted in humans and found that viable tissue was observed in the peripheral zone approximately 1.5 ± 0.5 mm from the edge of fat grafts, with a loss of approximately 60% of the grafted adipocytes in this viable zone and 40% survival. Coleman developed the technique of subcutaneous structural fat grafting by multilinear placement of minuscule amounts of fat parcels to optimize nutritional and respiratory support to the grafts at the recipient site. Eto and Pu have recently proposed a unique adipocyte survival theory called the host replacement theory describing 3 unique zones of fat transplantation recovery by which the depth of the viable surviving zone to support adipocyte survival was 300 μm from the graft edge, and beyond this, despite the reduced survival of the adipocytes, the resident ADSCs persist and become activated, promoting adipogenesis and replacing the dead adipocytes with new ones by dynamic remodeling. This theory reflects humans’ inherent biological system of compensatory proliferation, adaptive cell remodeling, and repair in response to cell apoptosis.

**Autologous Fat Preparation and Enrichment**

The yield, viability, and regenerative capacity of adipocytes and ADSCs are inherently sensitive to the autologous fat preparation process, which includes harvesting, isolation, processing, fortification, and transplantation. Donor site selection has been debated by many authors, taking into consideration diet-resilient fat (genetic), alpha receptors, adipocyte and ADSC...
quantity and quality, and site-specific fat availability and accessibility.31 Rohrich et al32 compared abdomen, thigh, flank, and medial knee donor sites, citing equal adipocyte counts and viability at all areas. Findings by Padoin et al33 found the lower abdomen and the inner thighs to support higher lipoaspirate cell concentrations and favorable sources of adult mesenchymal cells. Crawford et al34 documented higher adipocyte counts in the upper flanks as compared with the lower.

Tumescent anesthesia is considered standard care at both the donor and recipient sites. Epinephrine has a negligible effect on adipose and ADSCs; however, lidocaine concentrations of 2% or greater have proven to adversely affect the viability of preadipocytes and their differentiation into adipocytes.35

Donor-site harvesting techniques employ either manual liposuction or varied liposuction technologies to secure fat graft components, many of which claim to collect the viable fat cell extracts. Harvesting with conventional liposuction under high negative vacuum pressures can disrupt up to 90% of adipocytes; thus, low extraction pressure is key to preservation and survival of adipocytes and ADSCs.36 Shiffman and Mirrafati37 found that when a −700-mm vacuum was used for liposuction, cell damage of greater than 10% occurred. Crawford et al34 reported that low-pressure manual lipoaspiration provides 150% greater viable fat cells relative to conventional liposuction. Rohrich et al38 compared aspirates by massage, conventional liposuction, external ultrasound-assisted liposuction, or internal ultrasound-assisted liposuction and found that internal ultrasound-assisted liposuction resulted in a thermal liquefaction of mature adipocytes. Advocates for third-generation ultrasound report the technique of atraumatic manual aspiration for obtaining good short- and long-term results in adipocyte stabilization and have since returned to simple decantation.

Techniques for adipose tissue purification and isolation are decantation, washing and filtration, or centrifugation. A principal consideration in fat preparation is the decision to fortify the fat graft aspirate with stem cells. Preparatory options include unaltered ADSC-nonenriched fat, ADSC-enriched fat, cell-assisted lipotransfer (CAL)—enriched fat, platelet-rich plasma–treated fat, or variations thereof. In practice with Peer’s cell survival theory, many advocates have resorted to simple decantation, filtration, and washing techniques for purifying the fat graft aspirate. These atraumatic techniques favor minimal graft handling to preserve fat cell integrity and viability and by which retains some endothelial and ADSCs lacking centrifuge contamination and trauma. Rohrich et al32 and others3,43−46 have found that centrifugation techniques do not enhance fat tissue viability before implantation and that excessive centrifugation forces can damage and destroy both adipocytes and ADSCs. Botti et al,47 in a hemiface study comparing the 2 processing techniques of washed/filtered fat against centrifuged fat (3000 rpm at 3 minutes), found no clinical difference between these techniques for clinical adipocyte stability and have since returned to simple filtered fat grafting.

Centrifugation separates and isolates the adipocytes and ADSCs from serosanguinous inflammatory mediators and blood components, lipids, proteases, and the tumescent solution by-products in a stratified layered fashion. Oil and traumatized adipocytes reside at the top layer and concentrated viable adipocyte tissue levels out in the central and lowers levels, with high-density mesenchymal stem cell condensation at the lowest tissue column level.34,48 The optimal centrifugal force applied to the adipose tissue to adequately separate and preserve adipocyte and ADSC viability is based on centrifugation speed and time. Centrifugation at 3600 rpm for 10 seconds or 1 minute results in compacting the adipose cells without apparent cell damage, as reported by Shiffman and Mirrafati.37 Yoshimura et al39 found that centrifugation at 1200g decreased fat volume by 30%, damaging 12% of the adipocytes and 0% of the ADSCs. Kurita et al46 recommend 1200g (~3000 rpm) for 3 minutes as optimal for obtaining good short- and long-term results in adipose transplantation, as forces approaching 3000g significantly damage and reduce the number of viable ADSCs. Coleman50 and Kim et al51 recommend a centrifugation speed of 3000 rpm (1286g) for 3 minutes. Boschert et al52 performed histological analysis of the
stratified layers after centrifugation at 50g for 2, 4, 6, and 8 minutes, revealing a specific gradient with the density of viable fat cells increasing from the top to the bottom of the centrifugate fatty layer. After decanting the underlying serosanguinous fluid infranatant, the bottom or deepest layer of the tissue column contains the highest number of viable cells: 250% more viable cells when compared with the top layer and 140% more viable cells when compared with the middle layer. Conde-Green et al have observed that after centrifugation at 3000 rpm over 3 minutes, a “pellet” of tissue forms (the fourth layer) in the bottommost layer of the tissue column, which is rich in endothelial (expressing CD31) and adipose-derived mesenchymal stem cells (CD34 and CD105), both playing a crucial role in angiogenesis and adipogenesis. Li et al presume the preadipocyte population (CD31/CD34) to have the most adipogenic potential. The evidence supports various techniques as successful in isolating viable adipocyte and ADSC subpopulations, with increased cellular damage for centrifugation forces greater than 1200g (~3000 rpm).

CAL was introduced by Matsumoto et al to improve fat transfer survival outcomes converting ADSC-poor aspirated fat to ADSC-rich fat by adipocyte graft supplementation with concentrated fractions of adipose stem cells coined the stromal vascular fraction. After lipoaspirate collection by conventional liposuction, a portion of the adipose tissue is committed to an enzymatic collagenase digestion process and eventually centrifugation, resulting in a highly concentrated adipose stem cell pellet (the stromal vascular fraction). This freshly isolated stromal vascular fraction is mixed and eventually adhered to the nonprocessed adipose tissue, which is then injected into the recipient site, overcorrecting by approximately 20%. The stromal vascular fraction is rich in ADSCs (CD31–CD34+ CD45– CD90+ CD105– CD146–), endothelial (progenitor) cells (CD31+ CD34+ CD45– CD90+ CD105low CD146+), pericytes (CD31–CD34– CD45– CD90+ CD105– CD146+), blood-derived cells (CD45+), and other regenerative cells. CAL-transplanted fat in an animal study demonstrated improved neovascularization and 35% improved AFT graft survival on average when compared with nonCAL fat. Yoshimura et al have demonstrated CAL-enriched fat grafting in both facial and breast augmentation studies to be both safe and effective for soft-tissue augmentation and superior to conventional nonenriched fat grafts. Sterodimas et al reported a prospective study on facial fat grafting with singletransplantation CAL-enriched fat producing aesthetically acceptable results in comparison with non-CAL–treated adipocyte transplant without the need for repeat treatment sessions. Zhu et al demonstrated that adipose-derived regenerative cells not only increase graft retention by twofold but also improve the quality of the grafts in an animal study. CAL therapy practices considered controversial are currently under investigation and scrutiny by the US Food and Drug Administration. Alteration of human adipose tissue subjects one to strict regulation and interpretation guidelines.

The author’s AFT surgical technique entails enrichment of autologous fat grafts and the recipient bed with a centrifuged high-density ADSC isolate secured by minimal manipulation devoid of a collagenase additive.

**Aging Soft Tissues of the Face**

Contemporary imaging studies have advanced clinical understanding of anatomical aging. This dynamic process results in facial incongruity due to variable volumetric depletion, expansion, and redistribution. Facial adipose tissue is compartmentalized, each subunit unique with respect to variable atrophy and volume shifts, resulting in a facial concentric contraction. Fatty tissue malposition secondary to progressive laxity of the mandibular ligaments and septae creates the jowls and disrupts the smooth linear jawline. On computed tomography soft-tissue contrast studies, Gierlof et al observed deep midfacial medial cheek fat compartment dissension and volume loss, resulting in nasolabial fold accentuation, pseudoptosis, and cheek flattening. Also observed was volume loss of the buccal fat pad extension, creating submalar hollowing, as supported by prior studies by Rohrich et al. There occurs an ongoing cascade of boney remodeling, resorption, and regression of the mandibular and midfacial bones. Boney remodeling results in orbital aperture expansion, glabellar and maxillary angle reduction, mandibular angle widening, and loss of mandibular body length and height, all softening and diminishing aesthetic form. Cutaneous thinning and atrophy occur with external envelope expansion and descent (Figure 1).

The cosmetic surgeon must critically analyze the aging process inherent to each patient and tailor treatment to all anatomical layers contributing to the aesthetic deformity. Rejuvenation must rebuild the boney platform interface outward to the skin subcutaneous...
envelope. AFT administered deliberately and artistically establishes multilayered 3-dimensional volume restoration to correct the underlying anatomical deficiencies.

**Patient Selection: Considerations**

Proper patient selection and a consensual treatment plan are crucial for achieving successful aesthetic and emotional outcomes with AFT. The patient must specifically understand the potential for variable fat resorption and the need for sequential fat-grafting sessions to achieve optimal outcomes.

Many respected experts have emphasized the importance of primary volume restoration. Although volume depletion is considerable with aging, correction should take into consideration gravitational or positional influences, apparent or absolute soft-tissue ptosis, and cutaneous envelope expansion by managing these issues concomitantly. By addressing aspects of depletion, redistribution, and repositioning, AFT is delivered as a solitary cosmetic technique or an adjunctive procedure to resurfacing or surgical lifting procedures.

Optimal candidates for AFT are those patients in good health, of middle age (30–60 years), and manifest favorable skin elasticity. Patients should be euthyroid, nondiabetic, nonsmokers, weight stable, and noncompulsive nor extreme athletes. Patients are encouraged to increase their baseline weight of 1.4 to 2.3 kg preoperatively and avoid dieting for approximately 3 months posttreatment. Donor-site adipose availability is a prerequisite. Patients with advanced cutaneous laxity should be counseled on combination cosmetic procedures. Poor candidates for AFT are those with a genetic predisposition to obesity. HIV-infected patients or those on antiretroviral therapy are at risk for facial lipohypertrophy or “hamster syndrome” and potential medical-legal ramifications postoperatively. Avoid the “buffalo hump” as a donor site, as this can predispose to facial lipohypertrophy. Delayed fat transfer infections may develop, with a suspected correlation to coexisting odontogenic or sinus infections, contaminated surgical equipment, or preexisting permanent fillers or facial implants (M. Berman, oral communication, 2011).

Candidates for AFT will require preoperative laboratory tests (serum PG, complete blood cell count, prothrombin time, partial thromboplastin time, international normalized ratio, others), medical clearance by an internist (if indicated), and instructions to avoid blood thinners. All patients are initiated on a prophylactic antibiotic the day before the fat transfer procedure (ie, cephalexin), which should be continued for 7 days posttreatment.

**Preoperative Preparations: Analysis, Markings, and Volumes**

Patient facial analysis demands visual, tactile, and a visionary aptitude. Preoperative markings are a rule, and in a sitting upright position, color-coded markers are systematically drawn on the facial skin surface directed by critical visual inspection and a “palpate and draw” technique, mapping baseline anatomical boney landmarks and features, soft-tissue deformities, boney deficiencies, and rhytids, all to be addressed by deliberate sculptural fat enhancement (Figure 2). Additional skin markings are necessary for combined surgical procedures.

Visionary planning requires insightful preoperative calculation of volume requirements to restore the anatomical facial deficiencies and contours and to account for potential postoperative tissue contraction from fat resorption (Figure 3). Inherent to planning is an understanding that cutaneous envelope restoration requires a balance between tightening, resuspension, or subcutaneous volume expansion techniques. Facial fat compartment or subcutaneous atrophy contributing to temporal, malar, and submalar hollowing or accentuation of the nasolabial folds requires multilayered grafting.
melolabial fold and the jowl can be managed by volume blending or facelift effacement. Boney resorption progressing to orbital expansion, jawline blunting, or deprojection of the facial prominences, platforms, and planes may be restored by deep-layered grafting. The goal is to achieve aesthetic facial harmony through balance of volumes, contour, and positive and negative spaces affecting surface light reflection.

**Intraoperative Fat-Grafting Technique**

Comfort is provided by oral or intravenous sedation with continuous patient monitoring. The patient is prepped and draped in a routine sterile fashion. Tumescent anesthesia (1000 mL of Ringers lactate mixed with 50 mL of 1% lidocaine plain and 2 mL of epinephrine 1:1000) is injected regionally into the donor area with a 22-gauge spinal needle, allowing 20 minutes for vasoconstrictive anesthetic time. The facial recipient areas are anesthetized with trigeminal nerve blocks and/or regionally with dilute 0.5% lidocaine with epinephrine delivered by a 10-mL syringe and 27-gauge needle with controlled volumes in an effort to minimize soft-tissue distortion.

Fat is harvested at the donor site through a 3-mm incision placed by a No. 11 blade and collected in several sterile 10-mL Luer-lock syringes primed with 2 mL of normal saline fitted with a 15-cm-length double lumen 3-mm cannula (Byron Medical, Tucson, Ariz). The extraction technique is gentle and proceeds with low-pressure (1:2 mL aspiration) full-length radial strokes, manually aspirating the fat as described by Coleman. The author’s preferred donor sites are...
the abdomen and outer and inner thighs. Typically, one extracts double the precalculated volume to account for the lipodilution created by the syringe buffer solution and the local anesthetic. The collected adipose grafts housed in the 10-mL syringes are capped and positioned upright in a sterile test tube rack on the back table. Vertical orientation allows gravitational separation of the specimen into 2 layers; the upper supranatant layer of oil and adipocytes and the lower infranatant serosanguinous layer of tumescent solution and blood. The 3-mm donor incision sites are closed with 6-0 fast-absorbing plain gut (Ethicon, Blue Ash, Ohio) and the donor site dressed with 6-inch Cover-Roll (BSN Medical, Charlotte, NC).

**Author’s Grafting Technique**

The donor site must harbor an adequate adipose tissue reserve for this fat transplantation technique. The yield from syringe lipoextraction requires approximately two thirds of the lipoaspirate be apportioned to filtered washings and the other third to centrifugation for ADSC concentration. Once the supranatant fat has gravitationally separated within all of the upright collection syringes, the infranatant fluid is decanted. Under sterile technique, those syringes allocated to autologous fat grafting are gently rinsed with 0.9% NaCl physiologic saline through a strainer or gently flushed through 2 syringes and a connector. The solid collection of washed grafts is collected into 10-mL syringes and transferred immediately into multiple 1-mL transplantation syringes, avoiding air drying. The technique is gentle and atraumatic, isolating the adipocytes, ADSCs, and interstitial endothelial tissues from anti-inflammatory cells, oil, and blood product contaminants (Figure 4A).

The remaining third of the collected fat specimen secured in capped 10-mL syringes is placed in sterile sheaths within the centrifuge and spun at 1200g for 3 minutes. This maneuver stratifies the fatty columns into 3 discrete layers, with the lower layer consisting of high-density concentrated ADSCs overriding an infranatant serosanguinous fluid buffer. The infranatant fluid is decanted, and the lower 1–2 mL whitish high-density ADSC pellet is transferred into 1-mL syringes, preserving the central fat layer for additional AFT grafts if necessary (Figure 4B and C).

Selective ADSC seeding proceeds by evenly injecting fine aliquots of the high-density ADSC concentrate into the recipient treatment areas through 0.9-mm blunt-tipped micro-injector cannulas (Tulip Injector, San Diego, Calif). Injections are administered in a retrograde and radial fashion under low pressure from strategic access puncture incisions placed with an 18-gauge needle. The ADSC-rich component is injected in 0.02- to 0.03-mL increments, delivered in a multilayered linear fashion from the deep supraperiosteal level to the subcutaneous layers. The objective is for even distribution of the high-density ADSCs to the recipient tissue bed for preparation and reception of the washed fat grafts. Typically, 4–6 mL of the ADSC concentrate is evenly distributed within the hemifacial recipient zones relevant to the extent of volume restoration required. This preparatory volume accounts for a fraction of the total volume to be transplanted (Figure 5).

Sculptural fat restoration commences after recipient bed preparation, first addressing volumetric tissue replacement by precise linear injections of small aliquots of washed fat grafts in a multivectored and layered fashion. Microcannula-fitted transfer syringes and the artistic nondominant “thinking hand” serve as sculpting instruments. The washed adipocytes contained in 1-mL syringes are gently delivered in aliquots of 0.05 to 0.10 mL per pass into the deeper zones and 0.03 to 0.05 mL per pass into the more superficial layers, avoiding high-pressure force or bolus volume deposition. Excessive in-and-out cannula movement is avoided to reduce recipient bed trauma and to optimize volume delivery and spatial graft placement with each pass. It is imperative to

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**Figure 4.** (A) Washed and filtered fat grafts. (B) Centrifuged fat grafts: stratified lower-level high-density adipose-derived stem cell (ADSC) pellet. (C) One to two milliliter high-density pellet for selective ADSC seeding. PMSDOLLCC©
work actively from multiple viewpoints around the subject such as a sculptor, appraising the human facial figure in circumferential perspective. Volume restoration architecturally reestablishes a supportive soft-tissue scaffold, XYZ expansion, and secondary facial soft-tissue repositioning and projection. The injection patterns are cross-hatched in a lattice-type manner through precise access incisions to create volume constructs in contradistinction to simply filling and grossly reexpanding the subcutaneous envelope. Sculptural fat restoration, based on artistic principles and practices, entails selective subcutaneous augmentation with graded depository volumes to fashion complementary surface aesthetic shape and form (Figure 6). The severely deficient areas are addressed first by deep centralized graft placement, followed by tapered volumetric blending and feathering toward the surface and peripheral zones. The transplanted fatty “tissue clay” should be topographically injected to parallel anatomical contours and densities and to accentuate beauty features and silhouette lines. All fat-grafting procedures, regardless of site, require feathering and homogenous blending between facial fat compartments and aesthetic zones. Beautification is achieved by establishing a disposition of tissue fullness, accentuating aesthetic facial highlights and light reflections, and improving soft-tissue symmetry and balance.

Facial beauty emanates from the midfacial zone. The “Triangle of Beauty” and flowing ogee curves define facial elegance and attractiveness, serving as aesthetic templates. The bimalar eminences spanning the curved zygomatic arches constitute the widest dimension of the face and should be restored to flow smoothly into the temples, forehead, and periorbital zones and taper inferiorly into a gracile or chiseled mandibular jawline. Volume restoration of the midface should replenish the deep medial cheek fat compartment and spaces first and then progress to adjacent deep and superficial facial fat compartments, overriding the anterior platform of the maxilla. Grafting should proceed from deep (more forgiving) to superficial in a tapered fashion, lastly injecting the superficial cheek fat compartments with conservative volumes adjacent to the subcutaneous level. Finally, designer accentuation may be achieved by precise placement of conservative subcutaneous volumes of feathered fat along the apogee of the malar prominence and the zygomatic arch.

The submalar area should be restored artistically as it defines an aesthetic facial plane and accentuates the malar mound. Often the chiseled or soft hollowed-cheek appearance is considered an elegant feature of mature attractiveness. Infraorbital rim hollowing, tear trough, and malar and nasojugal grooves are restored by deep fat grafting delivered perpendicularly from an inferior nasolabial crease, oblique midmalar, and lateral orbital injection sites avoiding the sausage-type deformity. Nondominant hand index finger positioning along the edge of the boney infraorbital rim protects the globe, prevents orbital septal and fat pad compartment penetration, and ensures deep microcan- nula tip supraperiosteal placement. Selective AFT to the supraorbital rim delivered to the supraperiosteal level may create a lifted angulated appearance to the
lateral brow, add fullness to the upper eyelid, correct orbital rim deficiencies, or adjust the supraorbital crease. Temple deficiencies are injected immediately in the subcutaneous plane lateral to the temporoparietal fascia delivering small parcels of fat to restore fullness and soften concavities and hollows. Injections should feather along the temporal ridge and extend anteriorly to the lateral orbital rim. Gentle manual massage after graft placement establishes an evenness to the tissues.

The perioral complex, being structurally dynamic, demonstrates a resiliency to fat graft longevity, typically requiring planned serial AFT sessions. The nasolabial groove is injected from a low nasolabial crease incision with fat placement layered from the periosseum upward, focusing most of the layered grafting to the immediate subcutaneous level to efface the surface deformities. The marionette line (melolabial fold) and triangle are approached from a lateral oral commissure incision delivering conservative superficial fat volumes. Lastly, the jawline is injected from an infraorbicular crease or jawline incisions, feathering along the mandibular edge. Placement parallels the turning edge of the jawline, strengthening the mandibular angle and body apogees, and defines the submandibular shadow. Paramandibular sculptural fat restoration should preserve the gracile and delicately tapered jawline of the female or the strong chiseled mandible of the male. Placement should avoid facial elongation, excessive jawline heaviness or widening, or masculinization of the female patient. Artistically, the masseteric zone and mandibular angle may be augmented to create a squared appearance to the jawline, enhancing male attractiveness.

In skin-tight environments, AFT is provided as a solitary procedure (Figure 7). When applied concurrently with other procedures, AFT is executed prior to laser resurfacing or upon completion of a facelift procedure (Figures 8–10). The facial planes developed during the rhytidectomy dictate the positional level of fat graft placement. Typical volume averages injected during a rhytidectomy are 8–15 mL per side, totaling 15–30 mL for the full face, resulting in 3-dimensional restoration. Facial injection volumes are conservative (overcorrection 0–20%) to compensate for the buffer carrier fluids and graft resorption, relying on fat graft survival and the adaptive stem cell regeneration for volume stability.
Since cryopreservation requires technical standards, additives, and handling precautions impractical to the private practice setting, the author does not store fat at this time. Staged fat transfers can be performed as early as 6 months after the initial session; however, the author preferentially reserves touch-up injections to 8 to 12 months, to avoid premature overtreatment prior to adaptive regenerative healing. Yoshimura et al, Lam et al, and Strawford et al report the turnover time for ADSC recovery to be in excess of 2 years.

Postoperative care includes dietary supplements (vitamin C, zinc), stable caloric intake, antimicrobial therapy, and the avoidance of smoking. The grafted areas are protected from trauma, pressure, massage, or excess facial mobility for 2 weeks. All patients are routinely examined at 1 week postoperatively.

Complications

The potential risks and consequences of AFT treatment are thoroughly reviewed preoperatively. AFT complications in the author’s practice have included prolonged hemosiderin staining and bruising; telangiectasia matting; a calcified facial cyst; hematomas; prolonged malar edema; donor-site fasciitis; incisional tattoo staining; lumpiness and contour irregularities; undercorrection; variable, asymmetrical, or complete fat reabsorption; and the rare dissatisfied patient. The author has not experienced recipient site infections, although various cases are reported in literature to include delayed infections or atypical mycobacteria. Other complications have been reported.

Excessive volume replacement by tissue overfilling can result in irreversible degrees of facial lipohypertrophy to include an amorphous doughy, cherubic,
feline, monster, or hamster faces or the sausage lower eyelid or lip deformity. Fat grafting when placed indiscriminately or excessively can lead to masculinization of the female face, distortion, and aesthetic disability. There is no easy remedy for extracting or removing overinjected fat grafts. One must be consciously aware of genetic aging and overweight predispositions.

**Discussion**

Facial aging reflects a complex interplay of multi-level structural remodeling, volumetric involution, and cutaneous expansion. The challenge to the cosmetic surgeon is to accomplish aesthetic restoration grounded in judgment, artistry, and sound scientific principle. Diverse intrinsic and extrinsic variables contribute to the aging process. The physician must recognize presenting patterns of aging and establish realistic consensual aesthetic goals with the patient. Imaging reconstructs and cadaver studies now provide tangible evidence as to the underlying soft-tissue and boney structural changes of anatomical facial aging. Application of this knowledge to patient management markedly improves clinical analysis and facial restoration efforts.

Sculptural fat restoration requires an innovative artistic charge to AFT, integrating principles of art, sculpting, and science to guide the creative restoration process. As an artist, the physician must sculpt and “see” 3-dimensionally, organizing volumes, masses, and planes into visually pleasing contour, silhouette lines, and light reflections. The aesthetic in facial rejuvenation is captured compositionally by additive, reductive, and organizational techniques (Figure 11). Likewise, the aging face and neck should be approached holistically and comprehensively. Just as the sculptor meticulously applies repetitive layers of clay extrinsically to create contour and shape, the surgeon must precisely sculpt internally, building on the existing anatomical contours and structural volume deficiencies of the human armature. Attractiveness, although recognized in symmetry and balance, is often a deviation from the average or normal by enhanced specific facial volumes and features. Sculptural fat restoration implies that one must not only replenish healthy volumes but also create a favorable or slightly exaggerated disposition of fullness, reflective volumetric highlights, and accentuating features in a designer-type fashion. The cosmetic surgeon should advance skills beyond technical mediocrity and aspire to higher relief in patient results. One must study art, photography, attractive facial beauty, and sculpture to appreciate fine aesthetic details, which serve as the inspiration to continually improve upon one’s own work.

Since 2009, the author has practiced selective ADSC seeding with sculptural fat restoration using conservative transplantation volumes of washed adipocytes/high-density ADSCs (3:1) in 50 select patients. Graft survival of 50–90% has been recorded by patient feedback, clinical findings, and photodocumentation. The satisfaction rate is more than 90%, and up to 20% have requested additional volume. The author refrains from overinjection with AFT volume replacement. It is always practical and safer to add more volume later than to compromise an aesthetic result. Smaller AFT aliquots permit sculptural precision during anatomical volume restorative and augmentation. By preferentially augmenting with washed adipocytes delivered into the selectively prepared recipient bed, the author

![Figure 11. Portrait sculpting: 3-dimensional construction of volumes, planes, and contours. “TORN” PMSDOLLCC©](image)
has noted improved graft longevity and aesthetic outcomes. The author’s technique is distinct in comparison to the layered subcutaneous approach of Coleman or the multilevel intramuscular injection of the facial autologous muscular injection technique described by Amar. With exception to the masticator masseter and the temporalis muscles, the muscles of facial expression are “carpaccio-like” thin, and although they are important vascular sources for graft respiration and integration, consistent and efficient blind intramuscular filling of these structures during fat restoration is a challenge. The author’s technique relies on the direct administration of fat grafts as artistic tissue clay for precise volumetric correction and augmentation of boney and soft deficiencies and features, backed by the reparative principles of stem cell therapy and graft survival, rather than restricting placement to paramuscular proximity. This tailored approach allows latitude for achieving a heightened aesthetic in shape, form, and reflection.

In the author’s experience, it is always better to graft conservatively than to overfill and result in a distorted hypertrophic face, often irreversible and difficult to manage. Although generalized facial volume depletion occurs over time, the author discourages indiscriminate generalized panfacial overfilling for correction of the aging face or compensation for the lax cutaneous envelope, which may require additional resurfacing or tightening techniques as these attempts can often fall short of capturing aesthetic beauty. One cannot simply reapply the mask of youth to the aging face and neck to restore beauty. Humbling is the reality that fat grafting is uniquely individual and unpredictable at times. Adipocytes and stem cells vary in quality and quantity among individuals and are affected by aging and cell senescence.

Consistent fat graft stability has been observed by the author in the midfacial platform to include the malar, submalar, nasolabial, periorbital, and paramandibular zones. Variable retention consistently occurs in the dynamic facial areas such as the perioral zone, and fat serves as a poor option for intradermal rhytid enhancement. The semipermanent fillers (hyaluronic acid, poly-L-lactic acid, and calcium hydroxyapatite) can provide complementary and nonsurgical options to AFT and should be discussed in the planning process.

The cosmetic surgeon is obligated to incorporate safe and scientific-based medicine into the patient’s quest for beautification surgery. Although fat-grafting efforts continue to establish a universal practice algorithm and a standardized technique, they remain an exceptional restorative option for cosmetic patients, demonstrating high patient satisfaction with natural-appearing aesthetic outcomes and a source of high-density progenitor cells with vasculogenic mediators. AFT has evolved from a crude, unfounded volumizing technique void of supportive scientific data to a refined technique of structural volume replacement endorsed by ongoing clinical studies, now revealing unique properties of adipose tissue as a biological antidote for multiple cosmetic and medical conditions. It is imperative that our profession preserve AFT as a sustainable technique for cosmetic and reconstructive practices, adhering to safe practices and minimal manipulation for facial and body restoration.

Fortified adipocytes are considered by the author to be the reparative natural tissue clay for 3-dimensional restoration and beautification of the facial structural armature. It is the cosmetic bridge to achieving exceptional outcomes in aesthetic harmony and balance and natural-appearing results. In the course, the physician must appease the emotional response of the patient, which is influenced by self-esteem, cultural norms, and the media. By integrating artistic, anatomic, and scientific footprints that support stem cell–enriched fat grafting, the surgeon now has the tools to approach volume restoration systematically from a head, hand, and heart approach and create quintessential external masterpieces. The undiscovered potentials of stem cell therapy should inspire the artist within the surgeon and encourage ongoing innovation, creativity, and discovery.

References
22. Berman M. Update on stem cell therapy. AACS: Advanced Techniques on Liposuction Symposium; Beaver Creek, CO; March 2012.


61. Rohrich R, Pessa J. The fat compartments of the face: anatomy and clinical implications for


