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Breast Surgery

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Cheng-Hung Chiu, MD

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Abstract

Background: In recent years, there have been reports of success with autologous fat grafting to the breast for cosmetic breast enhancement. However, the procedure is generally contraindicated in women who are underweight (body mass index [BMI] <18.5).

Objectives: The author sought to determine the safety and success rate of autologous fat grafting for breast augmentation in underweight women.

Methods: Patients who underwent breast augmentation with autologous fat grafting and had adequate follow-up time (≥ 12 months) were assigned to group A (BMI >18.5) or group B (BMI ≤ 18.5 ; underweight). A retrospective analysis was performed to compare the safety and effectiveness of fat grafting between the study groups.

Results: Relative to group A, patients in group B were younger and had smaller differences in breast circumference (BCD) both pretreatment and posttreatment. The volume of injected fat was significantly smaller in group B. The differences in posttreatment complication rates and changes in BCD were not statistically significant between the study groups.

Conclusions: The same degree of breast enlargement was achieved in both study groups after autologous fat grafting for breast augmentation. The rate of posttreatment complications was not higher for underweight women. Therefore, it appears that BMI ≤ 18.5 is not a contraindication for this procedure.

Level of Evidence: 4

Keywords

breast augmentation, fat graft, underweight, body mass index



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Interest in breast augmentation by autologous fat transplantation for reconstructive and cosmetic purposes has been increasing. In 2005, Spear et al¹ reported that autologous fat transplantation was a safe technique to improve or correct significant contour deformities that otherwise would require more complicated and riskier procedures. In recent years, autologous fat grafting for cosmetic breast enhancement has been an option for patients, although skepticism remains about the unpredictability and low rate of graft survival associated with this procedure.²⁻⁴ As with any surgical manipulation of the breast, there can be complications after fat grafting, such as fat necrosis, cyst formation, and indurations.^{5,6}

Innovations designed to overcome these problems have been reported and reviewed.⁷⁻¹³ To improve the survival rate of injected fat, modifications in fat harvesting, fat processing,

and lipoinjection techniques have been implemented. Based on recent research, it has been suggested that cell-assisted lipotransfer with stromal vascular fraction (SVF) containing adipocyte-derived stem cells (ADSC) and other regenerative components may improve the survival rate of grafted fat.¹⁴

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After a systematic review, Rosing et al¹⁵ concluded that although the methods of fat harvesting, processing, and injection affect clinical outcome, the injection method is the most important of these. Despite advances in research and technique, the complication rate for structural fat injection in breast augmentation remains relatively high, ranging from 10% to 16%.^{4,14} In 2013, the author reported a lower complication rate (2.2%) from a solid injection method of autologous fat grafting in breast augmentation.¹⁶

Women whose body mass index (BMI) is < 18.5 are considered underweight,¹⁷ and their relatively low fat ratio is often considered a contraindication for breast augmentation with autologous fat. Many women with underdeveloped breasts are underweight, and such women represent a large proportion of those who desire breast augmentation. However, it appears that no study has addressed the relationship between BMI and the success of autologous fat grafting for breast augmentation. The purpose of this study was to determine the safety and success rate of autologous fat grafting in breast augmentation among underweight women.

METHODS

The study was approved by the institutional review board of the author's private clinic. All patients provided written informed consent for the procedure, having been advised of the potential complications of infiltrating fat into the breast, and all agreed to undergo routine posttreatment follow-up and ultrasonography.

From May 2010 to September 2013, autologous fat grafting to the breast was performed by the author in 339 patients. Indications for this procedure included correction of contour deformities after removal of saline or silicone gel implants, correction of congenital asymmetry of the breasts, and cosmetic augmentation. After exclusion of the patients with inadequate follow-up time (< 12 months), including those lost to follow-up, 282 patients remained and were enrolled in this study. These patients were assigned to 1 of 2 groups, based on BMI at the time of treatment: group A patients had BMI > 18.5 (n = 205), and group B patients had BMI ≤ 18.5 (n = 77). A retrospective analysis was performed to compare the safety and effectiveness of the procedure between these groups.

Physical examination and breast ultrasonography were performed 3, 6, and 12 months after treatment. Clinical data on all posttreatment complications were collected throughout follow-up for all patients. Breast ultrasonography was performed routinely at follow-up visits to determine the complication rates for fat necrosis, indurations, and calcifications. If a mass was palpable during physical examination or observed with ultrasonography, magnetic resonance imaging (MRI) was performed for further evaluation.

Aesthetic assessments were made based on pre- and posttreatment digital photographs of each patient. Both

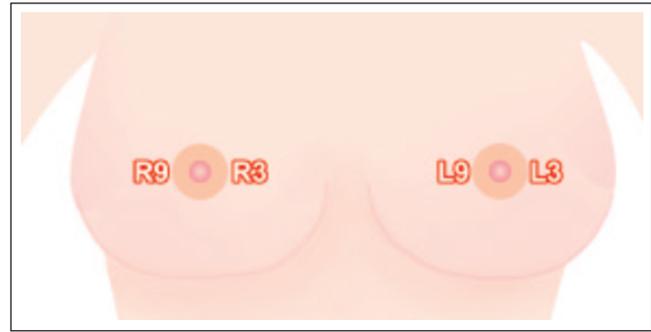


Figure 1. To increase accuracy of comparisons between pretreatment and posttreatment measurements of breast thickness, anchoring points were established at the 9-o'clock and 3-o'clock positions of the areolar margins of the right and left breasts (designated as R9, R3, L9, and L3).

frontal and bilateral oblique views were obtained before treatment and at each return visit following completion of treatment. These assessments were performed by the patients themselves and by an independent physician who did not participate in the patients' care. This physician performed all assessments for all study patients. Via a questionnaire, patients were asked to describe their satisfaction with aesthetic outcomes. There were 3 questions, each of which had 4 possible answers. Patients selected the most appropriate answer for each question. Each answer option has an associated score of 1 to 4, and thus the total score of each completed questionnaire ranged from 3 to 12. Total scores were grouped as follows: 10 to 12 = very satisfied, 6 to 9 = satisfied, and 3 to 5 = dissatisfied. (The English version of the questionnaire is available online at www.aestheticsurgeryjournal.com.) Based on pre- and posttreatment photographs, the independent physician rated the results as "very good" if the breasts were obviously augmented, "good" if the size and shape of the breasts had improved, and "not good" if breast size and shape had not improved. These assessments were made by both the patient and the physician at 3, 6, and 12 months posttreatment. The 12-month results are included in this study.

The difference in breast circumference (BCD) also was measured for each patient both pre- and posttreatment. BCD was defined as chest circumference at the nipple minus chest circumference at the inframammary fold. All patients also underwent pre- and posttreatment sonographic analysis of their breasts. Breast thickness was measured at the 3- and 9-o'clock positions of the areolar margins of each breast (L3, L9, R3, and R9 ["L" denotes left breast; "R" denotes right breast]) (Figure 1).

Harvesting of Adipose Tissue

Potential donor sites for fat harvest included the abdomen, flanks, hips, thighs, and calves and were identified and



Figure 2. Preparation of stromal vascular fraction (SVF)-enriched fat graft. (A) The collagenase-added fat was placed in a shaking incubator and centrifuged to isolate the lipoaspirate. (B) After centrifugation, the resulting cone tube showed 4 distinct layers of content. The thin, turbid, grayish layer near the bottom after washing was the collection of SVF. (C) Appearance of the remaining harvested fat after centrifugation to remove free oil and bloody component, before SVF and platelet-rich plasma were added. (D) The SVF-enriched fat, ready for injection.

established pretreatment, with the patient's consent. Before harvest, all patients received intravenous sedation and local tumescent anesthesia. Each harvest site was infiltrated with 150 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) 10 minutes before liposuction was initiated. Adipose tissue was harvested with a 3- or 4-mm aspiration cannula attached to a low-pressure suction machine set to -600 mm Hg.

Preparation of the SVF-Enriched Fat Graft

A portion of harvested fat (100 mL) was mixed with 1% type I collagenase (100 mg in 100 mL of normal saline solution) and transferred to a shaking incubator (Beauty Cell multi-functional bio-workstation [NB-803MS]; N-BIOTEK, Seoul, Korea) at 37°C (200 rpm), where the mixture remained for at least 30 minutes to dissolve the adipose tissue. The collagenase-dissolved fat was then centrifuged at 800 g for 5 minutes

to isolate the SVF-containing ADSC. After centrifugation, the resulting cone tube showed 4 distinct layers of content. The uppermost layer comprised lysed fat and oil, the second layer consisted of collagenase solution, and the bottom layer contained red blood cells (RBC). The turbid, grayish layer, which appeared between the RBC and collagenase solution, was the collection of SVF (ie, the third layer). During the isolation process, the remaining aspirated fat was prepared for grafting by centrifugation at 800 g for 4 minutes to remove free oil and blood components. Freshly isolated SVF was then combined with 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 (Becton Dickinson, Franklin Lakes, New Jersey) and connected to a 14-gauge, 15-cm, single-hole cannula for injection (Figure 2).

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 had

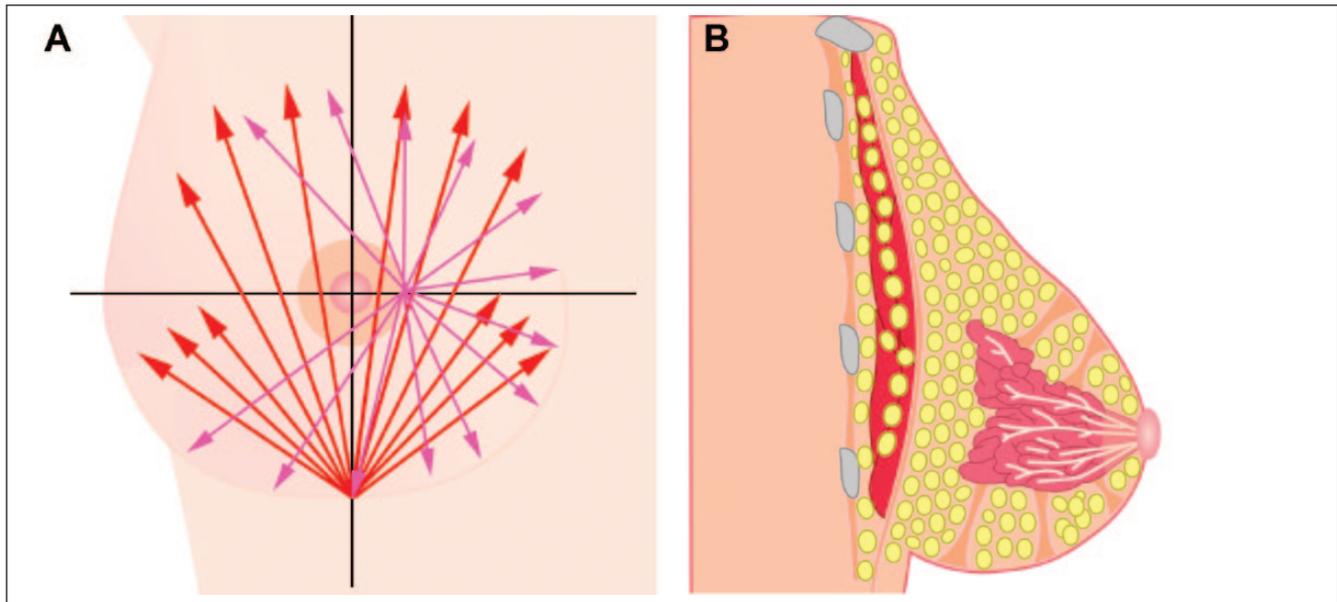


Figure 3. Injection pattern of grafted fat. (A) The grafted fat was injected in a fanning pattern through inframammary entry and/or para-areolar entry, as needed. (B) The fat (yellow) was injected into the breasts at subcutaneous, intramuscular, retromuscular, and premuscular layers.

been injected, the patient was moved to a sitting position for assessment of the injection progress and then was returned to the supine position for completion of the injections until desired results were achieved. The injections were made in a fanning pattern and in small aliquots, through multiple passes and tissue planes, to improve graft take. In both groups, the fat was injected to the breast at subcutaneous, intramuscular, retromuscular, and premuscular layers. In general, the amount of fat injected into the 4 layers was divided evenly among them but may have varied depending on the condition of the recipient site (Figure 3). The injection technique was the same for both groups.

Statistical Analysis

Demographics and results (including complication rates) were analyzed with SPSS software, version 17.0 (SPSS, Inc, an IBM Company, Chicago, Illinois). Statistical significance by *t* test was defined as $P < .05$.

RESULTS

Demographics

The mean age was 34.9 years (range, 18-57 years) for group A and 31.2 years (range, 20-49 years) for group B. Mean BMI was 21.2 (range, 18.6-30) in group A and 17.6 (range, 16-18.5) in group B.

Change in BCD

Mean pretreatment BCD was 8.0 cm (range, 2-21.5 cm) in group A and 6.3 cm (range, 1-14 cm) in group B. Mean posttreatment BCD was 11.5 cm (range, 4-30 cm) in group A and 9.9 cm (range, 2-20 cm) in group B. The mean volume of fat grafted to each breast was 254 mL (range, 160-320 mL) in group A and 241 mL (range, 110-300 mL) in group B. The differences in these data were statistically significant. Underweight patients were younger and had smaller preoperative and postoperative BCD. The volume of injected fat was significantly smaller in group B (Table 1).

The mean postoperative change in BCD was 3.5 cm (range, 0-13 cm) for group A and 3.6 cm (range, 0-7.5 cm) for group B; the difference was not statistically significant. Therefore, even though the volume of injected fat was lower for group B, the effectiveness of the breast enlargement was nearly the same for the 2 groups.

Postoperative Complications

Mean follow-up time did not differ significantly between the study groups: 23.7 months (range, 12-40 months) for group A and 23.0 months (range, 12-39 months) for group B (Table 1). In some patients, complications developed during the follow-up period. Complications included recipient site infection, fat necrosis, and small areas of induration (with or without calcification). The average time until

Table 1. Patient Data

Characteristic	Group A, Mean (SD)	Group B, Mean (SD)	P Value (by <i>t</i> Test)
No. of patients	205	77	
Age, y	34.9 (7.9)	31.2 (6.0)	.000
BMI	21.2 (2.0)	17.6 (0.7)	.000
Volume of fat injected into each breast, mL	254 (33.7)	241 (29.7)	.003
BCD, cm			
Pretreatment	8.0 (3.0)	6.3 (2.9)	.001
Posttreatment	11.5 (3.9)	9.9 (3.3)	.013
Change	3.5 (2.1)	3.6 (2.0)	.900
Follow-up time, mo	23.7 (8.4)	23.0 (8.3)	.602
Time to identify complications, mo	6.8 (3.6)	5.7 (3.3)	.828

BCD, difference in breast circumference; BMI, body mass index; SD, standard deviation.

Table 2. Number of Complications After Autologous Fat Grafting to the Breasts

Complication	Group A (n = 205)	Group B (n = 77)	P Value (by χ^2 Test)
Fat necrosis	2	1	
Infection	1	1	
Induration and/or calcification	10	5	
Others	0	0	
Total, No. (%)	13 (6.3)	7 (9.1)	.423

identification of complications was 6.8 months (range, 2-11 months) for group A and 5.7 months (range, 1-8 months) for group B; the difference was not significant (Table 1). The overall complication rate was 6.3% (13 of 205) in group A and 9.1% (7 of 77) in group B. Although the complication rate was higher for group B, the difference was not statistically significant (Table 2).

Aesthetic Outcomes

For group A patients, the physician rating was very good for 88 patients (42.9%), good for 90 (43.9%), and not good for 27 (13.2%). With respect to patient satisfaction in group A, 88 patients (42.9%) were very satisfied, 88 (42.9%) were satisfied, and 29 (14.2%) were dissatisfied.

For group B patients, the physician rating was very good for 32 patients (41.6%), good for 32 (41.6%), and not good for 13 (16.9%). Group B patient satisfaction was as follows: 29 patients (37.7%) were very satisfied, 36 (46.8%) were satisfied, and 12 (15.5%) were dissatisfied.

Table 3. Physician and Patient Satisfaction Ratings

Satisfaction Grade	Group A (n = 205), No. (%)	Group B (n = 77), No. (%)
Physician satisfaction		
Very good	88 (42.9)	32 (41.6)
Good	90 (43.9)	32 (41.6)
Not good	27 (13.2)	13 (16.8)
Patient satisfaction		
Very satisfied	88 (42.9)	29 (37.7)
Satisfied	88 (42.9)	36 (46.8)
Dissatisfied	29 (14.2)	12 (15.5)

The differences in physician and patient satisfaction between the study groups were not statistically significant (Table 3). Rather, there was close correlation between responses of physicians and patients (Figures 4-10).

DISCUSSION

Autologous fat grafting to the breast is not a simple procedure and is best performed by well-trained and skilled surgeons.¹⁸ When performed in underweight patients, additional challenges exist. Breast space is limited in these patients, and the overlying skin is often tight. Injecting too much fat in such cases may lead to graft failure. Moreover, because the fat layer in these patients is usually thin, it is often necessary to harvest fat from more areas of the body. In patients of normal weight, 1200 mL of aspirate can

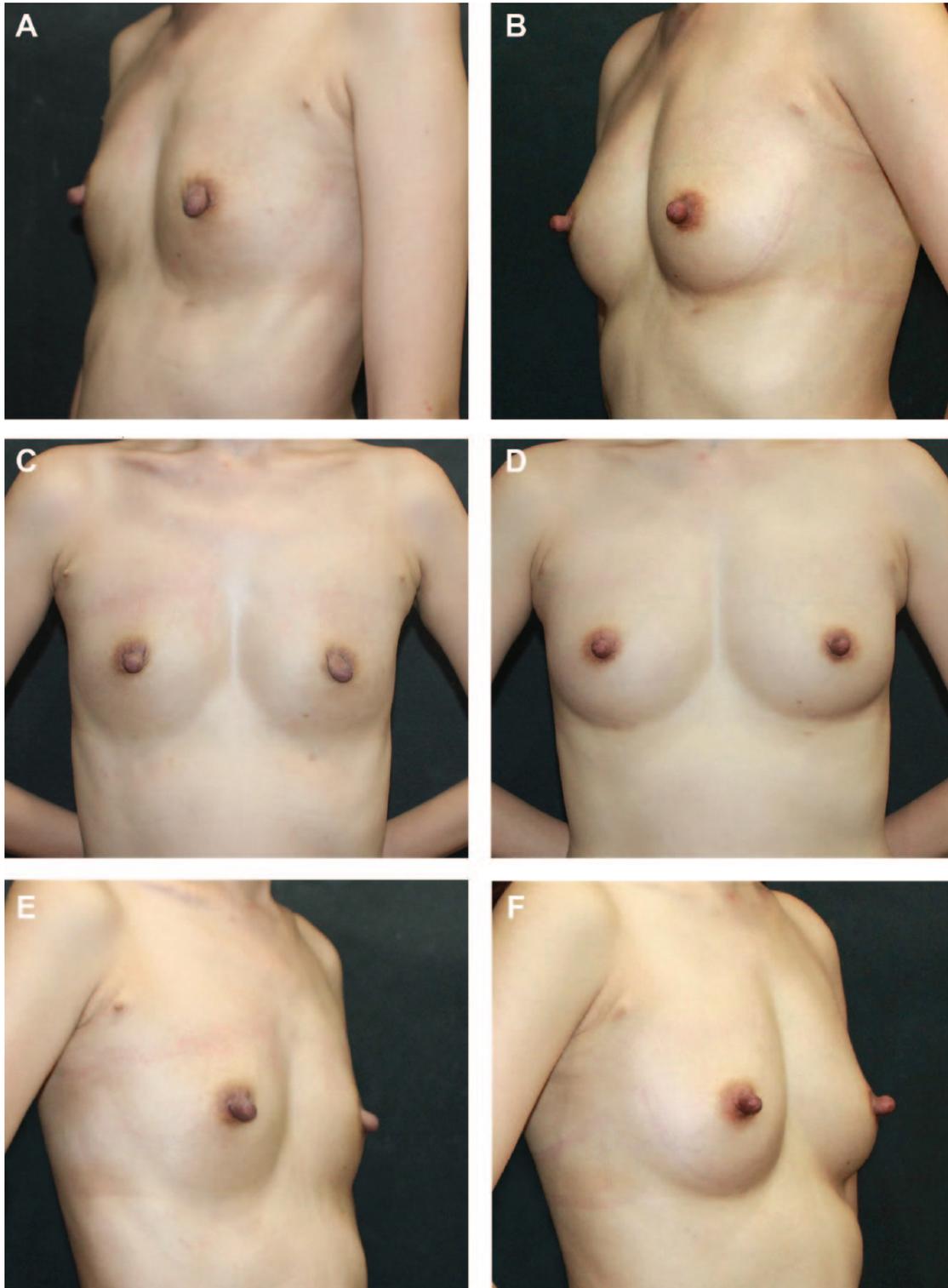


Figure 4. Patient 1: Pretreatment views (A, C, E) and posttreatment views at 12 months (B, D, F). This 32-year-old woman with a body mass index of 18.0 (height, 170 cm; weight, 52 kg) presented for cosmetic augmentation of the breasts. Autologous fat grafting of 250 mL in each breast was performed in 1 session. Her breast circumference increased from 9 cm (baseline) to 14.5 cm (at 12 months). Breast contour improved significantly as judged by the independent evaluator, and the patient was very satisfied with the result.

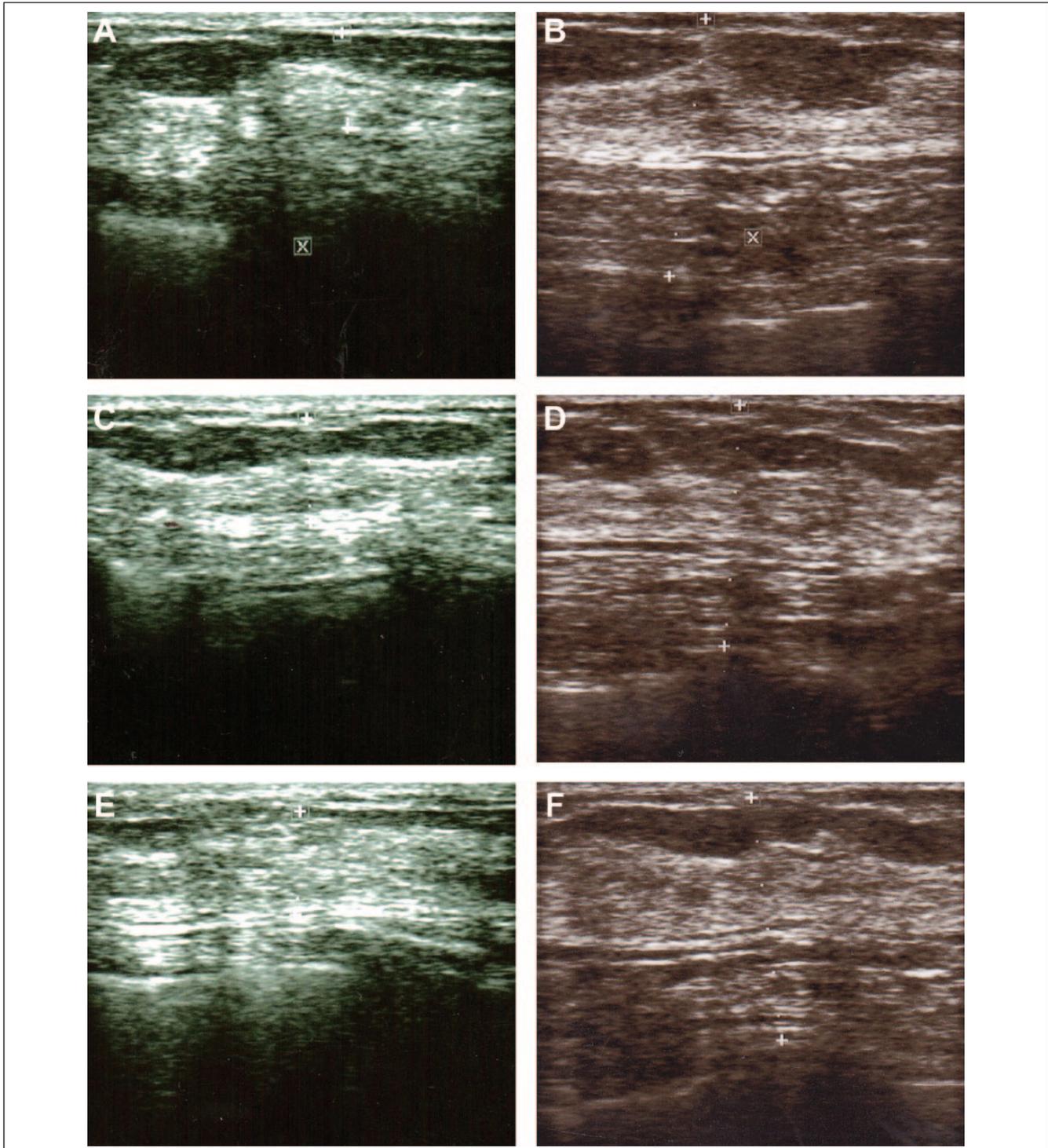


Figure 5. Patient 1: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 11.0 mm (A), 11.8 mm (C), 11.8 mm (E), and 12.4 mm (G) to 29.9 mm (B), 27.5 mm (D), 27.8 mm (F), and 30.1 mm (H), respectively, by 12 months posttreatment. There was no evidence of any complication.

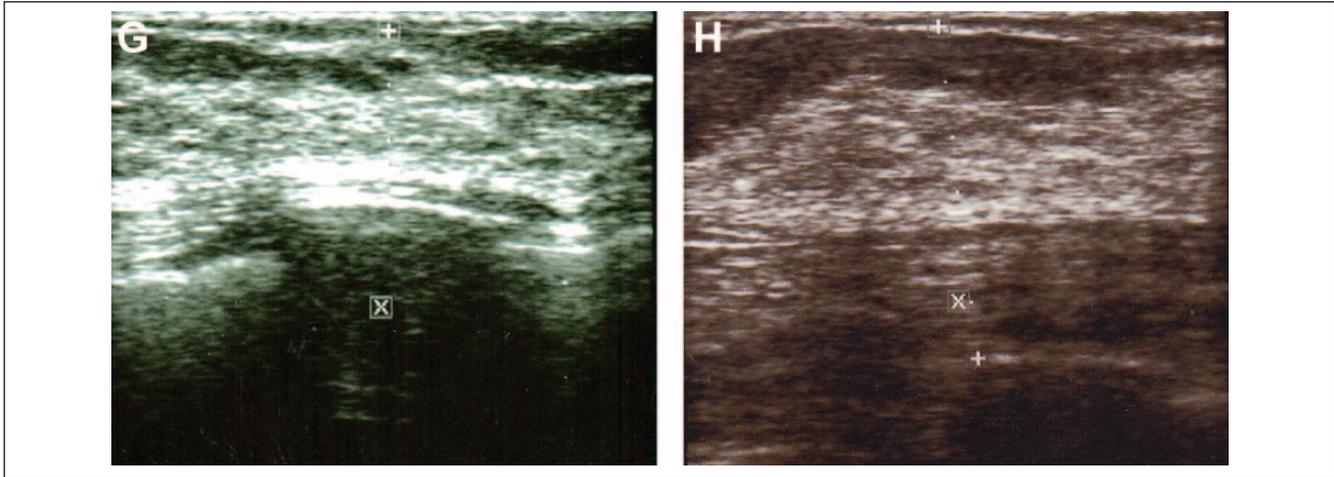


Figure 5. (continued) Patient 1: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 11.0 mm (A), 11.8 mm (C), 11.8 mm (E), and 12.4 mm (G) to 29.9 mm (B), 27.5 mm (D), 27.8 mm (F), and 30.1 mm (H), respectively, by 12 months posttreatment. There was no evidence of any complication.

typically be harvested from the inner, posterior, and lateral thighs. However, in underweight patients, obtaining this quantity of fat may require harvesting from additional sites, such as the abdomen, calves, and/or upper arms. Expert surgical technique is important for minimizing deformities at all donor sites.

In the present study, fat was harvested at a negative pressure of 600 mm Hg, less than that typical for manual liposuction. In a recent study, a significant difference in negative pressures (−537 mm Hg vs −643 mm Hg) was detected for manual liposuction with 10- and 60-mL syringes.¹⁹ In another study,²⁰ lipoaspirates from the abdomen obtained by mechanical (−700 mm Hg) or manual aspiration (−500 mm Hg) were processed and assayed for metabolic activity and angiogenic potential. Both methods preserved adipogenic cells, but it is not known whether one method is less traumatic than the other.²⁰ The pressure applied for mechanical liposuction in the present study (−600 mm Hg) was not higher than that for manual liposuction with the 60-mL syringe (−643 mm Hg) in the study by Gonzalez et al.¹⁹

Although measuring BCD is not the most accurate way to determine increases in breast size, it was deemed the most practical approach for this office-based practice. Yoshimura et al¹⁴ noted that an increase in BCD of 4 to 8 cm appeared to correspond to a 100- to 200-mL increase in the volume of each breast mound, which was partially confirmed by their preliminary evaluation using a 3-dimensional quantitative measurement system. Although underweight women in the present study had lower pre- and posttreatment BCD and significantly lower volumes of injected fat,

the change in BCD was the same as for women of normal weight. This result was attributed to the thinner chest circumference of underweight women, which allowed a smaller amount of fat to effect a similar degree of enlargement. Approximately 30% of our patients required another treatment to enlarge their breasts further in our experience. Most of these patients opted for an additional session of fat grafting because they preferred to cosmetically enlarge their breasts in this way.

Complications of autologous fat grafting to the breasts include fat necrosis, infection, indurations, and calcifications, all of which are detectable by routine posttreatment physical examination and/or ultrasonography of the breasts. The technique utilized for fat injection was that described by Coleman and Saboero²¹ (structural fat injection), whereby the grafted fat is injected in small aliquots with each pass to maximize the surface area of contact between the grafted fat and the recipient tissue. A large surface area of contact between the host tissue capillaries and newly grafted tissue promotes nutrition and minimizes the likelihood of liponecrotic cysts. Regardless, the complication rate for structural fat injection is relatively high (10%-16%).^{4,14}

Although structural fat injection has been the standard for fat transplantation, repeated to-and-fro motions of injection can result in a crowded graft and consequent graft failure.¹⁶ The author developed a solid injection method to ensure the highest contact area between grafted fat and recipient tissue. With this refinement, fat can be injected into 4 distinct layers of the breast. To guide the injection, the surgeon identifies the tip of the

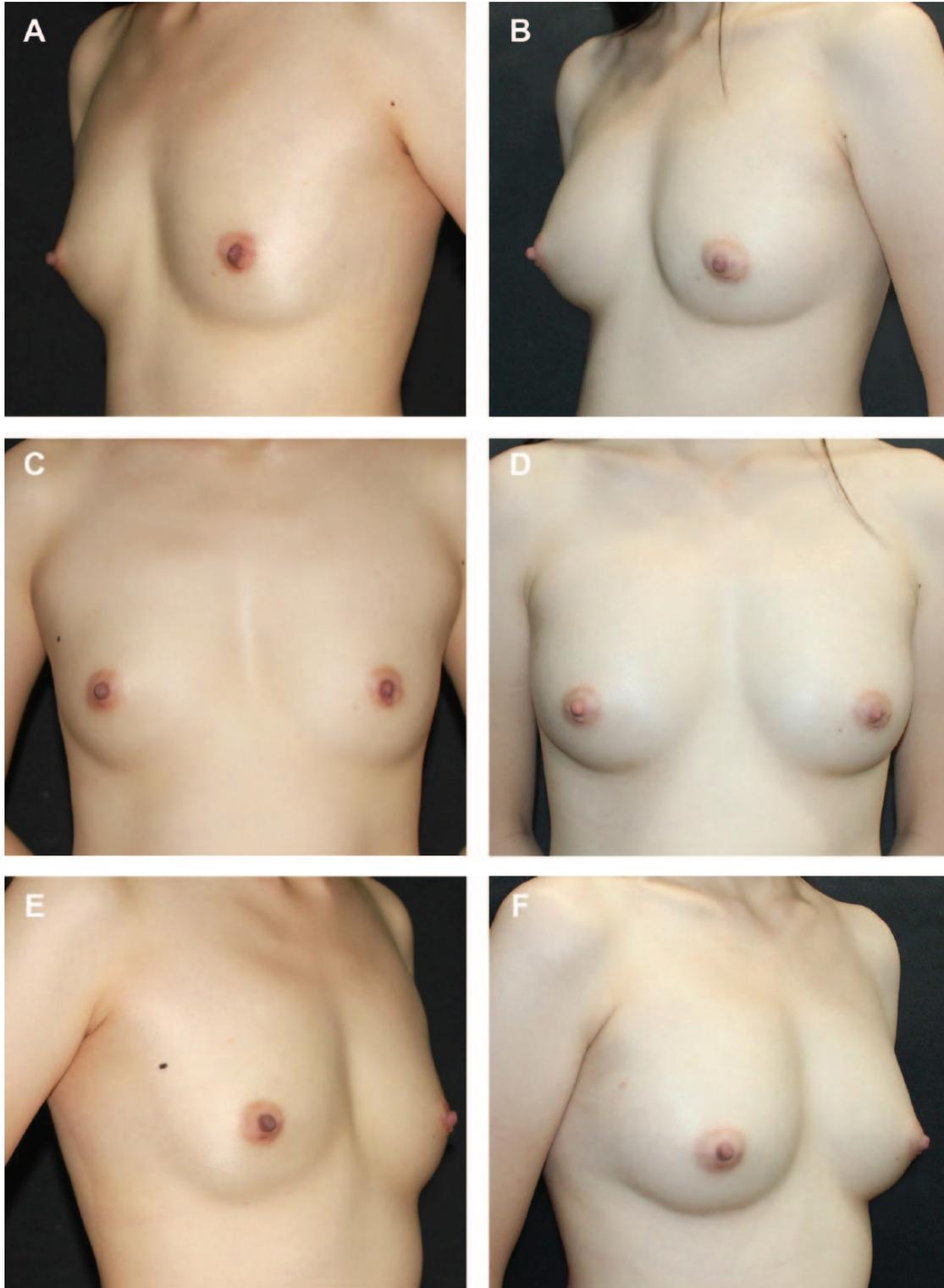


Figure 6. Patient 2: Pretreatment views (A, C, E, G, I, K, M) and posttreatment views at 23 months (B, D, F, H, J, L, N). This 27-year-old woman with a body mass index of 17.9 (height, 168 cm; weight, 50.5 kg) presented for cosmetic augmentation of the breasts. Autologous fat grafting of 260 mL to her right breast and 240 mL to her left breast was performed in 1 session. After the procedure, her breast circumference increased from 4 to 6 cm. Breast contour improved significantly as judged by the independent evaluator, and the patient was very satisfied with the result. The donor sites for this patient included posterior thighs (G, H), inner thighs (I, J), lateral thighs (K, L), and calves (M, N).

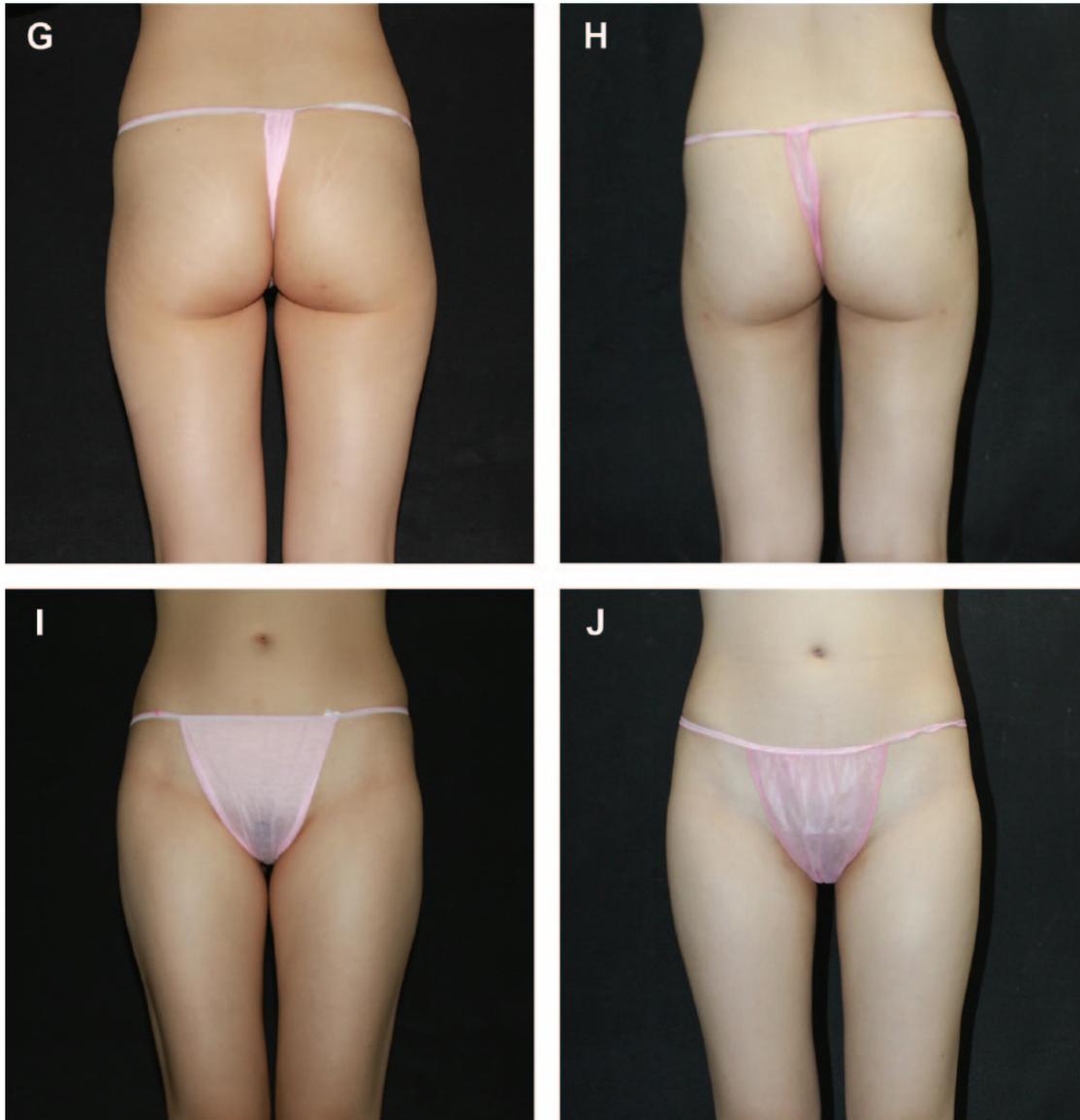


Figure 6. (continued) Patient 2: Pretreatment views (A, C, E, G, I, K, M) and posttreatment views at 23 months (B, D, F, H, J, L, N). This 27-year-old woman with a body mass index of 17.9 (height, 168 cm; weight, 50.5 kg) presented for cosmetic augmentation of the breasts. Autologous fat grafting of 260 mL to her right breast and 240 mL to her left breast was performed in 1 session. After the procedure, her breast circumference increased from 4 to 6 cm. Breast contour improved significantly as judged by the independent evaluator, and the patient was very satisfied with the result. The donor sites for this patient included posterior thighs (G, H), inner thighs (I, J), lateral thighs (K, L), and calves (M, N).

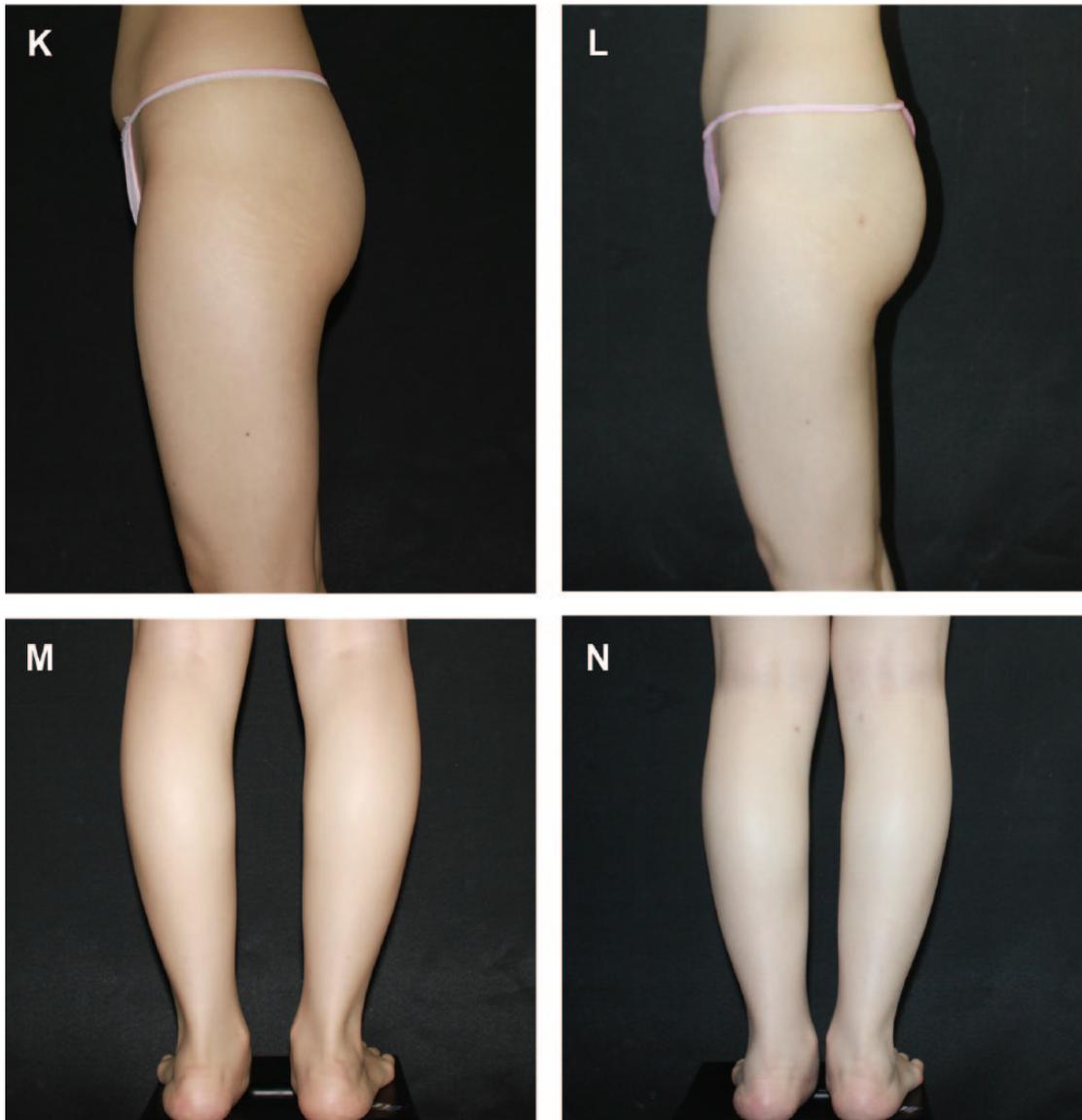


Figure 6. (continued) Patient 2: Pretreatment views (A, C, E, G, I, K, M) and posttreatment views at 23 months (B, D, F, H, J, L, N). This 27-year-old woman with a body mass index of 17.9 (height, 168 cm; weight, 50.5 kg) presented for cosmetic augmentation of the breasts. Autologous fat grafting of 260 mL to her right breast and 240 mL to her left breast was performed in 1 session. After the procedure, her breast circumference increased from 4 to 6 cm. Breast contour improved significantly as judged by the independent evaluator, and the patient was very satisfied with the result. The donor sites for this patient included posterior thighs (G, H), inner thighs (I, J), lateral thighs (K, L), and calves (M, N).

injecting cannula by feeling for it with the nondominant hand. The fat is injected only during withdrawal of the cannula, once the surgeon has detected solid feedback with the dominant hand (while advancing the cannula). If such feedback is not detected, injection is not performed. In such instances, the cannula is withdrawn and directed to a different space. The nondominant hand

continually compresses the breast to increase the contact area between the recipient tissue and the injected fat. After fat injection, the breasts should remain soft, and there should be no pressure leakage from the injection points (Figure 10). With this method, the complication rate of autologous fat grafting for breast augmentation in the author's hands was reduced from 14.2% to 2.2%.¹⁶

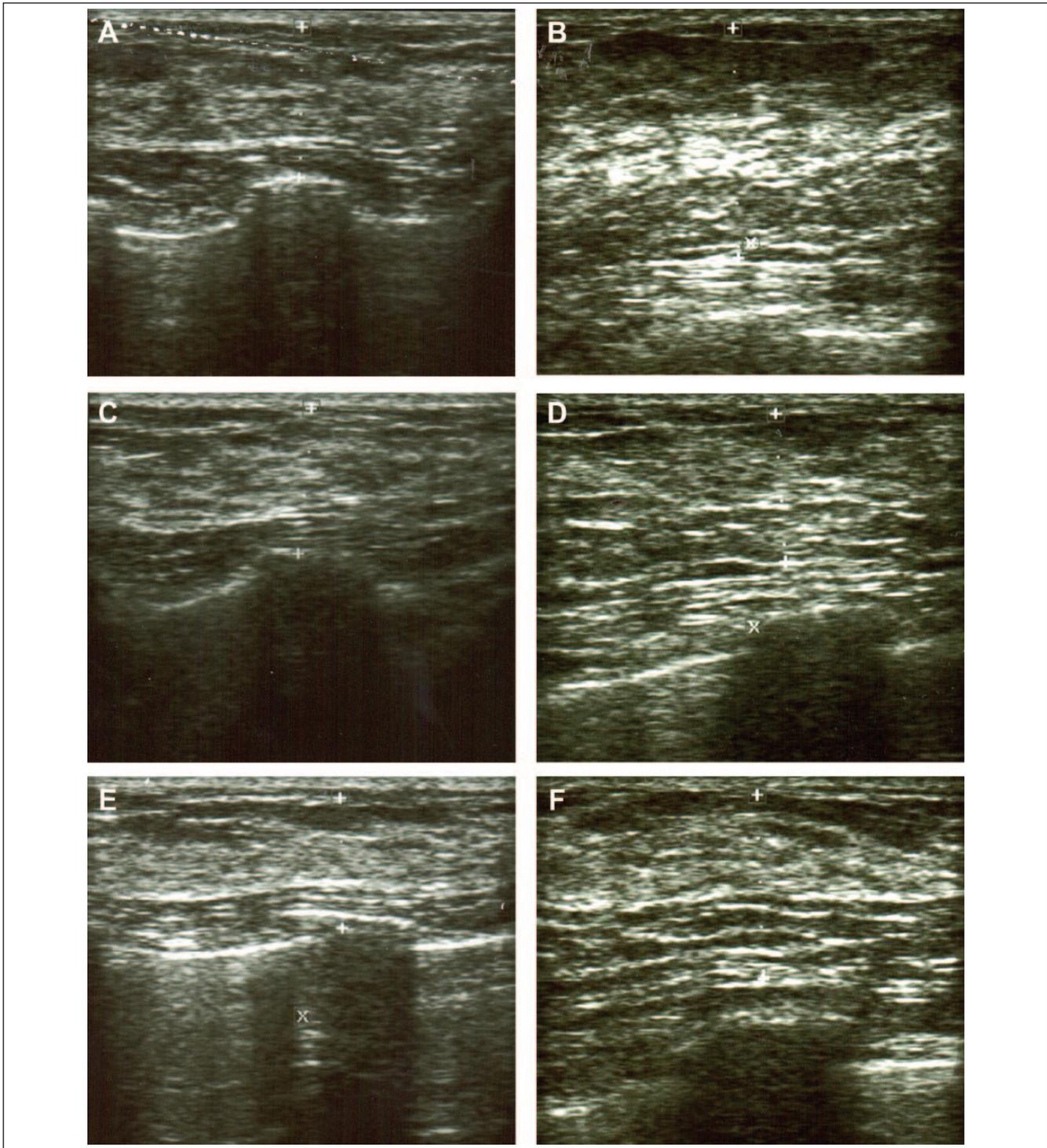


Figure 7. Patient 2: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 17.3 mm (A), 16.7 mm (C), 14.8 mm (E), and 14.0 mm (G) to 37.4 mm (B), 29.7 mm (D), 27.2 mm (F), and 32.3 mm (H), respectively, by 23 months posttreatment. There was no evidence of any complication.

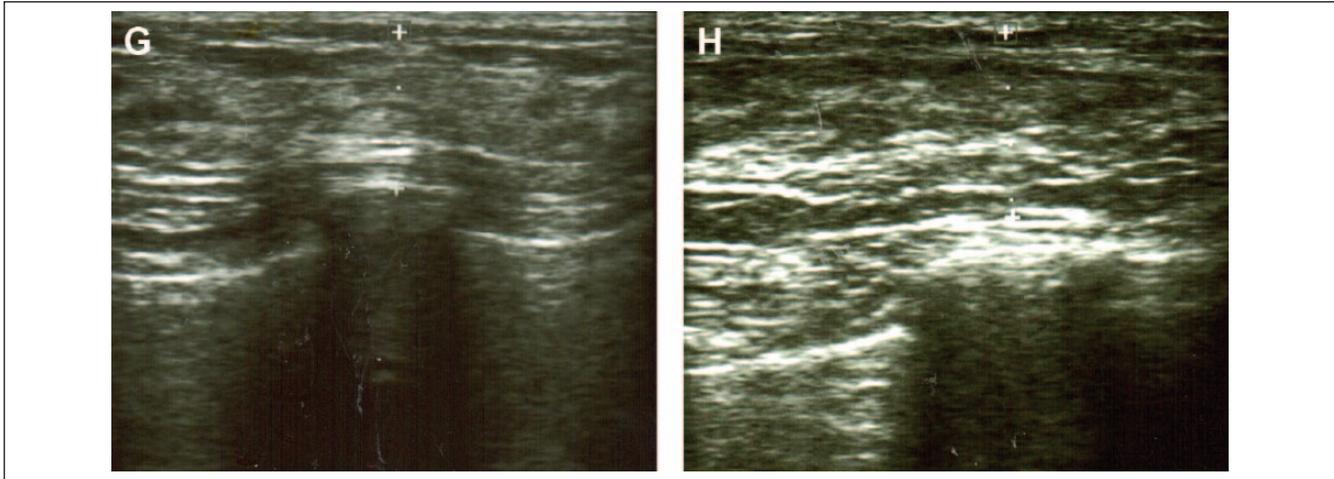


Figure 7. (continued) Patient 2: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 17.3 mm (A), 16.7 mm (C), 14.8 mm (E), and 14.0 mm (G) to 37.4 mm (B), 29.7 mm (D), 27.2 mm (F), and 32.3 mm (H), respectively, by 23 months posttreatment. There was no evidence of any complication.

(Videos demonstrating the injection technique are available online at www.aestheticsurgeryjournal.com.)

Posttreatment complication rates in the current study were 6.3% for group A and 9.1% for group B. Although group B had more complications, the between-group difference was not significant, indicating that the higher complication rate was not associated with the lower BMI of group B. The higher complication rates in both groups vs the author's previous results¹⁶ may relate to the introduction of the solid injection method for treatments performed after 2012. Some patients in the current study received autologous fat grafting by the solid injection method and some by the method of Coleman and Saboeiro.²¹ The distribution was random and blind in both groups, which explains why the complication rates in the current study were higher than that in the author's previous study.

Posttreatment care is important because clinical follow-up has shown that morphologic results are stable 3 to 4 months after the procedure if the patient's weight remains consistent.²² During this period, blunt trauma or forceful manipulation of the breasts should be avoided to prevent trauma-induced fat necrosis.

The time to detect complications in this study ranged from 1 to 11 months. Indurations and calcifications could develop as late as 11 months after the procedure. Therefore, to obtain the most accurate data, at least 12 months of follow-up is recommended.

A limitation of this study was that mammographic studies were seldom performed. There are several reasons for this. First, people in Taiwan are especially concerned about the safety of irradiation received during radiographic examination. In general, they prefer not to receive routine or sequential x-ray examinations if another option exists.

Second, our patients are referred for MRI only after the detection of complications during routine physical and ultrasound examinations. Although calcifications are not well characterized by ultrasonography, they can be recognized as echogenic foci, particularly when in a mass. Macrocalcifications will attenuate the acoustic beam and cause acoustic shadowing and, when situated in fat or fibroglandular tissue, are less conspicuous than when present in a mass. Punctate hyperechoic foci will be conspicuous in a hypoechoic mass. In the present study, routine postoperative ultrasound examinations were performed by the same technician at the author's clinic; if the results were positive, the patient was immediately referred to the breast center of a teaching hospital for dedicated breast MRI (Aurora Imaging, North Andover, Massachusetts).

CONCLUSIONS

In the present study, the same degree of breast enlargement was achieved in underweight and normal-weight women after autologous fat grafting for cosmetic breast augmentation. Complication rates were not higher for underweight patients, and therefore it appears that low BMI is not a contraindication for this procedure.

Disclosures

The author declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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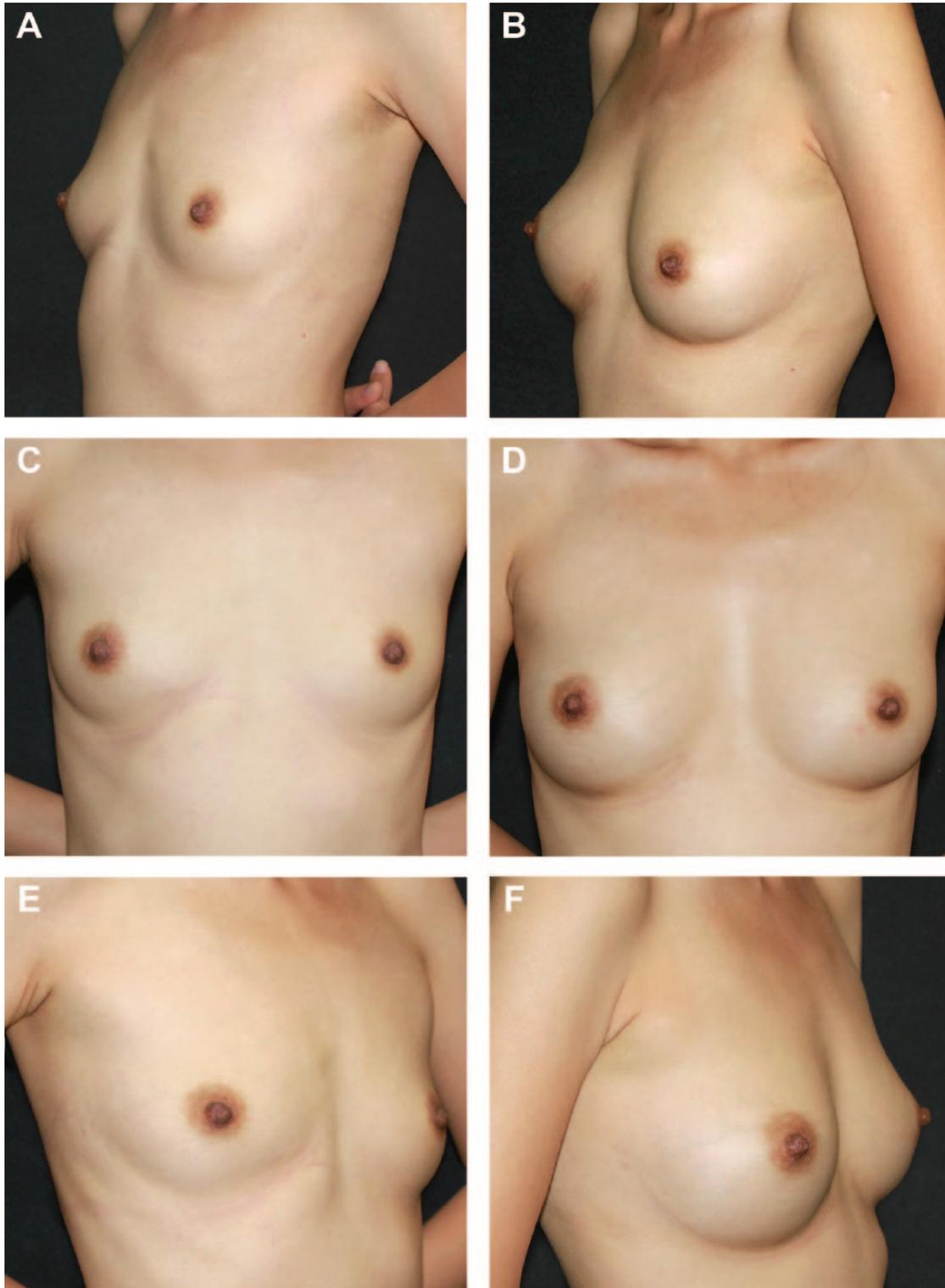


Figure 8. Patient 3: Pretreatment views (A, D, E) and posttreatment views at 38 months (B, D, F). This 28-year-old woman with a body mass index of 17.6 (height, 155 cm; weight, 42.5 kg) presented for cosmetic augmentation of the breasts. Autologous fat grafting of 250 mL in each breast was performed in 1 session. Her breast circumference increased from 5.5 cm (baseline) to 9.0 cm (at 38 months). Breast contour improved significantly as judged by the independent evaluator, and the patient was very satisfied with the result.

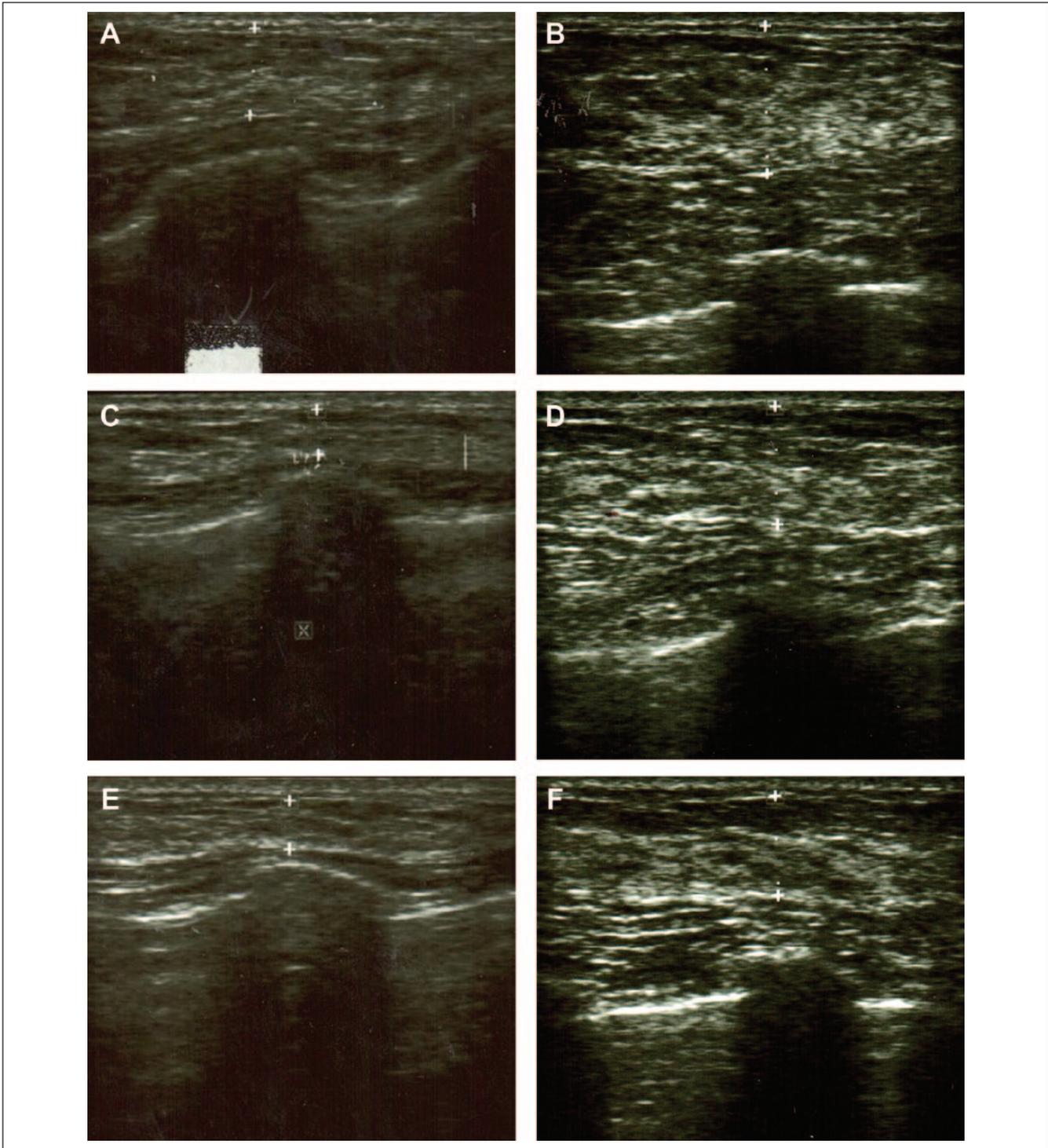


Figure 9. Patient 3: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 10.1 mm (A), 5.1 mm (C), 5.6 mm (E), and 6.7 mm (G) to 17.0 mm (B), 13.5 mm (D), 11.4 mm (F), and 13.2 mm (H), respectively, by 38 months posttreatment. There was no evidence of any complication.

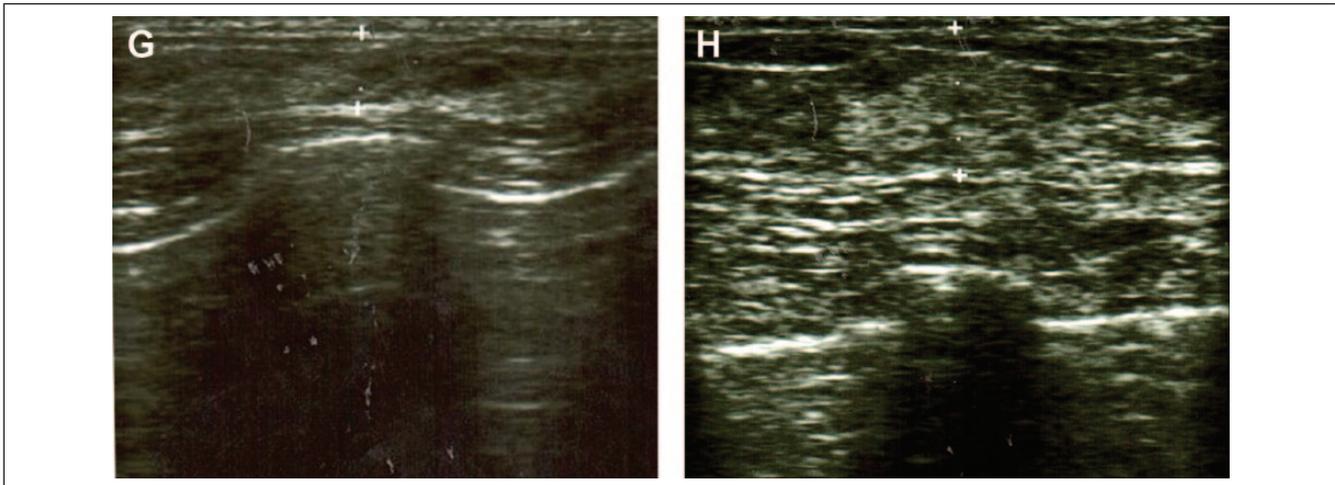


Figure 9. (continued) Patient 3: Breast ultrasonography shows that the thickness at anchoring points L3 (A, B), L9 (C, D), R3 (E, F), and R9 (G, H) increased from 10.1 mm (A), 5.1 mm (C), 5.6 mm (E), and 6.7 mm (G) to 17.0 mm (B), 13.5 mm (D), 11.4 mm (F), and 13.2 mm (H), respectively, by 38 months posttreatment. There was no evidence of any complication.

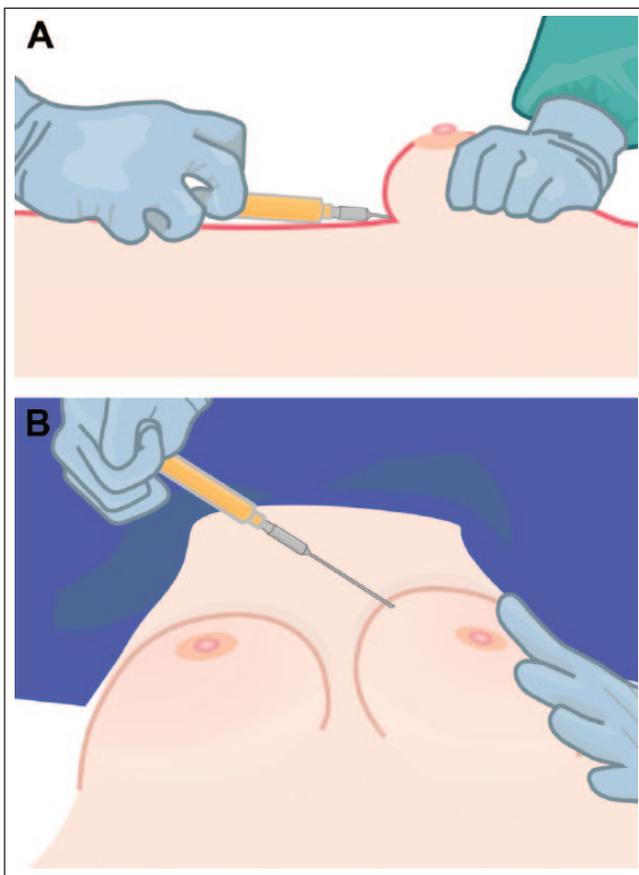


Figure 10. (A) With the solid injection method, fat was injected only after solid feedback had been detected by the dominant hand. (B) The nondominant hand compressed the breast to maintain this solid feedback and increase the contact area between the injected fat and the recipient tissue.

REFERENCES

1. Spear SL, Wilson HB, Lockwood MD. Fat injection to correct contour deformities in the reconstructed breast. *Plast Reconstr Surg.* 2005;5:1300-1305.
2. Delay E, Delpierre J, Sinna R, Chekaroua K. How to improve breast implant reconstructions. *Ann Chir Plast Esthet.* 2005;50(5):582-594.
3. Missana MC, Laurent I, Barreau L, Balleyguier C. Autologous fat transfer in reconstructive breast surgery: indications, technique and results. *Eur J Surg Oncol.* 2007;33(6):685-690.
4. Zheng DN, Li QF, Lei H, et al. Autologous fat grafting to the breast for cosmetic enhancement: experience in 66 patients with long-term follow up. *J Plast Reconstr Aesthetic Surg.* 2008;61:792-798.
5. Leibman AJ, Styblo TM, Bostwick J III. Mammography of the postreconstruction breast. *Plast Reconstr Surg.* 1997;99:698.
6. Danikas D, Theodorou SJ, Kokkalis G, Vasiou K, Kyriakopoulou K. Mammographic findings following reduction mammoplasty. *Aesthetic Plast Surg.* 2001;25:283-285.
7. Carpaneda CA, Ribeiro MT. Percentage of graft viability versus injected volume in adipose autotransplants. *Aesthetic Plast Surg.* 1994;18:17-19.
8. Coleman SR. Structural fat grafts: the ideal filler? *Clin Plast Surg.* 2001;28:111-119.
9. Ersek RA, Chang P, Salisbury MA. Lipo layering of autologous fat: an improved technique with promising results. *Plast Reconstr Surg.* 1998;101:820-826.
10. Fagrel D, Enestrom S, Berggren A, Kniola B. Fat cylinder transplantation: an experimental comparative study of three different kinds of fat transplants. *Plast Reconstr Surg.* 1996;98:90-96.
11. Har-Shai Y, Lindenbaum ES, Gamliel-Lazarovich A, Beach D, Hirshowitz B. An integrated approach for increasing

- the survival of autologous fat grafts in the treatment of contour defects. *Plast Reconstr Surg.* 1999;104:945-954.
12. Shiffman MA, Mirrafati S. Fat transfer techniques: the effect of harvest and transfer methods on adipocyte viability and review of the literature. *Dermatol Surg.* 2001;27:819-826.
 13. Ullmann Y, Hyams M, Ramon Y, Peled IJ, Leiderbaum ES. Enhancing the survival of aspirated human fat injected into nude mice. *Plast Reconstr Surg.* 1998;101:1940-1944.
 14. Yoshimura K, Sato K, Aoi N, Kurita M, Hirohi T, Harii K. Cell-assisted lipotransfer for cosmetic breast augmentation: supportive use of adipose-derived stem/stromal cells. *Aesthetic Plast Surg.* 2008;32:48-55.
 15. Rosing JS, Wong G, Wong MS, Sahar D, Stevenson TR, Pu LLQ. Autologous fat grafting for primary breast augmentation: a systematic review. *Aesthetic Plast Surg.* 2001;35:882-890.
 16. Chiu CH. A "solid injection method" to reduce postoperative complications in autologous fat grafting for breast augmentation. *Am J Cosmetic Surg.* 2013;30(1):1-6.
 17. Flegal KM, Graubard BI, Williamson DF. Excess deaths associated with underweight, overweight, and obesity. *JAMA.* 2005;293(15):1861-1867.
 18. Illouz YG, Sterodimas A. Autologous fat transplantation to the breast: a personal technique with 25 years of experience. *Aesthetic Plast Surg.* 2009;33:706-715.
 19. Gonzalez Am, Loboeki C, Kelly CP, et al. An alternative method for harvest and processing fat grafts: an in vitro study of cell viability and survival. *Plast Reconstr Surg.* 2007;120:285-294.
 20. Leong DTW, Hutmacher DW, Chew FT, et al. Viability and adipogenic potential of human adipose tissue processed cell population obtained from pump-assisted and syringe-assisted liposuction. *J Dermatol Sci.* 2005;37:169-176.
 21. Coleman SR, Saboeiro AP. Fat grafting to the breast revisited: safety and efficacy. *Plast Reconstr Surg.* 2007;119:775-785.
 22. Delay E, Garson S, Tousson G, Sinna R. Fat injection to the breast: technique, results, and indications based on 880 procedures over 10 years. *Aesthetic Surg J.* 2009;29(5):360-376.