HHS Public Access

Author manuscript

JAMA Surg. Author manuscript; available in PMC 2017 November 03.

Published in final edited form as:

JAMA Surg. 2017 October 01; 152(10): 944–950. doi:10.1001/jamasurg.2017.1716.

Effects of Fat Grafting on Patient-Reported Outcomes in Post-Mastectomy Breast Reconstruction—A Multicenter Prospective Analysis

Katelyn G. Bennett, MD[1], **Ji Qi, MS**[2], **Hyungjin M. Kim, ScD**[3], **Jennifer B. Hamill, MPH, MS**[4], **Edwin G. Wilkins, MD, MS**[5], **Babak J. Mehrara, MD**[6], and **Jeffrey H. Kozlow, MD, MS**[7]

[1]House Officer, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System

[2]Statistician, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System

[3]Research Scientist, Center for Statistical Consultation and Research, University of Michigan; Adjunct Professor Department of Biostatistics, University of Michigan

[4]Study Coordinator, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System

[5]Professor of Surgery, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System

[6]Chief, Plastic and Reconstructive Surgery, Memorial Sloan-Kettering Cancer Center

[7]Clinical Assistant Professor, Section of Plastic Surgery, Department of Surgery, University of Michigan Health System

Abstract

Importance—Fat grafting has proven to be a useful adjunct to breast reconstruction for the treatment of contour irregularities and volume deficits, but the proposed FDA regulations may severely limit the ability of plastic surgeons to continue its use in this clinical context.

Objective—To determine if fat grafting has an effect on patient-reported outcomes (PROs) in breast reconstruction patients.

Design—Longitudinal, multicenter, prospective cohort study conducted between February 2012 and July 2016.

Setting—Conducted at the 11 study sites associated with the Mastectomy Reconstruction Outcomes Consortium (MROC) study.

Participants—Eligible patients included women 18 years and older presenting for breast reconstruction following mastectomy with at least two years of follow-up. All primary procedure

Corresponding author: Jeffrey H. Kozlow, MD, University of Michigan, Section of Plastic Surgery, 1500 East Medical Center Drive, 2130 Taubman Center, Ann Arbor, MI 48109, P: 734-936-5895, F: 734-763-5354, jkozlow@med.umich.edu.

types (implant- and flap-based) were eligible. Patients were excluded if they had not completed breast mound reconstruction by one year after mastectomy.

Interventions—Fat grafting as an adjunct to breast reconstruction.

Main outcomes and measures—Primary end points were patient-reported outcome measures as assessed by the validated BREAST-Q, with higher scores indicating better health-related quality of life. Survey subscales included breast satisfaction, as well as psychosocial, physical, and sexual well-being. Patient-reported outcomes were compared between fat grafted and non-fat grafted patients.

Results—A total of 2,048 women were included, with 165 undergoing fat grafting between years one and two. One year postoperatively, patients who later underwent fat grafting reported significantly lower breast satisfaction (adjusted mean difference (AMD) = −4.74, CI −8.21 to −1.28, p=0.008), psychosocial well-being (AMD = −3.87, CI −7.33 to −0.40, p=0.029), and sexual well-being (AMD = −5.59, CI −9.70 to −1.47, p=0.008), compared to those who did not receive subsequent fat grafting. Following fat grafting, the fat grafted cohort reported similar breast satisfaction (AMD = −0.68, CI −4.42 to 3.06, p=0.719), psychosocial well-being (AMD = −0.59, CI −3.92 to 2.74, p=0.728), and sexual well-being (AMD = −2.94, CI −7.01 to 1.12, p=0.154) at two years postoperatively.

Conclusions and relevance—Fat grafting improves breast satisfaction, psychosocial well-being, and sexual well-being in breast reconstruction patients.

INTRODUCTION

Over the last two decades, fat grafting has revolutionized breast reconstruction, enabling plastic surgeons to significantly improve aesthetic outcomes[1–3]. Contour irregularities and volume deficits in both autologous and implant-based reconstructions can both be addressed with autologous fat transfer[4]. The concept was initially met with considerable skepticism, given concerns over differentiating between fat necrosis and cancer recurrence on imaging[5], and over possible stimulation of cancer development by transferred fat[6–7]. However, subsequent studies have failed to validate either concern[8–11]. The most recent guidelines on fat grafting released by the American Society of Plastic Surgeons (ASPS) conclude that “fat grafting does not increase the risk of breast cancer recurrence.” Furthermore, the Society endorses fat grafting as enabling breast reconstruction patients to “experience moderate to significant aesthetic improvement”, noting that “patients are satisfied with the results”[12]. Despite this endorsement, the Food and Drug Administration (FDA) has proposed new guidelines for autologous fat grafting. The FDA recently noted that since fat grafts do not mimic the “basic function” of native breast tissue, autologous fat may be regulated as a drug, device, and/or biological product under the Federal Food, Drug, and Cosmetic (FD&C) Act and/or Section 351 of the Public Health Service (PHS) Act[13]. Thus, well-designed research assessing the efficacy of fat grafting is essential not only for high-quality patient care but also to meet growing regulatory concerns over these procedures.

Despite the widespread assumption that patients are pleased with the results of fat grafting, there have been few studies assessing the effects of these techniques on patient-reported outcomes (PROs). Previous reports have evaluated patient satisfaction, but have not included

other quality of life measures. Existing research has also been limited by lower level study designs, often lacking control groups for comparison[14–20]. Only one small, retrospective case series has evaluated both breast satisfaction and quality of life after fat grafting using the validated BREAST-Q[21]. Given the limitations of the aforementioned studies, we sought to use a multicenter, prospective analysis to evaluate the effects of autologous fat grafting on PROs in patients undergoing implant- or flap-based breast reconstruction.

METHODS

The Mastectomy Reconstruction Outcomes Consortium (MROC) Study is a multi-center, prospective cohort study funded by the National Cancer Institute in 2011 to compare long-term outcomes among common techniques of breast reconstruction. Eligible patients included all women 18 years and older presenting for first time breast reconstruction following mastectomy for cancer treatment or prophylaxis. For the current analysis, patients were recruited between February 2012 and July 2016. Fifty-one plastic surgeons practicing at 11 centers in Michigan, New York, Illinois, Ohio, Massachusetts, Washington, D.C., Georgia, Texas, and Manitoba contributed patients to this study.

For this analysis, we included patients with at least two years of follow-up after breast mound reconstruction, with all primary procedure types (implant- and flap-based) being eligible. Women still awaiting expander-implant exchange at one year were excluded due to the potential confounding effects of the exchange procedure. Implant procedures converted to flap reconstructions were also excluded. Finally, any patients with reconstructive failure (defined as removal of the reconstructive flap or implant, without replacement) were not eligible for this analysis. In order to minimize the potential effects of breast mound formation as a significant contributor to patient reported outcomes, we specifically designed our study to evaluate only patients who completed breast mound reconstruction by year 1 and then had fat grafting between year 1 and year 2 to minimize confounding. Without making this distinction, we may have seen that fat grafted patients' PROs improved, but we would not have been able to evaluate the effect of fat grafting alone given the significant contribution the formation of a breast mound has on PROs. Patients who failed to complete the study's initial preoperative questionnaire were withdrawn from the study, due to their lack of baseline data.

After approval from each site's Institutional Review Board (IRB) or Research Ethics Board (REB), medical records for each patient were reviewed to obtain the demographic and clinical data used in our analysis. These reviews were conducted preoperatively and at one and two years postoperatively by each site project coordinator. On-line survey panels were completed by participants preoperatively, and at one week, three months, one year and two years following the initial reconstructive procedure. For purposes of the current analysis, we used the one and two year survey responses. All data were collected via Velos (Velos Inc., Fremont, CA), a web-based clinical trial management system.

PROs were assessed using the previously validated BREAST-Q, with scores ranging from 0–100, with higher scores indicating high satisfaction or better health-related quality of life[22]. Survey subscales analyzed included satisfaction with breast, as well as psychosocial,

physical, and sexual well-being. Patient reported outcomes (PROs) were compared between two cohorts of patients: those who underwent fat grafting between years one and year two and those who did not.

In addition to demographic and clinical variables such as age, body mass index (BMI, kg/m^2), and race, oncologic and reconstructive variables were also collected from the medical records. These variables included procedure type, indication for mastectomy, laterality, timing of reconstruction, radiation, cancer recurrence, additional revision procedures between years one and two, and complications. Procedure types were divided into three subgroups: 1) implant, 2) autologous, and 3) mixed. “Mixed” included bilateral patients who received implant reconstruction on one side and autologous on the other. Indications for mastectomy were categorized as either cancer treatment or prophylaxis. Timing of reconstruction was divided into three subgroups as well: 1) immediate, 2) delayed, and 3) mixed. Again, “mixed” referred to bilateral patients who received immediate reconstruction for one side and delayed reconstruction for the contralateral side. Likewise, radiation was divided into three subgroups: 1) before reconstruction, 2) during/after reconstruction, and 3) none. Cancer recurrence was documented as either 1) recurred or 2) did not recur. Other revision procedures were documented for both cohorts as a binary (yes/no) variable. Finally, the occurrence of complications was recorded as a binary variable at both year 1 and year 2 for both fat grafted and non-fat grafted patients. “Complication” was defined as any adverse postoperative event requiring additional treatment.

Demographic and clinical variables were compared across the cohorts using student’s t test for continuous variables and Pearson’s Chi square test for categorical variables. Patient-reported outcome measures at each time point were summarized as means and standard deviations for each group. In order to compare differences in PROs between the two groups, mixed-effects regression models were used with dependent variables being each PRO measure at postoperative years one and two. Each model included an indicator for fat grafting between years one and two as the primary predictor and controlled for baseline PRO scores. Each model also adjusted for relevant clinical characteristics and included random intercepts for centers (hospitals) to account for between-center variability[23]. Baseline and postoperative PRO measures were missing for some patients. To account for such missing data, multiple imputation with chained equations were employed to create 10 complete imputed data sets, each of which was used to run the regression models specified above. The results were then combined using Rubin’s rules[24]. Adjusted means of PRO measures based on the model were then presented. All statistical analyses were performed with SAS 9.4 (SAS Institute, Cary, NC), and statistical significance was set at less than 0.05.

RESULTS

Summary of Demographic Data

Our total cohort included 2,048 patients. Of these, 165 (8.1%) underwent fat grafting between years one and two, while 1,883 did not (91.9%). More than half received bilateral breast reconstruction (56.6%), and the majority (89.5%) underwent mastectomy for cancer treatment. With regard to procedure type, 59.9% of patients received implant-based reconstruction, 38.4% autologous, and 1.8% mixed procedures, while the vast majority of

reconstructions were immediate (89.7%). The average age of the cohort was 49.4, and average BMI was 26.7. With regard to race, 87.6% were Caucasian, 5.7% were African American, and 5.7% were Latino. Only 2.2% of patients were current smokers.

Clinical and demographic data are summarized in Table 1. Patients who were fat grafted between years one and two were younger (p=0.012) and also had a higher rate of complications during the time period than those who did not undergo fat grafting (p=0.002). Women undergoing fat grafting had a much higher rate of concurrent revision procedures during the same time period (74.5% versus 16.5%, p<0.001), and patients who received fat grafting between years one and two were more likely to have undergone fat grafting prior to year one (p<0.001). Non-fat grafted patients were more likely to have had implant-based reconstruction and less likely to have received radiation, regardless of timing (p=0.040 and p=0.006, respectively). Importantly, cancer recurrence during the study period did not differ significantly between the two groups—1.8% in the fat grafted group and 2.0% in the non-fat grafted group (p=0.86).

Comparison of PRO Measures

Table 2 summarizes unadjusted mean scores of the PRO measures for both groups at three separate time points: 1) pre-operation (baseline), 2) one year after starting reconstruction (one year post-op), and 3) two years after starting reconstruction (two years post-op). Unadjusted means showed little to no group differences at baseline in breast satisfaction, psychosocial well-being, physical well-being, or sexual well-being. However, at one year post-operatively, unadjusted PRO scores tended to be higher for non-fat grafted patients, compared with those who later underwent fat grafting between one and two years. Unadjusted means were comparable across the two cohorts at two years, at which point the fat grafted patients had completed fat transfer.

Adjusted mean differences (AMD) of PROs between the two groups based on mixed-effects regression models are also shown in Table 2. Controlling for covariates at one-year post-operatively, patients who later underwent fat grafting reported significantly lower scores on satisfaction with breast (AMD = −4.74, CI −8.21 to −1.28, p=0.008), psychosocial well-being (AMD = −3.87, CI −7.33 to −0.40, p=0.029) and sexual well-being (AMD = −5.59, CI −9.70 to −1.47, p=0.008), compared with women who did not receive subsequent fat grafting. The difference in physical well-being at one year post-operatively was not significant (AMD = −1.23, CI −3.71 to 1.25, p=0.330). By contrast, there were no significant differences at two years between the fat grafted and non-grafted cohorts for any of the BREAST-Q subscales (see Table 2, Figure 1). Patients who underwent fat grafting reported similar scores in satisfaction with breast (AMD = −0.68, CI −4.42 to 3.06, p=0.719), psychosocial well-being (AMD = −0.59, CI −3.92 to 2.74, p=0.728, physical well-being (AMD = −0.50, CI −3.36 to 2.36, p=0.729), and sexual well-being (AMD = −2.94, CI −7.01 to 1.12, p=0.154). In essence, the fat grafted group had “caught up” in their PRO scores by year two.

DISCUSSION

Although fat grafting was originally described by Neuber in 1893, it has only recently gained widespread acceptance for use in aesthetic and reconstructive breast surgery. As late as the 1990s, issues with high resorption rates limited its use[25]. Furthermore, fat necrosis, a common occurrence after fat injection, can be difficult to distinguish from malignancy on mammography[5,26]. As a result of these and other concerns, the ASPS released a sobering position statement in 1987, concluding, “the committee is unanimous in deploring the use of autologous fat injection in breast augmentation, [as] much of the injected fat will not survive,” and predicted that “detection of early breast carcinoma through xerography and mammography will become difficult and the presence of disease may go undiscovered”[27]. Use of fat grafting was further discouraged by evidence from both animal and human studies suggesting an increased risk of breast cancer recurrence as a consequence of these procedures[6,7,28].

More recently, newer and higher quality evidence has dispelled many of these traditional concerns over the safety of autologousfat grafting in breast reconstruction. Multiple studies have indicated that breast imaging and cancer screening can still be effectively managed following fat grafting[9, 29–31]. Although research on breast cancer risk and fat transfer is ongoing, recent reports have failed to demonstrate an association between breast cancer recurrence with fat grafting[9,10,32]. Finally, the development of newer grafting techniques by Coleman and others has reduced rates of reabsorption and fat necrosis[33]. Despite this, the FDA has released proposed guidelines that may significantly limit its use in patients undergoing breast reconstruction[13].

Although there is a growing body of evidence confirming the safety of autologous fat grafting in breast reconstruction, fewer studies have addressed its efficacy. Although many plastic surgeons report superior clinical outcomes with these techniques, there remains relatively few studies critically evaluating fat grafting outcomes using valid, reliable measures. In particular, there remains a shortage of research assessing PROs, specifically patient satisfaction, body image, and health-related quality of life. A systematic review on fat grafting in onco-plastic breast reconstruction identified only eight studies that assessed patient satisfaction (satisfied, neutral, or dissatisfied) after fat grafting as an adjunct for breast reconstruction[14]. The only study in the literature that examined PROs in addition to satisfaction in patients undergoing fat grafting was underpowered, with only 68 patients, and lacked a control group[21]. While surgeons can readily identify improvements in contour and volume deficits with fat transfer in breast reconstruction, PRO data are also needed to confirm the utility of these procedures. Patient-reported outcomes are now viewed by payers and policymakers (including the FDA) as key measures of the effectiveness and quality of care. These agencies recognize that post-operative outcomes, such as symptom severity, functional status, and even satisfaction with aesthetic appearance, can be reliably assessed by the patients themselves[34].

In our analysis, autologous fat grafting was associated with improvements in all four BREAST-Q subscale scores between years one and two following the initial reconstructive procedures. While the fat grafted cohort lagged significantly behind the non-grafted control

group in three of four PRO measures at year one, these differences diminished to non-significant levels by year two. Although these improvements might be attributable to factors other than fat grafting, our analyses did control for a wide variety of potential confounders, including (but not limited to) concurrent revision procedures, prior complications, and radiation. Also, baseline (pre-reconstruction) subscale scores were comparable for the fat-grafted and non-grafted cohorts, suggesting that our results likely not attributable to pre-existing group differences. These findings constitute the first evidence from a large, multicenter, prospective outcome study demonstrating the effectiveness of autologous fat grafting for breast reconstruction. The study design was also strengthened by its reliance on a validated, condition-specific PRO instrument.

The use of the BREAST-Q, a condition-specific PRO instrument was particularly important for this study. Introduced in 2011 after extensive field testing, the BREAST-Q was specifically designed and validated to evaluate patient-reported outcomes in breast surgery, with a distinct procedure module for breast reconstruction. Unlike more generic PRO instruments, the BREAST-Q assesses domains specific to breast reconstruction patients, including satisfaction, psychosocial functioning and sexuality, as they relate to the reconstruction. As noted earlier, four BREAST-Q subscales were analyzed in this study: satisfaction with breasts, physical well-being, psychosocial well-being, and sexual well-being. For each subscale, scores are reported in a range of 0–100, with higher scores indicating better outcomes. The BREAST-Q has pre-operative and post-operative versions, which are psychometrically linked to quantify change[22,25,36].

While the study's strengths are detailed above, it also had some inherent limitations. As with any non-randomized study design, our findings may have been attributable to unknown confounders not controlled for in our analysis. Because providers and patients have strong preferences in surgical decision-making, randomization in studies like ours is usually not feasible for practical and (perhaps) ethical reasons. The study was also limited by missing survey data at year two, although the rate of missing data between the two groups was not significantly different (p=0.616). However, it is always possible that patients who failed to complete questionnaires did so as a result of dissatisfaction or other unknown effects. Next, despite the use of a multi-center study design, our findings may not be generalizable to all patients in all locations. For example, the 11 centers in MROC are primarily all academic medical centers except for one private practice. In addition, due to self-selected nature of centers for participation, we cannot make conclusions about potential geographic differences in our outcome variables. However, our model did include random intercepts for centers (hospitals) to account for between-center variability which helps make our results more generalizable. Finally, we are unable to perform sub-group analysis between various cohorts due to a loss of power when our sample population was divided into sub-groups.

By providing multicenter, prospective data confirming the benefits of autologous fat grafting as a useful adjunct in breast reconstruction, it is hoped that this study will contribute to the ongoing discussion with payers and regulators over the safety and effectiveness of these procedures. Our findings should bolster the ongoing assertion that fat grafting is an important tool in breast reconstruction and that this option should remain available to reconstructive surgeons and to the patients they serve.

CONCLUSION

The results of this multicenter study indicate that autologous fat grafting provides measurable improvements in satisfaction and other patient-reported outcomes for women undergoing post-mastectomy breast reconstruction. Our findings have important implications for the ongoing regulatory debate over the safety and efficacy of fat grafting for breast reconstruction.

References

1. Nahabedian MY. Implant-based breast reconstruction: Strategies to achieve optimal outcomes and minimize complications. J Surg Oncol. 2016; 113(8):895–905. [PubMed: 26919072]
2. Harless C, Jacobson SR. Current strategies with 2-staged prosthetic breast reconstruction. Gland Surg. 2015; 4(3):204–11. [PubMed: 26161305]
3. de Blacam C, Momoh AO, Colakoglu S, Tobias AM, Lee BT. Evaluation of clinical outcomes and aesthetic results after autologous fat grafting for contour deformities of the reconstructed breast. Plast Reconstr Surg. 2011; 128(5):411e–418e.
4. Delay E, Guerid S. The Role of Fat Grafting in Breast Reconstruction. Clin Plast Surg. 2015; 42(3): 315–23. vii. [PubMed: 26116937]
5. Chala LF, de Barros N, de Camargo Moraes P, et al. Fat necrosis of the breast: mammographic, sonographic, computed tomography, and magnetic resonance imaging findings. Curr Probl Diagn Radiol. 2004; 33(3):106–26. [PubMed: 15215818]
6. Petit JY, Lohsiriwat V, Clough KB, et al. The oncologic outcome and immediate surgical complications of lipofilling in breast cancer patients: a multicenter study--Milan-Paris-Lyon experience of 646 lipofilling procedures. Plast Reconstr Surg. 2011; 128(2):341–6. [PubMed: 21502905]
7. Petit JY, Rietjens M, Botteri E, et al. Evaluation of fat grafting safety in patients with intraepithelial neoplasia: a matched-cohort study. Ann Oncol. 2013; 24(6):1479–84. [PubMed: 23393126]
8. Kneeshaw PJ, Lowry M, Manton D, Hubbard A, Drew PJ, Turnbull LW. Differentiation of benign from malignant breast disease associated with screening detected microcalcifications using dynamic contrast enhanced magnetic resonance imaging. Breast. 2006; 15(1):29–38. [PubMed: 16002292]
9. Silva-Vergara C, Fontdevila J, Descarrega J, Burdio F, Yoon TS, Grande L. Oncological outcomes of lipofilling breast reconstruction: 195 consecutive cases and literature review. J Plast Reconstr Aesthet Surg. 2016; 69(4):475–81. [PubMed: 26876108]
10. Kaoutzanis C, Xin M, Ballard TN, et al. Autologous Fat Grafting After Breast Reconstruction in Postmastectomy Patients: Complications, Biopsy Rates, and Locoregional Cancer Recurrence Rates. Ann Plast Surg. 2016; 76(3):270–5. [PubMed: 26101979]
11. Delay E, Garson S, Tousson G, Sinna R. Fat injection to the breast: technique, results, and indications based on 880 procedures over 10 years. Aesthet Surg J. 2009; 29(5):360–76. [PubMed: 19825464]
12. [Accessed October 21, 2016] Post-mastectomy Fat Graft/Fat Transfer ASPS Guiding Principles. https://www.plasticsurgery.org/Documents/Health-Policy/Principles/principle-2015-post-mastectomy-fat-grafting.pdf. Updated June, 2015
13. [Accessed October 21, 2016] Human Cells, Tissues, and Cellular and Tissue-Based Products (HCT/Ps) from Adipose Tissue: Regulatory Considerations; Draft Guidance. http://www.fda.gov/BiologicsBloodVaccines/GuidanceComplianceRegulatoryInformation/Guidances/Tissue/ucm427795.htm. Updated December, 2014
14. Groen JW, Negenborn VL, Twisk DJ, et al. Autologous fat grafting in onco-plastic breast reconstruction: A systematic review on oncological and radiological safety, complications, volume retention and patient/surgeon satisfaction. J Plast Reconstr Aesthet Surg. 2016; 69(6):742–64. [PubMed: 27085611]

15. Ho Quoc C, Piat JM, Carrabin N, Meruta A, Faure C, Delaye E. Breast reconstruction with fat grafting and BRAVA((R)) pre-expansion: Efficacy evaluation in 45 cases. Ann Chir Plast Esthet. 2016; 61(3):183–9. [PubMed: 26190626]
16. Laporta R, Longo B, Sorotos M, Pagnoni M, Santanelli di Pompeo F. Breast Reconstruction with Delayed Fat-Graft-Augmented DIEP Flap in Patients with Insufficient Donor-Site Volume. Aesthetic Plast Surg. 2015; 39(3):339–49. [PubMed: 25804440]
17. Thekkinkattil DK, Salhab M, McManus PL. Feasibility of autologous fat transfer for replacement of implant volume in complicated implant-assisted latissimus dorsi flap breast reconstruction. Ann Plast Surg. 2015; 74(4):397–402. [PubMed: 24149409]
18. Bonomi R, Betal D, Rapisarda IF, Kalra L, Sajid MS, Johri A. Role of lipomodelling in improving aesthetic outcomes in patients undergoing immediate and delayed reconstructive breast surgery. Eur J Surg Oncol. 2013; 39(10):1039–45. [PubMed: 23890717]
19. Cigna E, Ribuffo D, Sorvillo V, et al. Secondary lipofilling after breast reconstruction with implants. Eur Rev Med Pharmacol Sci. 2012; 16(12):1729–34. [PubMed: 23161048]
20. Serra-Renom JM, Munoz-Olmo JL, Serra-Mestre JM. Fat grafting in postmastectomy breast reconstruction with expanders and prostheses in patients who have received radiotherapy: formation of new subcutaneous tissue. Plast Reconstr Surg. 2010; 125(1):12–8. [PubMed: 20048576]
21. Bayti T, Panouilleres M, Tropet Y, Bonnetain F, Pauchot J. Fat grafting in breast reconstruction. Retrospective study of satisfaction and quality of life about 68 patients. Ann Chir Plast Esthet. 2016; 61(3):190–9. [PubMed: 26603209]
22. Pusic AL, Klassen AF, Scott AM, Klok JA, Cordeiro PG, Cano SJ. Development of a new patient-reported outcome measure for breast surgery: the BREAST-Q. Plast Reconstr Surg. 2009; 124(2): 345–53. [PubMed: 19644246]
23. Austin PC, Steyerberg EW. The number of subjects per variable required in linear regression analyses. J Clin Epidemiol. 2015; 68(6):627–36. [PubMed: 25704724]
24. Rubin, DB. Multiple Imputation for Nonresponse in Surveys. New York: John Wiley and Sons; 1987.
25. Ersek RA. Transplantation of purified autologous fat: a 3-year follow-up is disappointing. Plast Reconstr Surg. 1991; 87(2):219–27. discussion 228. [PubMed: 1750860]
26. Carvajal J, Patino JH. Mammographic findings after breast augmentation with autologous fat injection. Aesthet Surg J. 2008; 28(2):153–62. [PubMed: 19083521]
27. Report on autologous fat transplantation. ASPRS Ad-Hoc Committee on New Procedures, September 30, 1987. Plast Surg Nurs. 1987; 7(4):140–1. [PubMed: 3438355]
28. Zhang Y, Daquinag A, Traktuev DO, et al. White adipose tissue cells are recruited by experimental tumors and promote cancer progression in mouse models. Cancer Res. 2009; 69(12):5259–66. [PubMed: 19491274]
29. Lindegren A, Chantereau MW, Bygdeson M, Azavedo E, Schultz I. Autologous Fat Transplantation to the Reconstructed Breast Does not Hinder Assessment of Mammography and Ultrasound: A Cohort Study. World J Surg. 2016; 40(5):1104–11. [PubMed: 26732667]
30. Pinell-White XA, Etra J, Newell M, Tuscano D, Shin K, Losken A. Radiographic Implications of Fat Grafting to the Reconstructed Breast. Breast J. 2015; 21(5):520–5. [PubMed: 26133468]
31. Masia J, Bordoni D, Pons G, Liuzza C, Castagnetti F, Falco G. Oncological safety of breast cancer patients undergoing free-flap reconstruction and lipofilling. Eur J Surg Oncol. 2015; 41(5):612–6. [PubMed: 25800344]
32. Kronowitz SJ, Mandujano CC, Liu J, et al. Lipofilling of the Breast Does Not Increase the Risk of Recurrence of Breast Cancer: A Matched Controlled Study. Plast Reconstr Surg. 2016; 137(2): 385–93. [PubMed: 26818270]
33. Coleman SR. Facial recontouring with lipostructure. Clin Plast Surg. 1997; 24(2):347–67. [PubMed: 9142473]
34. Pezold ML, Pusic AL, Cohen WA, et al. Defining a Research Agenda for Patient-Reported Outcomes in Surgery: Using a Delphi Survey of Stakeholders. JAMA Surg. 2016
35. Cano SJ, Klassen AF, Scott AM, Cordeiro PG, Pusic AL. The BREAST-Q: further validation in independent clinical samples. Plast Reconstr Surg. 2012; 129(2):293–302. [PubMed: 22286412]

36. [Accessed October 21, 2016] BREAST-Q Users' Manual. https://webcore.mskcc.org/breastq/qscore/qscore-manual.pdf. Updated July, 2012

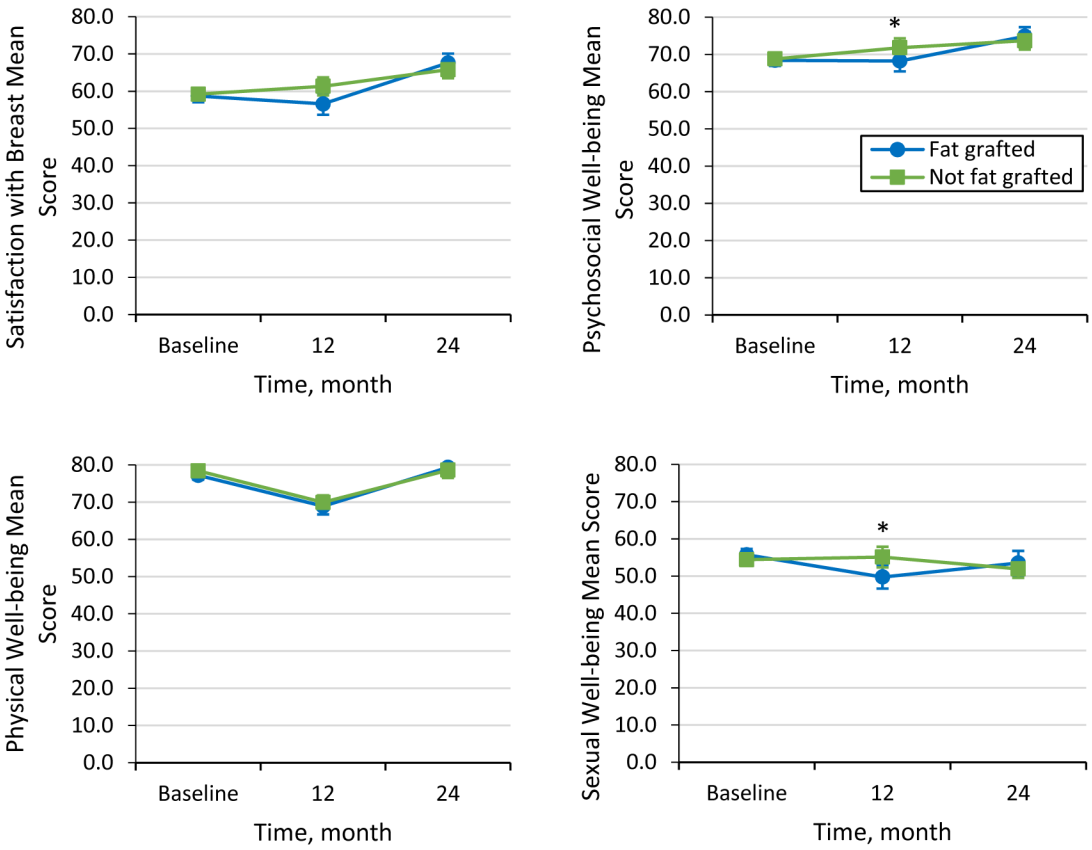

Figure 1.

Table 1

Clinical Characteristics of Patients by Fat Grafting Status

Variable	Fat grafting status between post-op year one and two		*P* Value
	Fat grafted n=165	Not fat grafted n=1883	
Age, mean (SD), year	47.5 (8.5)	49.5 (10.1)	0.012
BMI, mean (SD), kg/m^2	26.6 (5.1)	26.7 (5.6)	0.857
Race, No. (%)			
Caucasian	146 (89.0)	1649 (88.6)	0.908
African-American	10 (6.1)	107 (5.7)	
Other	8 (4.9)	105 (5.6)	
Ethnicity, No. (%)			
Hispanic/Latino	6 (3.7)	110 (6.0)	0.235
Non-Hispanic/Latino	156 (96.3)	1731 (94.0)	
Smoking history, No. (%)			
Non-smoker	107 (64.8)	1211 (65.0)	0.642
Previous smoker	56 (33.9)	610 (32.7)	
Current smoker	2 (1.2)	43 (2.3)	
Procedure type, No. (%)			
Implant	87 (52.7)	1139 (60.5)	0.040
Autologous	72 (43.6)	714 (37.9)	
Mixed	6 (3.6)	30 (1.6)	
Laterality, No. (%)			
Unilateral	65 (39.4)	824 (43.8)	0.278
Bilateral	100 (60.6)	1059 (56.2)	
Indication for mastectomy, No. (%)			
Therapeutic	150 (90.9)	1682 (89.3)	0.525
Prophylactic	15 (9.1)	201 (10.7)	
Timing of reconstruction, No. (%)			
Immediate	148 (89.7)	1690 (89.8)	0.977
Delayed	13 (7.9)	143 (7.6)	
Mixed	4 (2.4)	50 (2.7)	
Radiotherapy, No. (%)			
Before reconstruction	22 (13.3)	289 (15.3)	0.006
During/after reconstruction	38 (23.0)	262 (13.9)	
None	105 (63.6)	1332 (70.7)	
Fat grafting during post-op year one, No. (%)			

Variable	Fat grafting status between post-op year one and two		*P* Value
	Fat grafted n=165	Not fat grafted n=1883	
Yes	50 (30.3)	355 (18.9)	<.001
No	115 (69.7)	1528 (81.1)	
Other revision procedure done between post-op year one and two, No. (%)			
Yes	123 (74.5)	310 (16.5)	<.001
No	42 (25.5)	1573 (83.5)	
Cancer recurrence between post-op year one and two, No. (%)			
Recurred	3 (1.8)	38 (2.0)	0.861
Not recurred	162 (98.2)	1845 (98.0)	
Complication during post-op year one, No. (%)			
Yes	54 (32.7)	525 (27.9)	0.185
No	111 (67.3)	1358 (72.1)	
Complication between post-op year one and two, No. (%)			
Yes	11 (6.7)	48 (2.6)	0.002
No	154 (93.3)	1835 (97.5)	

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 2

Unadjusted Scores and Adjusted Difference Scores of BREAST-Q Patient-Reported Outcomes

BREAST-Q measure	Cohort	Un-adjusted Scores, mean (SD)			Adjusted mean difference (95% CI) [a] (fat grafted - not fat grafted)			
		Baseline	One year post-op	Two years post-op	One year post-op	*P* Value	Two years post-op	*P* Value
Satisfaction with breast	Fat grafted	58.7 (21.5)	60.1 (16.7)	65.6 (17.1)	−4.74 (−8.21, −1.28)	0.008	−0.68 (−4.42, 3.06)	0.719
	Not fat grafted	59.2 (22.5)	66.1 (17.2)	66.0 (18.3)				
Psychosocial well-being	Fat grafted	68.4 (18.7)	67.2 (19.3)	73.2 (19.2)	−3.87 (−7.33, −0.40)	0.029	−0.59 (−3.92, 2.74)	0.728
	Not fat grafted	68.8 (18.5)	73.5 (19.2)	75.3 (19.1)				
Physical well-being	Fat grafted	77.2 (16.0)	72.5 (13.5)	74.8 (15.2)	−1.23 (−3.71, 1.25)	0.330	−0.50 (−3.36, 2.36)	0.729
	Not fat grafted	78.4 (14.7)	76.2 (14.9)	76.8 (14.9)				
Sexual well-being	Fat grafted	55.7 (20.3)	48.0 (20.5)	52.8 (20.9)	−5.59 (−9.70, −1.47)	0.008	−2.94 (−7.01, 1.12)	0.154
	Not fat grafted	54.4 (20.9)	54.7 (21.0)	55.4 (21.9)				

Abbreviations: SD, standard deviation; CI, confidence interval.

[a]Based on mixed-effects regression models with each PRO measure at one or two years post-op as the dependent variable; Each model included an indicator for fat grafting between year one and two as the primary predictor, and included as covariates baseline PRO, age, BMI, procedure type, laterality, indication for mastectomy, timing of reconstruction, radiation, smoking history, race, ethnicity, prior fat grafting before year 1 PRO measurements, concurrent revision procedure, cancer recurrence, and prior complication; Also included are random intercepts for study sites (hospitals) and an interaction variable between fat grafting and concurrent revision procedures; Analyses were performed and combined using 10 imputed data sets.