

The Role of Autologous Fat Grafting in Secondary Microsurgical Breast Reconstruction

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Background: Autologous breast reconstruction offers higher rates of patient satisfaction, but not all patients are ideal candidates, often due to inadequate volume of donor sites. Although autologous fat grafting is frequently used to augment volume and contour abnormalities in implant-based breast reconstruction, its clear utility in microsurgical breast reconstruction has yet to be defined. Here, we examined patients undergoing autologous microsurgical breast reconstruction with and without the adjunct of autologous fat grafting to clearly define utility and indications for use.

Methods: A retrospective review of all patients undergoing autologous breast reconstruction with microvascular free flaps at a single institution between November 2007 and October 2011 was conducted. Patients were divided into 2 groups as follows: those requiring postoperative fat grafting and those not requiring fat grafting. Patient demographics, indications for surgery, history of radiation therapy, patient body mass index, mastectomy specimen weight, need for rib resection, flap weight, and complications were analyzed in comparison.

Results: Two hundred twenty-eight patients underwent 374 microvascular free flaps for breast reconstruction. One hundred (26.7%) reconstructed breasts underwent postoperative fat grafting, with an average of 1.12 operative sessions. Fat was most commonly injected in the medial and superior medial poles of the breast and the average volume injected was 147.8 mL per breast (22–564 mL). The average ratio of fat injected to initial flap weight was 0.59 (0.07–1.39). Patients undergoing fat grafting were more likely to have had deep inferior epigastric perforator and profunda artery perforator flaps as compared to muscle-sparing transverse rectus abdominis myocutaneous. Patients additionally were more likely to have a prophylactic indication 58% (n = 58) versus 42% (n = 117) ($P = 0.0087$), rib resection 68% (n = 68) versus 54% (n = 148) ($P < 0.0153$), and acute postoperative complications requiring operative intervention 7% (n = 7) versus 2.1% (n = 8) ($P < 0.0480$). Additionally, patients undergoing autologous fat grafting had smaller body mass index, mastectomy weight, and flap weight.

Conclusions: Fat grafting is most commonly used in those breasts with rib harvest, deep inferior epigastric perforator flap reconstructions, and those with acute postoperative complications. It should be considered a powerful

adjunct to improve aesthetic outcomes in volume-deficient autologous breast reconstructions and additionally optimize contour in volume-adequate breast reconstructions.

Key Words: breast reconstruction, autologous fat grafting, microsurgery
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BACKGROUND

There is an ongoing debate among surgeons regarding the advantages and disadvantages of both autologous and implant-based breast reconstructions. Although patient preference weighs heavily in reconstructive decision-making, surgical tools also contribute to not only aesthetically superior reconstructions but also patient satisfaction. Autologous reconstruction has been shown in some studies to have higher overall rates of patient satisfaction and improved long-term aesthetic outcome.^{1,2} Despite this fact, not all patients are ideal candidates, often due to inadequate volume of donor sites. In implant-based breast reconstruction, autologous fat grafting has proven to be a valuable tool to optimize aesthetic results by both increasing volume and camouflaging contour irregularities.³ Despite this fact, its clear role in microsurgical breast reconstruction has yet to be defined.

The use of autologous fat grafting for the correction of volume defects was initially described more than 100 years ago by Neuber to correct facial defects.⁴ At the same time, Czerney described using a lipoma from the back to recreate a breast in a patient after mastectomy.⁵ Contemporary evolution of autologous fat grafting was popularized by Coleman⁶ who described the use of liposuction and purification of adipocytes for injection into the face as a soft tissue filler. Bircoll and Novack then expanded this application to the breast.^{7–11}

There has been much controversy regarding autologous fat injections into the breast, related mainly to primary augmentation, due to theoretic risks of altered breast cancer detection. Initially, the American Society of Plastic and Reconstructive Surgeons ad hoc committee had rejected the idea of transplanted fat for breast augmentation due to this potential risk. However, The Fat Graft Task Force, in their recent consensus statement, found no evidence in the literature that autologous fat grafting into the breast interferes with breast cancer detection.¹² Therefore, the use of autologous fat grafting for breast enlargement is now widely accepted.

However, the postmastectomy patient should not be viewed the same as a patient undergoing primary augmentation.^{3,13–16} In mastectomy patients, all breast tissue has been removed, and therefore surveillance with mammogram is no longer required. In cases of subsequent autologous reconstruction, physical examination, and magnetic resonance imaging, when clinically indicated, will be used to assess abnormalities.

Bearing these facts in mind, at New York University Langone Medical Center, the routine use of autologous fat grafting as an adjunct to primary breast reconstruction began in early 2007. Since its initial description, we have observed a rise in the overall use of fat grafting as a secondary procedure in both implant-based and autologous breast

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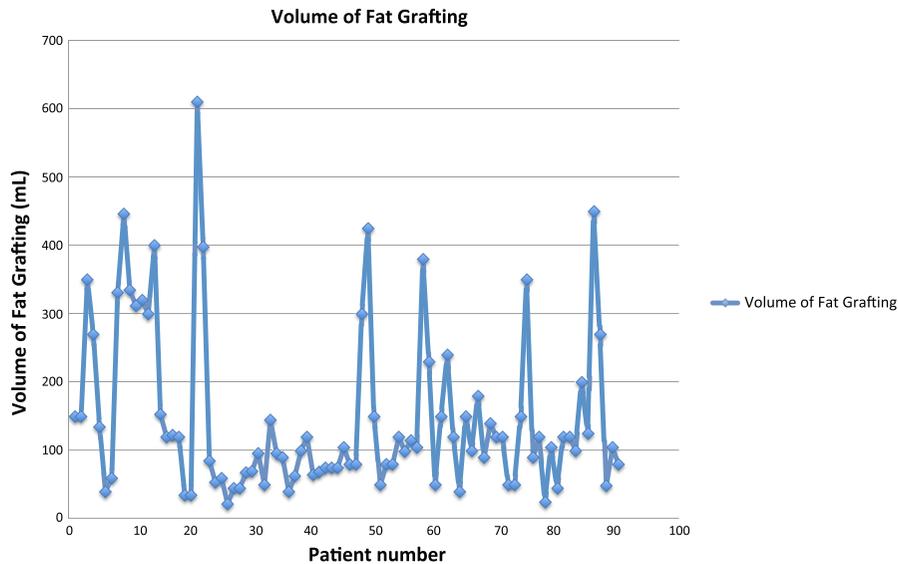


FIGURE 1. Distribution of autologous fat grafting.

reconstructions. The purpose of this investigation was to examine indications and outcomes of fat grafting in patients who previously underwent *autologous* microsurgical breast reconstruction. The authors hypothesize that fat grafting provides an overall powerful addition, but will more likely be needed and used in certain patient populations. These populations include patients with low body mass index (BMI) and small flap weights (to augment volume) and in patients experiencing contour deformities from fat necrosis or other complications. To prove this hypothesis, correlations were performed between the total number and total amount of fat grafting required and patient demographics (BMI and age), as well as intraoperative and postoperative details (mastectomy specimen weight, flap type and weight, need for rib harvest, acute and chronic complications including fat necrosis and need for revision surgeries, and location in the breast where fat grafting was required).

MATERIALS AND METHODS

After obtaining an institutional review board approval (S12-02030), a retrospective review of all patients undergoing autologous breast reconstruction with microvascular free flaps at New York University Langone Medical Center between November 2007

and October 2011 was conducted. Patients were recognized and both electronic medical record and office charts were evaluated for pertinent data. Breast reconstructions, once identified, were further divided into 2 cohorts, namely, those undergoing secondary autologous fat grafting and those not undergoing autologous fat grafting. The indications to perform fat grafting included need to augment volume-deficient reconstructions and need to improve postoperative contour abnormalities. All senior surgeons (R.A., N.S.K., M.C., C.A., and J.P.L.) perform autologous fat grafting as a routine adjunct to primary breast reconstruction in patients with these indications. Patients' preference additionally contributed to revision surgical intervention and was not accounted for in this evaluation. Patients were excluded from analysis if they sought follow-up with an outside physician or did not complete their reconstruction at New York University Langone Medical Center. Patients included for analysis had follow-up after microvascular free flap reconstruction at a minimum of 1 year (Fig. 1).

Autologous fat grafting was performed using a modified Coleman technique in all patients. Fat was harvested from the abdomen using a Coleman cannula under direct negative pressure with 10-mL syringes after the injection of tumescent solution consisting of 1-L LR, 20 mL of 1% lidocaine, and 1-A 1:1000 epinephrine. Fat was then processed

TABLE 1. Cohort Characteristics

	Fat Grafting (n = 100)	Non-Fat Grafting (n = 274)	P
Immediate reconstruction	74 (74)	198 (72.2)	0.729
Delayed reconstruction	26 (26)	76 (27.8)	0.729
Nipple areola sparing	28 (28)	52 (18.9)	0.057
Age, mean (SD), y	48.93 (7.64)	49.28 (9.19)	0.7506
Neoadjuvant radiation	6 (6)	13 (4.7)	0.6113
Adjuvant radiation	11 (11)	29 (10.6)	0.9118
Neoadjuvant chemotherapy	10 (10)	16 (5.8)	0.1567
Adjuvant chemotherapy	13 (13)	54 (19.7)	0.2347
Recent breast surgery	5 (5)	15 (5.5)	0.8494
Remote breast surgery	31 (31)	89 (32.5)	0.7833
Former smoker	5 (5)	17 (6.2)	0.6624
Smoker	1 (1)	2 (0.7)	0.770

Values are number (percentage) unless otherwise indicated.

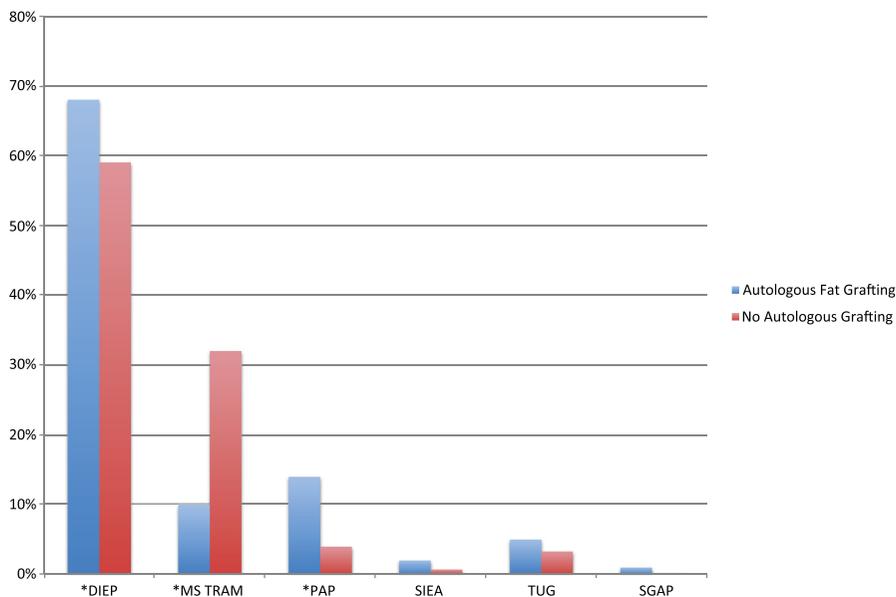


FIGURE 2. Volume of autologous fat grafting.

using centrifugation at 3000 rpm for 3 minutes. The centrifuged fat was allowed to precipitate, the serous fluid was drained, and the top layer of oil absorbed with a neuropaddle. The fat was then transferred into 3-mL syringes for injection in to the breast using small injection cannulas.

Patient demographics, indications for surgery, history of radiation therapy, patient BMI, mastectomy specimen weight, need for rib resection, flap weight, and complications were analyzed in comparison. Complications were divided into 2 main categories, namely, early flap complications and late complications. Early flap complications included arterial thrombosis, venous thrombosis, hematoma, partial and complete flap loss, and mastectomy skin flap necrosis. Late complications included fat necrosis and secondary infectious complications. Fat necrosis was detected by clinical examination based on a

hard mass on palpation and pain. Additional magnetic resonance imaging or ultrasound was occasionally obtained to confirm diagnosis; however, it was not routinely performed. Of note, fat cysts or other findings requiring imaging or biopsies were not evaluated in this study.

Statistical analysis was completed with minitab-16 software (State College, PA) using Fisher exact test, 2-proportion z test, χ^2 , and Student *t* test as necessary.

RESULTS

In the 4-year study period, 241 patients underwent 394 microvascular free flaps for breast reconstruction. Thirteen patients undergoing 20 microvascular free flaps were excluded from analysis due to refusal of second-stage revision surgery or because they did

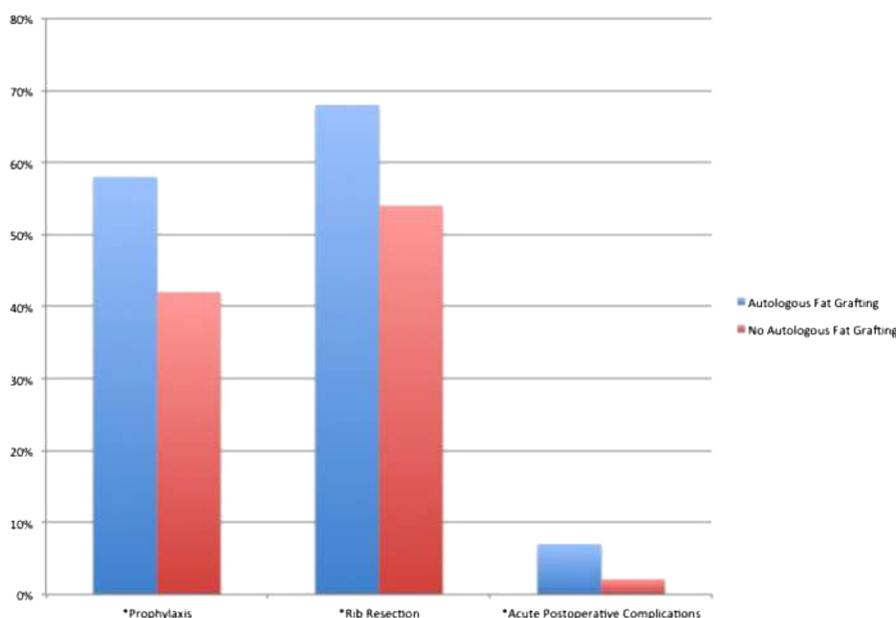


FIGURE 3. Flap distribution.

TABLE 2. Flap Characteristics

	Fat Grafting (n = 100)	Non-Fat Grafting (n = 274)	P
BMI, kg/m ²	25.05 (3.08)	27.09 (4.6)	0.00067
Mastectomy weight, g	427.2 (237.6)	575.46 (374.2)	0.01466
Flap weight, g	513.72 (201.9)	616.88 (288.67)	0.0162

Values are expressed as mean (SD).

not complete their reconstruction at New York University Langone Medical Center. Therefore, a total of 228 patients with 374 microvascular free flaps were included for analysis. On the basis of inclusion criteria, 100 (26.7%) reconstructed breasts underwent postoperative fat grafting, with an average of 1.09 (range, 1–3) operative sessions. All 5 senior surgeons (B.A., C.A., M.C., N.S.K., and J.P.L.) performed secondary autologous fat grafting during this period. Although overall fat grafting occurred 26.7% of the time, there was some degree of surgeon variability ranging from 15.2% to 56.6% (C.A., 56.6%; B.A., 35.5%; M.C., 25.3%; J.P.L., 15.4%; and N.S.K., 15.2%).

Fat grafting was most commonly performed 3 to 6 months after the initial flap surgery with a mean of 4.3 months, and overall follow-up ranged from 12 to 41 months with a mean of 18 months. Two breasts required 3 sessions and 6 breasts required 2 sessions. Average volume injected initially in patients requiring multiple sessions was similar to the initial volume injected in those only requiring 1 session at 160.25 (105.2) versus 126.84 (85.3) mL ($P = 0.3469$). Three (37.5%) breasts requiring multiple sessions suffered severe intraoperative complications during the initial reconstruction including venous ischemia ($n = 2$) and arterial ischemia ($n = 1$). No patients underwent immediate intraoperative fat grafting at the time of the initial flap. Patients had similar ages, percentages of immediate reconstructions, delayed reconstructions, and nipple areolar sparing mastectomies (Table 1).

Fat was most commonly injected into the medial and superior medial poles of the breast and the average volume injected was 147 (118.3) mL per breast (22–564 mL) (Fig. 2). The average ratio of fat injected to initial flap weight was 0.59 (range, 0.07–1.39). Patients undergoing fat grafting were more likely to have had deep inferior epigastric perforator (DIEP) and profunda artery perforator (PAP)

flaps as compared to muscle-sparing transverse rectus abdominis myocutaneous (Fig. 3). Those patients additionally were more likely to have a prophylactic indication, 58% ($n = 58$) versus 42% ($n = 117$) ($P = 0.0087$); rib resection, 68% ($n = 68$) versus 54% ($n = 148$) ($P < 0.0153$); and acute postoperative complications requiring operative intervention, 7% ($n = 7$) versus 2.1% ($n = 6$) ($P < 0.0480$).

Additionally, patients undergoing autologous fat grafting had smaller BMI, mastectomy weight, and flap weight (Table 2). Postoperative complications of fat grafting included 1 (1%) incidence of major infection at the recipient site requiring admission to the hospital with intravenous antibiotics.

Breast reconstructions undergoing secondary autologous fat grafting were more likely to have donor-site revision and nipple areolar reconstruction at 55.1% ($n = 32$) versus 29.4% ($n = 50$) ($P < 0.0001$) and 52% ($n = 52$) versus 32.8% ($n = 90$) ($P = 0.0007$), respectively. Additionally, patients not undergoing autologous fat grafting were more likely to have other types of secondary revision, 21.8% ($n = 6$) versus 0% ($n = 0$). These included addition of pedicled latissimus flap ($n = 4$) and secondary implant reconstruction ($n = 2$).

CASE EXAMPLES

Case 1

The first case was a 54-year-old white female, with a BMI of 23 kg/m², with history of stage III left breast cancer initially treated with mastectomy and immediate 2-stage tissue expander to implant breast reconstruction 15 months before presentation. Reconstruction was followed by chemotherapy and radiation therapy. The patient presented for evaluation of capsular contracture and was offered microsurgical autologous reconstruction (Fig. 4). She underwent removal of a 270-mL silicone implant, left stacked DIEP flaps, consisting of the left flap weighing 190 g and a right flap weighing 180 g, without complications (Fig. 5). Four months postoperatively, the patient underwent left nipple areolar reconstruction, revision of abdominal

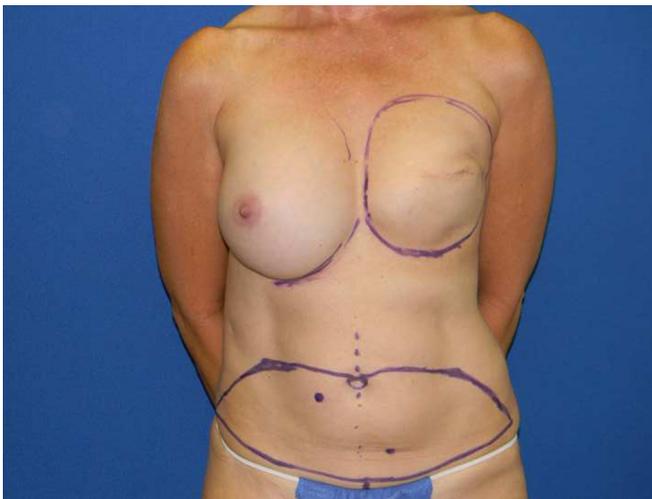


FIGURE 4. Preoperative patient after left mastectomy with radiation and implant reconstruction (a case example of low-volume fat grafting for contour abnormalities).

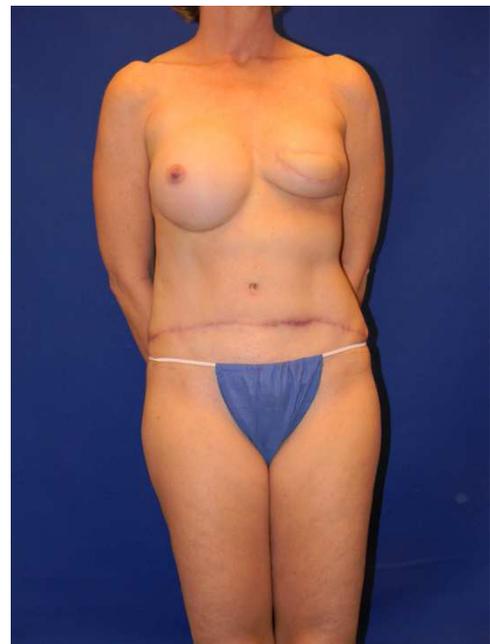


FIGURE 5. After left stacked DIEP flap (a case example of low-volume fat grafting for contour abnormalities).

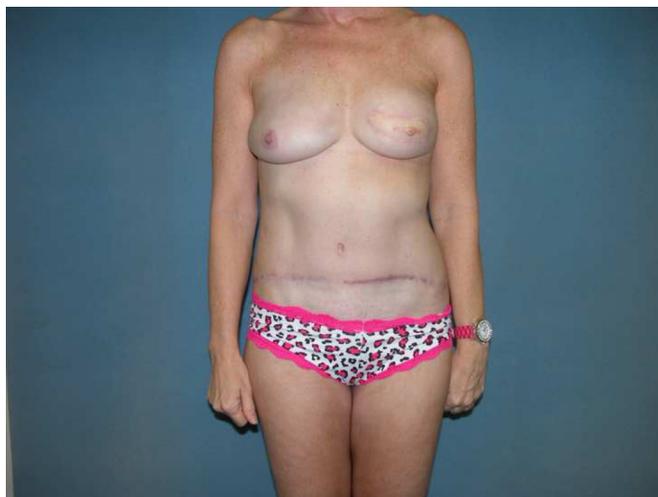


FIGURE 6. Six months follow-up after 100 mL of autologous fat grafting (a case example of low-volume fat grafting for contour abnormalities).

scars, and autologous fat grafting (100 mL) for contour abnormalities (Fig. 6).

Case 2

The second case was a 33-year-old white female, with a BMI of 22 kg/m², with history of right stage III breast cancer initially treated with bilateral mastectomy without reconstruction and right breast adjuvant radiation and chemotherapy. She presented for evaluation for delayed breast reconstruction and was offered bilateral PAP flaps. She underwent bilateral PAP flaps: right flap weighing 511 g and left flap weighing 488 g, without complications (Fig. 7). Three months later, she underwent bilateral nipple areolar reconstruction along with



FIGURE 7. After bilateral PAP flap (a case example of high-volume fat grafting for volume-deficient augmentation).



FIGURE 8. Three weeks after high-volume fat grafting (right breast 350 mL and left breast 150 mL) (a case example of high-volume fat grafting for volume-deficient augmentation).

large volume fat grafting, 350 mL on the right and 150 mL on the left (Fig. 8). Patient had good long-term results at 6 months after bilateral nipple areolar reconstruction and large volume fat grafting (Fig. 9).

DISCUSSION

When possible, autologous breast reconstruction offers multiple advantages when compared to implant-based reconstruction. Most notably, patients have higher short- and long-term patient satisfaction, along with improved psychosocial and sexual well-being.^{17,18} In defining a potential candidate, both availability and volume of donor sites need to be taken into consideration. Oftentimes, it is the paucity of immediately available soft tissue that may cause a surgeon to advise against an autologous microvascular free flap reconstruction. However, with the adjunct of fat grafting as a secondary procedure after the initial reconstruction, it may, in select patients, be



FIGURE 9. Eight months after high-volume fat grafting (a case example of high-volume fat grafting for volume-deficient augmentation).

possible to expand the indications and offer autologous reconstruction to more patients.

This study represents the largest series of secondary autologous fat grafting in microvascular breast reconstructions in the literature. Notably, it shows a 26.7% incidence of secondary autologous fat grafting in this patient population. Although not a high percentage overall, we have found that during the recent years the rate of fat grafting after microsurgical breast reconstruction has increased significantly. This may reflect the generally more widespread use and documented safety of fat grafting, as well as increased surgeons' experience in respect to expected outcomes and achievable long-term results. Our investigation evaluates a high number of microsurgical free flap breast reconstructions to determine indications and advantages for autologous fat grafting in this population. It needs to be noted, however, that the indications for fat grafting are not clearly defined and depend both patients' and surgeons' desire to improve the aesthetic result, as well as surgeons' preference. The latter clearly introduced a significant bias to the study, which needs to be taken into consideration when interpreting the results. As suspected in our initial hypothesis, in our population, patients undergoing secondary autologous fat grafting were more likely to have a smaller BMI, mastectomy weight, and flap weight than patients not undergoing fat grafting. We were able to augment the size of the reconstructed breast significantly, with an average ratio of fat injected to initial flap weight of 0.59. As described, in all cases the technique of fat grafting consisted of a modified Coleman technique. Although we have clinically observed good take of the graft and good long-term results, magnetic imaging and 3-dimensional scanning should be used to assess this more critically.⁹

This review is also limited by its retrospective nature. Although a single institutional investigation, several surgeons perform autologous reconstruction with no definitive protocol. Each surgeon has different indications for DIEP versus muscle-sparing transverse rectus abdominis myocutaneous versus alternative donor sites. An additional bias is that most of DIEP and PAP flaps were performed by a single surgeon who additionally performs the highest volume of fat grafting in autologous reconstructions at our institution. However, when further explored, the percentage of fat grafting performed by each surgeon was normally distributed and although 2 surgeons were outliers at 15.2% and 56.6, most of the surgeons performed similar percentages of autologous fat grafting.

As proven in implant-based breast reconstruction, fat grafting provides a powerful tool to address contour irregularities.¹⁹ Given that the flaps tend to settle in the lower pole of the breast, it is not surprising that most of our fat grafting occurred into the superior and superior-medial portions of the breast. Of note, rib harvest significantly increased the potential need for fat grafting in the future. Although this fact may also be surgeon and technique related, we now, whenever possible, therefore avoid harvest of the ribs but only expose the interspace.²⁰ Also, although tempting and well described in the literature, we have abandoned the use of second or third rib intercostal perforators for anastomoses. In our experience, especially in cases of immediate reconstructions in combination with skin-sparing mastectomies, the risk of skin flap necrosis is increased notably when sacrificing these vessels. Confounding factors like different mastectomy surgeons with different techniques for example when making such observations, however. We find though, that in cases of delayed reconstruction, the use of internal mammary artery perforators as the recipient vessels should still be strongly considered, because it is less morbid, has better aesthetic outcome, and last but not least preserves the internal mammary artery for potential future use like coronary artery bypass surgery for example.²¹

The fact that we encountered a higher rate of fat grafting in patients undergoing prophylactic mastectomy may be attributable to 2 reasons: First, although an optimal aesthetic result should be the

goal of any reconstruction regardless of the indication, patients undergoing prophylactic mastectomy tend to strive for an even more complete rehabilitation and cosmesis, and are more willing to undergo additional surgery to achieve this goal. Second, given the still-evolving debate regarding the safety of fat grafting in the setting of oncologic breast surgery, we were more reluctant to use this technique in cancer patients. However, as more recent data seem to indicate its safety, we have begun to expand our indications.^{22,23} Close short- and long-term follow-up of these patients remains mandatory however.

Patients undergoing autologous fat grafting were also more likely to have nipple areolar reconstruction and donor-site revisions, which again supports the hypothesis that patients undergoing fat grafting are generally striving for better aesthetic results and complete rehabilitation. Similar to other studies, we have found that fat grafting not only improves shape and contour of the breast but also has the additional benefit of adding pliability and natural texture. This improved consistency and natural feel can improve patient satisfaction significantly.²⁴

It is oftentimes argued that one advantage of microvascular free flap breast reconstruction is the single-stage nature of the procedure. We have found, that, although not mandatory, most of our patients, 95% (n = 217) are nonetheless willing to undergo a second procedure to enhance their final reconstructive result.

CONCLUSIONS

Fat grafting should be considered an adjunct to optimize contour in volume-adequate breast reconstructions, but more importantly as a mean to augment size in volume-deficient reconstructions, specifically in patients with low BMI seeking autologous reconstruction. It is therefore a valuable tool, especially for patients undergoing prophylactic mastectomies who strive to achieve the best cosmetic result possible. Given the ongoing debate regarding the safety and efficacy of fat grafting, we advocate continued 3-dimensional surveillance for oncologic reasons and to monitor graft survival.

REFERENCES

1. Bodin F, Zink S, Lutz JC, et al. [Which breast reconstruction procedure provides the best long-term satisfaction?]. *Ann Chir Plast Esthet*. 2010;55:547–552.
2. Christensen BO, Overgaard J, Kettner LO, et al. Long-term evaluation of postmastectomy breast reconstruction. *Acta Oncol*. 2011;50:1053–1061.
3. Kanchwala SK, Glatt BS, Conant EF, et al. Autologous fat grafting to the reconstructed breast: the management of acquired contour deformities. *Plast Reconstr Surg*. 2009;124:409–418.
4. Saint-Cyr M, Rojas K, Colohan S, et al. The role of fat grafting in reconstructive and cosmetic breast surgery: a review of the literature. *J Reconstr Microsurg*. 2012;28:99–110.
5. Hultman CS, Daiza S. Skin-sparing mastectomy flap complications after breast reconstruction: review of incidence, management, and outcome. *Ann Plast Surg*. 2003;50:249–255; discussion 255.
6. Coleman SR. Facial recontouring with liposuction. *Clin Plast Surg*. 1997;24:347–367.
7. Bircoll M. Cosmetic breast augmentation utilizing autologous fat and liposuction techniques. *Plast Reconstr Surg*. 1987;79:267–271.
8. Bircoll M, Novack BH. Autologous fat transplantation employing liposuction techniques. *Ann Plast Surg*. 1987;18:327–329.
9. Chan CW, McCulley SJ, Macmillan RD. Autologous fat transfer—a review of the literature with a focus on breast cancer surgery. *J Plast Reconstr Aesthet Surg*. 2008;61:1438–1448.
10. Missana MC, Laurent I, Barreau L, et al. Autologous fat transfer in reconstructive breast surgery: indications, technique and results. *Eur J Surg Oncol*. 2007;33:685–690.
11. Delay E, Garson S, Tousson G, et al. Fat injection to the breast: technique, results, and indications based on 880 procedures over 10 years. *Aesthet Surg J*. 2009;29:360–376.

12. Gutowski KA. Current applications and safety of autologous fat grafts: a report of the ASPS fat graft task force. *Plast Reconstr Surg.* 2009;124:272–280.
13. Serra-Renom JM, Munoz-Olmo JL, Serra-Mestre JM. Fat grafting in post-mastectomy breast reconstruction with expanders and prostheses in patients who have received radiotherapy: formation of new subcutaneous tissue. *Plast Reconstr Surg.* 2010;125:12–18.
14. Spear SL, Wilson HB, Lockwood MD. Fat injection to correct contour deformities in the reconstructed breast. *Plast Reconstr Surg.* 2005;116:1300–1305.
15. Losken A, Pinell XA, Sikoro K, et al. Autologous fat grafting in secondary breast reconstruction. *Ann Plast Surg.* 2011;66:518–522.
16. Coleman SR, Saboeiro AP. Fat grafting to the breast revisited: safety and efficacy. *Plast Reconstr Surg.* 2007;119:775–785; discussion 786–777.
17. Colakoglu S, Khansa I, Curtis MS, et al. Impact of complications on patient satisfaction in breast reconstruction. *Plast Reconstr Surg.* 2011;127:1428–1436.
18. Zhong T, McCarthy C, Min S, et al. Patient satisfaction and health-related quality of life after autologous tissue breast reconstruction: a prospective analysis of early postoperative outcomes. *Cancer.* 2012;118:1701–1709.
19. de Blacam C, Momoh AO, Colakoglu S, et al. Evaluation of clinical outcomes and aesthetic results after autologous fat grafting for contour deformities of the reconstructed breast. *Plast Reconstr Surg.* 2011;128:411e–418e.
20. Sacks JM, Chang DW. Rib-sparing internal mammary vessel harvest for microvascular breast reconstruction in 100 consecutive cases. *Plast Reconstr Surg.* 2009;123:1403–1407.
21. Rozen WM, Ye X, Guio-Aguilar PL, et al. Autologous microsurgical breast reconstruction and coronary artery bypass grafting: an anatomical study and clinical implications. *Breast Cancer Res Treat.* 2012;134:181–198.
22. Perez-Cano R, Vranckx JJ, Lasso JM, et al. Prospective trial of adipose-derived regenerative cell (ADRC)-enriched fat grafting for partial mastectomy defects: the RESTORE-2 trial. *Eur J Surg Oncol.* 2012;38:382–389.
23. Rubin JP, Coon D, Zuley M, et al. Mammographic changes after fat transfer to the breast compared with changes after breast reduction: a blinded study. *Plast Reconstr Surg.* 2012;129:1029–1038.
24. Schultz I, Lindegren A, Wickman M. Improved shape and consistency after lipofilling of the breast: patients' evaluation of the outcome. *J Plast Surg Hand Surg.* 2012;46:85–90.