

## 8 Facial Rejuvenation with Fat Cells

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### 8.1 Abstract

Signs of aging in the face result not only from descent of ptotic skin but also, and more importantly, loss of volume in key anatomical locations. Fat grafting to the face is an effective technique in restoring volume and soft tissue support to the aging face. It may also have additive stem cell regenerative effects. Fat grafts are placed with cannulas using a parallel tunneling technique. The fat is placed in small aliquots. To preserve maximum viability of the graft, the fat is meticulously harvested using low-pressure suction, and prepared after centrifugation. Pulsed electromagnetic field therapy has been an adjunct to the procedure in the past few years. It has been observed to significantly reduce postoperative edema and shorten the recovery time. In some cases where there is a modest amount of skin laxity, ultrasound skin tightening is also applied to provide skin contraction over the augmented volume. The results have been durable and very satisfying for patients, and the procedure is safe.

### 8.2 Introduction

Volumetric facial aging occurs through a complex interplay of hard and soft tissue atrophy, weakening of support systems, and progressive skin laxity. These factors contribute to predictable loss of youthful highlights and vectors of descent that occur in the face, including flattening of the lateral brow, malar depression, and jowling by the anterior mandible. It is the senior author's (A.K.) opinion, based on observations over 20 years, that all classic stigmata of facial aging are initiated by volume atrophy, particularly of the central face, specifically the medial brow, nasojugal groove, pyriform region, and prejowl depression. This observation allows casual observers to decipher the *code of aging*, enabling them to assign a rough age to strangers and passersby on the street. Once this morphological code is understood, volume restoration can be used to reverse the physical signs of aging.

Traditionally, plastic surgeons viewed aging as a process of redundancy with descent, and, therefore, they focused on tightening the skin and underlying structures. Techniques were designed to address changes in facial lamellae starting with skin lifts alone or in combination with malar imbrication,<sup>1</sup> flaps involving the superficial musculoaponeurotic system (SMAS),<sup>2-5</sup> subperiosteal dissections,<sup>6,7</sup> and composite flaps<sup>8</sup> using a variety of facelift incisions. These procedures were then modified to address facial lamina through minimally invasive techniques

using cranial suspension,<sup>9</sup> variations of which are still being reported in the literature.<sup>10</sup>

A paradigm shift occurred 20 years ago from exclusive skin stretching and tightening toward attempts at volume replacement for restoration of facial contour and rejuvenation. This perspective was popularized by the advent of Coleman's fat injection technique. This led to a greater understanding of facial anatomy and the structural changes that occur with aging.

In cadaveric studies, Rohrich and Pessa described changes in facial structures with age.<sup>11</sup> Their study revealed that fat compartments of the face age independently and undergo changes in volume and position specific to their locations. Others have reported that changes in the distribution of fat in the face occur with age, with both soft tissue atrophy and hypertrophy occurring adjacent to one another, especially in the periorbital and perioral regions.<sup>12</sup> Beyond soft tissue changes are changes in the facial skeleton that occur with aging. Pessa and colleagues described aging of the bony orbits using three-dimensional (3-D) computed tomographic (CT) imaging and reported loss of anterior projection with aging through recession of the superomedial upper orbit and inferolateral orbit.<sup>13,14</sup> Kahn and Shaw found a significant increase in orbital aperture area with increasing age, which may contribute to brow descent and lateral orbital hooding with time.<sup>15</sup> Other studies have focused on changes in the maxilla, zygoma, and mandible that occur with aging, thus confirming that bony remodeling does occur with age. Although the volume of facial aging has not been quantified, the senior author has posited the question: Can a study be designed to follow aging with 3-D CT scans lead to a regional guide of volume replacement?

With bone and soft tissue atrophy, soft tissue descent, and qualitative changes in soft tissues, facial aging proves to be a complex synergy of local structural changes and environmental influences that occur over time. Thus it is only logical that operations limited to the excision of skin and soft tissue with redraping over the *existing skeletal volume*, may be satisfactory at the time of operation, but certainly do not address the changes that occur with age. This pattern of thinking addresses vectors of tension but does not mitigate the 3-D changes occurring in the face. In contrast, fat grafting offers a mechanical effect on the aged face along with a biological benefit presumed to be secondary to the transplanted stem cells. When performed appropriately, such that the fat cells survive and continue to be viable and functional, the aesthetic restoration achieved postoperatively persists for a longer period of time (► Fig. 8.1 a,c).



**Fig. 8.1** (a) Patient before facelift, upper blepharoplasties, and fat grafting surgery. (b) Six weeks postoperatively. Note the degree of postoperative swelling at 6 weeks was not unusual before the routine use of pulsed electromagnetic frequency. (c) Seven years and 5 months postoperatively. Note durable correction of bony and soft tissue atrophy. Patient had no revisional surgery during the postoperative period, only fillers to the nasolabial folds and lips.

Therefore, surgical repair of volumetric facial aging should start with regional restoration of volume and proceed to redraping of the soft tissue lamellae if descended.<sup>16</sup> Over the last 24 months, the senior author has used Ultherapy (Ulthera, Mesa, AZ, USA) for an intermediate group of patients who need more than volume replenishment but the degree of soft tissue descent does not warrant a facelift. Revolumization can be per-

formed with fat grafting or synthetic fillers. The ease and efficacy of harvesting techniques rendered by liposuction have led to fat grafting as the preferred medium for volume enhancement (► Fig. 8.2). This widespread adoption of fat grafting has led to techniques that have been shown to have a significant beneficial impact on facial rejuvenation over time.



**Fig. 8.2** (a, b) Before malar fat grafting and endoscopic browlift. (c, d) Ten years and 9 months postoperatively. Note improvement in dyschromia that frequently accompanies successful fat grafting. Note persistent atrophy in areas that were not grafted: lateral forehead, nasolabial region, and mandible, especially the labiomental area of the lateral chin. (e, f) Ten months after a second operation consisting of 60 mL of panfacial fat grafting. Note restoration of forehead contour, brow height, nasolabial fill, and mandibular prominence.

### 8.3 Indications

Patient evaluation is focused on highlighting areas of facial atrophy followed by determining, in concert with the patient, areas of donor site harvest. Medical evaluation is obtained per American Association for Accreditation of Ambulatory Surgery Facilities (AAAASF) protocol. Virtually all areas of the face can be treated with fat grafting. The following areas are particularly amenable and consistent stigmata of aging in patients: medial brow, nasojugal groove, pyriform region, prejowl depression, temple, and forehead.

### 8.4 Technique

Patients are given clonidine in the preoperative area to minimize blood pressure changes in the postoperative period that can lead to exacerbated swelling. Celebrex is initiated 48 hours

preoperatively to minimize narcotic use and potential nausea and emesis. Patients are then taken to the operating room, and general anesthesia is always used. The donor sites are infiltrated with tumescent solution (1 mL per 1 mL of expected volume of fat harvested), and fat is harvested using a 3 mm Luer-lock cannula under low pressure in 10 mL syringes. The fat is then collected in 60 mL syringes, and oil and serum are decanted prior to centrifugation.

The harvested fat samples are then centrifuged at 3,000 rpm for 2 to 4 minutes depending on the tissue turgor of the specimens. The goal is a homogeneous paste that can be easily and predictably injected. The oil and serum are once again fractionated and decanted. The viable fat cells are then placed in 1 mL syringes in preparation for injection. The fat type is assessed prior to injection. Less fibrous fat has better flow characteristics, providing for smoother infiltration. It is important to be cognizant of the flow characteristics of fat being injected to prevent irregularities and to use similar-quality specimens symmetrically.

Attention is then directed to the recipient sites in the face. No incisions are made. A 16-gauge needle is used to provide cannula access. Then small aliquots of fat are injected with a 17-gauge side-port bullet-tip cannula (Grams Medical, Costa Mesa, CA, USA). The tip of the cannula is placed to a depth until bone is palpated. Fat is injected in tiny aliquots to maintain intimate contact with adequate vascular supply. Digital control of aliquot dispersion is used, and side-to-side sweeping of the cannula is minimized to prevent local tissue trauma, which can affect the final result.

Injections are performed first in the deep compartments with careful attention focused on local skin turgor. If skin laxity and contour are not sufficiently addressed, then injection proceeds superficially. It is imperative to constantly reevaluate the global aesthetic of the face while injecting to ensure blending of adjacent areas. The usual amount of fat injected varies depending on the site and individual. The end point is an aesthetic appearance. Overall, the amount needed to produce facial rejuvenation varies between 80 and 100 mL per face (► Fig. 8.3).

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**Fig. 8.3** (a, b) A 54-year-old woman with cachexia secondary to breast cancer and colon cancer, including chemotherapy. This patient had undergone unsuccessful fat grafting by a different surgeon 1 year earlier. (c, d) Ten months after 122 mL panfacial fat grafting. Note youthful contour and skin quality that typically continue to improve over time.

Steri-Strips (3 M, St. Paul, MN, USA) are placed over the sites of skin puncture. A pulsed electromagnetic frequency (PEMF) de-

vice is immediately placed in the operating room and turned on for 15 minutes per hour until the patient is discharged from the

recovery room. Patients are sent home the same day with the device to be used 15 minutes, four times a day until full recovery is achieved. Patients usually only require acetaminophen for additional pain management.

From 1993 to 2012, the senior author has performed a total of 750 patient-operations for facial rejuvenation with fat grafting. Over the last 2 years, 75 patients have undergone similar procedures with the addition of a pulsed electromagnetic device to minimize postoperative edema and reduce pain. No major complications were observed, including hematoma, infection, or motor deficits. All patients were satisfied with their aesthetic outcomes. Five patients requested limited regional modification (reduction in volume). One patient was noted to have

her fat grafts spontaneously change over time, enlarging dramatically. This occurred in only two of the regions that had been injected. She was diagnosed with a pituitary tumor that produced a high level of growth hormone.

Length of recovery is the issue that creates the most apprehension among patients. Prior to our routine use of PEMF, recovery time could take many weeks and even months in some cases (► Fig. 8.1 a, b). Patients who present for secondary fat grafting still remember the duration of their recovery, though they are quite happy with the eventual result. Since starting routine postoperative PEMF, socially significant swelling is present for no longer than 7 to 14 days (► Fig. 8.4 a-d, ► Fig. 8.5).



**Fig. 8.4** Before (a), 5 days after (b), 12 days after (c), and 4 weeks after (d) transconjunctival lower blepharoplasty and full facial fat grafting (80 mL) using postoperative pulsed electromagnetic frequency. Same patient is shown on full facial view before (e) and 4 weeks after (f) surgery.



**Fig. 8.5** Anteroposterior views before (a), 3 days after (b), 4 days after (c), 11 days after (d), and 12 days after (e) reconstructive septorhinoplasty with conchal cartilage harvesting and full facial fat grafting (80 mL) using postoperative pulsed electromagnetic frequency.

## 8.5 Discussion

Fat transplantation to the face has been used for facial volume enhancement for over a century. Neuber was the first to graft fat to the face for a defect secondary to tuberculosis osteitis.<sup>17</sup> Three years later, fat grafting to the periorbital area in conjunction with periosteal dissection to mobilize prior scar tissue was reported.<sup>18</sup> At the turn of the 20th century, Hollander first described using a syringe and needle to transplant fat tissue,<sup>19</sup> which was then used in conjunction with rhinoplasty,<sup>20</sup> rhytidectomy,<sup>19</sup> and ear reconstruction.<sup>21</sup> However, it was not until 1976 when Fischer<sup>22</sup> first described the aspiration of fat through a cannula that the advent of liposuctioned fat for reinjection was born. Nearly a decade later, the injection of suctioned fat to the face was first described<sup>23</sup> and fat grafting had been adopted by many plastic surgeons. In the late 1980s, plastic surgeons became skeptical of the use of fat grafting due to lack of longevity, early negative result,<sup>24–26</sup> and concern over the inhibition of the early detection of breast carcinoma.<sup>27</sup> Most

recently, improvements in methods and technique, largely led by Coleman,<sup>28</sup> have led to a resurgence in the use of fat grafting.

Survivability of grafted fat has been a long topic of controversy. Literature over the decades has reported resorption rates ranging from 20 to 90%.<sup>29,30</sup> Animal studies have supported these values with graft loss ranging from 45 to 79%, based on technique and the number of grafts used.<sup>31</sup> Early pioneers such as Illouz contended that “the human body is an excellent culture medium,” and augmentation should be done with ~ 30% overcorrection to account for graft resorption.<sup>32</sup> Other authors have concluded that “some surgeons have some impressive results, but most of us have many disappointing results.”<sup>33</sup> This ambivalence in the literature had led to a chasm over the efficacy of fat transplantation among plastic surgeons worldwide.

Like all procedures in plastic surgery, there are nuances between the techniques of practitioners. Fat grafting is particularly sensitive to variability in technique and may account for differences in survival of grafted fat. Harvesting of fat via liposuction was found to have nearly 90% viability<sup>34,35</sup> with improved survival when extracted with minimal negative pressure.<sup>36</sup> In addition, the site of harvest has not been shown to

make a significant difference with respect to graft survival.<sup>37</sup> Methods of refinement including but not limited to centrifugation and washing are done to better isolate adipocytes for transplantation. A blunt cannula is attached to the 1 mL Luer-lock syringe filled with the refined tissue, which is inserted in small aliquots to maximize the surface area of the graft to native tissue.<sup>38</sup>

Many practitioners, however, inject fat such that only a small percentage survives. This may be due to inadequate harvesting techniques, refinement techniques, or injection techniques. These practitioners are treating fat as a filler substitute instead of a fat graft, the latter having a greater potential for revascularization. Furthermore, placement of the fat graft is often done only under local anesthesia, which makes it very difficult to properly place small enough samples diffusely. Fluctuations in blood pressure occur regularly under local anesthesia, leading to bleeding and edema, all of which may adversely affect graft survival. Finally, the way in which the fat grafts are placed may make a difference. In the senior author's experience, the parallel tunneling technique is preferred to the commonly reported "fanning out" technique to minimize tissue trauma where the tunnels overlap with resultant inflammatory response and recipient site cell necrosis.

Although revolumization of the face can be achieved with several presently available fillers, the use of fat grafting is usually preferred to the use of synthetic fillers, the so-called liquid facelifts and lunchtime facelifts. Contrary to the way they were initially conceived and marketed, fillers do have downtime with occasional prolonged and significant bruising and swelling and even permanent deformity. Significantly, continuous access to fillers has led to a widespread facial aesthetic that is unattractive and artificial in appearance.

Fat grafts, on the other hand, when properly performed, have biological activity and become integrated into the local soft tissue. Revision is only necessary when enough atrophy of adjacent fat and bone tissue has taken place, in roughly a decade's time, compared with fillers, which are needed every year. Fat grafts are now as reversible as fillers. They can be reversed surgically through aspiration or nonsurgically by melting them thermally with focused ultrasound. In addition, in the senior author's experience, fat grafts have the added benefit of improving skin quality. Overall, reconstitution of the face with fat grafting addresses the complex interplay in soft tissue and bony aging, addressing its cause, as opposed to fillers, which have conventionally been used to treat specific areas of the face, thereby only treating a symptom.

Despite its preference over synthetic fillers, complications do occur with fat grafting. The most common complications are related to unappealing aesthetics related to the volume of fat injected. Fat grafting is a truly three-dimensional technique requiring patience, an aesthetic eye, and a global approach to facial rejuvenation. Irregularities may also occur, which can be attributed to misplacement, fat necrosis, or migration of nonviable fat cells.<sup>39</sup> These are all preventable issues with the proper techniques. Like fillers, on rare occasions, intravascular injection

of fat has been reported to have caused arterial occlusion leading to stroke and blindness,<sup>40</sup> which may be prevented with the use of a blunt cannula and limited volumes of injection.

In addition to complications, patients in the postoperative period often experience a considerable degree of swelling adjacent to the site of fat graft placement. Elevation of the affected region, cold therapy, and external pressure using foam tape may help to stop the tide of progressive edema. Patients may also complain of pain, primarily at the donor site, which is treated supportively. Several surgeons have reported swelling that is present for several weeks after surgery.<sup>28</sup>

Supportive care to diminish pain and edema in the postoperative period can also be achieved using PEMF therapy. This has been demonstrated both in the clinical setting<sup>41,42</sup> and in animal studies.<sup>43</sup> This reduction of pain and swelling has been postulated to occur by potent anti-inflammatory effects and improved biological healing via the calcium-calmodulin-nitric oxide pathway.<sup>44</sup>

In the past, the duration of swelling was highly unpredictable and lengthy for many patients. In the senior author's experience, the recent addition of PEMF therapy to the postoperative regimen has made the healing process much more predictable for patients. In general, the device, a coil, is simply laid over the face while the patient is reclining. The physics of this technology require that the device not be bent or distorted. Treatment is initiated in the operating room as soon as the procedure is completed and is used at least four times per day for a duration of 15 minutes each time. Patients may continue to use the device until they are happy with the improvement of facial edema. Ice may also be used simultaneously with PEMF therapy.

Considerable beneficial results are seen with the use of this device. Patients can be out and about wearing sunglasses within a week of the procedure and usually return to work and their social lives within 2 weeks with occasional ecchymosis in the periorbital region. PEMF therapy may also be beneficial for vascularization of fat grafts, thus improving the overall goal of achieving facial rejuvenation.

Volume augmentation of the face must be performed with constant reevaluation of the global aesthetic of the regions being injected. For example, injection of the forehead helps restore a natural convex contour, best viewed from the "worm's eye" perspective to ensure adequate augmentation. Once the forehead has been restored, adjacent areas may appear disproportionately aged. For instance, injection into the subbrow results in more youthful restructuring and repositioning of the brow. This is in keeping with Lambros's concept that brows do not descend as much as we elevate them.<sup>45</sup> Fat augmentation of the prejowl helps to diminish the prominence of the jowl, while at the same time supporting the oral commissure and re-creating a more youthful labiamental sulcus. Volume restoration of the submental crease helps to improve mentalis muscle ptosis and make platysmal banding less apparent (► Fig. 8.6) while fat grafting to the chin reduces mentalis strain (► Fig. 8.7). Thus volume augmentation of the face exploits the complex interplay between regions of the face while fat grafting is performed.



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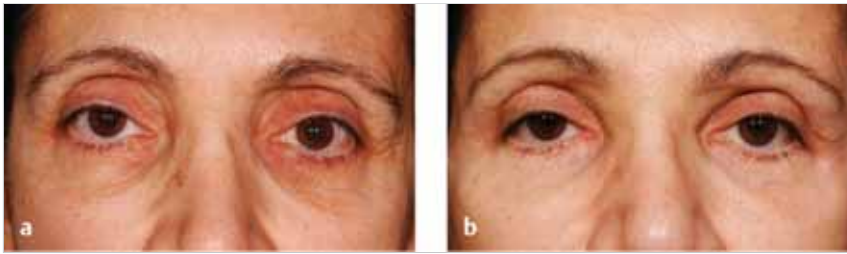
**Fig. 8.6** Lateral views of patient in Fig. 8.2. (a) Before second operation that consisted of fat grafting. (b) Ten months after facial fat grafting. Note improvement in mandibular definition and correction of submental contour with submental crease fat grafting.



**Fig. 8.7** Anteroposterior views of face (a, b), eyes (c, d), and (e, f) mandible. Facial fat grafting (55.5 mL), including forehead, brow, and malar and lower lid regions in conjunction with upper lid skin-only blepharoplasty and lower lid transconjunctival blepharoplasty. Fat (22 mL) was grafted to the chin and labiomental and submental crease regions. Fat grafting (16 mL) was added 16 months later to the malar/lower lid and chin regions during another procedure. Note the improvement in mentalis strain with fat grafting to the chin and labiomental and submental crease regions. Also note the improvement in skin quality with fat grafting. Anteroposterior view: Interpupillary distance and lower facial height are stable for reference. Close-up lateral of mandible: Line from nevus to anterior edge of interlabial line is stable for reference. Close-up eyes: Interpupillary distance is stable for reference.

Textural skin flaws are usually discussed in terms of skin damage. Treatment usually focuses on addressing the skin with laser or peel techniques. Volume restoration appears to provide a synergistic method of treating skin quality through a proposed

skin cell mechanism (► Fig. 8.2, ► Fig. 8.3, ► Fig. 8.7, ► Fig. 8.8). In addition, restoration of structural support may allow skin, as an organ, to function more physiologically.



**Fig. 8.8** Anterioposterior view before (a) and 26 months after (b) facial fat grafting to the brow and upper eyelid areas. Note improvement in dyschromia.

It has been the senior surgeon's observation that injected areas tend to age more slowly than noninjected ones. This observation has been reproducible over many years of clinical practice (► Fig. 8.2, ► Fig. 8.9). Perhaps viable fat, when successfully grafted, may act as stem cells that have the potential for long-

term soft and hard tissue repair and regeneration. It is more likely, however, that volume augmentation with fat grafting provides for mechanical support as well as biological effects on the local soft tissues.



**Fig. 8.9** Before (a) and 7 years after (b) rhinoplasty and facial fat grafting only to the malar and pyriform apertures. Note maintenance of medial malar and pyriform aperture convexity. Compare with the advanced aging of the lower lids, forehead, and temporal areas.

The concepts and techniques described in this chapter have evolved into a global approach to facial rejuvenation. Defined regions of the face are addressed with fat grafting, including but not limited to the forehead, brows, temples, labiomental sulcus, and submental crease. This technique builds from deep to superficial and takes the view that restoration of the deep support structures will improve the appearance of more superficial tissues of the face (► Fig. 8.4 e, f). Fat augmentation may address some of the fundamental causes that lead to the stigmata of facial aging and represents a powerful tool in the hands of an aesthetic surgeon.

## 8.6 Conclusions

Fat grafting to the face addresses the most important cause of facial aging, namely loss of volume and structural support. Its results are longer-lasting and more natural than those obtained from synthetic fillers. With improvements in technique, the procedure has become more reliable and safer. The addition of PEMF has further improved graft viability and has significantly reduced postoperative edema.

## 8.7 References

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