

Immediate Large-Volume Grafting of Autologous Fat to the Breast Following Implant Removal

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Abstract

Background: To optimize autologous breast augmentation, a simple and reproducible surgical approach that maximizes the volume of fat transferred to the breast while minimizing the number of sessions and the operating time is needed.

Objectives: The authors describe a novel approach for large-volume fat grafting to the expanded skin and subcutaneous tissue of the breast immediately after explantation, exchanging the volume provided by the implants with transplanted fat in a single session.

Methods: Eighty patients (160 breasts) undergoing explantation and autologous fat transfer were evaluated in a prospective study. Fat was harvested with the lipomatic power-assisted liposuction machine (Lipomatic Eva SP, Euromi SA, Verviers, Belgium) and was injected with simultaneous vibration and tunnelization of the recipient site by means of the same machine with suction disabled. Changes in breast volume were measured in terms of bra cup size, and patients were monitored by mammography and ultrasonography. Patient satisfaction was assessed with a questionnaire administered 6 months postoperatively.

Results: Injected fat volumes ranged from 300 to 600 mL per breast. Operating times ranged from 45 to 90 minutes. For all patients, one injection session was sufficient to replace the volume of the previous implant. Patients were monitored for an average of 2 years, and complications included cyst formation in 9 of 160 breasts (5.6%) and infection in 2 breasts (1.25%).

Conclusions: Power-assisted transfer of autologous fat to the breast improves the ability of the recipient site to receive the graft and allows for explantation and fat transplantation in a single session. This approach is suitable for patients who desire a natural-appearing breast that is similar in volume to their previous implant.

Level of Evidence: 4



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Despite being a frequently performed plastic surgery procedure, breast implantation is associated with considerable revision rates, approaching 24% at 4 years postoperative and 36% at 10 years postoperative.¹ Complications necessitating revision include capsular contracture, pain, inadequate soft tissue coverage of the implant, asymmetry, and excessive fullness of the upper pole. Revisional surgery to treat these conditions may involve changing the style of the implant, placing an acellular dermal matrix, performing a pocket reassignment, or performing a permanent explantation.

Several investigators have advocated for breast augmentation by autologous fat transfer as an alternative or adjunct to implantation. Following the introduction of breast augmentation with autologous fat, a variety of surgical procedures

have been developed to optimize fat harvesting, purification, and transplantation. Currently, breast augmentation by autologous fat transfer is considered a significant advancement in breast surgery. Recent surgical approaches to breast augmentation by autologous fat transfer include Brava expansion and fat grafting (Brava LLC, Miami, FL),²⁻⁴

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composite breast augmentation,⁵ and simultaneous implant exchange with fat.⁶

Although existing procedures for autologous breast augmentation are acceptable, an approach for large-volume fat transfer that is simple, reproducible, and efficient and that minimizes surgical time and sessions remains elusive. In this study, we present a novel approach to autologous breast augmentation that enables large-volume fat grafting to the breasts immediately following explantation. We adapted a power-assisted liposuction instrument (Lipomatic Eva SP, Euromi SA, Verviers, Belgium) to facilitate vibration and tunnelization of the subcutaneous space and abundant skin envelope of the expanded breast at the time of implant removal. Explantation and fat transfer can be performed in one session, with grafted fat fully replacing the volume previously occupied by the implant. The proposed fat transfer strategy includes the following key points: (1) utilization of the stretched envelope and abundant subcutaneous space by immediate fat transfer to the space vacated by the implant; (2) subcutaneous tunnelization with the Lipomatic machine, to enlarge the breast space and optimize its function as a matrix while ensuring contact between the grafted fat and the recipient site; and (3) simultaneous vibration and tunnelization of the recipient site to optimize the diffusion of fat and enable large-volume fat transfer.

METHODS

Patients and Study Design

Eighty consecutive women (160 breasts) who underwent lipomatic breast explantation and power-assisted transfer of autologous fat to the breast from February 2009 to May 2013 were evaluated in a prospective study. Patients were supplied with detailed information regarding the surgical procedure and were informed that the power-assisted fat transfer technique would not duplicate the projection and upper-pole fullness of the breast implantation. All patients provided written informed consent. Preoperatively, medical charts were reviewed, and clinical and radiologic breast examinations were performed.

Ideal candidates for power-assisted breast augmentation by fat transfer were patients who desired a natural, ptotic breast with the same volume as or a slightly smaller volume than was provided by their existing implants; patients who had previously undergone breast implantation and wished to undergo explantation because of an unsatisfactory outcome, capsular contracture, or pain; and, finally, patients who presented with concerns of excessive upper-pole fullness following breast implantation or who felt their augmented breast shape to be unnatural for their age. Patients were excluded from the study if they were current smokers or had a history of heavy smoking (ie, 10 packs/year).

Patients with a prevalent family history of breast cancer were excluded from the study and were advised against undergoing this procedure.

Surgical Procedure and Postoperative Care

Preoperative markings of the donor and recipient sites were made with the patient standing. Recipient site markings included the midline, the inframammary fold, and the zones for lipofilling. Donor site markings included the flanks, the thighs, and/or the lower abdomen. The patient was kept in the supine position during the entire operation. The Lipomatic system was employed to infiltrate tissue with Klein's solution and to harvest and graft fat. Specifically, fat was harvested with a 3-mm multiple-hole cannula attached to a hand-piece and set to 3000 rpm and 0.7 atm. Lipoaspirate was collected into a closed system and decanted. The remaining solution of adipose tissue was transferred into sterile 60-mL syringes. Explantation was performed while the lipoaspirate separated. Implants were removed through a 4-cm incision in the inframammary crease. The pocket was visually inspected with a lighted retractor. Capsulotomy was performed for patients with grade 1 or 2 capsular contractures, by means of electrocautery. Capsulectomy was performed for patients with grade 3 or 4 contractures, ruptured implants, or evidence of implant pathology discovered through preoperative imaging or intraoperative implant inspection.

After explantation, multidirectional and multilayered tunneling of the recipient site in the subcutaneous plane was conducted. Tunnelization was performed to prepare a matrix for fat grafting and involved 9 to 12 access points in the periareolar region and at the lower inner and lower outer quadrants of the breast. Blood and crystalloids were removed from the decanted fat and the infranatant was discarded.

For grafting, the Lipomatic instrument was disconnected from its suction system, and fat was injected through a customized v-shaped multi-hole cannula (3-mm diameter; Figure 1) that enabled simultaneous vibration of the recipient site. Injections were made at access points along the axilla, periareolar margin, and inframammary fold in a multiplanar fashion to the superficial and deep subcutaneous spaces and to the parenchymal, pericapsular, muscular, and submuscular spaces, to maximize fill volume along the preoperative markings. Injections also extended around the breast and to the upper and lower poles to augment the base and height of the breast. Injections were made close to the midline, to create cleavage and ensure a smooth contour. The total amount of fat injected was based on a 1.5:1 ratio of transplanted fat to the volume of the previous implant.

Upon completion of grafting, the breast pocket was inspected to confirm hemostasis, accumulated fluid or fat



Figure 1. Cannulae utilized in this study for fat harvesting and injection. Both cannulae are 3 mm in diameter and 25 cm in length. The harvesting cannula (A) contains 9 holes, and the injection cannula (B) contains 3 holes.

was aspirated, and a drain was inserted into the pocket. The inframammary wound was then closed in multiple layers, and compressive garments were placed over the donor sites. Patients were instructed to wear a bra for 6 weeks, to minimize tension on the breasts. Drains were removed when the output from the wound was less than 25 cc per 24 hours. Patients were also scheduled to undergo annual postoperative mammography during follow-up. A video demonstrating the technique described by the authors is available online as Supplementary Material.

Assessment of Patient Satisfaction

At 6 months postoperatively, patients were asked to complete a non-anonymous questionnaire prepared by the authors to assess the patients' satisfaction with the surgical outcome, preoperative and postoperative care, and psychological and physical well-being. A blank copy of the questionnaire is available online as Supplementary Material.

Imaging and Volume Analysis

Patients with inconclusive preoperative ultrasonography and/or mammography results also underwent a magnetic resonance imaging (MRI) scan preoperatively and at 12 months postoperatively. These patients' preoperative and 12-months-postoperative breast volumes and fat resorption rates were also measured. For all patients, fat resorption at 6 months postoperatively was estimated by measuring the patient's bra cup size and comparing it with their preoperative bra size.

RESULTS

Eighty consecutive women (160 breasts) underwent power-assisted liposuction, explantation, and power-assisted autologous fat transfer to the breast. The mean age of the patients was 42 years (range: 25-68 years), and the mean body mass index was 26 kg/m² (range: 23-35 kg/m²). Total fat injected per breast ranged from 300 to 600 mL (Table 1). Each patient

Table 1. Patient Demographics

Demographics	Study Group
No. of patients	80
No. of breasts	160
Mean age, years (range)	36 (25-68)
Mean BMI, kg/m ² (range)	26 (23-35)
Mean injection volume, mL/breast (range)	420 (300-600)
Mean implant volume, mL (range)	275 (200-400)
Mean operating time, minutes (range)	65 (45-90)
Mean follow-up, years (range)	2 (1-4)

BMI, body mass index.

was treated in a single session, and operating times ranged from 45 to 90 minutes (mean: 65 minutes). Patients resumed sedentary activities 4 days postoperatively and resumed normal activities within 1 week of their operation (Figures 2-4). Patients were monitored for 1 to 4 years, with an average follow-up of 2 years.

At 3 months postoperatively, cystic masses developed in 9 of 160 breasts (5.6%). Of these, eight breasts (5%) were treated conservatively, with only close monitoring and observation, and the cystic masses gradually resolved without surgical intervention (Table 2). One breast (0.6%) that developed a cystic mass required aspiration, revealing a yellowish substance that a microbiologic analysis determined was consistent with sterile abscesses of necrotic fatty tissue. Of 80 patients, 2 (2.5%) developed infections, consisting of breast erythema and mild cellulitis, on one side, which resolved with oral antibiotics. Physical examination or imaging revealed no other evidence of discharge or fluid collection. No other complications at the recipient site (eg, pneumothorax, fat embolism) or the donor sites were noted.

Of the 80 patients, 72 (90%) completed a questionnaire at 6 months postoperatively to assess their satisfaction with the procedure (Figure 5). Five patients (6.2%) declined to complete the questionnaire, and three patients (3.8%) withdrew from the study before 6 months postoperatively. Of 72 survey respondents, 65 (90.3%) indicated that they would repeat the surgical procedure, 59 patients (81.9%) were satisfied with their postoperative breast shape, and 55 patients (76.4%) reported that their psychological well-being improved as a result of the operation. Overall, 60 survey respondents (83.3%) reported being satisfied with the procedure and would recommend the procedure to someone else.

Imaging Findings and Resorption

All patients underwent a preoperative mammogram, a mammogram at 6 months postoperatively, and yearly

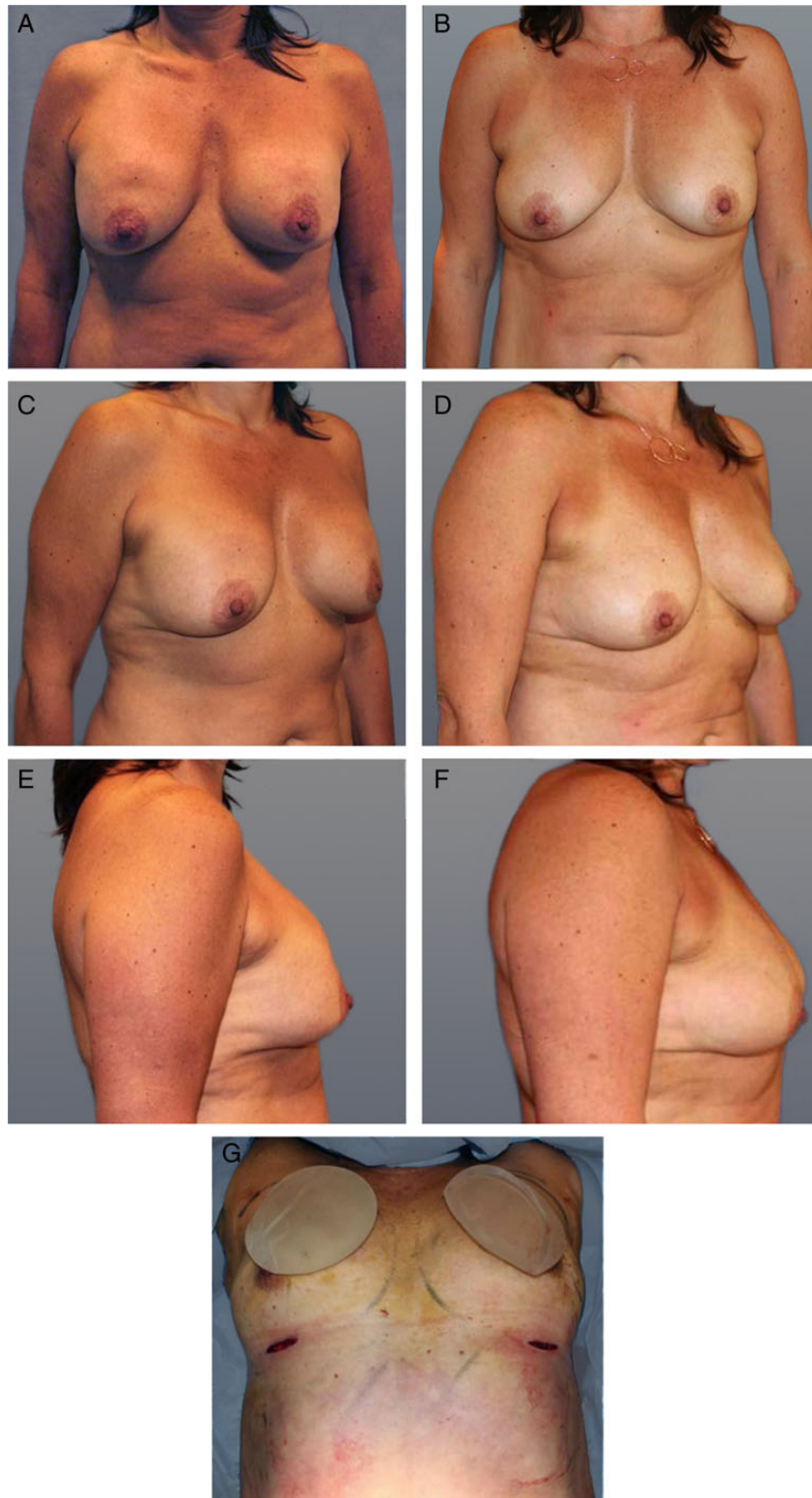


Figure 2. (A, C, E) This 45-year-old woman previously underwent bilateral breast augmentation with silicone implants (225 cc per breast) and presented with bilateral capsular contractures. (B, D, F) Two years after exchange of implants with autologous fat (350 mL per breast). (G) Intraoperative view following bilateral explantation.



Figure 3. (A, C, E) This 41-year-old woman previously underwent bilateral breast augmentation with silicone implants (200 cc per breast) and presented with capsular contracture of the left breast and chronic pain. (B, D, F) Two years after exchange of implants with autologous fat (300 mL per breast). Intraoperative views following (G) bilateral explantation and (H) fat transplantation.

mammograms after that to detect new calcifications, cysts, and masses. All patient mammograms were evaluated by breast radiologists and were negative for pathologic findings. Patients who underwent an MRI scan also underwent fat resorption rate analysis (Figure 6). The average fat

resorption rate was 40.6% (range, 36.8%-43.4%). For the entire patient group, measurements of bra cup size preoperatively and 6 months postoperatively indicated that breast volume was maintained following exchange of implants with fat.



Figure 4. (A, C, E) This 50-year-old woman previously underwent bilateral breast augmentation with silicone implants (350 cc per breast) and presented with asymmetric breasts, capsular contracture of the left breast, and chronic pain. (B, D, F) One year after exchange of implants with autologous fat (600 mL per breast). Intraoperative views following (G) removal of the right implant and (H) fat grafting to the right breast, with the left implant still in place.

DISCUSSION

The results of recent studies from several countries indicate general approval among practitioners of autologous fat grafting

and demonstrate the versatility and safety of this technique for patients who are suitable candidates.^{2,7-14} Currently, grafting of autologous fat to the breast is indicated for simple aesthetic augmentation and for correction of breast asymmetry

Table 2. Incidence of Complications (N = 160 Breasts)

Complication	No. of Breasts, (%)
Recipient site infection (breast)	2 (1.25)
Cystic masses	9 (5.6)
Major complications	0 (0)

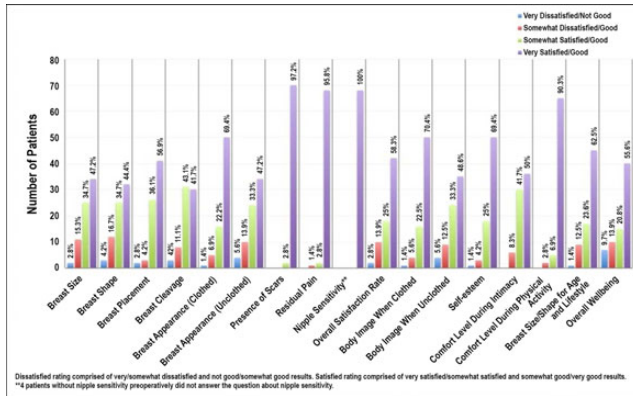


Figure 5. Results of the patient satisfaction questionnaire.

or deformities; this surgical procedure is also employed as an adjunct or primary tool for breast reconstruction and soft-tissue coverage of breast implants.^{5,7} Fat grafting is an ideal technique for accomplishing the exchange of breast implants with autologous fat. In this study, we describe power-assisted autologous fat transfer to the breast, a novel approach that immediately follows explantation and utilizes the pliancy of the stretched skin, soft tissue, and expanded subcutaneous space of the breast as a scaffold for large-volume fat injection.

Whereas fat can be harvested from donor sites by means of manual cannulae, we adapted a power-assisted system (Lipomatic) to enable highly precise and efficient fat harvesting in conjunction with tunnelization, vibration of the recipient site, and fat transfer.

Various sizes of cannulae are available for manual or power-assisted fat harvesting, but Erdim et al¹⁵ found that large harvesting cannulae (ie, 3 mm in diameter) preserve more viable adipocytes for fat grafting. As such, the power-assisted system we adapted utilizes a customized v-shaped multi-hole 3 mm in diameter cannula for fat grafting. Although no one harvesting or processing methodology is regarded as superior,^{16,17} selecting the flanks and thighs as donor sites to exchange breast implants with autologous fat is ideal since it enables the physician to improve the patient’s body contour simultaneous with the breast augmentation procedure.

One challenge of breast augmentation with fat obtained by liposuction is optimization of the volume of fat transferred in a single session. Brava, an external breast tissue expander, was developed by Khouri et al¹⁸ to improve graft

survival in autologous breast augmentation. Brava and similar methods have yielded promising results and have been gaining popularity among plastic surgeons for more than 12 years. Del Vecchio⁶ has reported a two-stage process of preexpansion of the recipient site and simultaneous exchange of the implant with injected fat. The power-assisted fat grafting procedure proposed in the present study optimizes immediate large-volume fat transfer in one session. This technique is not an alternative to external pre-expansion with Brava; instead, it is a novel surgical method of large-volume fat grafting.

Our technique of power-assisted breast augmentation expands the recipient site by means of vibration and multi-layered tunnelization during fat injection (Figure 7), which we suggest maximizes dispersal of fat in the breast space by expanding it as fat is injected. This application optimizes graft survival by avoiding fat graft crowding or overloading of scattered zones of fat while minimizing tension (Figure 8). The combination of vibration and tunnelization applied to the stretched breast skin and subcutaneous tissues at the time of implant removal creates an optimal substrate for large-volume fat grafting. With this surgical procedure, fat injection volumes approaching 600 mL per breast were achieved.

Two factors minimize the operating time for power-assisted augmentation by fat grafting. First, our unique experience with the Lipomatic system enabled rapid fat harvesting and tunnelization of the recipient site with vibration, for faster fat injection. Surgeons unacquainted with power-assisted liposuction will have a learning curve, common with any new surgical technique or tool, before they are skilled enough to apply the technique in a similar fashion. Second, the procedure involves two teams of surgeons working simultaneously, with one team removing the implants and performing capsulotomy or capsulectomy while the other team harvests and prepares the autologous fat.

Vibration and tunnelization with the lipomatic instrument release tethering of the parenchyma and ligaments, thereby relaxing and expanding the breast parenchyma to provide a larger subcutaneous space for fat injection and improve the contour of the augmented breast. Tunnelization around the breast facilitates the release of tethered soft tissue, further enlarging the breast space. Contact points between the fat grafts and the recipient sites are maximized by means of multiple access points for tunnelization and injection and by multiplanar delivery of fat, thereby increasing revascularization, which improves survival of the fat grafts.^{3,19-21} Our surgical approach involves multidirectional and multi-layered tunnelization with the Lipomatic system; this prepares a matrix in the recipient site, ensures maximal space for grafting, and limits the size of the fat lobules injected at any given location. When combined with vibration, tunnelization facilitates fat diffusion and dispersion and maximizes the interface between graft and recipient surfaces.

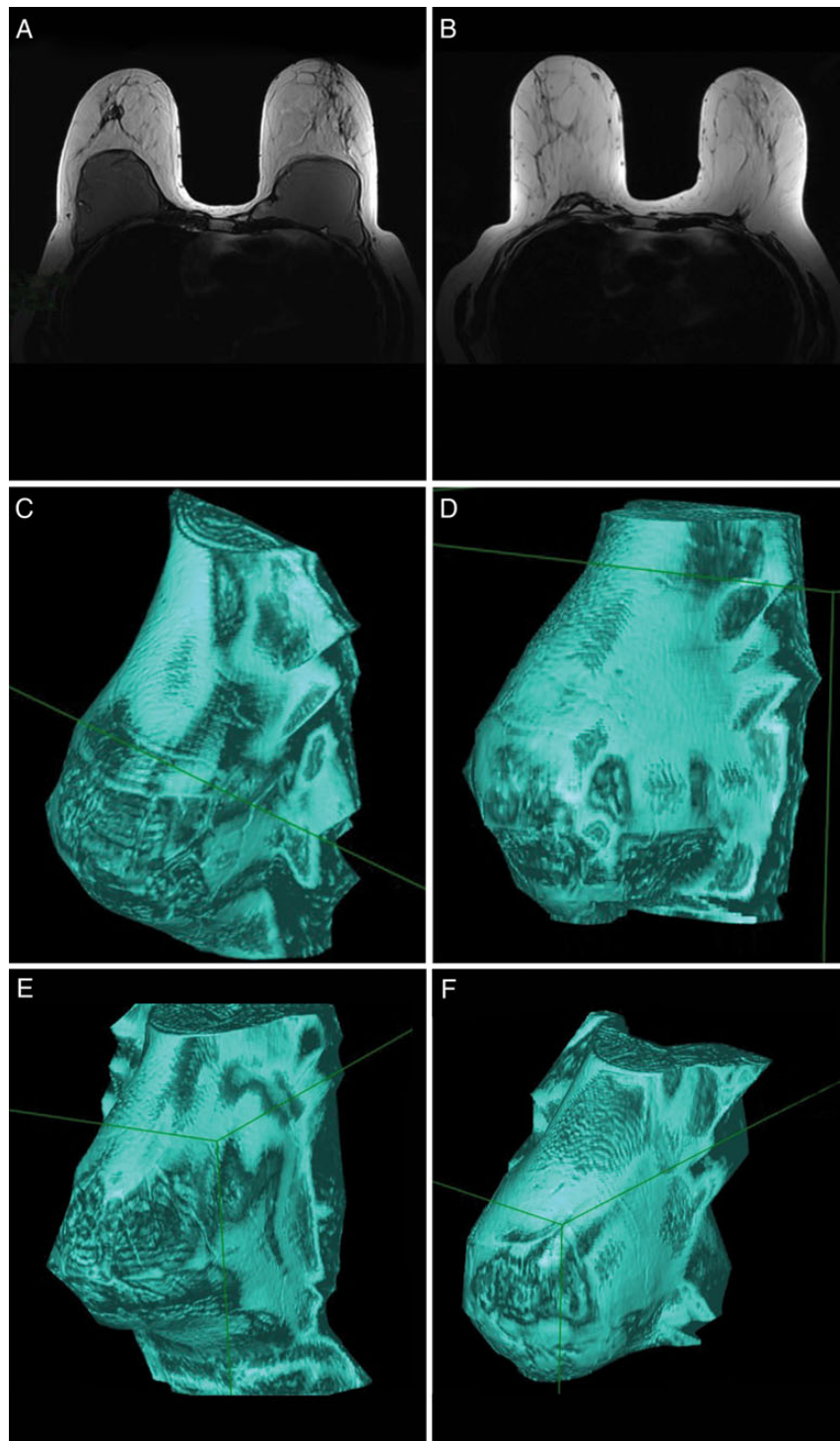


Figure 6. This 48-year-old woman previously underwent bilateral breast implantation (325 cc per breast). She presented with capsular contracture of the right breast and breast asymmetry. (A) Preoperative and (B) 1-year-postoperative mammography. The results of a magnetic resonance imaging (MRI) scan indicated preoperative breast volumes of 1539.80 mL (C, right breast) and 1602.33 mL (E, left breast). One year after explantation and grafting with 520 mL (right) and 480 mL (left) of autologous fat, MRI results indicated breast volumes of 1534.08 mL (D, right breast) and 1552.85 mL (F, left breast). This corresponded to a resorption rates of 38.6% (right breast) and 42.6% (left breast). Images were captured with a 1.5-T Magnetom Avanto (Siemens Medical Solutions USA, Inc., Malvern, PA, USA). The MRI protocol consisted of a T2 sequence with 1-mm-thick sections. Processing was performed with the Carestream Vue PACS workspace v11.4.0; 3-dimensional module (Carestream Health, Inc., Rochester, NY).

Instead of centrifugation, we advocate for sedimentation or straining of harvested fat to avoid compacting the lipoaspirate and to encourage the harvested fat's diffusion into the recipient site. Lipoaspirate processed by sedimentation or straining yields more dilute fat with an increased resorption rate. The volume of injected fat must be increased to adjust for the volume lost to resorption. In conjunction with vibration, injection of diluted fat increases the grafting capacity of the recipient site by expanding the subcutaneous space, dispersing fat, and preventing the coalescence of fat lobules. Fat grafts become vascularized on approximately day 7 after transplantation.²² This is sufficient time for fluid in the more dilute lipoaspirate to be absorbed; therefore, the fluid will not impede contact between the graft and recipient site for vascularization. Moreover, the transfer of diluted fat helps prevent high compartmental pressures following fat injection, because fluid resorption decreases the pressures that might otherwise hinder survival of the fat lobules.

The ratios of fat volume to previous implant volume for power-assisted autologous fat transfer can range from 2:1 to 1.5:1. We found that a 1.5:1 ratio yielded satisfactory outcomes for the patients in this study. Most of the patients in this study desired a breast that appeared consistent with their age; that was similar in volume to or slightly smaller in volume than their existing implants; and that had a

natural texture, size, and shape. For patients who wish to obtain a larger breast volume, a 2:1 ratio is possible, but the surgeon should be careful to avoid overfilling the recipient site, which would induce high pressures and could compromise the surgical outcome.

Power-assisted breast augmentation by fat transfer involves the injection of fat to all breast quadrants, beyond the zone previously occupied by the implant. This expanded injection area accommodates larger injection volumes (up to 600 mL per breast) without increasing pressure at the recipient site. Candidates for this procedure have existing breast implants, so their skin and breast parenchyma are already expanded and can accommodate a larger volume of fat during the grafting procedure.

We suggest scoring the capsule and placing intracapsular drains to ensure the total collapse of the capsule and to facilitate the expansion of the subcutaneous space by the large-volume fat transfer. This approach also minimizes postoperative breast sliding, thereby helping to maintain breast projection and avoid ptosis. In our experience, a properly performed capsulotomy in patients with grade 1 or 2 contractures was similar to capsulectomy, in terms of the fat volume that could be accommodated.

The location of the existing implant does not affect the quantity of fat that can be injected during the power-

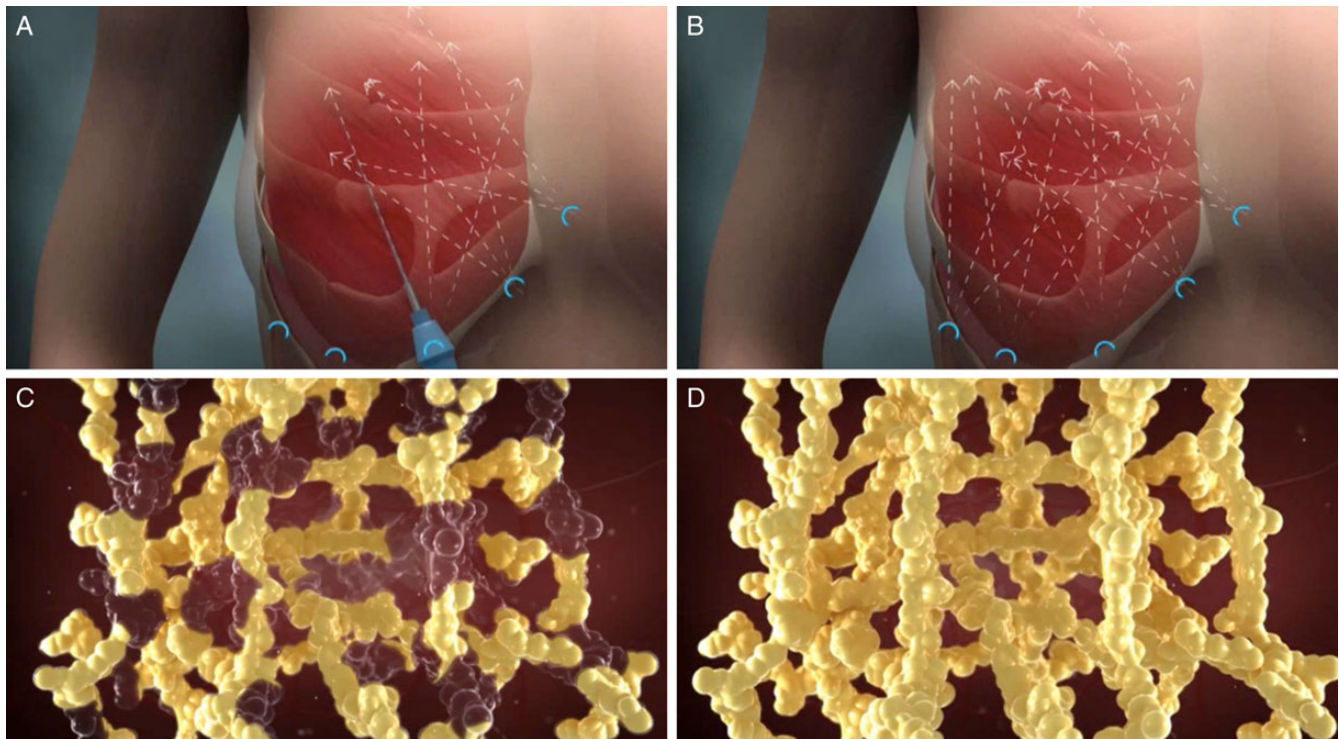


Figure 7. Illustration depicting tunnelization of the recipient site immediately after explantation. (A, B) Subcutaneous tunnelization occurs through several access points in a multidirectional and multilayered fashion, with the power-assisted liposuction instrument detached from its suction system. This prepares a matrix for fat grafting. (C, D) Tunnelization and vibration at the recipient site during fat grafting facilitate diffusion and dispersion of fat in the breast tissue, maximizing its spatial occupancy and enabling a large injection volume.

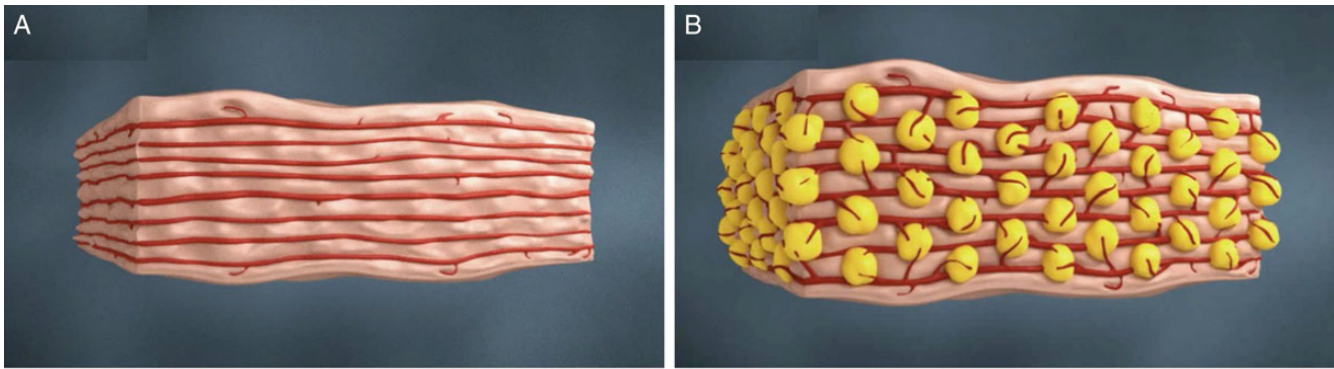


Figure 8. Illustrations depicting the recipient site (A) before and (B) after fat grafting. The surgical procedure described in this study combines tunnelization and vibration of the recipient site during fat transfer, which disperse fat and avoid crowded or overloaded zones of fat lobules. This technique is thought to maximize contact between the fat grafts and the recipient tissue, thereby optimizing revascularization.

assisted breast augmentation procedure or its surgical outcome. We treated patients who had previously undergone breast implantation in the subglandular, subfascial, or submuscular planes, or by the dual-plane technique. All of these patients underwent successful exchange of their implants with autologous fat.

Imaging and Safety

As with any surgical manipulation of the breast, fat grafting is associated with several complications, such as fat necrosis and the development of calcifications, cysts, or palpable lumps.⁷ However, fat grafting to the breast results in fewer radiographic abnormalities than reduction mammoplasty.²³ All patients in this study underwent preoperative baseline ultrasonography and mammography of the breast, postoperative imaging at 6 months follow-up, and yearly imaging after that. This imaging protocol is helpful for identifying any masses, cysts, or suspicious lesions that develop postoperatively.

Limitations

Power-assisted breast augmentation by fat transfer is not applicable to all types of breasts and is especially unsuitable for patients who desire highly projected breasts. Such patients should instead be offered breast implantation or composite breast augmentation.⁵

This study had several limitations. We relied on bra cup size to estimate changes in breast volume following the surgical procedure. In addition, patient satisfaction in this study was evaluated with a nonanonymous questionnaire developed by the authors. Standardized tools such as MRI, 3-dimensional photography, and/or a validated survey, such as the BREAST-Q, would have been preferable for assessing surgical outcomes and patient satisfaction. Lastly,

the effects of tunnelization and vibration were assessed based on our observations. A clinical study involving a control group is needed to determine the precise benefits associated with vibration and tunnelization.

CONCLUSIONS

To our knowledge, this study is the first to describe a method of fat injection that employs a power-assisted system to facilitate vibration and tunnelization of the expanded breast space and skin envelope immediately after explantation, to enable large-volume fat grafting. This surgical approach minimizes operating time and the number of surgical sessions and is suitable for patients who wish to remove their implants and achieve a natural breast appearance and texture. Power-assisted breast augmentation by fat transfer involves the novel concepts of tunnelization and vibration during fat grafting, which we have employed to safely and successfully enhance the breasts without a prosthesis. In addition to augmentation, this surgical approach may be applicable to breast reconstruction, buttock augmentation, and brachioplasty.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

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