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Breast

Patient Outcomes after Fat Grafting to the Radiated Chest Wall before Delayed Two-stage Alloplastic Breast Reconstruction

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Background: Two-stage alloplastic breast reconstruction in patients having received mastectomy and radiation is associated with a high rate of complications. Fat grafting has been shown to mitigate the effects of radiation on the chest wall to allow for alloplastic reconstruction. In this study, we assess the outcomes (after a mean follow-up of 28 months), including complications and revisional procedures, of women who had fat grafting to the radiated chest wall before two-stage implant-based breast reconstruction.

Methods: A retrospective chart review was performed on consecutive patients seeking delayed implant-based reconstruction after simple mastectomy and postmastectomy radiation therapy between 2011 and 2015. All patients underwent two sessions of fat grafting to the radiated chest wall before inserting a tissue expander and subsequent exchange to a silicone implant.

Results: Twenty patients were included in the study. No reconstructive failures were recorded. The short-term complication rate was 5%, with one hematoma leading to a revisional procedure. The mean follow-up after reconstruction was 28 months. During follow-up, two patients (10%) developed capsular contracture grade IV with implant malposition, leading to capsular revision and implant exchange. Four patients (20%) underwent additional fat grafting for contour deformities.

Conclusions: Fat grafting before two-stage alloplastic breast reconstruction in patients treated with mastectomy and postmastectomy radiation therapy may provide an alternate method of alloplastic reconstruction in a select group of patients who are not suitable for autogenous reconstruction. Follow-up data show that additional surgery may be required for correction of implant malposition and capsular contracture.
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INTRODUCTION

Alloplastic breast reconstruction in the setting of postmastectomy radiation therapy (PMRT) is associated with an increased risk of complications.[1–5] These complications include infection, seroma, delayed wound healing, implant exposure, and capsular contracture.[6,7] The rate of reconstructive failure is high (40%).[4] In addition, patient satisfaction in this context is reported to be low.[8] In the context of radiation, autologous breast reconstruction has been shown to have lower rates of complications and improved levels of patient satisfaction.[9,10] Because of these data, PMRT patients are often encouraged to undergo autologous breast reconstruction.[11,12] Despite this, there is a subset of patients who elect to undergo alloplastic reconstruction in the context of radiation because they are not candidates for autologous reconstruction. These may be younger patients with a low body mass index (BMI) without an appropriate donor site or who chose the procedure because of a personal preference.

In recent years, the advent of fat grafting has expanded the indications for alloplastic breast reconstruction. Fat grafting in the context of breast reconstruction can be used to add contouring volume and to provide the regenerative effect induced by adipose-derived stem cells.[13] Due to its regenerative capacities and reversing

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the effects of radiation, fat grafting has been reported as a method to prepare the radiated chest wall for alloplastic breast reconstruction.[14–16] Several published case series have demonstrated low short-term complications and improved patient satisfaction when fat grafting was combined preoperatively with implant-based breast recontruction.[17–19] However, many of these publications are limited by short-term follow-up. The purpose of this study was to assess the outcome period beyond 90 days postoperative in women who have received delayed implant-based breast reconstruction in combination with fat grafting after PMRT.

Takeaways

Question: Does fat grafting to the chest wall in breast cancer patients treated with mastectomy and radiation provide an additional option for implant-based breast reconstruction?

Findings: Twenty patients underwent delayed two-stage implant-based breast reconstruction after two sessions of fat grafting. Outcomes and complications are reported with no reconstructive failures.

Meaning: Our data support the benefits of fat grafting in patients treated with postmastectomy radiotherapy who may choose implant-based breast reconstruction.

PATIENTS AND METHODS

Patient Population

This was a retrospective cohort study of a consecutive series of women seeking delayed alloplastic breast reconstruction at a single tertiary institution in Toronto, Canada, between December 2011 and June 2015. All patients were referred from their family physician or oncologic surgeon, for consideration of delayed breast reconstruction after simple bilateral or unilateral mastectomy and PMRT as treatment of breast cancer. No patients had undergone a previous attempt at breast reconstruction. There were no previous reconstruction failures within the cohort. All procedures were performed at an ambulatory facility (Women's College Hospital, Toronto, Canada), and standard day surgery patient selection criteria were applied. All patients included in the study were nonsmokers. Patients with textured implants were excluded from the study.

All patients received conventional dosing for PMRT, which was 50–50.4 Gy in 1.8–2.0 Gy per fraction (25–28 total fractions) to the chest wall and 45–50 Gy in 1.8–2.0 Gy per fraction (25 total fractions) to the regional lymph nodes. The study was approved by the local institutional ethics board (Title: Radiated Chest Wall Fat Grafting and Implant-based Breast Reconstruction, #2021-0147-E).

Timing and Surgical Technique

All procedures were performed by a single plastic surgeon (J.S.) who specializes in breast reconstruction. The surgical protocol is outlined in Figure 1. Informed consent was obtained before each surgery, which included a full discussion of the published benefits, risks, and alternatives of implant-based breast reconstruction in the setting of an irradiated field (Fig. 1).

The surgeon first determined fat grafting suitability based on clinical examination of the patient, including chest wall for signs of radiation damage and donor site availability. Radiation was completed at least 6 months before the first session of fat grafting. A minimum of two chest-wall fat-grafting sessions were performed, with approximately 3 months between sessions. Additional sessions of fat grafting were offered to patients who would benefit from fat injected into the subcutaneous plane on top of the pectoralis major muscle. Fat was harvested using a modified Coleman technique via hand aspiration with a 4-mm blunt tip cannula and 10-ml syringes. Fat was then prepared by gravity purification to remove the oil and aqueous portions.

Needle Rigottomies were performed at the mastectomy scar site with a standard a Coleman Rigottomy-cannula, and fat was injected into the subcutaneous layer in small aliquots, using 3-mm blunt tip cannulas on a 10-ml syringe. The fat was injected first, under the mastectomy scar. One-third of the total fat volume was injected into the superior pole of the breast (superior to the mastectomy scar) and two-thirds of the fat volume in the lower pole (inferior to the mastectomy scar), the area requiring the greatest expansion.

The tissue expander (TE) was inserted approximately 3 months after the last session of fat grafting. All TEs were placed in a subpectoral dual plane position accessed through an inframammary fold (IMF) incision. Although the IMF incision added an additional scar to the chest wall, this position avoided reopening the original mastectomy scar, which is positioned at the apex of the breast mound and the point of maximum tension during the expansion process. The serial expansion process of the irradiated tissue was slower than the standard filling sequence of tissue expansion. After the size and volume objectives were obtained the expander was left for several months to allow the new pocket to mature. The final stage of the procedure was then performed with removal of expander and insertion of the implant through the inframammary incision. Nipple–areolar complex reconstruction was performed if applicable and desired by the patient at the time of inserting the final implant.

A contralateral procedure for symmetry, if required, was performed at the second stage. The patients were offered either breast reduction, a mastopexy, or breast augmentation. If the patient originally presented with bilateral mastectomies, bilateral TEs were inserted at the time of the first stage procedure with the same size and fill schedule.

After completion of the reconstruction procedure, patients underwent regular follow-ups in the clinic (1 week, 3 weeks, 3 and 6 months, and 12 months postoperative) throughout their reconstructive process and an annual follow-up thereafter.

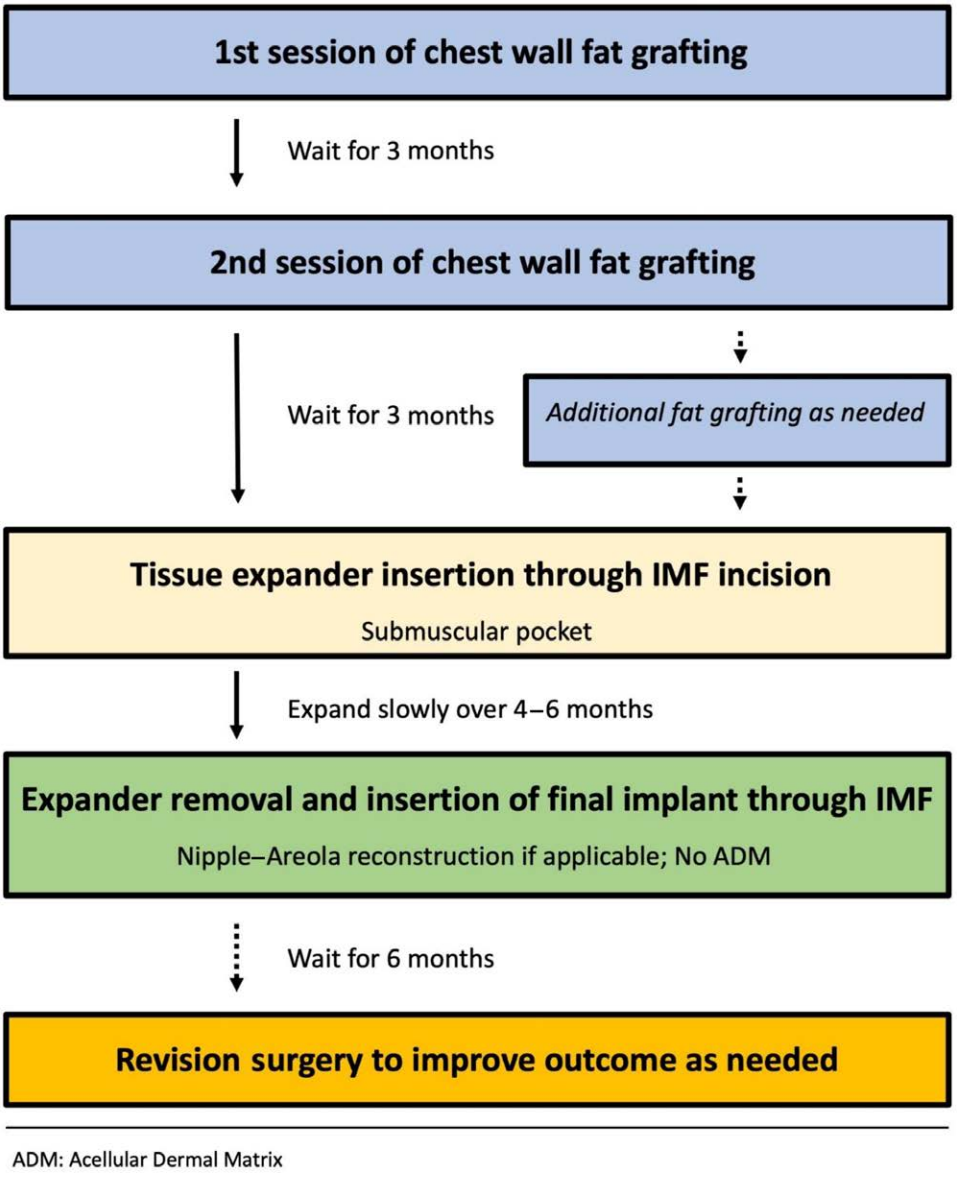

Fig. 1. Surgical protocol.

Data and Statistics

All data were collected from patient charts. Data reviewed included patient characteristics (age, BMI, comorbidities); oncological status (oncological clearance and recurrence) and oncological treatments received (type of mastectomy, radiation, and chemotherapy status); and reconstructive surgery information (dates of operations, volume of fat injected, volume of tissue expansion and implants, complications, and additional procedures).

Minor short-term complications were defined as complications in between the reconstructive steps and within 90 days after the final implant was inserted that were managed conservatively, and included delayed wound healing, surgical site infections managed with oral antibiotics, and postoperative seroma managed by drainage in clinic. Major short-term complications were defined as any complications that required reoperation or admission to hospital in between the reconstructive steps and within 90 days after the final implant was inserted.

In addition, outcomes and complications were recorded 90 days after the second-stage insertion of the implant. The description of capsular contracture according to the Baker classification,[20] as well as malposition rates requiring reoperation caused by capsular contracture were collected from the clinical chart.

Data were then analyzed using IBM SPSS Statistics and Microsoft Excel. Descriptive statistics were used to report results. Categorical factors were assessed using frequencies and percentages. Categorical factors were reported as mean and range. Time periods between every surgical step and follow-up appointments were calculated and reported as mean and range.

RESULTS

Twenty women who underwent fat grafting procedures after simple mastectomy and PMRT were included in the study. Six patients had unilateral mastectomy and 14 had bilateral mastectomies. All breast cancer cases treated with radiation were unilateral; contralateral mastectomies were performed for prophylactic reasons. The mean age of the patients was 46 years (range, 28–64). The mean BMI was 22.1 kg/m^2 (range, 18.7–26.6); 80% had a normal BMI (BMI < 25 kg/m^2) and 4% were above (BMI > 25 kg/m^2).[2] Six patients had comorbidities, including hypertension in one patient, dyslipidemia in one patient, gastroesophageal reflux disease in two patients, and a history of deep vein thrombosis/pulmonal embolism in two patients. Eighteen patients had received chemotherapy. Patient demographics are shown in Table 1.

Overall, the mean time from end of radiation to the first session of fat grafting was 20.4 months (range, 6.3–81.6). The mean time from first fat grafting procedure to placing the final stage implant was 18 months (range, 10.4–32.8). One patient received four sessions of fat grafting, and the remaining 19 women received two sessions. The mean volume of fat injected at each session was 43.7 cm^3 (range, 16–69 cm^3). The mean total volume of fat injected in each patient was 91 cm^3 (range, 40–171 cm^3). The fat was harvested primarily from the abdominal area (92.5%) or from the thigh and buttock (7.5%).

The mean initial volume at the time of insertion of the TEs was 97 cm^3 (range, 60–120 cm^3), and the mean final volume of the TEs was 330 cm^3 (range, 215–470 cm^3). The mean number of TE injections performed was six (range, 4–10). In anticipation of a higher resistance to expansion, a slower expansion schedule occurring every 3 weeks was implemented. The size of the definitive implants ranged from 290 cm^3 to 500 cm^3 (mean, 373 cm^3). Round smooth silicone-filled implants were used in all patients.

Short-term Complications

No complications occurred related to the fat grafting procedures after insertion of the TE or during expansion. One woman experienced a hematoma after implant exchange (5%), which required reoperation on postoperative day 6. No reconstructive failures were seen.

Table 1. Patient (n = 20) Demographic Data

	Total	%
Mean age (y) (range)	46 (28–64)	
Mean BMI kg/m^2 (range)	22.1 (18.7–26.6)	
Comorbidities	6	30
Chemotherapy	18	90
Unilateral mastectomy	6	30
Bilateral mastectomy	14	70
Mean time (mo) end of radiation to fat grafting (range)	20.4 (6.3–81.6)	
Median follow-up (mo) (interquarltile range)	19.2 (4.5–41)	

Outcomes and Surgical Revisions

The median time from implant exchange to date of last follow-up visit was 19.2 months [interquartile range, 4.5–41], with a longest follow-up of 92.5 months. During the follow-up period, a revisional procedure on the radiated breast was performed in five patients (25%). The mean time from insertion of the implant to the first surgical revision was 13.3 months (range, 5–31.3 months). One patient (5%) underwent nipple transposition because of malposition. In the other four (20%), an additional session of fat grafting (mainly in the upper pole) was performed to improve breast contouring and aesthetics. In addition, two (10%) of these patients developed implant malposition because of capsular contracture grade IV and required revisional procedures, which consisted of capsular revision and implant exchange. During the assessment of capsular contracture, we acknowledge that we did not assess what layer of soft tissue overlying the implant was responsible for the perception of stiffness or contracture. We do not know whether the stiffness was secondary to pectoralis muscle fibrosis or contracture of the capsule itself. These procedures were performed at a mean of 8.4 months (range, 8.3–8.5 months) after finishing the reconstruction. No local recurrence of breast cancer on the reconstructed side were reported. An overview of complications is shown in Table 2 and case examples in Figures 2 and 3.

When comparing the capsular contracture group (n = 2) with the noncapsular contracture group (n = 19) in terms of amount of fat grafted and time period since the end of radiation, the following results were seen. The mean amount of fat injected in the capsular contracture group was 94 cm^3 (range, 77–111 cm^3) and 91 cm^3 (range, 40–171 cm^3) in the noncapsular contracture group. The mean time from end of radiation to the first session of fat grafting was 9.9 months (range, 9.2–10.6) in the capsular contracture group and 21.5 (range, 6.3–81.6) in the noncapsular contracture group. The low number of patients being compared does not allow any real statistically significant calculation (Figs. 2 and 3).

Procedures at the Nonirradiated Side

In all 14 bilateral mastectomies, an implant-based reconstruction on the nonirradiated breast was performed.

Table 2. Postoperative Complications at Each Stage of the Reconstruction

n = 21	Fat Grafting	Stage 1 (TE)	Stage 2 (Implant)	Total	%
Less than 90 Days Postoperative					
Minor complication	0	0	0	0	0
Major complication	0	0	1*	1	5
Reconstructive failure	0	0	0	0	0
Greater than 90 Days Postoperative					
Capsular contracture			2	2	10
Implant malposition			2	2	10
Contour deformity			4	4	20
Nipple-malposition			1	1	5

*Hematoma.

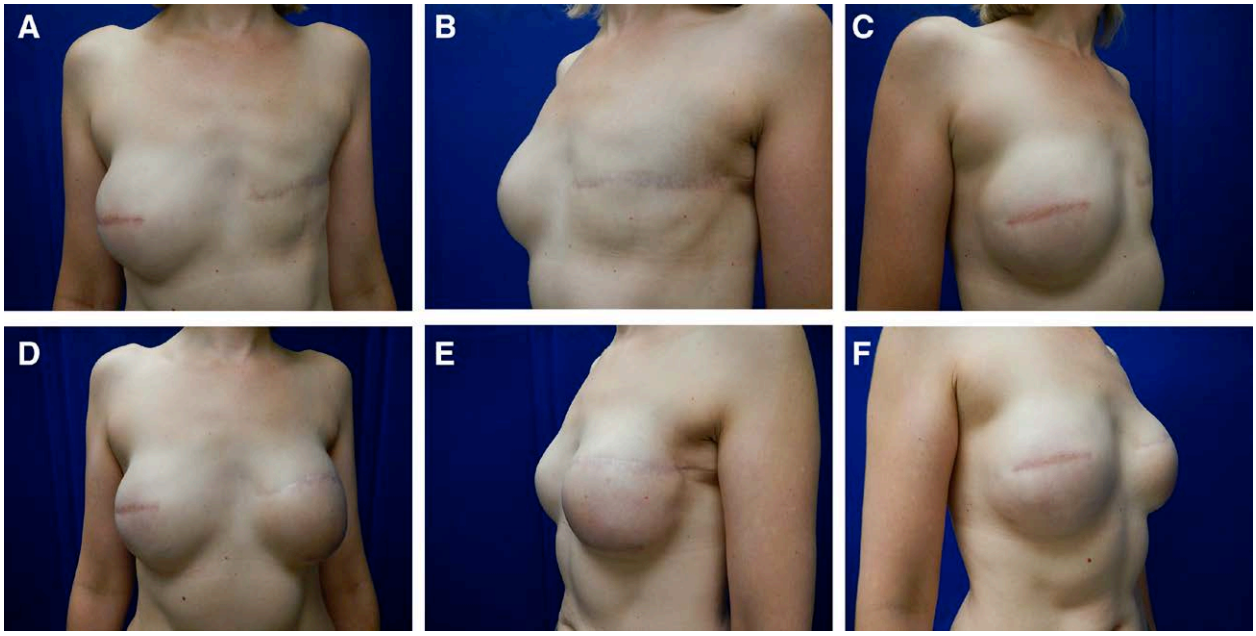

Fig. 2. Photographs of the patient's breasts at 1-year follow-up. A–C, Preoperative photographs, and D–F, Postoperative photographs. This photo sequence shows a 46-year-old patient with BRCA1 who was diagnosed with left invasive lobular breast cancer. She was treated with left mastectomy (T1b, N2, 5/27 nodes positive). The treatment included chemotherapy: PMRT (50 Gy/25). Reconstruction included two episodes of left chest wall fat grafting, 60 cm^3 total volume, 3 months apart. Tissue expander inserted through IMF incision and exchange to 360 cm^3 round smooth silicone implant were done as the final stage.

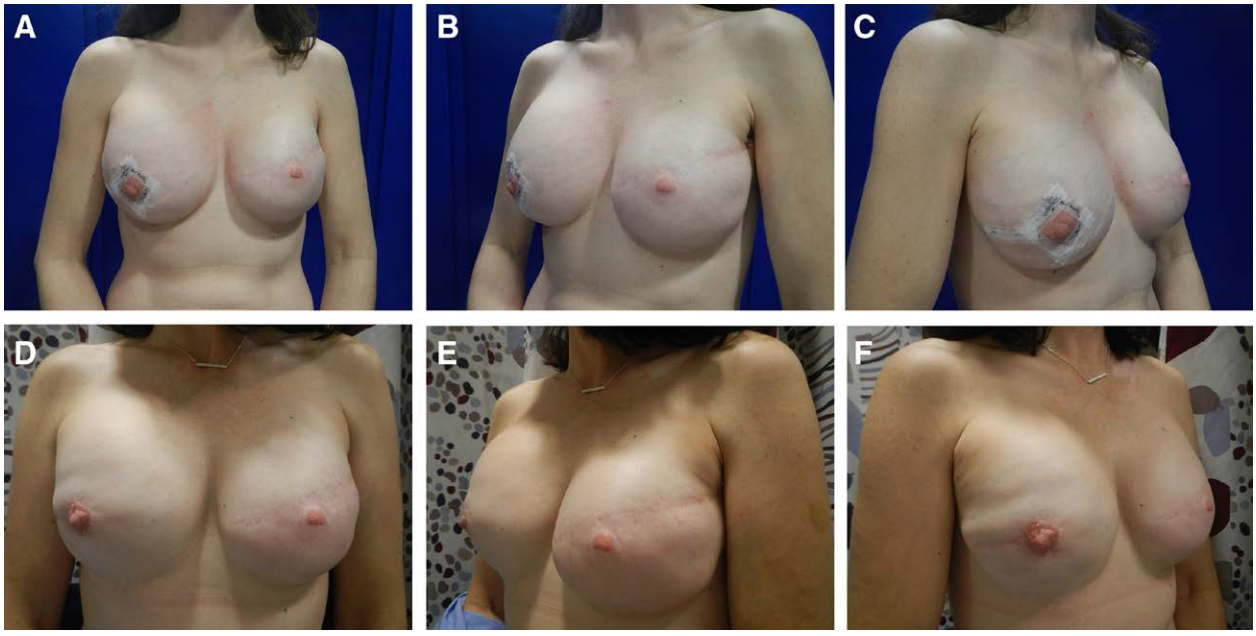

Fig. 3. Images of the patient's breasts after fat grafting and reconstruction at 3 months with repositioning of the nipple and nipple grafting to the left side. A–C, Postoperative photographs, and D–F, patient photographs at 3-years follow-up. This is a 41-year-old women with BRCA1 and left invasive ductal breast cancer treated with mastectomy (T1b, N2, 4/16 nodes), chemotherapy, and PMRT (50 Gy/25). Reconstruction included a right prophylactic mastectomy with direct to implant reconstruction with a round smooth gel implant and acellular dermal matrix. On the left side, the patient had two sessions of chest wall fat grafting, with 80 cm^3 total volume of fat given 3 months apart. Access for tissue expander and insertion of the 500 cm^3 round smooth gel implant in the final stage were done through an IMF incision.

Five of the six unilateral mastectomies had a balancing procedure on the contralateral breast, with three breast reductions and two breast augmentations.

DISCUSSION

This retrospective study provides results and outcomes supporting the beneficial effect of fat grafting prior to two-stage alloplastic breast reconstruction in patients with PMRT. The beneficial regenerative effect of fat grafting on radiated tissue prior to alloplastic breast reconstruction was demonstrated by Sarfati et al.[19] They reported complications in four of 28 patients with one implant loss due to chronic seroma and development of a fistula after alloplastic breast reconstruction and serial fat grafting post radiotherapy. Salgarello et al[17] treated 16 radiated patients with two to three sessions of fat grafting at least 3 months before a two-stage alloplastic breast reconstruction[17] and did not experience any short-term complications. Similarly, Ribuffo et al[18] demonstrated a complication rate of 0% in 16 patients. Of note, these studies had relatively short follow-up times (mean, 15–18 months). Our study results of these short-time complication rates align with these previous estimates. In our series, one hematoma occurred following the final stage insertion of the silicone implant, and no reconstructive failures were recorded.

With the use of fat grafting as a means of preparing the radiated mastectomy skin for alloplastic reconstruction, we found a considerably lower rate of complications compared with the existing literature without fat grafting. A recent meta-analysis of prosthetic breast reconstruction without fat grafting in previously irradiated breasts by Lee and Mun[21] showed a risk of reconstructive failure of 14% and total complications risk of 36% overall.

This study provides additional data from patients being initially treated with mastectomy and PMRT who have received fat grafting before a two-stage breast reconstruction with a follow-up of 19.2 [interquartile range 4.6–40.3] months and a longest follow-up of 92.5 months. During this follow-up, two patients (9.8%) developed implant malposition with capsular contracture of grade IV and underwent revisional surgery. Capsular contracture in these patients may develop well beyond our period of observation (median follow-up 28 months). The rate of capsular contraction in the literature without fat grafting in the setting of PMRT and alloplastic reconstruction ranges from 12.5% to 53.3%.[22] Our reported implant malposition rate of 9.8% is similar to implant malposition rates in breast reconstruction without radiation quoted from 5% to 9.8%[23,24] and much lower compared with a malposition rate of 27.8% in the context of radiation.[25]

In this study, 11 of these patients underwent nipple–areolar reconstruction using local flaps and grafts, having previously received radiation to this area without complications. Nipple–areolar reconstruction using local flaps was performed in several patients once the radiated mastectomy flap had been prepared with fat grafting. Further studies are needed to provide a formal assessment of the nipple reconstruction regarding aesthetic outcome and longevity of projection in an irradiated field with fat grafting. Our surgical protocol utilized an inframammary fold incision for access instead of the original mastectomy scar. Although the IMF incision adds an additional scar to the chest wall, this incision position avoids reopening the original mastectomy scar, which is at the apex of the breast mound and at the point of maximum tension during the expansion process. This concept has previously been reported by Percec et al.[6] These authors suggest that because the mastectomy scar lies in the center of the breast, it receives increased radiation. The IMF, on the other hand, is at the outer edge of the radiation field and therefore receives a lesser dose.[18]

Many factors influence patients' decision for or against alloplastic reconstruction. In the context of having received radiation treatment, many patients will choose autologous breast reconstruction options.[12] However, in our experience, there exists a subset of younger patients with low BMI who did not want additional donor site scars or were not suitable for autologous breast reconstruction. We recognize that this unique cohort of patients deserves further study regarding what options were presented to them and how they choose this type of breast reconstruction. The method we present here may add another option for this group of patients. Other patients seen for breast reconstruction after mastectomy radiation were directed to autologous based breast reconstruction. With improved surgical techniques, refined radiation dosing, and the introduction of acellular dermal matrices, indications for alloplastic reconstruction in the context of radiation has changed. Some patients with thin body habitus and low BMI may not have suitable donor sites to meet their reconstructive goals with autologous breast reconstruction.[26] These patients instead aim for an implant-based breast reconstruction. This is highlighted by our study population with a low mean BMI of 22.2 kg per m^2. On the other hand, one might argue that these patients also do not have enough donor fat to harvest for lipofilling. In our experience, this is not the case. Even small amounts of fat grafted, 44.2 cm^3 in this study per session, were noted to improve tissue quality through fat rejuvenation effects.

Limitations

This is a retrospective study with a small cohort of patients from a single institution. This study describes a surgical approach to alloplastic reconstruction in the context of the radiated postmastectomy breast as well as the authors' outcomes after patients undergo this reconstructive path. The study does not have a control arm and, therefore, is not designed to detect statistical difference. This study has a variable follow-up time with a median follow-up period of 19.2 months. We acknowledge that capsular contracture may develop well beyond the 2-year window of observation in this study. This study could have benefited from a longer follow-up period.

A larger multi-institutional study with a prospective approach would offer more definitive findings. Despite the retrospective nature of our study, through thorough chart review, there were minimal missing data. In addition, this study was conducted in Canada, where patients

have universal health care, and this procedure is covered by provincial healthcare. As a result, insurance status does not limit the ability to have access to this procedure.

A formal patient-reported outcome measurement tool was not an objective of this small study. Future studies should formally evaluate patient-reported outcomes after this multistep surgical protocol.

CONCLUSIONS

This study reports outcomes in 20 patients who underwent fat grafting in advance of delayed two-staged alloplastic breast reconstruction following PMRT. Our findings support the current literature that fat grafting is a safe reconstructive option that can be carried out in an ambulatory setting. No reconstructive failures occurred. This technique may provide an alternate option for alloplastic reconstruction in a select group of patients treated with PMRT who are not suitable for autogenous reconstruction.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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