Is There an Ideal Donor Site of Fat for Secondary Breast Reconstruction?

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Abstract

Background: Loss of volume after autologous fat transfer to the breast is well documented, and various methods to improve long-term survival of fat grafts have been investigated (including both distant and neighboring harvest sites), but no optimal technique has been identified.

Objective: The authors compare fat graft survival from 2 anatomical donor sites to determine whether there is an optimal site for fat graft harvesting in breast reconstruction.

Methods: Seventy-three patients (109 breasts) who received fat grafting to reconstructed breasts from 2009 to 2012 were enrolled in this retrospective study and divided into 2 groups: group A had fat harvested from the abdomen and group B from the thighs. Fat grafting was performed using a modified Coleman technique for symmetry. For all patients, 3-dimensional scans were obtained and volumes were analyzed.

Results: Forty-six patients (66 breasts) received an average of 101 mL of fat injected from the abdomen, and 27 (43 breasts) received an average of 102 mL from the thighs. Group A had 82% volume retention at 16 days, 63% at 49 days, and 45% at 140 days. Group B had 86% at 16 days, 63% at 49 days, and 46% at 140 days ($P > .05$). Patients were also stratified by radiation exposure and volume injected; neither affected donor site volume retention ($P > .05$).

Conclusions: Our data suggest that donor site, regardless of volume injected or tissue radiation, did not affect volume retention in fat grafting. Longer-term studies are needed to assess the stability of the breast after fat grafting.

Keywords

3D imaging, fat grafting, donor site, viability, breast surgery

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Fat grafting has emerged as a tool for improving volume, symmetry, and overall shape in the reconstructed breast. Loss of volume after autologous fat transfer (AFT) to the breast is a well-documented phenomenon, and recent studies have indicated 40% to 50% volume retention after fat transfer.[1-5] Authors have studied various ways to improve long-term survival of fat grafts (washing, centrifugation, cell treatment, injection technique, etc) but failed to identify any definitive optimal methods.[1-5]

One variable that may influence retention in fat grafting is the donor site; however, no clinical study has delineated which site would optimize volumetric retention. Millard[6] argued, in *Principalization of Plastic Surgery*, that tissue losses should be replaced in kind; thus, plastic surgeons have questioned whether neighboring or distant adipose tissue donor sites would optimize aesthetic results in AFT. Rohrich et al[7] reported that fat explanted from various donor sites provided statistically equivalent viable cells. Li et al[8] reinforced those findings, documenting that fat from assorted human donor sites had equivocal sustainability in nude mice.

Previous work has documented the validity of 3-dimensional (3D) imaging in assessing surgical outcomes of AFT.[9-12] In this study, we utilized 3D imaging to compare

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fat graft survival from 2 anatomical sites and determine whether there is an optimal site for fat graft harvesting in breast reconstruction.

METHODS

Patients

A retrospective chart review was conducted on an institutional review board–approved database of patients who had undergone autologous fat injection to their reconstructed breasts between January 2009 and December 2012. From the database, 73 consecutive patients (109 breasts) were included in the study. Injection volume correlated to preoperative 3D asymmetry, and all patients achieved intraoperative breast symmetry. All patients were treated by 1 of the senior authors (N.K. or M.C.). Patients were stratified into 2 groups: group A had fat transferred from the anterior abdomen and group B from the lateral thighs. The donor site was selected based on patient preference, as long as the surgeon determined that enough fat was present to achieve the reconstructive goal. Patients who received AFT from multiple harvest sites or from sites other than the abdomen and thighs were excluded from the study. A secondary survey organized the patients into various subgroups to assess possible relationships between the donor site and the quality of the recipient tissue (radiated vs nonradiated) or volume of injected fat.

All surgeries were performed using a modified Coleman technique to achieve breast symmetry, as described in previous work.[5] Typically, the donor site was infiltrated with tumescent solution (1 L lactated Ringer's solution, 40 mL 1% lidocaine, and 1 mL 1:1000 epinephrine). Fat was aspirated with a standard liposuction machine using a 3- to 4-mm harvesting cannula, captured in a sterile collection bottle, transferred with a sterile method to 10-mL syringes, and centrifuged for 3 minutes at 3000 revolutions per minute. The lowest level of substrate in the syringe was drained, and the highest level (oil) was decanted from the syringe with a Neuropad (TRIGOcare International GmbH, Wiehl, Germany). The middle layer was transferred to 3-mL syringes and injected with blunt-tip injection cannulas, approximately 0.1 mL with each pass. The amount of fat injected, injection sites, and donor sites were recorded intraoperatively for each revised breast. Postoperatively, patients were placed in supportive bras.

3D Analyses

The imaging modality in this study was similar to the one described in our group's previous work.[9-12] A preoperative scan was obtained using the Canfield VECTRA 3-pod system (Canfield Scientific, Inc, Fairfield, New Jersey). Patients were positioned midline, 2 feet from the center camera, instructed to stand straight with their chins at 90°, and arranged with their arms at their sides. Final images were captured during the expiratory phase of the respiratory cycle to minimize chest wall movement. Images were obtained preoperatively and at every subsequent postoperative visit. The imaging protocol corresponded to the routine postoperative visits of the senior authors; typical screening included postoperative day 16 (± 5 days), day 49 (± 5 days), and day 140 (± 5 days). At each screening, 3D measurements were calculated.

Table 1. Patient Demographics

Demographic	Value
Patients, n	73
Breasts, n	109
Average age, y	49
Average fat injected, mL	104
Range of fat injected, mL	16-300
Irradiated breasts, n	29
Autologous revisions, n	23
Implant revisions, n	74
Lumpectomy revisions, n	12

3D Volumetric Analysis

Constructed surface scans were imported into a secondary 3D software program, Geomagic Studio 12 (Geomagic, Inc, Morrisville, North Carolina), for all volumetric data analysis. Breast volumes were calculated using an established algorithm described in our group's previous work. All preoperative and postoperative breast images were aligned to a reference X, Y, and Z coordinate axis, and total breast volume was computed for each breast. Breast volumes were recorded in cm^3 pixels (1 cm^3 = 1 mL).[9-12]

RESULTS

Lipografting was performed between 3 months and 2 years (average, 1 year) after the patients' last breast reconstruction procedure. All patients underwent only 1 lipografting procedure. The average patient age was 49 years (range, 29-74 years). Patient demographics are listed in Table 1. Forty-six patients (66 breasts) received AFT from the abdomen (group A) and 27 patients (43 breasts) from the thighs (Group B). Group A received an average injection volume of 101 mL and retained 82% at 16 days, 63% at 49 days, and 45% at 140 days. Group B received an average injection volume of 102 mL and retained 86% at 16 days, 63%

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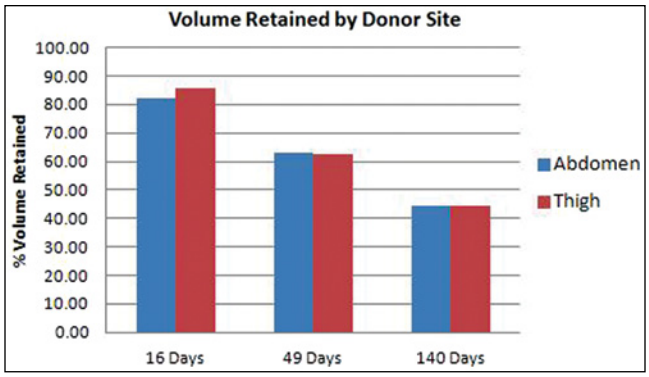

Figure 1. Percentage of volume retained over 140 days in 2 patient populations stratified by autologous fat donor sites: the abdomen (group A) and the thighs (group B). No statistical difference was found.

at 49 days, and 46% at 140 days. No statistical differences were found (Figure 1).

For subgroup analysis, patients first were divided based on radiated versus nonradiated tissue. There were 29 radiated and 80 nonradiated breasts. All patients in the radiated subgroup received lipografting at least 1 year after radiation treatment. In the radiated subset, there were 17 abdominal donor breasts (group A) and 12 thigh donor breasts (group B). At 16 days in the radiated subset, there was 97% average volume retention in group A and 72% average in group B (P = .0149). At 49 days, 57% average volume was retained in group A and 67% average was retained in group B (P = .63). At 140 days, 43% average was retained in group A and 54% in group B (P = .71) (Figure 2A). In the nonradiated subset, there were 49 abdominal donor breasts (group A) and 31 thigh donor breasts (group B). At 16 days in the nonradiated subset, there was 79% volume retention in group A and 90% in group B (P = .42). At 49 days, there was 65% volume retention in group A and 59% in group B (P = .67). At 140 days, there was 45% volume retention in group A and 43% in group B (P = .87) (Figure 2B). No statistical differences were found.

For a second subgroup analysis, patients were divided based on the volume of fat injected. In the observed time period, 46 breasts received fat injections of more than 100 mL (large volume) and 63 received injections of less than 100 mL (small volume). In the large volume subset, there were 27 abdominal donor breasts (average amount injected, 152 mL; range, 100-300 mL) from group A and 19 thigh donor breasts (average amount injected, 148 mL; range, 103-246 mL) from group B. At 16 days, there was 92% volume retention in group A and 73% in group B (P = .027). At 49 days, there was 68% volume retention in group A and 51% in group B (P = .20). At 140 days, there was 58% volume retention in group A and 50% in group B (P = .52) (Figure 3A). In the small volume subset, there were 39 abdominal donor breasts (average amount injected, 66 mL; range, 16-97 mL) from group A and 24 thigh donor breasts (average amount injected, 66 mL; range, 17-99 mL) from group B. At 16 days, there was 79% volume retention in group A and 94% in group B (P = .35). At 49 days, there was 57% volume retention in group A and 78% in group B (P = .10). At 140 days, there was 34% volume retention in group A and 43% in group B (P = .60) (Figure 3B). No statistical difference was found at 49 days or 140 days postoperatively.

A representative selection of patients from various subgroups is illustrated in Figures 4 and 5.

DISCUSSION

Fat grafting has emerged as a useful method for breast contouring in aesthetic and reconstructive patients. Various modalities (vector measurements, subjective assessments, volumetric studies, etc) have assessed retention after fat transfer and have reported long-term survival rates to be approximately 40% to 50% of the injected volume.[1-4] We reported on the use of 3D imaging to assess the morphology of the breast after fat grafting[12] and applied 3D technology to determine the ideal donor site by measuring volume retention after fat grafting from the abdomen and thighs to the breast for secondary reconstruction.

Because of suboptimal survival rates after fat transfer, various studies have explored ways to optimize graft volume retention, including harvest, processing, and transplant techniques.[1-4] Recently, investigators have begun to evaluate whether any relationship exists between donor site and retention. Li et al[8] documented, in animal models after 12 weeks of transplantation, that graft weight, volume, and histologic parameters did not differ by tissue donor site. Ullman et al[13] reiterated these findings, stating that donor sites did not differ in vascularization, cyst formation, fibrosis, necrosis, or inflammation. Rohrich et al[7] studied liposuction aspirate and noted statistically equivalent viable cells from various donor sites. These limited studies suggested no difference in volume retention based on donor sites and laid the foundation for further study of the topic.

In this study, 3D imaging provided volumetric measurements after fat transfer and did not document a statistical difference in the percentage of retention between abdominal fat and thigh fat. These findings reinforce the animal studies and suggest that donor sites do not influence volumetric retention. To further evaluate potential differences in donor site fat, we separated the study groups based on radiation exposure and volume of fat injected. Neither variable influenced the late findings of volumetric retention (both donor sites had equivocally viable cells independent of recipient bed or volume placed) in this study.

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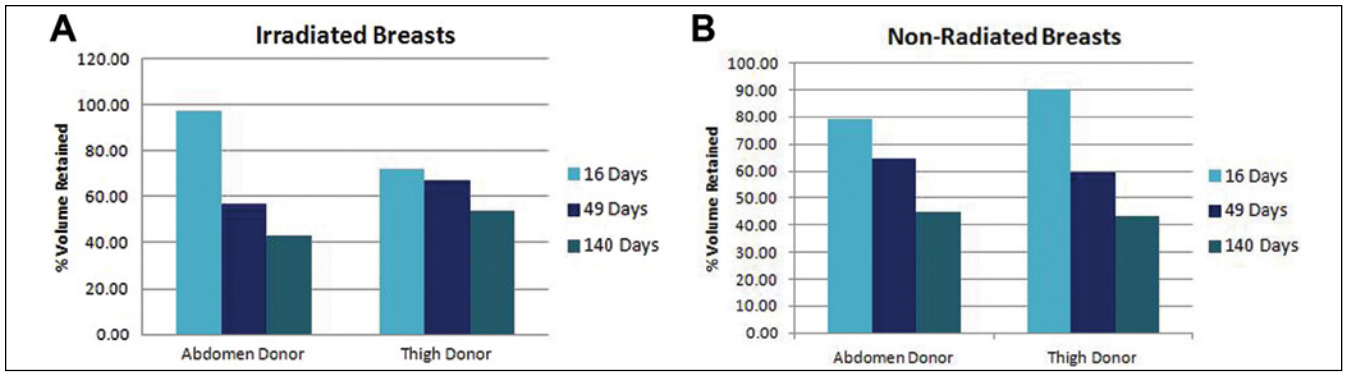

Figure 2. Percentage of volume retained over 140 days in 2 groups separated by fat graft donor site and subdivided based on those who had (A) radiation therapy and (B) no radiation therapy. No statistical difference in volume retention was seen in these subgroups.

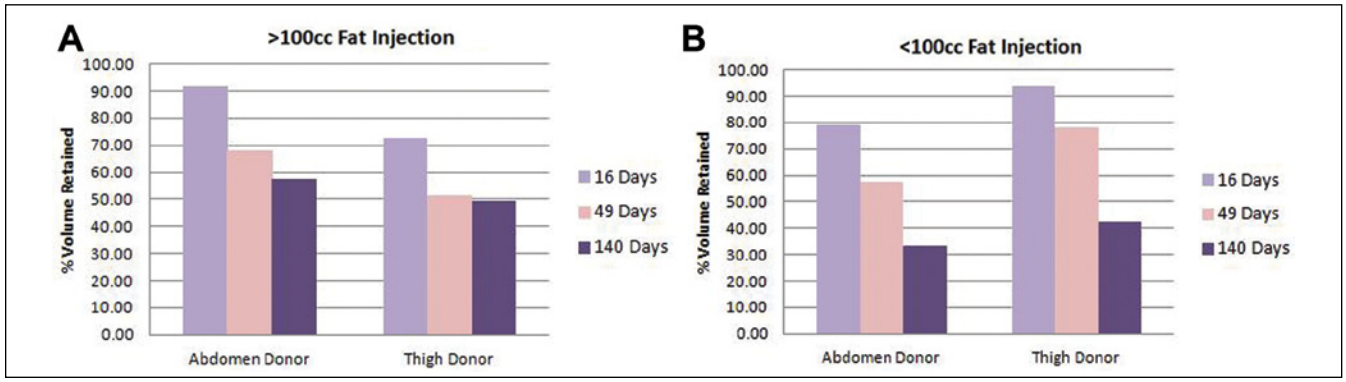

Figure 3. Percentage of volume retained over 140 days in 2 groups separated by fat graft donor site and subdivided based on those who had (A) more than 100 mL of fat injected and (B) less than 100 mL. No statistical difference in volume retention was seen in these subgroups.

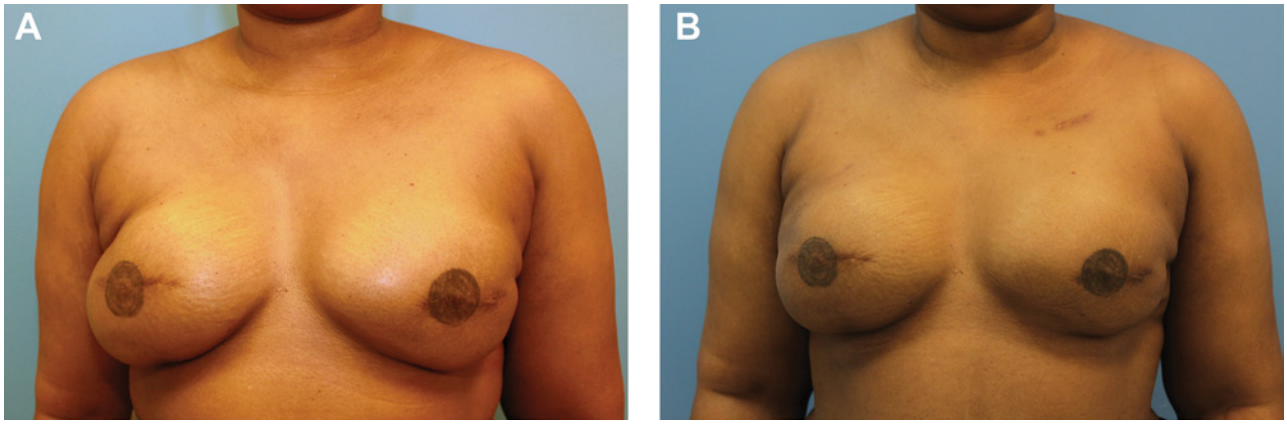

Figure 4. (A) This 36-year-old woman presented for autologous fat grafting after bilateral 2-stage implant reconstruction following chemotherapy without radiation. (B) Forty-seven days after abdominal lipografting, which took place 696 days after reconstruction. In the left breast, 170 mL of abdominal fat was injected; in the right, 300 mL.

The significant differences in retention rates found in the early postoperative days are inconsequential secondary to persistent postoperative edema and tissue remodeling.

Conversely, Padoin et al[14] argued that different body locations have different concentrations of adipose-derived stem cells (ADSC), which may influence donor site

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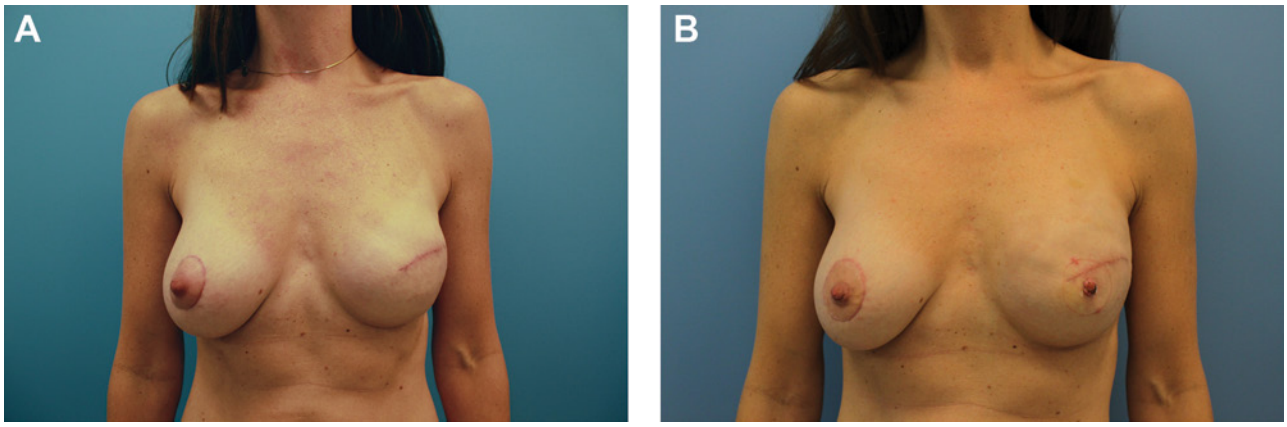

Figure 5. (A) This 42-year-old woman presented for autologous fat grafting after left breast 2-stage implant reconstruction and right breast augmentation mastopexy. The patient did not receive chemotherapy or radiation. (B) Twelve days after thigh lipografting, which took place 92 days after reconstruction. In the left breast, 72 mL of fat from the thigh was injected.

retention rates. In general, the abdomen and thigh have the highest concentrations of ADSC, and the sites' equivalent concentrations may explain why there was no statistically significant difference in fat graft survival in our study. We plan to use 3D imaging to assess multiple donor sites to support this claim.

Our approach accurately assessed donor site volume retention and provided the groundwork for future research. However, there are limitations to this study. We documented the volume retention of 2 donor sites, but patients typically use multiple donor sites, and surgeons may combine fat from sites before transfer. There are no reports in the literature on the efficacy of independent versus combined donor sites, but 3D imaging can now be used to investigate this concept. Longer and larger studies are needed to confirm the presumed dynamics of fat from various donors. We used only a modified Coleman technique with a closed system collection, centrifugation, and fat transfer, but our results encourage further investigation into the impact of different fat harvesting, preparation, and isolation techniques on donor site selection.

Previous studies with 3D imaging have documented the resolution of postoperative edema after 3 months; the stabilization of volumetric retention in this study at the late time points supports these findings. This study not only assessed some key factors (radiation and volumetric injection) associated with fat grafting retention but also outlined a system to study other patient comorbidities as well as the type of primary breast reconstruction and its influence on donor site selection.

CONCLUSIONS

Our findings indicated that the volumetric retention of fat transfer from various donor sites, specifically the abdomen or the thigh, is not statistically different and that radiation and injection volume do not affect donor site volume retention. Longer and larger studies are needed to confirm the presumed dynamics of the breast after AFT.

Disclosures

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