

# Fat Grafting for Facial Rejuvenation and Contouring

## A Rationalized Approach

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**Abstract:** The clinical outcome after fat grafting for facial rejuvenation and contouring can be less optimal because lack of *standardized* techniques is performed by the surgeon for the procedure. In this review, the author has tried to provide a rationalized approach to fat grafting for facial rejuvenation and contouring. The preferred donor sites include low abdomen and inner thigh especially in younger patients. Fat grafts should be harvested with low negative pressure via syringe liposuction technique to ensure the integrity as well as the optimal level of cellular function. Fat grafts should be processed with proper centrifugation that can reliably produce purified fat and concentrated growth factors and adipose-derived stem cells, all of which are beneficial to improve graft survival. Fat grafts should be placed after certain principles with gentle injection of small amount during the withdraw phase of each pass in multiple tissue planes and levels with multiple passes to ensure maximal contact of graft with vascularized tissue in the recipient site. The approach described in this review is supported by the most recent scientific studies and thus can likely provide a more predictable long-lasting result if performed properly.

**Key Words:** fat transplantation, fat grafting, lipotransfer, Coleman technique, facial rejuvenation, facial contouring

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Fat grafting can be a good option for facial rejuvenation and contouring because fat is abundant, readily available, inexpensive, host compatible, and can be harvested easily and repeatedly.<sup>1</sup> Comparing with any available synthetic fillers, fat can be an ideal filler for facial rejuvenation and contouring since the clinical result can be permanent without any concerns or complications related to fillers.<sup>2</sup> However, the overall survival rate after fat grafting is around 50% in most reported studies, which has not been considered ideal procedures for its clinical application. To improve fat graft survival has therefore been constantly driving force for scientists and clinicians to search for better techniques of fat grafting.

Since mid-1990s, Dr Sydney R. Coleman from New York City has championed and popularized the technique primarily for facial fat grafting. His technique, also referred as the Coleman technique, emphasizes proper harvest, process, and placement of fat grafts. Without knowing the rationale for each step at that time, only a few surgeons were able to achieve predictable and long-lasting result after fat grafting to the face.<sup>3,4</sup>

For the last 10 years, many remarkable advances in fat grafting have been made and fat grafting becomes a popular procedure in plastic surgery especially for facial rejuvenation and contouring. In this review, the author introduces his preferred technique for fat grafting to the face based on most recent scientific studies by many investigators. He

describes it as a *rationalized approach* for facial rejuvenation and contouring because such an approach is more scientifically sound. Hopefully, the readers will be able to use the information provided here to guide their clinical practice of fat grafting to the face so that the best possible outcome of fat grafting can be achieved for their patients.

### CLASSIFICATIONS FOR FAT GRAFTING

Fat grafting technique can be arbitrarily classified into 5 essential components. They are how to select the donor sites, how to harvest the fat grafts, how to process the fat grafts, how to prepare the recipient sites, and how to inject the fat grafts. Fat grafting can also be arbitrarily divided into 3 categories based on the volume needed: small volume fat grafting (<100 mL) is performed primarily for facial rejuvenation or regenerative approach; large volume fat grafting (100–200 mL) is performed primarily for breast and body contouring; or mega volume fat grafting (>300 mL) is performed primarily for buttock augmentation, breast augmentation, or breast reconstruction. Each category may have its respective technique for the procedure.<sup>5</sup> In this review, the author only focuses on techniques for small volume fat grafting because the techniques for large or mega volume fat grafting can be quite different.

### BASIC TECHNIQUES OF FAT GRAFTING TO THE FACE

#### Donor Site Selection

A variety of body areas that uniformly have abundant or excess fat are suitable as donor sites for harvest of fat grafts such as abdomen, flanks, buttocks, medial and lateral thighs, or knees. As a general rule, donor sites that enhance body contour are selected and are easily accessible in the supine position, which is the position that is used for almost all facial augmentation procedures. Although there is no evidence of a favorable donor site for harvest of fat grafts because the viability of adipocytes within the fat grafts from different donor sites may be considered equal, higher concentration of adipose-derived stem cells (ADSCs) is found in the lower abdomen and inner thigh in one study.<sup>6</sup> In addition, in younger age group (<45 years old), fat grafts harvested from both lower abdomen and inner thigh have higher viability based on a single assay test.<sup>7</sup> With what we know about the potential role of ADSCs in fat grafting,<sup>8</sup> the lower abdomen and inner thighs should, therefore, be chosen as the *better* donor sites for fat grafting to the face<sup>6,7</sup> (Fig. 1). These donor sites are not only easily accessible by the surgeons with a patient in the supine position but also scientifically sound as long as patients have adequate amount of adipose tissue in those areas. In the author's practice, an average of 30 mL is usually needed for most facial rejuvenation and contouring cases.

#### Fat Grafting Harvesting

The syringe aspiration, as a relatively less traumatic method for harvest of fat grafts, is supported by the more recent studies and should be considered as a standardized technique of choice for harvest of fat grafts.<sup>9</sup> However, this technique can be time-consuming even for experienced surgeons and the large quantity of fat grafts may not easily be obtained with this technique.

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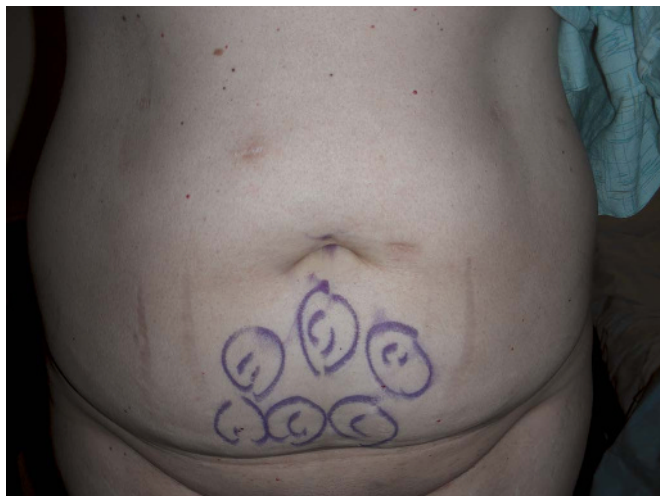
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**FIGURE 1.** Lower abdomen as a commonly selected donor site for facial fat grafting.

Placement of incisions can be done with a number 11 blade in the locations where the future scar can easily be concealed. The size of incision is about 2 to 3 mm. A small clamp is used to dilate the underlying subcutaneous tissue through the incision to allow insertion of the harvesting cannula with ease. The anesthetic solution is then infiltrated to the donor site 10 to 15 minutes before fat extraction, which makes harvesting of fat graft easier and less traumatic. The tip of the infiltration cannula is usually blunt and has several openings on the side. The ratio of aspirated fat to tumescent solution should be about 1:1 so that each pass of fat extraction can be more efficient.

A 10-mL Luer-Lok syringe is used and connected with a harvesting cannula. For harvesting fat grafts from the lower abdomen or inner thigh, the harvesting cannula is 15-cm long with a blunt tip and has dual openings like the shape of a bucket handle. Recently, a newly designed harvesting cannula with a multiple side holes has been used (Fig. 2). This kind of the cannula can be more efficient for fat extraction. Gentle pulling back on the plunger creates a 2-mL space vacuum negative pressure in the syringe. With gentle back and forth movement of the syringe, the fat is gradually collected inside the syringe (Fig. 3). If little fat with too much fluid is present within the syringe, the fluid can



**FIGURE 2.** A newly designed cannula with multiple side holes for graft harvest. The cannula has a total of 6 side holes and can be used more effectively for fat harvest.



**FIGURE 3.** Fat grafts can be aspirated with back and forth movement with a 10-mL syringe and a 2-cm space vacuum negative pressure.

be easily pushed out from the bottom of the syringe in a vertical position and fat extraction can be continued. After harvest, all incision sites are closed with interrupted sutures once excess tumescent fluid or blood is milked out.

### Fat Graft Processing

Several methods have been proposed to effectively remove the infiltrated solution and cell debris within the lipoaspirates and to obtain more concentrated fat grafts. However, it is actually the most controversial and disagreeable issue in fat grafting even among many experts in the field. Common methods for processing fat grafts include centrifugation, filtration, or gravity sedimentation.

Centrifugation, as proposed by Coleman, is the author's preferred method to process fat grafts. There are several advantages of centrifugation of fat grafts. More viable adipocytes are found at the bottom of middle layer after centrifugation even with a force of 50g for 2 minutes based on viable cell counts, and this makes manipulation of fat graft for use easier but with better viability.<sup>10,11</sup> Recent studies have shown that proper centrifugation can concentrate not only adipocytes and ADSCs but also several angiogenic growth factors within the processed fat grafts.<sup>12,13</sup> Because higher content of stem cell or angiogenic growth factor positively correlated with fat graft survival both in experimental and clinical studies,<sup>14</sup> centrifugation at 3000 rpm (about 1200g) for 3 minutes appears to offer more benefits for this effectively concentrating adipocytes and ADSC and should be a valid method of choice for processing fat grafts, especially for small volume fat grafting.<sup>9</sup>

The Luer-Lok aperture of the 10-mL syringe locked with a plug at completion of harvest is ready for centrifugation (Fig. 4). After careful removal of the plunger, all lipoaspirate-filled 10-mL syringes are placed into a centrifuge and are then centrifuged with 3000 rpm (about 1200g) for 3 minutes. Greater *g* force or longer duration of centrifugation may be harmful to adipocytes and is therefore not recommended.<sup>15</sup>

Attention should be made to avoid prolonged exposure of fat grafts to air and to avoid bacterial contamination. After being centrifuged, lipoaspirates with the syringe are divided into 3 layers: the oil content in the upper layer, fatty tissue in the middle layer, and the fluid portion at the bottom (Fig. 5). The oil can be decanted from the Luer-Lok syringe. The residual oil is wicked with a cotton strip or swab. The fluid at the bottom can be easily drained out once the plug at the Luer-Lok aperture is removed.



**FIGURE 4.** At completion of fat harvest, each syringe is locked with a plug and covered with a Tegaderm dressing to prevent prolonged exposure to air and possible contamination. It is ready for centrifugation.

The concentrated fat in the syringe can then be transferred to a 1-mL syringe (our preferred size of syringe for fat injection to the face) with an adaptor. A 1-mL syringe is made of acrylic material and has little resistance while fat grafts are injected. In addition, the injected volume can easily be controlled by the surgeon with such a syringe (Fig. 6).

### Preparation of Recipient Site

Unlike other parts of the body such as breast, pre-expansion to the face for facial rejuvenation or contouring is usually not required. Because of rich blood supply in the face, the possibility of intravascular injections causing fat embolism to the brain or eye can be real and may be avoided by preinjection of 1% lidocaine with 1:200,000 epinephrine to planned fat grafting sites for possible vasoconstriction especially in the temporal and periorbital areas. Adequate compression to those areas after injection of above anesthetic solution is needed to minimize swelling in the area so that precise placement of fat grafts can still be made by the



**FIGURE 5.** Syringes are placed after centrifugation at 3000 rpm for 3 minutes. Oil in the upper layer and liquid in the lower layer are discarded. Only the fat grafts in the middle layered are collected.



**FIGURE 6.** Fat grafts are transferred to multiple 1-mL syringes for injection. A 1-mL acrylic syringe is preferred for facial fat grafting.

surgeon according to the volume requirement of fat grafts in each area. In addition, release firm attachment of the skin over the proposed injected areas such as in the nasolabial fold with a sharp cannula can also be performed so that the space is created between the skin and underlying tissue for placement of fat grafts (Fig. 7).

### Placement of Fat Grafts

One of the most important techniques of fat grafting may be how to place fat grafts. The key to a successful fat graft injection is to achieve an even distribution of fat grafts in the recipient site. By doing so, the injected fat grafts may have a maximal amount of contact with the tissue in the recipient site for better fat graft survival through plasmatic imbibition and neovascularization (Fig. 8). Not only grafting with small volume in each pass can get better surgical outcomes but also complications such as fibrosis, oil cyst formation, calcification, or even infection with large-bolus grafting can be avoided. To achieve this goal, small volume (no more than 0.1 mL) of fat grafts should be injected in each pass. Slow injection of 0.5 to 1 mL per second should be injected during the withdrawal phase in each pass to minimize trauma to the fat graft.<sup>16,17</sup> Fat grafts should be placed via multiple passes



**FIGURE 7.** The forked-tip cannula can be used to release fibrotic tissue, scar, or adhesion.



**FIGURE 8.** An example of well processed and concentrated fat grafts without oils and red blood cells.

within multiple tissue planes and tunnels in multiple directions<sup>1,17</sup> (Fig. 9). The volume requirement for each area of the face in the author's practice is reported in Table 1.

Injection should be as gentle as possible to avoid a possible injury to vessel or nerve. Injection with resistance would compromise the result and increase the chance of associated complications (Fig. 10). The injecting cannulas usually range from 20 G to 12 G in diameter and vary in length and shape according to the volume and area to be grafted. Only a dull tip injection cannula is selected to avoid accidental intravascular injection (Fig. 11). The most commonly used cannulas are 5 to 9 cm in length for facial procedure. In general, a smaller cannula should be used for fat grafting to the area such as the periorbital region where only a smaller volume of fat grafts is injected in each pass. Smaller cannulas may also allow the surgeon to have more precise control over the volume when extremely tiny amount of fat grafts is injected. The cannula includes straight or curved one and blunt or forked tip to meet different needs. The cannula with forked tip can cut through tissues and can be used to release fibrotic tissue or scar, adhesion, or ligament attachments.

Preoperative photograph with a detail planing marked on the patient is important for intraoperative comparison because the changes



**FIGURE 9.** An intraoperative view shows fat injection to the face. Such an injection is meticulously performed based on the techniques described in the article.

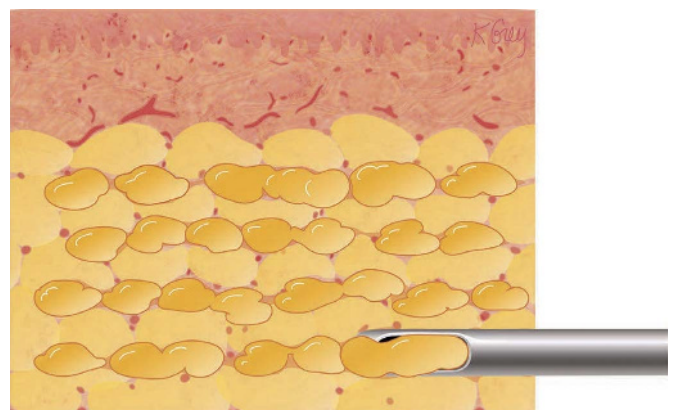
**TABLE 1.** Volume Requirement of Fat Grafting for Each Area of the Face

Forehead	10–15 mL
Temporal fossa	4–6 mL
Upper eyelid	1 mL
Lower eyelid/cheek junction	1–2 mL
Cheek	4–10 mL
Nasal dorsum	2–4 mL
Nasolabial fold	1–2 mL
Upper/lower lip	1–2 mL
Marionette line	1–2 mL
Chin	4–6 mL

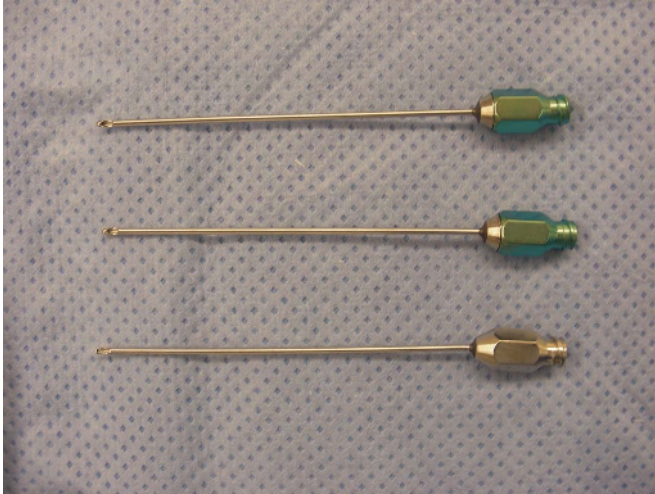
need to be made with fat grafting in the operating room usually are very subtle. The surgeon should make sure where the cannula tip is during the entire injection process. If there is any doubt about the tip location, tent the cannula tip toward the skin and then see blanching of the skin overlying the advanced cannula to reveal its exact location. If fat grafts are placed in a correct location, the *augmented* effect in the grafted area can easily be identified. If volume is not increased even though grafting is in the right place, other factors that may restrict volume enlargement should be taken into consideration such as fibrotic adhesion or tight skin envelope. Fibrosis or adhesion can be dissected with an 18-G needle or a forked tip cannula. Attention should be made to avoid a *bolus* injection, and the basic principles for the placement of fat grafts should be followed to ensure the better outcome and avoid fat necrosis.

## POSTOPERATIVE CARE

Swelling in the recipient site is expected for 1 or 2 weeks, and the grafted areas can become firm or hard in the first few weeks. Patients should be informed about this normal process after fat grafting, and some reassurance to them may be necessary. However, when fat grafting is done to the face, prolonged swelling (up to 6 weeks) may be expected. During the recovery time, ice packing, tight compression with elastic bandage, or massage in the grafted area should be avoided because all of the above may compromise fat graft survival and final outcome. However, taping over the grafted areas may relieve some discomfort from swelling and prevent the patient from pressing or touching the areas (Fig. 12). Any direct trauma or shear force over the grafted areas may jeopardize fat graft



**FIGURE 10.** Schematic diagram shows a proper technique of fat injection. Placement of minuscule amounts of fat grafts with each pass as the cannula is withdrawn. Fat grafts should be placed with multiple bypasses but in multiple tissue planes and tunnels. Copyright Thieme Publishers.



**FIGURE 11.** Several dull tip injection cannula are used for facial fat grafting.

survival and should be avoided. A representable case is included here to demonstrate the results after facial rejuvenation and contouring from the author's practice (See case example below).

## OTHER CONSIDERATIONS

### Anesthesia

Anesthesia for harvest of fat grafts can be performed under general anesthesia or local anesthesia with or without intravenous sedation. The tumescent solution used for donor site analgesia or hemostasis should contain the lowest concentration of lidocaine possible because its high concentration may have detrimental effect on the adipocyte function and viability.<sup>18</sup> In general, the author uses 0.03% of lidocaine in 1 L of Ringer lactate solution. The tumescent solution also contains epinephrine with a concentration of 1:200,000. Epinephrine can precipitate vasoconstriction in the donor sites as well as the recipient sites, which may decrease blood loss, bruising, hematoma, and the possibility of intra-arterial injection of the transplanted fat especially when injecting around periorbital areas or in the temporal area.

### Overcorrection

Whether overcorrection is necessary or not for fat grafting remains unclear. Because the viable fat grafts are only observed in the peripheral zone approximately 1.5 mm from the edge of the grafts and the percentage of graft viability depends on its thickness and geometrical shape,<sup>19</sup> overcorrection for better graft survival in the recipient site appears to be lack of scientific support. In addition, significant overcorrection may increase the incidence of fat necrosis and subsequent calcification or even severe infection.<sup>20</sup> Therefore, *significant*



**Case example.** A, A 29-year-old Asian woman desired facial rejuvenation and contouring. B, The preoperative design and plan for her facial rejuvenation and contouring. C, An immediate intraoperative appearance after her facial fat grafting. She had a total of 37mL fat grafting to her face (forehead, 15mL; temporal fossa, 5 mL for each side; medial lid/cheek junction, 1.5 mL for each side; nasolabial fold, 2 mL for each side; and chin, 5 mL). D, The results at 5 months follow-up.



**FIGURE 12.** Taping the injected area for immediate postoperative care after facial fat grafting.

overcorrection should be avoided until its necessity and safety can be confirmed by future studies.

### Timing for Subsequent Injection

Because overall take rate of fat grafting by even experienced surgeons ranges from 50% to 90%,<sup>1,17,21</sup> additional procedures are always necessary to achieve an optimal outcome. However, there is no scientific study which has addressed the timing of subsequent fat grafting. So far, only *expert* opinion has been mentioned in the literature regarding this specific issue. It has been described as the timing of additional fat grafting sessions should be deferred until 6 months postoperatively so that the inflammatory response in the grafted area can be diminished.<sup>22</sup>

It is often difficult to assess the surgical outcome during the first few weeks after fat grafting. In general, the extent of swelling and the waiting period that it needs to resolve is also volume dependent. We have observed that the transplanted fat gradually loses its volume with time and usually becomes stabilized at 3 months postoperatively if surgical recovery is uneventful. Therefore, the timing of a subsequent fat grafting procedure should be deferred to at least 3 months after previous transplantation.

### DISCUSSION

Much of the current scientific studies support this rationalized approach to facial fat grafting described in this review for small volume fat grafting.<sup>23,24</sup> Besides the proper selection of donor sites (ie, the lower abdomen or inner thigh for small volume fat grafting), fat grafts should be harvested with a less traumatic method such as syringe aspiration or lower suction pressure and then processed with proper centrifugation. Fat grafts should be placed in a small amount (no more than 0.1 mL or equivalent amount for large volume) with each pass but with multiple passes in multiple tunnels, multiple tissue levels, and multiple directions. Anesthetic (or tumescent) solution with low lidocaine concentration should be chosen for infiltration of the donor site. Significant overcorrection should be avoided to minimize complications such as fat necrosis. The timing for subsequent injection may be about 3 to 6 months after previous injection (Table 2). It is also critical to inform the patient that a subsequent procedure may be necessary after the first fat grafting if the expected results have not been achieved.

Complications of fat grafting to the face are not common and can usually be avoided with meticulous surgery.<sup>3,4</sup> Complications from the donor site are the same as those expected from liposuction that include depression and uneven body surface. Liposuction for graft harvest should aim to enhance lower abdominal or inner thigh contour by careful assessment for the location of the excess fat. The recipient site may develop hematoma, infection, nerve injury, or, rarely, vessel thrombosis as the acute complications or small fat necrosis as the late complications. Fortunately, acute complications are very rare and usually not develop if the procedure is performed by experienced surgeons. Fat necrosis may develop continued fibrosis from the macrophages trying to phagocytose the nonviable adipose graft in the recipient site.<sup>22</sup> Fat necrosis in the face usually presents with a subcutaneous nodule, which may require excision depending on severity of those conditions.

### CONCLUSIONS

Techniques of fat grafting for facial rejuvenation and contouring should be performed with this approach based on most recent scientific studies. Improvement of fat grafting techniques can be accomplished with fat graft harvesting, processing, recipient site preparation, and placement. With the techniques and other important considerations described in this review, fat grafting can be performed in a more satisfactory fashion for facial rejuvenation and contouring with expected good clinical outcome but no complications. Although this review describes a rationalized approach to facial fat grafting at the present time, future additional investigations are still needed to provide more scientific evidences for what would be the best approach for facial rejuvenations and contouring.

**TABLE 2.** Summary of Basic Techniques and Considerations for Fat Grafting

Preferred donor sites	Lower abdomen or inner thigh
Anesthesia	Low concentration of lidocaine for infiltration
Fat graft harvesting	A less traumatic syringe technique
Fat graft processing	Centrifugation with a proper setting (ie, 3000 rpm or 1200g for 3 min)
Recipient site preparation	Injection of anesthetics for vasoconstriction Percutaneous scar or adhesion release if needed
Placement of fat grafts	Placed in a small amount (0.1 mL or equivalent amount) for each pass in the withdraw phase but with multiple passes in multiple tissue planes, multiple levels, and multiple directions
Overcorrection	Not recommended
Postoperative care	Proper immobilization of the grafted area Swelling is always expected. Additional injection may be necessary.
Timing for subsequent injection	3–6 mo after previous injection

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