

Should Immediate Autologous Breast Reconstruction Be Considered in Women Who Require Postmastectomy Radiation Therapy? A Prospective Analysis of Outcomes

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Background: In women who require postmastectomy radiation therapy, immediate autologous breast reconstruction is often discouraged. The authors prospectively evaluated postoperative morbidity and satisfaction reported by women undergoing delayed or immediate autologous breast reconstruction in the setting of postmastectomy radiation therapy.

Methods: Patients enrolled in the Mastectomy Reconstruction Outcomes Consortium study, who received postmastectomy radiotherapy and underwent immediate or delayed free abdominally based autologous breast reconstruction, were identified. Postoperative complications at 1 and 2 years after reconstruction were assessed. Patient-reported outcomes were evaluated using the BREAST-Q questionnaire preoperatively and at 1 and 2 years postoperatively. Bivariate analyses and mixed-effects regression models were used to compare outcomes.

Results: A total of 175 patients met the authors' inclusion criteria. Immediate reconstructions were performed in 108 patients and delayed reconstructions in 67 patients; 93.5 percent of immediate reconstructions were performed at a single center. Overall complication rates were similar based on reconstructive timing (25.9 percent immediate and 26.9 percent delayed at 1 year; $p = 0.54$). Patients with delayed reconstruction reported significantly lower prereconstruction scores ($p < 0.0001$) for Satisfaction with Breasts and Psychosocial and Sexual Well-being than did patients with immediate reconstruction. At 1 and 2 years postoperatively, both groups reported comparable levels of satisfaction in assessed BREAST-Q domains.

Conclusions: From this prospective cohort, immediate autologous breast reconstruction in the setting of postmastectomy radiation therapy appears to be a safe option that may be considered in select patients and centers. Breast aesthetics and quality of life, evaluated from the patient's perspective, were not compromised by flap exposure to radiation therapy. (*Plast. Reconstr. Surg.* 139: 1279, 2017.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, III.

Radiotherapy has widespread use in breast cancer. Indications for radiotherapy, especially in the adjuvant setting, have broadened. In conjunction with surgery, radiation

therapy is a foundational component of multimodal treatment for locally advanced breast cancer. Postmastectomy radiation therapy has been shown to increase overall survival and decrease locoregional recurrence in patients with node-positive disease.¹⁻⁴ However, postmastectomy radiation therapy can negatively affect breast

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reconstruction, thus complicating the timing and method of reconstruction used.

Multiple studies have reported on the increased morbidity associated with all forms of immediate breast reconstruction in the setting of postmastectomy radiation therapy.⁵⁻⁷ Early studies on flap exposure to radiation found significant rates of flap fibrosis, fat necrosis, and shrinkage, which in severe cases could necessitate flap replacement.^{8,9} Consequently, patients undergoing postmastectomy radiation therapy have been traditionally offered delayed autologous breast reconstruction in efforts to minimize postoperative complications and compromise of the quality of the transferred soft tissue. Delayed autologous breast reconstruction avoids exposure of flap tissue to radiation and offers the restoration of a breast mound that closely approximates natural breast tissue. These benefits come at a price to the patient, who lives without a breast for a substantial period.¹⁰⁻¹⁶ Immediate breast reconstruction, in contrast, optimizes breast aesthetics by limiting scars and potentially avoids the psychosocial sequelae of a mastectomy alone.¹⁷

In recent years, a few studies have reported on favorable outcomes with immediate breast reconstruction with subsequent postmastectomy radiation therapy.¹⁸⁻²¹ Chatterjee et al. demonstrated no significant reduction in flap volumes in patients who underwent postmastectomy radiation therapy compared to women who did not have radiation therapy.¹⁹ Others reported acceptable aesthetic outcomes in the setting of flap irradiation, with limited revision procedures required.^{20,21} However, most studies to date have been retrospective evaluations of single-center experiences, with limited information on outcomes from the patient's perspective. The purpose of this study was to prospectively evaluate postoperative morbidity and breast-specific patient-reported outcomes in women who have undergone immediate and delayed autologous breast reconstruction in the setting of postmastectomy radiation therapy.

PATIENTS AND METHODS

Study Population

Patients were recruited as part of the Mastectomy Reconstruction Outcomes Consortium study, a 5-year, prospective, multicenter cohort study of mastectomy reconstruction patients funded by the National Cancer Institute (1R01CA152192). Fifty-seven plastic surgeons from 11 centers in the United States (Michigan, New York, Illinois, Ohio,

Massachusetts, Washington, D.C., Georgia, and Texas) and Canada (British Columbia and Manitoba) contributed patients to the study, which began in February of 2012. Appropriate institutional review board approval was obtained from all sites.

Women age 18 years or older, undergoing first-time unilateral or bilateral mastectomy with immediate or delayed breast reconstruction, were eligible for the Mastectomy Reconstruction Outcomes Consortium study. For the purposes of this study, 175 patients met our inclusion criteria, having undergone postmastectomy radiation therapy and either immediate or delayed abdominally based autologous breast reconstruction. Our cohort also had to have at least 1 year of postreconstruction follow-up. Eligible reconstruction methods were as follows: free transverse rectus abdominis musculocutaneous flaps, deep inferior epigastric perforator flaps, superficial inferior epigastric perforator flaps, or a mixture of two of these procedures in bilateral cases. Patients who underwent radiation therapy before mastectomy, patients with both immediate and delayed reconstructions, or patients with tissue expanders or implants at the time of reconstruction were excluded. Reconstructive procedure choice was based on patient and surgeon preference.

Statistical Analyses

Clinical and demographic characteristics between immediate and delayed patients were compared using chi-square tests. For clinical outcomes, breast and donor-site complications at 1 year were summarized as counts and percentages for each group. A mixed-effects logistic regression model was further performed, with the dependent variable being the presence or absence of any type of breast complication. The model included radiation timing (immediate versus delayed) as the primary predictor. The model also included clinical and demographic characteristics as covariates, and random intercepts for centers (hospitals) to account for between-center variability. Adjusted odds ratios with 95 percent confidence intervals and corresponding *p* values from the model were reported.

For patient-reported outcomes, we focused on five domains of BREAST-Q measures: Satisfaction with Breasts, Psychosocial Well-being, Physical Well-being (chest and upper body), Physical Well-being (abdomen), and Sexual Well-being. Mean patient-reported outcome scores before surgery and the mean difference of patient-reported

outcomes from before to after surgery were summarized separately for the two groups (immediate versus delayed breast reconstruction). To further compare 1- and 2-year patient-reported outcomes between the groups, separate mixed-effects regression models were used for each patient-reported outcome measure. Each model was adjusted for baseline value of the corresponding outcome variable and adjusted for clinical and demographic characteristics. The model also included centers (hospitals) as random intercepts to account for between-center variability. To reduce potential bias from nonresponse or missing patient-reported outcomes at 1 and 2 years, analyses were weighted by the inverse of the probability of response. The probability of response was estimated based on data from all eligible study participants ($n = 175$), where a separate logistic regression model was fit for each outcome measure, with nonmissing response status as the dependent variable and baseline patient characteristics and baseline values of the outcome variable as predictors. All statistical analyses were performed in SAS 9.4 (SAS Institute, Inc., Cary, N.C.).

RESULTS

In 175 patients who met our inclusion criteria, immediate autologous breast reconstruction with postmastectomy radiation therapy was performed in 108 patients, and delayed breast reconstruction after postmastectomy radiation therapy was performed in 67 patients. Table 1 outlines pertinent demographic and oncologic characteristics of the cohort. Both groups of patients had similar demographic distributions and treatment variables, with the exception of the laterality of reconstruction, specific reconstruction types, ethnicity, and the timing of the delivery of chemotherapy. Bilateral reconstructions were performed more often in the immediate setting (34.3 percent versus 13.4 percent). More deep inferior epigastric perforator and superficial inferior epigastric perforator flaps were performed in the immediate reconstruction group, and free transverse rectus abdominis musculocutaneous flaps were performed more frequently in the delayed reconstruction group. As would be expected, chemotherapy was delivered after reconstruction with greater frequency in patients undergoing immediate breast reconstruction (75 percent versus 3 percent). Most of the immediate reconstructions [$n = 101$ (93.5 percent)] included in the study were performed at a single center, with the rest performed at four other centers. Delayed reconstructions were

distributed more evenly among eight centers. The average time from completion of radiation therapy to reconstruction was 24.7 months (range, 2.9 to 163.8 months).

Breast and abdominal donor-site complications are listed in Table 2. Postoperative breast complications occurred in 26.3 percent of the patients, with mastectomy flap necrosis representing the complication with the highest rate of occurrence (7.4 percent). Overall complication rates for the immediate and delayed reconstruction groups were similar (25.9 percent and 26.9 percent, respectively; $p = 0.540$). With the exception of higher partial flap necrosis in patients undergoing delayed reconstruction (7.5 percent versus 0 percent; $p = 0.008$), specific flap complications including flap loss, fat necrosis, dehiscence, hematomas, and seromas were not higher with immediate reconstruction. Mastectomy flap necrosis occurred exclusively in the immediate reconstruction group (12.0 percent), as expected. Abdominal donor-site complications were also similar for both groups of patients, with the exception of a higher seroma rate in the immediate reconstruction patients (13.0 percent versus 1.5 percent; $p = 0.01$). Even after controlling for demographic and clinical covariates, no significant difference was found for overall breast complications in patients with immediate or delayed breast reconstruction at 1 and 2 years after reconstruction (Table 3). Patients with a body mass index greater than 30 kg/m² had greater odds of overall breast complications (OR, 2.54; 95 percent CI, 1.14 to 5.68; $p = 0.023$) compared with patients with a body mass index less than 30 kg/m² at 1 year after reconstruction.

Before reconstruction, patients undergoing delayed autologous breast reconstruction reported significantly lower scores for the BREAST-Q domains of Satisfaction with Breasts (36.3 versus 59.5; $p < 0.0001$), Psychosocial Well-being (50 versus 66.1; $p < 0.0001$), and Sexual Well-being (29.8 versus 52.1; $p < 0.0001$) (Table 4). Controlling for baseline measures and covariates, at 1 and 2 years after reconstruction, patients reported no difference in scores in all but one of the assessed BREAST-Q domains between the delayed and immediate reconstruction groups; at 2 years of follow-up, Physical Well-being of the chest was scored higher (80.6 versus 70.5; $p = 0.048$) in patients with delayed reconstruction. Patients in both groups reported significantly higher breast satisfaction at 1 and 2 years after surgery compared with baseline ($p = 0.018$ for immediate reconstruction at 1 year and $p = 0.047$

Table 1. Clinical and Sociodemographic Characteristics of the Study Sample

| Variable | Timing | | | <i>p</i> |
|--------------------------|-------------|---------------|-------------|----------|
| | Overall (%) | Immediate (%) | Delayed (%) | |
| No. | 175 | 108 (61.7) | 67 (38.3) | |
| Age | | | | |
| 30–39 yr | 19 (10.9) | 11 (10.2) | 8 (11.9) | 0.952 |
| 40–49 yr | 52 (29.7) | 33 (30.6) | 19 (28.4) | |
| 50–59 yr | 70 (40) | 44 (40.7) | 26 (38.8) | |
| >60 yr | 34 (19.4) | 20 (18.5) | 14 (20.9) | |
| BMI | | | | |
| <30 kg/m ² | 91 (52) | 59 (54.6) | 32 (47.8) | 0.377 |
| ≥30 kg/m ² | 84 (48) | 49 (45.4) | 35 (52.2) | |
| Race | | | | |
| White | 156 (90.7) | 97 (90.7) | 59 (90.8) | 0.980 |
| Other | 16 (9.3) | 10 (9.4) | 6 (9.2) | |
| Ethnicity | | | | |
| Hispanic | 10 (5.8) | 1 (0.9) | 9 (13.4) | 0.001 |
| Non-Hispanic | 164 (94.3) | 106 (99.1) | 58 (86.6) | |
| Education level | | | | |
| No college degree | 83 (47.7) | 51 (47.7) | 32 (47.8) | 0.990 |
| College degree | 91 (52.3) | 56 (52.3) | 35 (52.2) | |
| Employment status | | | | |
| Full-time* | 96 (55.5) | 57 (53.3) | 39 (59.1) | 0.756 |
| Part-time | 20 (11.6) | 13 (12.2) | 7 (10.6) | |
| Unemployed | 57 (33) | 37 (34.6) | 20 (30.3) | |
| Income | | | | |
| <\$50,000 | 47 (27.7) | 26 (24.8) | 21 (32.3) | 0.162 |
| \$50,000–\$99,999 | 65 (38.2) | 46 (43.8) | 19 (29.2) | |
| >\$100,000 | 58 (34.1) | 33 (31.4) | 25 (38.5) | |
| Marital status | | | | |
| Married or partnered | 137 (78.3) | 86 (79.6) | 51 (76.1) | 0.584 |
| Not married or partnered | 38 (21.7) | 22 (20.4) | 16 (23.9) | |
| Laterality | | | | |
| Unilateral | 129 (73.7) | 71 (65.7) | 58 (86.6) | 0.002 |
| Bilateral | 46 (26.3) | 37 (34.3) | 9 (13.4) | |
| Reconstruction type | | | | |
| FTRAM | 21 (12) | 1 (0.9) | 20 (29.9) | <0.001 |
| DIEP | 115 (65.7) | 76 (70.4) | 39 (58.2) | |
| SIEA | 29 (16.6) | 24 (22.2) | 5 (7.5) | |
| Mixed† | 10 (5.7) | 7 (6.5) | 3 (4.5) | |
| Mixed† | 10 (5.7) | 7 (6.5) | 3 (4.5) | |
| Smoking | | | | |
| Nonsmoker | 99 (56.6) | 58 (53.7) | 41 (61.2) | 0.600 |
| Previous smoker | 71 (40.6) | 47 (43.5) | 24 (35.8) | |
| Current smoker | 5 (2.9) | 3 (2.8) | 2 (3) | |
| Chemotherapy | | | | |
| After reconstruction | 83 (47.4) | 81 (75) | 2 (3) | <0.001 |
| Not after reconstruction | 92 (52.6) | 27 (25) | 65 (97) | |

BMI, body mass index; FTRAM, free transverse rectus abdominis musculocutaneous; DIEP, deep inferior epigastric perforator; SIEA, superficial inferior epigastric perforator.

*Full-time employment includes full-time students.

†Mixed reconstruction denotes different flap types for each breast in a bilateral reconstruction procedure.

at 2 years, and $p < 0.0001$ for delayed reconstruction at both time intervals) (Table 5). Delayed reconstruction patients also had improved psychosocial well-being ($p < 0.0001$ at 1 and 2 years) and sexual well-being ($p < 0.0001$ at 1 and 2 years) compared with baseline. Physical well-being for abdomen was not fully restored for both groups at 1 year (within-patient mean difference, -10.9 , $p < 0.0001$ for immediate reconstruction; and -9.2 , $p = 0.001$ for delayed reconstruction), although it was nearly restored for the delayed group by year 2 (-10.1 for immediate reconstruction and -2.0 for delayed reconstruction). Similarly, although

not statistically significant, physical well-being of the chest was not fully restored for patients undergoing immediate reconstruction (-3.0 at 1 year and -2.4 at 2 years).

DISCUSSION

In this study, assessing the effects of postmastectomy radiation therapy on flap complication rates and patient satisfaction, we have found limited postoperative differences when comparing delayed and immediate autologous breast reconstruction. Overall breast complications for delayed

Table 2. One-Year Postoperative Complications in Patients Undergoing Immediate and Delayed Autologous Breast Reconstruction

| | Total (%) | Immediate (%) | Delayed (%) | <i>p</i> * |
|--|-----------|---------------|-------------|------------|
| No. | 175 | 108 | 67 | |
| Breast complications | | | | |
| Any breast complication | 46 (26.3) | 28 (25.9) | 18 (26.9) | 0.540 |
| Postoperative bleeding or hematoma | 8 (4.6) | 6 (5.6) | 2 (3.0) | 0.712 |
| Wound dehiscence | 10 (5.7) | 4 (3.7) | 6 (9.0) | 0.185 |
| Wound infection requiring oral antibiotics | 4 (2.3) | 2 (1.9) | 2 (3.0) | 0.638 |
| Wound infection requiring IV antibiotics | 2 (1.1) | 1 (0.9) | 1 (1.49) | 1.000 |
| Wound infection requiring surgical or percutaneous drainage of abscess | 4 (2.3) | 3 (2.8) | 1 (1.5) | 1.000 |
| Mastectomy skin flap necrosis | 13 (7.4) | 13 (12.0) | 0 (0.0) | 0.002 |
| Acute partial flap necrosis | 5 (2.9) | 0 (0.0) | 5 (7.5) | 0.008 |
| Chronic fat necrosis of the reconstructed flap | 11 (6.3) | 4 (3.7) | 7 (10.5) | 0.107 |
| Seroma | 1 (0.6) | 0 (0.0) | 1 (1.5) | 0.383 |
| Total reconstructive flap loss | 0 | 0 | 0 | — |
| Donor-site complications | | | | |
| Any donor-site complication | 54 (30.9) | 43 (39.8) | 11 (16.4) | 0.244 |
| Postoperative bleeding or hematoma at donor site | 2 (1.1) | 2 (1.9) | 0 (0.0) | 0.525 |
| Wound dehiscence at donor site | 18 (10.3) | 13 (12.0) | 5 (7.5) | 0.445 |
| Wound infection at donor site requiring oral antibiotics | 4 (2.3) | 4 (3.7) | 0 (0.0) | 0.299 |
| Wound infection at donor site requiring IV antibiotics | 2 (1.1) | 1 (0.9) | 1 (1.5) | 1.000 |
| Wound infection at the donor site requiring surgical or percutaneous drainage of abscess | 2 (1.1) | 2 (1.9) | 0 (0.0) | 0.525 |
| Donor-site necrosis | 9 (5.1) | 8 (7.4) | 1 (1.5) | 0.156 |
| Chronic fat necrosis of the donor site | 5 (2.9) | 3 (2.8) | 2 (3.0) | 1.000 |
| Donor-site seroma | 15 (8.6) | 14 (13.0) | 1 (1.5) | 0.010 |
| Abdominal wall bulge, laxity or hernia | 3 (1.7) | 1 (0.9) | 2 (3.0) | 0.559 |

IV, intravenous.

*Based on Fisher's exact test for individual complication items, and based on mixed-effects logistic regression model for any breast complication and any donor-site complication.

and immediate breast reconstruction were similar at 26.9 percent and 25.9 percent, respectively ($p = 0.540$). These complication rates fall within the range reported in the literature (6 to 62.6 percent) on DIEP flap breast reconstruction.²²⁻²⁴ Also consistent with the reported literature on autologous flap outcomes, patients with higher body mass indices ($>30 \text{ kg/m}^2$), had significantly greater odds for breast complications (OR, 2.54; 95 percent CI, 1.14 to 5.68) than patients with lower body mass indices ($<30 \text{ kg/m}^2$).²⁵⁻²⁷ With regard to outcomes, patients undergoing delayed breast reconstruction reported significantly lower scores for baseline satisfaction with breasts and psychosocial and sexual well-being relative to similar patients undergoing immediate reconstruction (Table 3). These preoperative patient-reported outcomes differences in patients with delayed versus immediate breast reconstruction had dissipated at 1 and 2 years after reconstruction.

Radiotherapy has multiple harmful effects on soft tissue and breast reconstruction, ranging from wound healing challenges to skin and flap fibrosis.^{8,9,28-38} With well-documented concerns, the consensus has been to approach immediate reconstruction in patients requiring postmastectomy radiation therapy with caution and delay

flap reconstruction until after radiation therapy to optimize reconstructive results and decrease radiation-associated flap complications.³⁹

Over time, there has been a swell in the level of interest for immediate breast reconstruction. National rates for immediate reconstruction have risen annually, and the need for radiation therapy does not appear to have deterred this growth.^{40,41} With this in mind, a few authors have further explored the feasibility of immediate autologous breast reconstruction with postmastectomy radiation therapy.^{20,21,42,43} Mirzabeigi et al. retrospectively evaluated 407 patients undergoing immediate free flap reconstruction at a single institution.²¹ Of these patients, 127 were exposed to postmastectomy radiation therapy and compared to 280 nonirradiated patients. They found a higher incidence of volume loss and fat necrosis in both unilateral and bilateral flap reconstructions exposed to radiation; however, revision procedures in irradiated and nonirradiated flaps were similar.²¹ Studies by Chang et al. and Taghizadeh et al. found no differences in complications between irradiated and nonirradiated free flap breast reconstruction. Complications they assessed included fat necrosis, wound healing, and additional surgical procedures for associated volume deficiencies.^{20,43}

Table 3. Mixed-Effects Logistic Regression for Any Type of Breast Complication at 1 and 2 Years after Reconstruction

| | 1 Year Postoperatively (n = 175) | | | 2 Years Postoperatively (n = 140) | | |
|--------------------------|----------------------------------|------------|----------|-----------------------------------|------------|----------|
| | OR | 95% CI | <i>p</i> | OR | 95% CI | <i>p</i> |
| Timing | | | | | | |
| Immediate | | Ref. | | | Ref. | |
| Delayed | 1.57 | 0.49–5.00 | 0.442 | 0.88 | 0.24–3.25 | 0.848 |
| Reconstruction type | | | | | | |
| DIEP | | Ref. | | | Ref. | |
| FTRAM | 0.22 | 0.04–1.15 | 0.073 | 0.53 | 0.11–2.49 | 0.421 |
| SIEA | 1.54 | 0.60–3.94 | 0.367 | 1.11 | 0.39–3.12 | 0.847 |
| Mixed | 1.04 | 0.20–5.57 | 0.961 | 0.74 | 0.05–11.37 | 0.827 |
| Laterality | | | | | | |
| Unilateral | | Ref. | | | Ref. | |
| Bilateral | 1.63 | 0.65–4.10 | 0.297 | 1.55 | 0.59–4.11 | 0.374 |
| Chemotherapy | | | | | | |
| Not after reconstruction | | Ref. | | | Ref. | |
| After reconstruction | 0.99 | 0.35–2.82 | 0.992 | 0.77 | 0.24–2.50 | 0.659 |
| Age | | | | | | |
| 30–39 yr | | Ref. | | | Ref. | |
| 40–49 yr | 2.44 | 0.54–11.07 | 0.247 | 3.83 | 0.64–22.80 | 0.138 |
| 50–59 yr | 1.61 | 0.37–7.11 | 0.525 | 1.74 | 0.30–10.17 | 0.537 |
| >60 yr | 2.04 | 0.42–9.94 | 0.377 | 3.55 | 0.57–22.01 | 0.172 |
| BMI | | | | | | |
| <30 kg/m ² | | Ref. | | | Ref. | |
| ≥30 kg/m ² | 2.54 | 1.14–5.68 | 0.023 | 2.12 | 0.88–5.10 | 0.094 |
| Smoking | | | | | | |
| Nonsmoker | | Ref. | | | Ref. | |
| Previous/current smoker | 0.82 | 0.38–1.80 | 0.622 | 1.00 | 0.43–2.33 | 0.994 |
| Race | | | | | | |
| White | | Ref. | | | Ref. | |
| Other | 0.62 | 0.14–2.68 | 0.518 | 0.67 | 0.14–3.27 | 0.621 |
| Education level | | | | | | |
| College degree | | Ref. | | | Ref. | |
| No college degree | 1.25 | 0.56–2.79 | 0.584 | 1.00 | 0.41–2.44 | 0.994 |
| Marital status | | | | | | |
| Married or partnered | | Ref. | | | Ref. | |
| Not married or partnered | 1.59 | 0.65–3.88 | 0.305 | 1.62 | 0.60–4.39 | 0.340 |

Ref., reference; FTRAM, free transverse rectus abdominis musculocutaneous; DIEP, deep inferior epigastric perforator; SIEA, superficial inferior epigastric perforator.

The reality is that irradiation protocols even at centers of excellence within the United States differ, and therefore the results of our current study must be interpreted with this in mind. Consistent with recent research, this current study's findings suggest that immediate abdominally based breast reconstruction in women undergoing postmastectomy radiation therapy can be safe and without significant morbidity. Complication rates between the delayed and immediate reconstruction groups were similar. There were no differences in major or minor complications, including delayed wound healing, infection, flap loss, or fat necrosis, between our two cohorts at 1 year. Overall complications were also not affected at 2-year follow-up. Although we did not evaluate volume changes and degree of firmness or fibrosis as part of the study, these concerns are assessed indirectly from the patient's perspective, which is arguably the most important endpoint in this context.

Understanding that immediate breast reconstruction offers important psychosocial and physical benefits to women undergoing mastectomy, we sought to evaluate satisfaction and quality-of-life changes related to immediate and delayed flap reconstruction with postmastectomy radiation therapy.⁴⁴ With the use of the BREAST-Q, we found that patients undergoing delayed autologous breast reconstruction reported lower preoperative scores for Satisfaction with Breasts and Psychosocial and Sexual Well-being (Table 4), thus corroborating previous findings on timing of reconstruction.¹⁷ However, at 1 and 2 years after reconstruction, these differences did not exist between the immediate and delayed breast reconstruction groups. However, scores for Physical Well-being of the chest in patients with immediate reconstruction were lower than in those with delayed reconstruction at the end of the observation period. Postoperative breast satisfaction, which assesses the patient's perspective on issues

Table 4. Summary of Patient-Reported Outcomes (BREAST-Q) before Reconstruction and at 1 and 2 Years after Reconstruction

| BREAST-Q Domains | Preoperatively | | 1 Year Postoperatively | | 2 Years Postoperatively | |
|--|----------------|------------|------------------------|------------|-------------------------|------------|
| | Mean | <i>p</i> * | Mean† | <i>p</i> ‡ | Mean† | <i>p</i> ‡ |
| Satisfaction with Breasts | | | | | | |
| Immediate | 59.5 | <0.001 | 65.9 | 0.550 | 66.5 | 0.240 |
| Delayed | 36.3 | | 69.6 | | 75.0 | |
| Psychosocial Well-being | | | | | | |
| Immediate | 66.1 | <0.001 | 71.1 | 0.412 | 71.9 | 0.118 |
| Delayed | 50.0 | | 75.1 | | 82.6 | |
| Physical Well-being (chest and upper body) | | | | | | |
| Immediate | 72.9 | 0.358 | 68.2 | 0.485 | 70.5 | 0.048 |
| Delayed | 70.8 | | 70.6 | | 80.6 | |
| Physical Well-being (abdomen) | | | | | | |
| Immediate | 87.3 | 0.058 | 70.8 | 0.921 | 72.2 | 0.171 |
| Delayed | 82.9 | | 70.2 | | 81.2 | |
| Sexual Well-being | | | | | | |
| Immediate | 52.1 | <0.001 | 51.2 | 0.125 | 59.5 | 0.526 |
| Delayed | 29.8 | | 60.4 | | 64.7 | |

*For the comparison of preoperative patient-reported outcome means between immediate and delayed reconstruction groups.

†Adjusted for nonresponse, covariates, and sites (hospitals).

‡For the comparison of postoperative patient-reported outcomes between immediate and delayed reconstruction patients, adjusted for baseline values, nonresponse, covariates, and sites (hospitals).

Table 5. Within-Patient Change in Patient-Reported Outcomes (BREAST-Q) from Preoperative Baseline to 1 and 2 Years after Reconstruction

| BREAST-Q Domains | Within-Patient Change from Preoperatively to 1 Yr Postoperatively | | Within-Patient Change from Preoperatively to 2 Yr Postoperatively | |
|--|---|----------|---|----------|
| | Mean* | <i>p</i> | Mean* | <i>p</i> |
| Satisfaction with Breasts | | | | |
| Immediate | 5.8 | 0.018 | 6.0 | 0.047 |
| Delayed | 30.1 | <0.001 | 32.2 | <0.001 |
| Psychosocial Well-being | | | | |
| Immediate | 4.2 | 0.033 | 3.7 | 0.129 |
| Delayed | 21.2 | <0.001 | 24.1 | <0.001 |
| Physical Well-being (chest and upper body) | | | | |
| Immediate | -3.0 | 0.057 | -2.4 | 0.173 |
| Delayed | 1.9 | 0.324 | 5.8 | 0.007 |
| Physical Well-being (abdomen) | | | | |
| Immediate | -10.9 | <0.001 | -10.1 | <0.001 |
| Delayed | -9.2 | 0.001 | -2.0 | 0.437 |
| Sexual Well-being | | | | |
| Immediate | 0.2 | 0.944 | 0.0 | 0.996 |
| Delayed | 24.2 | <0.001 | 22.8 | <0.001 |

*Adjusted for nonresponse and sites (hospitals).

such as aesthetics, softness, and symmetry, were similar for both groups of patients. In addition, quality of life from the psychosocial and sexual standpoints was equivalent in both groups of patients. Previous attempts at evaluating aesthetic outcomes on immediate flap reconstruction with postmastectomy radiation therapy have done so primarily from the surgeon’s perspective.^{9,31,32,42,45} Although the surgeon’s assessment of aesthetic outcomes is of value, an evaluation of aesthetic outcomes in addition to quality-of-life measures from the patient’s perspective is even more vital. Our findings indicate that women in this cohort

who underwent immediate autologous breast reconstruction have high levels of satisfaction preoperatively and continue to be content with their reconstructed breasts after radiation therapy.

Our findings may relate in part to advances in radiotherapy techniques, including three-dimensional planning and simple intensity modulation, which increasingly allow for greater dose homogeneity within the treated fields. Of note, the vast majority of our patients who underwent immediate flap reconstruction were managed at a single academic center within the Mastectomy Reconstruction Outcomes Consortium. The irradiation

protocol at that center therefore merits specific consideration: a total dose was typically 50.4 Gy in 28 fractions of 1.8 Gy/day, with the use of field-in-field, intensity-modulated radiation therapy to deliver treatment to the reconstructed breast. A boost to the reconstructed breast was not used. Moreover, 45 Gy in 25 fractions was delivered to nodes as believed to be indicated by the local radiation oncologists; for instance, internal mammary nodes were treated in patients with medial tumors or other high-risk features such as N2 disease. This regimen is not atypical in the context of international practice patterns in this setting,⁴⁶ although many institutions, including the senior author's (A.O.M.) center, use slightly larger (2 Gy) fractions, which may increase late effects. Also of potential relevance is the fact that a bolus may be used at other centers to increase the dose to the skin as an intentional target of treatment, again with possible implications for acute and late toxicity. Such subtle differences in radiation techniques may be meaningful, and those seeking to generalize from this study's results should consider whether the radiation protocols at their own institution vary considerably from those used for the vast majority of patients undergoing immediate reconstruction considered in this study. Also with potential implications for many institutions are findings from recent radiation oncology studies that show benefits of decreased recurrence⁴⁷ and improved survival⁴⁸ with regional nodal irradiation in patients with node-positive early-stage breast cancer; although some of the patients treated with radiation therapy in this series did receive treatment to the internal mammary nodes, radiation oncologists may now choose to treat this region in a larger proportion of patients receiving postmastectomy radiotherapy, with possible implications for both toxicity and radiotherapeutic coverage.

The overwhelming evidence in the literature indicates that immediate breast reconstruction is oncologically safe.^{49–51} A topic of considerable debate, however, relates to the potential for compromised delivery of radiation therapy to the chest wall with a reconstructed breast in place.⁵² Motwani and colleagues, evaluating their institutional experience with delivery of radiation therapy to primarily autologous flaps, observed some degree of compromise in the delivery of radiation therapy to 52 percent of reconstructed patients compared with 7 percent in matched controls without reconstruction, when delivery of 45 to 50 Gy to the internal mammary region was one of the criteria by which adequacy was judged.⁵² These findings

are in contrast to a number of studies from other institutions that have shown no compromise to the delivery of radiation therapy to the chest wall with immediate breast reconstruction.^{53–55} Using standard field arrangements and three-dimensional planning, Chung et al. demonstrated that they were able to achieve excellent coverage of the reconstructed breast and internal mammary nodes in patients with implant and autologous breast reconstruction, although it is important to note that the mean heart dose was nontrivial (5.8 Gy) in left-side patients in whom internal mammary treatment was delivered.⁵³ Given growing recognition of the importance of minimizing cardiac dose, consideration of advanced radiation techniques such as breathing control is important for all patients with left-side disease, and particularly those receiving internal mammary treatment, whether the patient has undergone reconstruction or not.

This study has a number of strengths, which include the prospective multicenter design. The prospective nature of this project allows for rigorous and standardized measurement of preoperative confounders, for which the analyses may then appropriately control, and the documentation of patient-reported outcomes changes that occur over time. The planned multicenter design was limited by the fact that most of the immediate reconstructions were performed at one center, limiting the generalizability of our findings. Other limitations include a relatively small sample size and the length of follow-up; the length of follow-up is important because of the potential for late effects of radiation therapy. However, we followed patients for 2 years after reconstruction, similar to other studies on long-term patient-reported outcomes on reconstruction.⁴⁴ Longer term studies on this topic would be of great value.

CONCLUSIONS

From this prospective cohort, immediate autologous breast reconstruction in the setting of postmastectomy radiation therapy appears to be a safe option that may be considered in select patients and centers. Breast aesthetics and quality of life, evaluated prospectively from the patient's perspective, were not compromised by flap exposure to radiotherapy. Given the known benefits of immediate breast reconstruction to the patient, immediate autologous breast reconstruction should at least be considered even in patients who will require radiotherapy. Although not generalizable to all centers, these findings emphasize

the importance of intentional multidisciplinary involvement and exchange between specialists involved in the care of this patient population.

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