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Long-term Patient-Reported Outcomes in Postmastectomy Breast Reconstruction

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IMPORTANCE Previous outcome studies comparing implant and autologous breast reconstruction techniques have been limited by short-term follow-up, single-center design, and a lack of rigorous patient-reported outcome data. An understanding of the expected satisfaction and breast-related quality of life associated with each type of procedure is central to the decision-making process.

OBJECTIVE To determine outcomes reported by patients undergoing postmastectomy breast reconstruction using implant or autologous techniques 2 years after surgery.

DESIGN, SETTING, AND PARTICIPANTS Patients were recruited from 11 centers (57 plastic surgeons) across North America for the Mastectomy Reconstruction Outcomes Consortium study, a prospective, multicenter trial, from February 1, 2012, to July 31, 2015. Women undergoing immediate breast reconstruction using implant or autologous tissue reconstruction after mastectomy for cancer treatment or prophylaxis were eligible. Overall, 2013 women (1490 implant and 523 autologous tissue reconstruction) met the inclusion criteria. All patients included in this analysis had 2 years of follow-up.

EXPOSURES Procedure type (ie, implant vs autologous tissue reconstruction).

MAIN OUTCOMES AND MEASURES The primary outcomes of interest were scores on the BREAST-Q, a validated, condition-specific, patient-reported outcome instrument, which were collected prior to and at 2 years after surgery. The following 4 domains of the BREAST-Q reconstruction module were evaluated: satisfaction with breasts, psychosocial well-being, physical well-being, and sexual well-being. Responses from each scale were summed and transformed on a 0 to 100 scale, with higher numbers representing greater satisfaction or quality of life.

RESULTS Of the 2013 women in the study (mean [SD] age, 48.1 [10.5] years for the group that underwent implant-based reconstruction and 51.6 [8.7] years for the group that underwent autologous reconstruction), 1217 (60.5%) completed questionnaires at 2 years after reconstruction. After controlling for baseline patient characteristics, patients who underwent autologous reconstruction had greater satisfaction with their breasts (difference, 7.94; 95% CI, 5.68-10.20; $P < .001$), psychosocial well-being (difference, 3.27; 95% CI, 1.25-5.29; $P = .002$), and sexual well-being (difference, 5.53; 95% CI, 2.95-8.11; $P < .001$) at 2 years compared with patients who underwent implant reconstruction.

CONCLUSIONS AND RELEVANCE At 2 years, patients who underwent autologous reconstruction were more satisfied with their breasts and had greater psychosocial well-being and sexual well-being than did those who underwent implant reconstruction. These findings can inform patients and their clinicians about expected satisfaction and quality of life outcomes of autologous vs implant-based procedures and further support the adoption of shared decision making in clinical practice.

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More than 60% of women who have a mastectomy for breast cancer treatment choose to undergo breast reconstruction, representing an increase in the use of breast reconstruction of nearly 20% since 1998.[1] With the advent of genetic testing, advances in reconstructive and imaging techniques, and an increased presence in the media of breast reconstruction, the number of women undergoing mastectomy for prophylaxis has increased in tandem, also contributing to the rise in demand for breast reconstruction after mastectomy.[2-6]

Breast reconstruction can improve a patient's quality of life and alleviate the psychological distress associated with mastectomy.[7] Despite the considerable literature evaluating outcomes after breast reconstruction, only a minority of patients make high-quality decisions about breast reconstruction, a statistic that calls for better shared decision making.[8,9] As multiple techniques exist in breast reconstruction, shared decision making—a collaborative process between patients and clinicians—can help patients navigate the process by using evidence-based, patient-centered data in combination with patient preferences.[10] Such data in breast reconstruction studies were not previously available owing to a lack of well-developed and valid, condition-specific, patient-reported outcome measures.[11,12] However, our understanding of the association of breast reconstruction with patient-reported outcomes has substantially improved through the widespread use and adoption of the BREAST-Q,[13-16] a validated, breast surgery-specific, patient-reported outcome instrument calibrated to detect differences between specific procedure groups and patients over time.[17]

Previous studies have also been limited by an absence of patients' preoperative or baseline assessments of satisfaction with their breasts and their quality of life. Baseline scores are important, as women undergoing breast reconstruction after mastectomy may start the process with different levels of satisfaction with their breasts and quality of life.[18] Moreover, most breast reconstruction outcome studies have reported experiences from a single institution, which calls into question the generalizability of their results. Finally, follow-up of patients in previous studies has been limited. Outcomes, especially patient-reported outcomes, may change over time. Recently, the 1-year patient-reported outcomes of the Mastectomy Reconstruction Outcomes Consortium (MROC) study found that women who chose autologous reconstruction were more satisfied with their breasts and reported greater psychosocial and sexual well-being than did women who chose breast reconstruction via implant-based reconstruction.[18] Although these findings are important, we recognize the need to evaluate patient-reported outcomes beyond 1 year of patients who undergo immediate breast reconstruction after mastectomy.

In this study, we build on the 1-year patient-reported outcomes of the MROC study and discuss patient-reported outcomes of immediate breast reconstruction at 2 years after surgery. We also present a descriptive analysis of patient-reported outcome data at 3 and 4 years after mastectomy. The goal of this study was to evaluate the experiences of women with longer-term follow-up to assess the association of breast reconstruction with patient-reported outcomes over time. We anticipate that this information will inform patients and their clinicians about expected quality of life outcomes of autologous vs implant-based procedures and further support the adoption of shared decision making in clinical practice.

Key Points

Question How do satisfaction and breast-related quality of life differ between patients undergoing implant-based vs autologous immediate breast reconstruction at 2 years after surgery?

Findings In this multicenter cohort study, patients who underwent autologous reconstruction reported significantly greater satisfaction with their breasts (BREAST-Q score difference, 7.94), psychosocial well-being (difference, 3.23), and sexual well-being (difference, 5.53) at 2 years compared with patients who underwent implant reconstruction.

Meaning At 2 years after reconstruction, patients who underwent autologous reconstruction reported significantly greater satisfaction and breast-related quality of life compared with patients who underwent implant-based techniques.

Methods

Study Population

Patients were recruited as part of the MROC study, which involved 57 plastic surgeons at 11 academic and private practice sites across the United States and Canada. The primary aim of the MROC study was to evaluate the outcomes of different types of breast reconstruction. Women 18 years or older undergoing first-time immediate or delayed unilateral or bilateral reconstruction after mastectomy for breast cancer treatment or prophylaxis were eligible. Approval was obtained from the following institutional review boards at the US sites and research ethics boards at the Canadian sites: University of Michigan Human Research Protection Program, Memorial Sloan Kettering Institutional Review Board, Brigham and Women's Hospital Partners Human Research Committee, Georgia Institute of Plastic Surgery Institutional Review Board, Georgetown University Institutional Review Board, MD Anderson Cancer Center Institutional Review Board, Northwestern University Institutional Review Board, Saint Joseph Mercy Hospital Institutional Review Board, The Ohio State University Human Research Protection Program, University of Manitoba Office of Research Ethics & Compliance, and University of British Columbia Office of Research Ethics. All patients provided written informed consent.

For this analysis, we included patients enrolled in the MROC study from February 1, 2012, to July 31, 2015, who underwent immediate implant-based (ie, direct-to-implant, tissue expander and implant) or autologous (ie, pedicled transverse rectus abdominis myocutaneous flap, free transverse rectus abdominis myocutaneous flap, deep inferior epigastric perforator flap, or superficial inferior epigastric artery flap) breast reconstruction after mastectomy for cancer treatment or prophylaxis. All patients had at least 2 years of follow-up after reconstruction. Patients were excluded from the study

if they did not complete the study's preoperative surveys, received latissimus dorsi reconstructions (with or without tissue expander and implant), underwent a mixed approach (ie, bilateral reconstruction with unilateral implant and unilateral autologous reconstruction) or mixed timing (ie, immediate reconstruction on one side, delayed reconstruction on the contralateral side), changed their reconstructive technique during enrollment in the study, and/or experienced reconstructive failure (defined as removal of implant without replacement or total flap loss).

Questionnaire Administration

Patients completed the BREAST-Q up to 90 days before surgery and at 1, 2, 3, and 4 years after surgery. Respondents to our questionnaires at 3 and 4 years originally consented for up to 2 years of follow-up, then re-consented if they were willing to complete questionnaires beyond this 2-year time point. If patients were unable to complete questionnaires electronically, a paper version was provided to them either in the clinic or by mail.

Dependent Variables

The primary outcome of interest was BREAST-Q scores. The BREAST-Q reconstruction module is a validated, condition-specific, patient-reported outcome measure that has been widely used to measure health-related quality of life and satisfaction in patients who undergo breast reconstruction. The BREAST-Q was developed using a modern psychometric approach called *Rasch measurement theory analysis*.[19] The scales that were used in this study included the following: satisfaction with breasts, psychosocial well-being, sexual well-being, physical well-being of the chest and upper body, and physical well-being of the abdomen. Responses from each scale were summed and transformed on a 0 to 100 scale, with higher numbers representing greater satisfaction or quality of life.

Primary Independent Variable and Covariates

The primary independent variable was procedure type (ie, autologous vs implant-based reconstruction). Demographic and clinical variables included age, body mass index, race, ethnicity, educational level, income, marital status, employment status, diabetes status, smoking status, laterality of reconstruction (ie, unilateral vs bilateral), lymph node management, indication for mastectomy, type of mastectomy received, radiotherapy, and chemotherapy.

Statistical Analysis

Patient characteristics by procedure type were analyzed using the *t* test for continuous variables or χ^2 test for categorical variables. Preoperative, 1-year, and 2-year postoperative patient-reported outcome scores for each procedure type were summarized using mean (SD) values. To further compare patient-reported outcome scores, separate mixed-effects regression models were constructed, with dependent variables being the outcome measures at 1 and 2 years after reconstruction. Each model included an indicator for procedure type (with implant reconstruction as the reference group) and an indicator for time (with 1 year after reconstruction as the reference group). Clinical and demographic covariates and baseline values of the corresponding outcome measure, as well as 2 sets of random intercepts—1 for centers (hospitals) and 1 for patients nested within centers—were also included. This arrangement allowed for the comparison of postoperative patient-reported outcome scores between 2 procedure types over time while also accounting for between-patient and between-center variability.

Patient-reported outcome scores at 2 years after reconstruction were missing for 796 of 2013 patients (39.5%). To reduce potential bias, multiple imputations with chained equations were used to create 10 complete imputed data sets in which missing data for covariate, 1-year outcomes, and 2-year outcomes were imputed. The regression models specified above were fit for each imputed data set. The results were then combined using Rubin's rules.[20] Statistical analyses were performed using SAS, version 9.4 (SAS Institute), and $P < .05$ was considered statistically significant. For the data collected at 3 and 4 years after reconstruction, only descriptive statistics were generated to evaluate outcomes of these patients because of the relatively small sample size and lower response rates.

Results

Summary of Demographic Data

A total of 2013 patients were included in the analyses. Of these women, 1490 (74.0%) elected to undergo implant-based reconstruction, and 523 (26.0%) chose autologous reconstruction. Of the 523 patients who underwent autologous reconstruction, 320 (61.2%) underwent deep inferior epigastric perforator flap procedures, 75 (14.3%) underwent pedicled transverse rectus abdominis myocutaneous flap procedures, 69 (13.2%) underwent free transverse rectus abdominis myocutaneous flap procedures, and 59 (11.3%) underwent superficial inferior epigastric artery flap procedures. Two years after reconstruction, 1217 patients (60.5%) completed the BREAST-Q survey. As expected, response rates decreased at 3 and 4 years after reconstruction, with 422 respondents (21.0%) completing the patient-reported outcome questionnaire at 3 years and 205 respondents (10.2%) completing the patient-reported outcome questionnaire at 4 years.

Baseline demographic and clinical variables of the 2 procedure groups are summarized in **Table 1**. Age, body mass index, laterality of reconstruction, lymph node management, type of mastectomy received, diabetes status, smoking status, and use of radiotherapy were significantly different between patients who underwent implant-based and those who underwent autologous reconstruction. However, there were no differences in the distribution of indication for mastectomy or use of chemotherapy between the 2 groups. There were differences in education and income levels; however, there were no differences in distributions of race, ethnicity, marital status, or employment status.

Unadjusted Mean Patient-Reported Outcome Scores

Mean patient-reported outcome scores obtained preoperatively and at different times after surgery are presented in

Table 1. Clinical and Demographic Characteristics of Patients by Procedure Type

Characteristic	No./Total No. (%)		*P* Value
	Implant-Based Reconstruction (n = 1490)[a]	Autologous Reconstruction (n = 523)[a]	
Age, mean (SD), y	48.1 (10.5)	51.6 (8.7)	<.001
Body mass index, mean (SD)[b]	25.4 (5.1)	29.0 (5.6)	<.001
Laterality of reconstruction, No. (%)			
Unilateral	559 (37.5)	313 (59.8)	<.001
Bilateral	931 (62.5)	210 (40.2)	
Indication, No. (%)			
Therapeutic	1317 (88.4)	467 (89.3)	.58
Prophylactic	173 (11.6)	56 (10.7)	
Lymph node management, No. (%)			
None	306 (20.5)	141 (27.0)	<.001
Sentinel lymph node biopsy	744 (49.9)	281 (53.7)	
Axillary lymph node dissection	440 (29.5)	101 (19.3)	
Mastectomy type, No. (%)			
Nipple sparing	267 (17.9)	15 (2.9)	<.001
Simple or modified radical	1212 (81.3)	508 (97.1)	
Mixed	11 (0.7)	0	
Diabetes, No. (%)			
Yes	38 (2.6)	34 (6.5)	<.001
No	1452 (97.4)	489 (93.5)	
Smoking status			
Never smoker	1005/1473 (68.2)	304/521 (58.3)	<.001
Previous smoker	437/1473 (29.7)	200/521 (38.4)	
Current smoker	31/1473 (2.1)	17/521 (3.3)	
Radiotherapy, No. (%)			
Before reconstruction	74 (5.0)	90 (17.2)	<.001
During or after reconstruction	277 (18.6)	118 (22.6)	
None	1139 (76.4)	315 (60.2)	
Chemotherapy, No. (%)			
During or after reconstruction	470 (31.5)	168 (32.1)	.81
None	1020 (68.5)	355 (67.9)	
Race			
White	1303/1477 (88.2)	449/517 (86.8)	.10
Black	96/1477 (6.5)	28/517 (5.4)	
Other	78/1477 (5.3)	40/517 (7.7)	
Ethnicity			
Hispanic or Latina	86/1464 (5.9)	21/512 (4.1)	.13
Non-Hispanic or Latina	1378/1464 (94.1)	491/512 (95.9)	
Educational level			
High school or less	107/1485 (7.2)	84/520 (16.2)	<.001
Some college	203/1485 (13.7)	111/520 (21.3)	
College degree	650/1485 (43.8)	233/520 (44.8)	
Masters or doctoral degree	525/1485 (35.4)	92/520 (17.7)	
Income, $			
<50 000	197/1445 (13.6)	119/507 (23.5)	<.001
50 000-99 999	428/1445 (29.6)	208/507 (41.0)	
≥100 000	820/1445 (56.7)	180/507 (35.5)	
Marital status			
Married or partnered	1165/1478 (78.8)	417/522 (79.9)	.61
Not married or partnered	313/1478 (21.2)	105/522 (20.1)	

(continued)

Table 1. Clinical and Demographic Characteristics of Patients by Procedure Type (continued)

Characteristic	No./Total No. (%)		P Value
	Implant-Based Reconstruction (n = 1490)[a]	Autologous Reconstruction (n = 523)[a]	
Employment status			
Full-time (including student)	851/1473 (57.8)	311/515 (60.4)	.45
Part-time	200/1473 (13.6)	60/515 (11.7)	
Unemployed	422/1473 (28.6)	144/515 (28.0)	

[a] The cell values may not total to the overall cohort size owing to missing data.

[b] Calculated as weight in kilograms divided by height in meters squared.

Table 2. Summary of Patient-Reported Outcome Scores on BREAST-Q by Procedure Type

Patient-Reported Outcome on BREAST-Q	Procedure	Score, Mean (SD)				
		At Baseline	At 1 y	At 2 y	At 3 y	At 4 y
Satisfaction with breast	Implant-based reconstruction	64.0 (21.3)	63.1 (17.4)	64.2 (18.0)	64.3 (18.6)	62.4 (17.4)
	Autologous reconstruction	58.2 (20.2)	68.6 (17.0)	68.5 (18.3)	74.1 (17.5)	70.9 (18.6)
Psychosocial well-being	Implant-based reconstruction	71.9 (17.5)	71.8 (19.3)	74.5 (18.9)	75.8 (19.0)	74.5 (19.1)
	Autologous reconstruction	68.0 (18.2)	74.7 (19.3)	75.5 (19.0)	81.7 (17.4)	78.9 (18.3)
Physical well-being of chest and upper body	Implant-based reconstruction	80.3 (14.3)	76.0 (14.6)	77.3 (14.3)	77.7 (14.4)	77.8 (15.2)
	Autologous reconstruction	76.8 (15.3)	74.9 (15.1)	75.6 (15.4)	78.4 (15.0)	75.7 (16.0)
Physical well-being of abdomen	Implant-based reconstruction	90.8 (12.7)	NA[a]	NA[a]	NA[a]	NA[a]
	Autologous reconstruction	87.4 (15.1)	74.6 (19.5)	76.3 (19.8)	77.9 (19.0)	78.8 (20.1)
Sexual well-being	Implant-based reconstruction	58.8 (19.0)	52.7 (21.1)	53.9 (21.3)	55.7 (19.8)	53.5 (20.7)
	Autologous reconstruction	53.5 (20.8)	55.5 (20.6)	57.1 (21.7)	62.1 (19.6)	59.9 (19.8)

Abbreviation: NA, not available.

[a] BREAST-Q physical well-being of abdomen scores were not collected for patients who underwent implant-based reconstruction.

Table 2. Compared with patients who underwent implant reconstruction, those who underwent autologous reconstruction reported higher satisfaction with their breasts longitudinally over time, although they began the process of reconstruction with lower scores in this domain. Patients who underwent implant reconstruction reported relatively stable scores for satisfaction with their breasts at 2, 3, and 4 years after reconstruction. Psychosocial well-being scores among both groups of patients remained elevated at 2, 3, and 4 years after reconstruction compared with reported baseline scores. The difference between preoperative and postoperative scores was greater across all time points in the group that underwent autologous reconstruction than in the group that underwent implant reconstruction. Unadjusted mean patient-reported outcome scores for physical well-being of the chest appeared to decrease from baseline at all time points for patients who underwent implant reconstruction but remained relatively stable over time for those who underwent autologous reconstruction. Across all time points, patients who underwent implant reconstruction reported worsened sexual well-being scores compared with baseline. Patients who underwent autologous reconstruction, however, reported higher sexual well-being scores at all follow-up points compared with baseline. For physical well-being of the abdomen, patients undergoing autologous procedures reported significantly lower scores at 1 year after reconstruction compared with baseline (mean difference, -13.70; 95% CI, -16.00 to -11.40; $P < .001$). This difference remained at 2 years after surgery (mean difference, -12.90; 95% CI, -14.90 to -10.90; $P < .001$).

Mixed-Effects Regression Model Results

Results from the mixed-effects regression models are presented in **Table 3.** Patients who chose autologous reconstruction had significantly higher levels of satisfaction with their breasts (mean difference, 7.94; 95% CI, 5.68-10.20; $P < .001$), psychosocial well-being (mean difference, 3.27; 95% CI, 1.25-5.29; $P = .002$), physical well-being of the chest (mean difference, 1.69; 95% CI, 0.13-3.24; $P = .03$), and sexual well-being (mean difference, 5.53; 95% CI, 2.95-8.11; $P < .001$) at 2 years compared with patients who chose implant reconstruction.

Across the entire cohort, patients reported higher psychosocial well-being (mean difference, 1.38; 95% CI, 0.52-2.24; $P = .002$) and physical well-being of the chest (mean difference, 0.91; 95% CI, 0.19-1.63; $P = .01$) at 2 years compared with 1 year after surgery. There was no significant change in satisfaction with the breast (mean difference, 0.41; 95% CI, −0.53 to 1.35; $P = .39$) or sexual-well-being (mean difference, 0.69; 95% CI, −0.16 to 1.54; $P = .11$) scores between the 1-year and 2-year follow-up times.

Discussion

Given the personal and intimate nature of breast reconstruction, patient-centered data are arguably the best measures of outcomes. These data inform patients and clinicians of the potential risks and expected outcomes between different types of reconstruction, helping future patients navigate through the options that exist for breast reconstruction. One major

Table 3. Mixed-Effects Regression Model for Postoperative Patient-Reported Outcomes

Variable	β (95% CI)			
	BREAST-Q Satisfaction With Breast	BREAST-Q Psychosocial Well-being	BREAST-Q Physical Well-being	BREAST-Q Sexual Well-being
Age	0.04 (−0.04 to 0.12)	0.22 (0.13 to 0.30)[a]	0.03 (−0.04 to 0.11)	0.21 (0.11 to 0.32)[a]
Body mass index	−0.30 (−0.45 to −0.15)[a]	−0.16 (−0.34 to 0.01)	−0.23 (−0.35 to −0.11)[a]	−0.16 (−0.34 to 0.01)
Baseline outcome	0.09 (0.05 to 0.12)[a]	0.38 (0.34 to 0.43)[a]	0.35 (0.31 to 0.39)[a]	0.37 (0.32 to 0.42)[a]
Time				
1 y Postoperatively	[Reference]	[Reference]	[Reference]	[Reference]
2 y Postoperatively	0.41 (−0.53 to 1.35)	1.38 (0.52 to 2.24)[b]	0.91 (0.19 to 1.63)[b]	0.69 (−0.16 to 1.54)
Procedure type				
Implant-based reconstruction	[Reference]	[Reference]	[Reference]	[Reference]
Autologous reconstruction	7.94 (5.68 to 10.20)[a]	3.27 (1.25 to 5.29)[b]	1.69 (0.13 to 3.24)[b]	5.53 (2.95 to 8.11)[a]
Laterality				
Unilateral	[Reference]	[Reference]	[Reference]	[Reference]
Bilateral	2.81 (1.23 to 4.39)[b]	−0.16 (−1.81 to 1.49)	−0.75 (−1.98 to 0.48)	0.23 (−1.64 to 2.10)
Indication for mastectomy				
Therapeutic	[Reference]	[Reference]	[Reference]	[Reference]
Prophylactic	0.80 (−2.04 to 3.63)	2.76 (−0.49 to 6.02)	0.45 (−1.85 to 2.76)	1.81 (−1.71 to 5.32)
Lymph node management				
None	[Reference]	[Reference]	[Reference]	[Reference]
Axillary lymph node dissection	−2.57 (−5.22 to 0.08)	−1.86 (−4.58 to 0.86)	−0.53 (−2.62 to 1.57)	−1.22 (−4.46 to 2.01)
Sentinel lymph node biopsy	−1.78 (−4.14 to 0.58)	−0.95 (−3.37 to 1.47)	0.60 (−1.15 to 2.34)	−1.37 (−3.91 to 1.16)
Mastectomy type				
Simple or modified radical	[Reference]	[Reference]	[Reference]	[Reference]
Nipple sparing	0.38 (−2.20 to 2.96)	2.65 (0.29 to 5.02)[b]	0.07 (−1.88 to 2.02)	5.25 (2.62 to 7.87)[a]
Mixed	−2.02 (−13.82 to 9.78)	0.66 (−10.61 to 11.93)	−0.66 (−9.62 to 8.30)	−5.46 (−19.50 to 8.58)
Diabetes				
No	[Reference]	[Reference]	[Reference]	[Reference]
Yes	−1.17 (−5.75 to 3.42)	3.43 (−1.66 to 8.52)	−1.81 (−4.91 to 1.29)	0.44 (−5.06 to 5.95)
Smoking status				
Never smoker	[Reference]	[Reference]	[Reference]	[Reference]
Previous smoker	−3.30 (−4.90 to −1.70)[a]	−2.24 (−3.80 to −0.67)[b]	−0.92 (−2.25 to 0.41)	−3.09 (−5.07 to −1.10)[b]
Current smoker	−6.14 (−12.69 to 0.40)	−4.79 (−10.19 to 0.60)	−2.05 (−6.16 to 2.05)	−3.62 (−9.59 to 2.35)
Radiotherapy				
None	[Reference]	[Reference]	[Reference]	[Reference]
Before reconstruction	−1.60 (−4.56 to 1.36)	−1.04 (−4.53 to 2.44)	−0.40 (−2.49 to 1.69)	0.32 (−3.43 to 4.07)
During or after reconstruction	−7.35 (−9.51 to −5.19)[a]	−4.14 (−6.24 to −2.04)[a]	−6.04 (−7.65 to −4.42)[a]	−3.41 (−6.11 to −0.71)[b]
Chemotherapy				
None	[Reference]	[Reference]	[Reference]	[Reference]
During or after reconstruction	−1.25 (−3.33 to 0.83)	−1.93 (−3.74 to −0.12)[b]	0.75 (−0.60 to 2.10)	−2.70 (−5.06 to −0.34)[b]
Race				
White	[Reference]	[Reference]	[Reference]	[Reference]
Black	1.66 (−1.85 to 5.16)	5.31 (0.71 to 9.90)[b]	1.05 (−1.97 to 4.07)	6.55 (1.72 to 11.37)[b]
Other	−1.63 (−6.13 to 2.87)	−1.58 (−4.82 to 1.66)	−2.88 (−5.95 to 0.18)	−0.08 (−4.79 to 4.63)
Ethnicity				
Non-Hispanic/Latina	[Reference]	[Reference]	[Reference]	[Reference]
Hispanic/Latina	2.89 (−1.24 to 7.01)	−0.71 (−4.73 to 3.30)	0.92 (−1.61 to 3.44)	4.13 (−0.39 to 8.65)
Educational level				
High school or less	[Reference]	[Reference]	[Reference]	[Reference]
Some college	−3.55 (−7.18 to 0.09)	−1.93 (−4.90 to 1.04)	−1.08 (−3.60 to 1.44)	−4.12 (−7.73 to −0.50)[b]
College degree	−2.55 (−5.55 to 0.44)	−1.41 (−4.27 to 1.46)	0.28 (−1.77 to 2.33)	−3.57 (−7.03 to −0.10)[b]
Masters or doctoral degree	−1.93 (−5.23 to 1.38)	−1.52 (−4.61 to 1.57)	1.28 (−0.98 to 3.55)	−3.87 (−7.84 to 0.09)

(continued)

Table 3. Mixed-Effects Regression Model for Postoperative Patient-Reported Outcomes (continued)

Variable	β (95% CI)			
	BREAST-Q Satisfaction With Breast	BREAST-Q Psychosocial Well-being	BREAST-Q Physical Well-being	BREAST-Q Sexual Well-being
Income, $				
<50 000	[Reference]	[Reference]	[Reference]	[Reference]
50 000-99 999	−0.64 (−3.06 to 1.79)	1.28 (−1.18 to 3.74)	1.03 (−1.00 to 3.06)	−0.75 (−4.11 to 2.61)
≥100 000	0.89 (−1.80 to 3.59)	2.36 (−0.25 to 4.97)	1.48 (−0.66 to 3.61)	−0.82 (−3.86 to 2.21)
Marital status				
Not married or partnered	[Reference]	[Reference]	[Reference]	[Reference]
Married or partnered	2.43 (0.50 to 4.37)[b]	2.73 (0.83 to 4.64)[b]	0.36 (−1.34 to 2.07)	2.66 (0.12 to 5.19)[b]
Employment status				
Unemployed	[Reference]	[Reference]	[Reference]	[Reference]
Full-time	1.43 (−0.51 to 3.38)	0.22 (−1.75 to 2.19)	−0.25 (−1.63 to 1.13)	0.32 (−2.04 to 2.67)
Part-time	−0.56 (−3.08 to 1.96)	−0.13 (−2.74 to 2.48)	2.08 (0.20 to 3.96)[b]	1.87 (−1.75 to 5.48)

[a] $P < .001$.

[b] $P < .05$.

decision is whether to undergo implant-based or autologous breast reconstruction. Although there are many factors to consider, an understanding of the expected satisfaction with breasts and quality of life is central to the decision-making process.

At 2 years after surgery, patients in our study who underwent autologous reconstruction reported significantly higher levels of satisfaction with their breasts and quality of life, as measured by higher psychosocial, physical, and sexual well-being scores, than did patients who underwent implant reconstruction. However, these benefits in satisfaction and quality of life may come with a price in abdominal donor site morbidity. Abdominal well-being among patients who underwent autologous reconstruction not only worsened from baseline in the acute 1-year postoperative period, but did not return to baseline even at 2 years after surgery. The magnitude of the difference was clinically meaningful; patients who underwent autologous reconstruction reported a mean decrease of 13 points in physical well-being of abdomen scores at 2 years compared with baseline. Most patients who chose autologous reconstruction underwent abdominal muscle-sparing techniques, such as deep inferior epigastric perforator flaps (61.2%), while only 14.3% underwent muscle-sacrificing pedicled transverse rectus abdominis myocutaneous flap procedures. Although many speculate that abdominal muscle-sparing techniques lessen donor site morbidity compared with pedicle-based techniques, our findings suggest otherwise. Studies to determine why physical well-being is compromised after abdominal muscle-sparing techniques are needed.

Our study also provides insights about how patient-reported outcomes change over time. A previous study focused on patient-reported outcomes of breast reconstruction at 1 year and showed that patients who underwent autologous reconstruction were more satisfied with their breasts and had greater psychosocial and sexual well-being than did patients who underwent implant reconstruction.[18] There was, however, no difference in physical well-being of the chest between the 2 groups at this time point.[18] In contrast, at 2 years in the present study, all domains of the BREAST-Q, including physical well-being of the chest, significantly favored autologous vs implant reconstruction. The magnitude of the differences in patients' satisfaction with their breasts and sexual well-being also became greater at 2 years, highlighting how patient-reported outcomes can change over time.

The literature on outcomes of breast reconstruction is vast; however, there are few studies that evaluate patient-reported outcomes beyond 1 year. Here, we present descriptive statistics of patient-reported outcomes at 3 and 4 years after reconstruction. To our knowledge, this is the first prospective study of patient-reported outcomes after immediate breast reconstruction to evaluate patient outcomes up to 4 years after their initial surgery. Unadjusted mean patient-reported outcome scores at 3 and 4 years suggest a sustained positive association of autologous reconstruction on patient satisfaction and sexual well-being but also highlight that physical well-being of the abdomen does not return to baseline scores even at 4 years after reconstruction. The sustained satisfaction in the long term with breast and sexual well-being among patients who underwent autologous reconstruction may represent the ability of the reconstructed breast to naturally age or undergo ptosis, thus maintaining better symmetry with the contralateral breast, a commonly cited benefit of autologous reconstruction among older women.[21] For patients who underwent implant-based reconstruction, satisfaction with breast and sexual well-being appeared to gradually worsen over time, with lower unadjusted mean patient-reported outcome scores at 4 years compared with baseline. Alluding to the argument made about patients who underwent autologous reconstruction benefiting from natural aging of the reconstructed breast, the worsening over time among patients who underwent implant reconstruction may reflect the inability of the reconstructed breast to undergo ptosis to match the contralateral breast. Despite the difference between the 2 groups, all patients in our study, whether undergoing implant or autologous reconstruction, reported improved psychosocial well-being at 3 and 4 years after re-

construction compared with baseline, emphasizing the positive outcome that breast reconstruction can have on long-term quality of life.

Although the focus of our study was to compare patient-reported outcomes of different reconstruction types, our findings show that other patient and treatment characteristics are significantly associated with patient-reported outcomes. Another important decision facing patients after mastectomy is whether to undergo unilateral or bilateral reconstruction. Despite the rise in risk for complications and health care use costs,[22,23] more patients are electing to undergo contralateral prophylactic mastectomy for unilateral breast cancer, especially in the setting of immediate breast reconstruction.[24-26] In addition to concern for contralateral malignant neoplasms and anxiety, another reason women cite for undergoing contralateral prophylactic mastectomy is the desire for symmetry,[27] which can have a significant association with patient-reported outcomes, especially satisfaction with the breast, as our findings suggest. The ability to control for symmetry may affect the fact that women who undergo bilateral procedures report higher patient-reported outcomes than do women who undergo unilateral reconstruction.[24] In addition, future studies to determine the association of laterality and type of reconstruction (ie, bilateral autologous vs bilateral implant-based reconstruction) with patient-reported outcomes are warranted. Our analysis also reaffirms that radiotherapy during or after reconstruction is negatively associated with satisfaction and breast-related quality of life.[28-30] We acknowledge that other factors besides reconstruction type can affect patient-reported outcomes of breast reconstruction over time.

Strengths and Limitations

Strengths of this study include its multicenter, prospective design; inclusion of preoperative patient-reported outcome data; use of the BREAST-Q; and longer follow-up. However, limitations remain. First, we recognize that our results at 3 and 4 years may be affected by response bias given the lower response rates at our later follow-up times (21.0% at 3 years and 10.2% at 4 years). Second, most of our patients underwent reconstruction at urban academic centers, so our findings may not be generalizable to women treated at smaller, nonacademic centers. Third, as this study was a nonrandomized clinical trial, there may have been confounders that were not controlled for. Fourth, our findings may reflect lead-time bias in that patients who underwent autologous reconstruction had nearly 2 years to recover, while it took longer for patients who opted for an implant-based procedure to complete their reconstruction. Finally, given our exclusion of patients who changed their reconstructive technique (97 patients) and those who experienced reconstructive failure (123 patients), our findings reflect the experiences of women who successfully completed their desired reconstructive technique and may not be applicable to subgroups of women who were excluded.

Conclusions

Using multicenter prospective data from patients who underwent immediate breast reconstruction, we found that patients who opted for autologous reconstruction had higher satisfaction with their breasts and better breast-related quality of life at 2 years after surgery than did patients who underwent implant reconstruction. However, these patient-reported outcome benefits experienced by patients who underwent autologous reconstruction were accompanied by worsened abdominal (or donor site) well-being, emphasizing the importance of educating patients about the tradeoffs inherent in choosing a reconstructive option. In the long term, all patients, regardless of reconstruction type, reported improved psychosocial well-being compared with preoperative scores, highlighting the positive association of postmastectomy breast reconstruction with breast-related quality of life.

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Concept and design: Kim, Hamill, Wilkins, Pusic.
Acquisition, analysis, or interpretation of data: All authors.
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Invited Commentary

Autologous vs Prosthetic Breast Reconstruction
Where Do We Stand?

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In this issue of *JAMA Surgery*, 2 studies based on a prospective cohort, the Multicenter Reconstruction Outcomes Consortium, examine the outcomes of breast reconstruction across 11 centers.[1,2] The first study examined complication rates of postmastectomy breast reconstruction at 2 years after surgery.[1] Patients who underwent autologous reconstruction had greater odds of developing complications and experiencing reoperative complications compared with patients who underwent prosthetic reconstruction, but had a lower chance of infection and failure. Overall failure rates were 7.1% with implant-based techniques and 1.2% for deep inferior epigastric artery perforator flaps. A startling finding was the rate of reoperative complications, which ranged from 15.5% for expander implant reconstruction to 29.2% for the deep inferior epigastric artery perforator flap procedure. These rates are similar to those published by Alderman et al[3] in the 2-year follow-up of the Michigan Breast Reconstruction Outcome study conducted more than 15 years ago. Further analysis of the reoperative complications will help us understand and improve these numbers.

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The second study examined 2-year satisfaction with scores on the BREAST-Q survey, a validated patient-reported outcome instrument.[2] The authors found greater satisfaction and breast-related quality of life in patients who underwent au-