

ORIGINAL ARTICLE

A “Solid Injection Method” To Reduce Postoperative Complications in Autologous Fat Grafting for Breast Augmentation

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1 Introduction: Over the last decades, there has been an increasing interest in breast augmentation using autologous fat transplantation for reconstructive and cosmetic purposes. However, autologous fat graft to the breast is not a simple procedure and should be performed only by well-trained and skilled surgeons. The rate of postoperative complications is reported in the literature to be 10–16.7%. To reduce complications in autologous fat graft to the breast, the author developed a solid injection method to increase the contact area of the grafted fat and the recipient tissue.

Materials and Methods: From May 2010 to February 2012, we performed autologous fat grafting for 281 patients. After exclusion of the patients with inadequate follow-up time (<6 months) or who were lost to follow-up, 190 patients were enrolled in this study. The enrolled patients were randomly divided into group A, in which structural fat grafting was done by the method described by Coleman, and group B, in which the solid injection method was administered. For the solid injection method, the operator used his nondominant hand to compress the breast to increase the contact area with the injected fat when performing the fat graft injection. At the end of the fat injection, the breasts were still soft, and there was no pressure leakage from the entries. The data between the 2 groups was analyzed using a two-sample *t* test, and the complication rates were analyzed using a chi-square test.

Results: The age of the patients ranged from 21 to 57 years (mean = 34 years). The volume of fat harvested was 776 mL to 5050 mL (mean = 1593 mL), and the volume of fat grafted to each breast was 120 to 310 mL (mean = 246 mL). There were 56 patients enrolled in group A and 134 patients enrolled in group B. All patients were followed up from 7 to 28 months, with an average of 15.1 months postop-

eratively. The differences of patient data in both groups were statistically insignificant. Postoperative complication rates were 14.2% in group A and 2.2% in group B, the difference of which is statistically significant ($P = .001$).

Conclusions: The solid injection method can reduce postoperative complications in autologous fat grafting. There were 4 principles to be followed in this method: Principle I, the fat should be injected only into an area with “solid” feedback while processing the injection; Principle II, the fat should never be injected into an empty area; Principle III, the breasts should be soft at the end of injection; and Principle IV, there should be no/minimal pressure leakage from the entries after the injection.

Over the last decades, there has been increasing interest in breast augmentation using autologous fat transplantation for reconstructive and cosmetic purposes.¹ In 1987, Bircoll² reported his experience using fat removed by liposuction and transplanted by transcutaneous injection to the breast. In the same year, however, the American Society of Plastic and Reconstructive Surgeons Ad Hoc Committee on New Procedures³ condemned fat grafting to the breast due to concerns that potential scarring and calcifications may interfere with detection of breast cancer.

A decade later, the American Society of Plastic Surgeons formed a Fat Grafting Task Force, which reported that fat grafting may be considered for breast augmentation and correction of defects associated with medical conditions and previous breast surgeries. However, results have been dependent on technique and surgeon expertise.⁴

In 2005, Spear et al⁵ reported that autologous fat transplantation is a very safe technique that can improve or correct significant contour deformities after breast reconstruction, which otherwise would require more

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complicated and riskier procedures to improve. In recent years, autologous fat grafting to the breast has been reported to be a useful procedure for cosmetic breast enhancement in many patients who desire such a procedure (although there is still skepticism about this procedure).⁶⁻⁸ Certain problems remain, however, such as unpredictability and a low rate of graft survival. In addition, complications after fat grafting to the breast, such as fat necrosis, cyst formation, and indurations, can be seen as in any other surgical manipulation of the breast.^{9,10} Many innovations to overcome these problems have been reported and reviewed previously.¹¹⁻¹⁷

Modifications of fat harvesting, fat processing, and lipoinjection techniques to improve the survival rate for injected fat have been attempted. In recent years, researchers have indicated that cell-assisted lipotransfer, in which stromal vascular fraction (SVF) containing adipocyte-derived stem cells and many other regenerative components, can be used to improve the survival rate of grafted fat.¹⁸ Although the methods of fat harvesting, processing, and injection all have an impact on successful clinical outcomes, the injection method is considered to be the most important.¹⁹

Coleman advocated structural fat grafting for soft tissue rejuvenation of the face and hand with convincing cosmetic results.^{12,20} In his method, the grafted fat should be placed in small aliquots with each pass to maximize the surface area of contact between the grafted fat and the recipient tissue.²⁰ A large surface area of contact between the host tissues with their capillaries and newly grafted tissue promotes nutrition and reduces the number of liponecrotic cysts. However, in breast augmentation by fat grafting, structural fat injection still resulted in a complication rate ranging from 10–16.7%.^{8,18}

Although structural fat injection has been the golden rule of fat transplantation, the repeated to and fro motions of injection can result in a crowded graft and consequent graft failure if the surgeon does not pay attention to avoiding such crowding. For further refinement of the lipoinjection, the author developed a solid injection method to ensure the highest contact area between grafted fat and recipient tissue.

Materials and Methods

From May 2010 to February 2012, we performed autologous fat grafting for 281 patients. A retrospective analysis was made to identify the effectiveness of this solid injection method. The study was approved by the

Institutional Review Board of the Aesthetic Department of Genesis Clinic. After the exclusion of patients with inadequate follow-up time (<6 months) or who were lost to follow-up, there were 190 patients enrolled in this study.

All patients had to sign a consent form that presented potential complications of infiltrating fat into the breast and agree to undergo routine postoperative mammography and ultrasonography.

The difference in breast circumference was also evaluated for every patient preoperatively and postoperatively. Breast circumference difference was defined as the chest circumference at the nipple minus the chest circumference at the inframammary fold.

The indications for autologous fat grafting to the breast included correction of contour deformities after removal of saline bags or silicone gel implants, correction of congenital asymmetry of the breasts, and cosmetic augmentation of the breasts. All surgeries were performed by the author.

Postoperative complications were detected by physical examination and breast sonography when patients returned for follow-up. Any kind of complication, including fat necrosis, infection, induration, and others, were recorded and the rate of complication was calculated.

Adipose Tissue Harvesting

Potential donor sites for fat graft harvest, including the abdomen, flanks, hips, and thighs, were identified preoperatively with the patient's consent. All procedures were performed under intravenous sedation and local tumescent anesthesia. Approximately 150 mL to 300 mL of tumescent anesthesia (1000 mL of lactated Ringer's solution, 80 mL of 2% lidocaine, and 2 mL of 1:1000 epinephrine) was infiltrated into the site for fat graft harvesting 10 minutes before initiating liposuction. A 3-mm or 4-mm aspiration cannula loaded to a low-pressure suction machine (under 600 mm Hg) was then used to harvest adipose tissue.

Preparation of the SVF-enriched Fat Graft

Of the harvested fat, 100 mL was mixed with 1% type I collagenase (100 mg in 100 mL normal saline solution) and transferred to an incubator. Shaking incubation under 37°C and 200 rpm for at least 30 minutes to dissolve the adipose tissue was done for isolation of SVF containing adipocyte-derived stem cells. During the isolation process, the other aspirated fat was prepared for grafting by centrifugation at 800 g

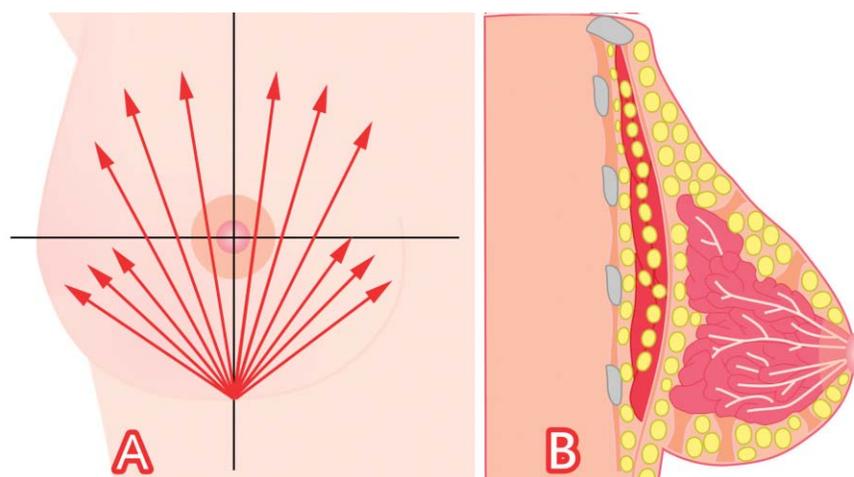


Figure 1. (A) The grafted fat was injected in a fanning pattern through inframammary entry and/or para-areolar entry if needed. (B) The fat was injected into the breasts at subcutaneous, intramuscular, retromuscular, and premuscular layers.

for 4 minutes to remove free oil and blood component. Freshly isolated SVF was then attached to the aspirated fat, with the fat acting as a living scaffold before transplantation. The SVF-enriched fat was then transferred to 10-mL BD syringes and connected to a 14-gauge, 15 cm, single-hole cannula ready for injection.

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Delivery of the SVF-enriched Fat Graft

Injections were performed with the patient in a supine position. After approximately two thirds of the total volume was injected, the patient was moved to a sitting position for assessment of the injection progress, then returned to the supine position for completion of the injections until the desired results were achieved. The injections were made in a fanning manner and in small aliquots through multiple passes and tissue planes to improve graft take.

The enrolled patients were randomly divided into group A, in which structural fat grafting was done by the method described by Coleman¹² and Coleman and

Saboeiro²⁰; and group B, in which the solid fat injection method was administered as described below.

For group A, the fat was injected to the breast at subcutaneous, intramuscular, retromuscular, and premuscular layers. The amount of fat to be injected to the 4 layers was divided evenly but was also more or less dependent upon the recipient site condition (Figure 1). The surgeon injected the fat in small aliquots with each pass according to the technique of structural fat grafting. However, no special attention was paid to avoid contact with the injected fat during the to and fro motions.

For group B, the fat was injected into the same 4 layers of the breast as above. The surgeon used his nondominant hand to feel the tip of the injecting cannula and help guide the injection. The fat was only injected on withdrawal, when the operator felt a solid feedback while advancing the cannula. No injection was performed when the operator felt empty feedback from the cannula. At this moment, it was understood

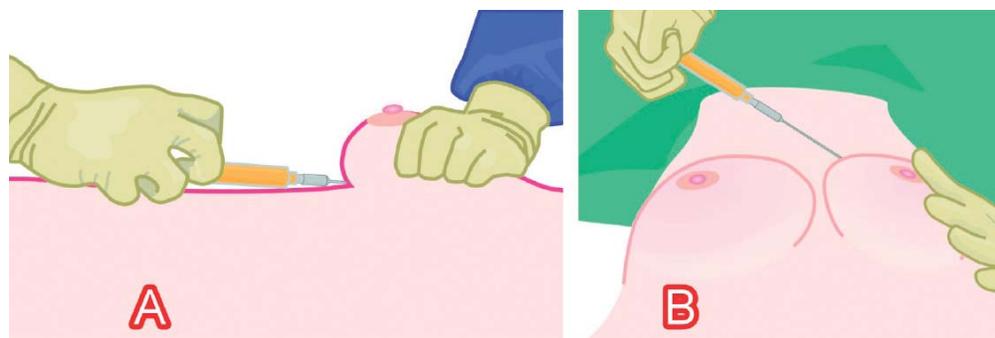


Figure 2. (A) For the “solid injection method,” the surgeon injected the fat only when solid feedback was detected by use of the dominant hand. (B) The nondominant hand was used to compress the breast to create this solid feedback, increasing the contact area between the injected fat and the recipient tissue.

Table 1. Patient Data

Items*	Group A (SD)	Group B (SD)	<i>t</i> Test <i>P</i> Value
No. of patients	56	134	
Age	34.9 (7.9)	33.7 (7.3)	.961
BMI	20.7 (2.3)	20.1 (2.5)	.993
Volume of fat harvested	1478 mL (365)	1641 mL (676)	.019
Volume of fat injected for each breast	239 mL (26)	249 mL (32)	.525
Preoperative BCD	8.1 cm (3.6)	7.8 cm (3.1)	.233
Postoperative BCD	11.9 cm (4.4)	11.5 cm (3.2)	.027
Operative change in BCD	3.8 cm (1.7)	3.6 cm (2.1)	.302

*BMI indicates body mass index; BCD, difference in breast circumference.

that no fat should be injected and that the cannula should be withdrawn and directed to a different space. The surgeon used his nondominant hand to compress the breast to increase the contact area with the injected fat when performing the fat graft injection. At the end of the fat injection, the breasts were still soft, and there was no pressure leakage from the entries (Figure 2).

Results

From May 2010 to February 2012, 190 patients were enrolled in this study. The age of the patients ranged from 21 to 57 years (mean = 34 years). The volume of fat harvested was 776 mL to 5050 mL (mean = 1593 mL), and the volume of fat grafted to each breast was 120 to 310 mL (mean = 246 mL).

Among these patients, 168 (88.4%) of them were operated on for cosmetic augmentation of the breasts, 18 (9.5%) patients were operated on for correction of congenital asymmetry of their breasts, while the other 5 (2.6%) patients were operated on for correction of contour deformities after removal of saline bags or silicone gel implants.

There were 56 patients enrolled in group A and 134 patients enrolled in group B. All patients were fol-

lowed up from 7 to 28 months, averaging 15.1 months postoperatively. The age distribution, body mass index of the patients, the volume of fat harvested, and the fat graft injected in both groups were recorded (Table 1). Differences of patient data in both groups were not statistically significant.

Complications included postoperative recipient site infection, fat necrosis, and small areas of induration. For group A, fat necrosis developed in 2 patients, postoperative recipient site infection was found in 1 patient, and small indurations inside the breasts were found in 5 patients. The overall complication rate in group A was 14.2%. For group B, there were no patients with fat necrosis or surgical site infection. Three patients developed small indurations inside the breasts. The complication rate was 2.2%. The difference in the complication rate between the 2 groups was statistically significant (Table 2).

Discussion

Autologous fat grafting to the breast is not a simple procedure and should be performed only by well-trained and skilled surgeons. A recent study confirms that this procedure is being performed incorrectly by untrained and untutored physicians and can result in major complications.²¹ An extensive literature review indicates that major complications observed after lipografting of the breast were related mainly to technical errors and to the wrong anatomic site of harvesting and implantation of the fat.²² Early and late complications have been described, and they correlate highly with technique.

Early complications (within 4 weeks of the initial procedure) included surgery-site infection ranging from superficial infection of both the donor and grafted sites to abscess formation of the graft site requiring operative drainage. Even systemic sepsis has been

Table 2. Complications After Autologous Fat Graft to the Breasts

Items	Group A	Group B	Chi-square Test
Complications			
Fat necrosis	2	0	
Infection	1	0	
Induration	5	3	
Others	0	0	
Complication rate	14.2% (8/56)	2.2% (3/134)	<i>P</i> = .001

reported.²³ Late complications included liponecrotic cysts, indurations, fat resorption, calcification formation, and unsatisfactory results. Calcifications, fat necrosis, cyst formation, and indurations can be seen as in any other surgical manipulation of the breast.^{9,10}

The primary complication of breast lipografting is the formation of liponecrotic cysts, which have characteristically benign appearances in sonography, mammography, and magnetic resonance imaging.^{21,24} It is possible that fat necrosis is caused by injection of too much fat to one area or by accumulation of injected fat to one area due to the movement of the pectoralis major muscle.

How do we minimize the formation of liponecrotic cysts? We agree with Coleman's opinion; ie, fat should be placed in small aliquots with each pass to maximize the surface area of contact between the grafted fat and the recipient tissue.²⁰ However, the literature reviewed showed that the complication rate after fat grafting to the breasts was still high—from 10% to 16.7%.^{8,18}

In our study for group A, with the patients given fat grafting according to Coleman's method, the complication rate was 14.2%. This value was close to that in the literature. However, when we changed to the "solid injection method," the complication rate was lowered to 2.2%, which was statistically significant.

In the "solid injection method," surgeons should follow several principles, as described below.

Principle I: Fat should be injected into an area only with "solid" feedback while processing the injection. The nondominant hand of the surgeon should be used to increase this feedback. A larger surface area of contact between the host tissues with the newly grafted tissue can be achieved in this way, which results in a reduction of the number of liponecrotic cysts.

Principle II: The fat should never be injected into an "empty area." An empty feedback sensation means the tip of the injection cannula is inside the "sea of fat." More injection of fat into such a place can only result in lumping (Figure 3).

Principle III: The breasts should be soft after the injection. A hard breast is the result of increased intramammary pressure, which results from improper placement of fat. The "solid injection method" ensures the injection of fat within recipient tissue and does not result in high pressure inside the breasts.

Principle IV: There should be no or minimal pressure leakage from the entries of the injection. Pressure leakages from the entries are ominous in autologous fat grafting to the breasts. If the breasts are soft and

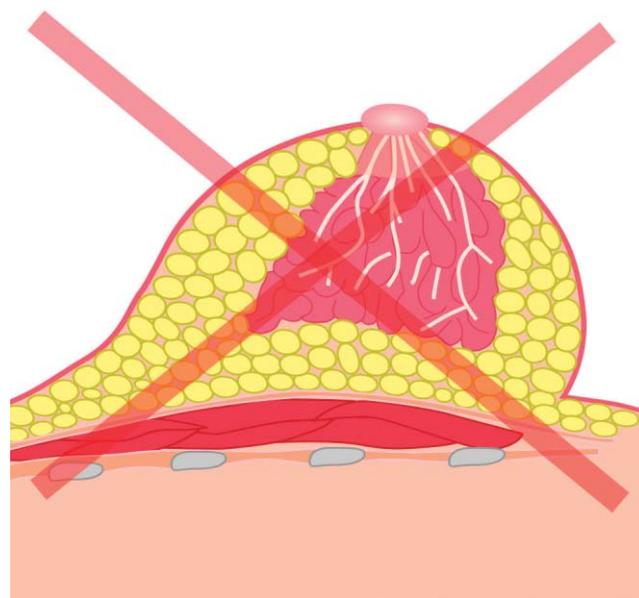


Figure 3. The fat should never be injected into the "sea of fat," which is detected via an empty feedback sensation. If fat is injected into an area with empty feedback at the tip of the cannula, the prognosis will be inferior.

there is no leakage as the surgeon molds the breasts, the results tend to be good and acceptable.

Conclusions

In conclusion, autologous fat grafting to the breast can be a useful procedure for cosmetic enhancement in many patients who desire such a procedure. Post-operative complications can be reduced or avoided by use of the "solid injection method."

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