
Predictors of Breast Asymmetry after Breast-Conserving Operation for Breast Cancer

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- BACKGROUND:** Although breast-conserving surgery is the standard of care for early-stage breast cancer, many women report breast asymmetry after this procedure. Risk factors for poor esthetic outcomes are not well understood.
- STUDY DESIGN:** A self-administered survey was sent to patients who underwent lumpectomy (n = 898) at the University of Michigan Medical Center between January 2002 and May 2006 (n = 714, response rate = 79.5%). Breast asymmetry was assessed using items from the Breast Cancer Treatment and Outcomes Survey. Responses were summed to generate a score, and linear regression was used to generate adjusted breast asymmetry scores by patient-related factors (age, body mass index [BMI], tumor size, and tumor position in the breast) and treatment factors (reexcision lumpectomy, radiation therapy, and postoperative seroma).
- RESULTS:** Patient-related risk factors for breast asymmetry included younger age (asymmetry score: 18.7 versus 16.2, p = 0.03), higher BMI (17.1 versus 19.2, p = 0.007), and larger tumors (16.7 versus 19.1, p = 0.01). Resection of superior medial tumors and inferior lateral tumors was also associated with substantially higher asymmetry. Treatment-related risk factors for asymmetry included reexcision lumpectomy (18.1 versus 16.9, p = 0.013), postoperative seroma (19.3 versus 17.2, p = 0.005), and radiation therapy (17.9 versus 15.0, p = 0.008). Increasing breast asymmetry score was associated with a higher odds of desiring breast reconstruction (odds ratio = 1.2, 95% CI, 1.13 to 1.30).
- CONCLUSIONS:** Both patient- and treatment-related factors place women at risk for poor esthetic outcomes after breast-conserving surgery. Oncoplastic and reconstructive options should be considered for those at a higher risk for poor esthetic outcomes at the time of consultation. (*J Am Coll Surg* 2008;206:274–280. © 2008 by the American College of Surgeons)
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Breast-conserving surgery is the standard of care for early-stage breast cancer and is considered an indicator of quality of care.^{1–4} Compared with mastectomy, breast-conserving surgery is associated with less morbidity and disfigurement. Patients can have unrealistic expectations of breast appear-

ance postoperatively, and many patients report breast asymmetry after breast-conserving surgery.^{5–8} Understanding ways to optimize the esthetic outcomes after breast-conserving surgery can improve patient satisfaction and the quality of care delivered to breast cancer patients.

Risk factors for poor esthetic outcomes after breast-conserving surgery are not well understood. For example, women with larger breast size and younger women are often perceived to be ideal breast-conserving surgery candidates. Few studies have systematically evaluated the effect of patient factors, such as age and body habitus, on patient-reported esthetic outcomes. Treatment factors can also play an important role in postoperative esthetic outcomes after breast-conserving surgery, such as the location of tumor in the breast, occurrence of postoperative complications, and need for tumor reexcision. Up to 60% of breast-conserving surgery patients require multiple excisions to achieve disease-free margins, but the effect of these multiple procedures on postoperative esthetic outcomes is unknown.^{9–12} It is important to identify women at risk for poor esthetic

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Abbreviations and Acronyms

BCTOS	= Breast Cancer Treatment and Outcomes survey
BMI	= body mass index
OR	= odds ratio

outcomes after breast-conserving surgery. These patients might be candidates for additional surgical options, such as oncoplastic techniques or reconstructive procedures, which are associated with superior esthetic results and improved longterm quality of life, compared with breast-conserving operation alone.^{13,14}

To study this, we surveyed a sample of women at our institution who underwent lumpectomy during a 4-year period to describe patient and treatment-level factors associated with breast asymmetry after breast-conserving operation and to determine the desire and pursuit of breast reconstruction among women who undergo breast-conserving operation for breast cancer.

METHODS**Study population**

The study sample consisted of women who underwent breast-conserving operations at the University of Michigan Medical Center between January 2002 and May 2006 (n = 898). Of these women, 714 (79.5%) responded to the survey.¹⁵ Women who underwent operations for benign disease alone and women who underwent mastectomy were excluded. The study protocol was approved by the Institutional Review Board at the University of Michigan. Nonresponders were slightly more likely to be younger than responders (53.6 years versus 55.8 years), to be of non-Caucasian race (8.8% African American, 12.3% of other ethnicity), and less likely to have undergone reexcision lumpectomy (45.9%).

Measures

Dependent variables included eight items from the Breast Cancer Treatment and Outcomes survey (BCTOS) to determine breast asymmetry. The BCTOS is a 22-item survey instrument designed to measure perceived esthetic and functional status after breast-conserving surgical treatment and radiotherapy and validated in the breast cancer population. Item construction and reduction were guided by expert opinion. The BCTOS encompasses three domains: functional status, cosmetic status, and breast-specific pain. Psychometric analysis has demonstrated good internal consistency of the scales (Cronbach's α 0.81 to 0.91). Eight items about esthetic outcomes were used in the mailed survey to elicit patient-perceived postoperative breast

asymmetry (Appendix).¹⁶ Additionally, we asked patients to rate differences in breast skin color. Answers to each item were rated on a 4-point Likert scale (1 = no difference between breasts, 2 = slight difference between breasts, 3 = moderate difference between breasts, and 4 = large difference between breasts). Responses were summed to generate an overall asymmetry score. Patients were also queried about their desire to pursue, or receive, breast reconstruction. Patients were categorized as having undergone reconstruction if they reported having any type of breast reconstruction or a symmetry procedure on either the diseased or contralateral breast.

The patient-level factors included in our analysis were patient age, body habitus, tumor position in the breast, and tumor size. Patient age at the time of operation was obtained by report from the mailed survey. Body habitus information was categorized as body mass index (BMI) (calculated as kg/m²) and was self-reported. Tumor size and disease stage were obtained from the University of Michigan Cancer Registry. Tumor size was categorized as: < 1 cm, 1.0 to 1.9 cm, 2.0 to 2.9 cm, \geq 3.0 or larger. Tumor stage was based on the 6th edition of the *American Joint Commission on Cancer Coding and Staging Manual* (Springer, 2002). Pathologic stage information was available for 84% of patients. For those patients for whom pathologic stage was not available, clinical stage was used (16%). To determine position of the tumor within the breast, patients were asked to mark the location of their tumor on a diagram of the breast. These responses were reviewed by the authors and categorized as: upper outer quadrant tumors, upper inner quadrant tumors, lower outer quadrant tumors, lower inner quadrant tumors, and central tumors.

Treatment level factors included in our analysis were number of reexcision lumpectomies, receipt of radiation therapy, and occurrence of postoperative complications. Information about reexcision was obtained from the medical record. Reexcision was defined as any additional surgical breast procedure after either an excisional biopsy or lumpectomy, excluding those procedures performed for immediate postoperative complications, such as hematoma. The receipt of postoperative radiation therapy and the occurrence of postoperative complications were obtained by patient self-report. Patients were queried about these postoperative complications: hemorrhage requiring reoperation, wound dehiscence, thromboembolic phenomena, surgical site infection, and the occurrence of postoperative seroma.

Statistical analysis

We used descriptive statistics to display the characteristics of the patient sample and used Student's *t*-tests to generate bivariate associations between our independent and depen-

Table 1. Demographic Characteristics of the Study Population

Characteristic	n	%
Race		
Caucasian	555	90.1
African American	34	5.5
Other	27	4.4
Education		
High school or less	144	23.2
Some college	214	34.5
College graduates or beyond	263	42.4
Annual income		
< \$30,000	92	17.0
\$30,000–\$59,999	156	28.8
> \$60,000	293	54.2
Marital status, married or partnered	450	72.9
Age (y)		
40 or younger	48	7.7
41–50	159	25.4
51–60	209	33.4
61–70	118	18.9
71 or older	92	14.7

dent variables. We chose to collapse the category of multiple excisions to two or more excisions. Few women underwent three or more excisions, and we had limited statistical power to perform this subgroup analysis. We specifically excluded patients who required a mastectomy from this analysis, as the BCTOS was not designed to capture esthetic outcomes in this population.

We tested the correlation between esthetic outcomes and each independent variable using linear regression and generated adjusted asymmetry scores by independent variables. Of the postoperative complications included in our analysis, postoperative seroma was the only complication substantially associated with breast symmetry and was the only complication included in the multivariate analysis. Additionally, both bra cup size and BMI were highly correlated when testing for multicollinearity in our regression analysis. We elected to include BMI in our multivariate analysis as a measure of breast size. Logistic regression was used to assess the correlation of patient- and treatment-related factors and desire and pursuit of breast reconstruction. Second-order interactions were tested, but no statistically or clinically significant interactions were found. Wald tests were used to test for differences for group variables. A *p* value < 0.05 was considered statistically significant. All analysis was performed using STATA 9.0. (Stata Corp).

RESULTS

Table 1 displays the demographic characteristics of the study sample. The majority (90.1%) of patients was Cau-

Table 2. Clinical Characteristics of the Study Population

Characteristic	n	%
Body habitus		
BMI		
< 25	251	38.9
25–30	221	34.3
31–35	97	15.0
≥ 35	76	11.8
Position of the tumor in the breast		
Upper outer	269	51.1
Upper inner	101	19.2
Lower inner	43	8.2
Lower outer	78	14.8
Central	35	6.7
Disease factors		
No. of lumpectomies		
1	322	51.4
2	263	42.0
3 or more	41	6.6
Tumor size (cm)		
< 1	210	34.2
1.0–1.9	240	39.1
2.0–2.9	108	17.6
> 3	56	9.1
Received radiation therapy	585	86.4
Disease stage		
In situ disease	145	21.3
I	314	46.0
II	187	27.4
III or IV	36	5.3
Postoperative complications		
Hemorrhage	12	1.8
Wound dehiscence	19	2.9
Thromboembolism	6	0.9
Infection	87	13.2
Seroma	96	14.6

BMI, body mass index (calculated as kg/m²).

casian, college graduates (42.4%), and had an annual income > \$60,000 (56.2%). Most women (74.1%) were married or partnered, and mean age was 53.4 years.

Table 2 details the clinical characteristics of the study sample. With respect to BMI, 37.9% of women reported a BMI < 25, 35.4% reported a BMI between 25 and 30, 15.2% reported a BMI from 31 to 35, and 11.5% reported a BMI > 40. Approximately half of the women reported that their tumors were located in the upper outer quadrant of their breast (51.1%), and 19% reported upper inner quadrant tumors. Only 9% reported lower inner quadrant tumors, 15.5% reported lower outer quadrant tumors, and 2.4% reported central tumors.

Table 3. Patient and Treatment Factors Correlated with Breast Asymmetry after Breast-Conservation Therapy

Patient factors	Adjusted breast asymmetry score	p Value
Patient age (y)		
40 or younger	18.7	0.41
41–50	18.2	0.46
51–60	17.7	Reference
61–70	16.2	0.04
71 or older	16.5	0.13
Wald test	2.69 (p = 0.03)	
BMI		
< 25	17.1	Reference
25–30	17.4	0.55
31–35	17.8	0.33
≥ 35	19.2	0.007
Wald test	2.55 (p = 0.06)	
Tumor size, cm		
< 1	16.7	Reference
1.0–1.9	17.7	0.05
2.0–2.9	18.0	0.06
≥ 3	19.1	0.015
Wald test	2.16 (p = 0.09)	
Position of the tumor in the breast		
Upper outer	17.0	Reference
Upper inner	18.7	0.006
Lower inner	16.3	0.42
Lower outer	18.6	0.022
Central	17.9	0.62
Wald test	3.30 (p = 0.01)	
Treatment factors		
Postoperative seroma		
No	17.2	Reference
Yes	19.3	0.005
No. of excisions		
1	16.9	Reference
≥ 2	18.1	0.013
Radiation therapy		
No	15.0	Reference
Yes	17.9	0.008

Higher asymmetry scores represent more asymmetry between the diseased breast and the contralateral breast.

BMI, body mass index (calculated as kg/m²).

In this sample, 50.3% of women underwent only 1 surgical excision of their breast cancer, 43.0% underwent 2 surgical procedures, and 6.7% underwent 3 procedures (Table 2). In this sample, 92% of women received radiation therapy, and most women (73.2%) presented with tumors < 2 cm. The majority of women had either in situ disease or stage I disease (70.1%). Overall, 24.4% of women reported experiencing a postoperative complication, with the

Table 4. Subgroup Analysis of Aspects of Breast Asymmetry by Receipt of Reexcision Lumpectomy

Aspect	Breast cancer treatment and outcomes survey score		
	One excision	Two or more excisions	p Value
Breast size	2.29	2.46	0.01
Hardening of breast	1.85	1.92	0.35
Breast skin color	1.69	1.59	0.17
Fit of your clothing	1.56	1.67	0.08
Fit of your bra	1.93	2.08	0.03
Nipple appearance	1.90	2.03	0.14
Scar tissue	2.21	2.48	0.001
Breast retraction	1.71	1.95	0.001
Breast shape	2.15	2.40	0.001
Total breast asymmetry score (sum of all above items)	Mean 17.11	Mean 18.41	0.002

Scale ranges from 1 (little to no difference between breasts) to 4 (large difference between breasts). Higher scores represent larger breast asymmetry.

most common complication being the occurrence of postoperative seroma (13.1%).

Table 3 displays adjusted breast asymmetry scores after breast-conserving operation for each independent variable. Higher scores represent increasing asymmetry between the diseased breast and the contralateral breast. With respect to patient factors, younger women reported higher asymmetry scores (40 years or younger, 18.7; 41 to 50 years, 18.2; 51 to 60 years, 17.7; 61 to 70 years, 16.2; 71 years and older, 16.5; Wald test = 2.69, p = 0.03). Additionally, women with higher BMI reported increasingly higher scores of breast asymmetry (< 25: 17.1, 25 to 30: 17.4, 31 to 35: 17.8, > 35: 19.2, Wald test 2.13, p = 0.06). Women with larger tumors reported more breast asymmetry (tumors < 1 cm: 16.7, tumors 1.0 to 1.9 cm: 17.7, tumors 2.0 to 2.9 cm: 18.0, tumors ≥ 3 cm: 19.1, Wald test: 3.30, p = 0.01). Finally, women with upper inner quadrant tumors reported the highest asymmetry score (asymmetry score 18.7), followed by lower outer quadrant tumors (asymmetry score: 18.6), followed by central tumors (asymmetry score: 17.9), upper outer tumors (asymmetry score: 17.0), and lower inner tumors (asymmetry score: 16.3) (Wald test = 3.36, p = 0.01). With respect to treatment factors, women who underwent reexcision had significantly higher asymmetry scores compared with women who did not undergo reexcision (18.1 versus 16.9, p = 0.013). Women who reported the occurrence of a postoperative seroma had higher breast asymmetry scores compared with women who did not (19.3 versus 17.2, p = 0.005), and women who received radiation therapy had significantly higher asymmetry scores compared with women who did not receive radiation therapy (17.9 versus 15.0, p = 0.008).

Table 4 displays a subgroup analysis of breast asymmetry by reexcision lumpectomy. Scores for each aspect of asymmetry range from 1 (least asymmetry) to 4 (most asymmetry). Women who underwent multiple breast lumpectomies reported significantly more asymmetry in breast size (2.46 versus 2.29, $p = 0.01$), fit of bra (2.08 versus 1.93, $p = 0.03$), presence of scar tissue (2.48 versus 2.21, $p < 0.001$), breast retraction (1.95 versus 1.71, $p < 0.001$), and breast shape (2.40 versus 2.5, $p = 0.001$) compared with women who did not require any reexcisions. Across all measures of breast symmetry, women who underwent 2 or more excisions reported significantly higher asymmetry scores compared with women who underwent only 1 excision (18.4 versus 17.1, $p = 0.002$).

Table 5 details the desire and receipt of breast reconstruction after breast-conserving operation in the study sample. Increasing breast asymmetry score was associated with a higher odds of desiring, but not receiving, breast reconstruction (odds of desiring breast reconstruction = 1.2, 95% CI, 1.13 to 1.30; odds of undergoing breast reconstruction = 1.1, 95% CI, 0.95 to 1.17). Additionally, women who received radiation therapy were significantly less likely to desire, or to receive, breast reconstruction after breast-conserving operation (odds of desiring breast reconstruction = 0.1; 95% CI, 0.02 to 0.23; odds of undergoing breast reconstruction = 0.1, 95% CI, 0.03 to 0.56). Finally, younger women were more likely to desire breast reconstruction (odds ratio [OR] = 3.1; 95% CI, 1.01 to 9.34) and receive breast reconstruction (OR = 5.1; 95% CI, 1.18 to 21.91) after breast-conserving operation compared with women aged 51 to 60 years.

DISCUSSION

In this sample of women undergoing breast-conserving operation, both patient and treatment factors are correlated with postoperative breast asymmetry. Important patient-related risk factors include younger age, larger body habitus, larger tumor size, and tumor position, specifically superior medial tumors and inferior lateral tumors. Treatment-related risk factors for postoperative asymmetry include tumor reexcision, postoperative seroma, and radiation therapy. Reexcision after initial lumpectomy was common and was associated with substantially more breast asymmetry with respect to breast size, breast shape, breast retraction, and fit of undergarments. Finally, increasing breast asymmetry score was significantly correlated with a desire for breast reconstruction after breast-conserving operation.

This study is one of the first to examine the effect of both patient- and treatment-related factors on esthetic outcomes after breast-conserving operation. Although many studies

Table 5. Desire and Pursuit of Breast Reconstruction after Breast-Conserving Operation

Patient factors	Odds of desiring breast reconstruction	Odds of undergoing breast reconstruction
Age (y)		
40 or younger	3.0 (0.99–9.25)	4.9 (1.11–21.2)
41–50	1.2 (0.50–2.84)	0.7 (0.15–3.13)
51–60	Reference	Reference
61–70	0.4 (0.09–1.38)	2.0 (0.53–7.40)
71 or older	0.07 (0.01–0.63)	0.4 (0.06–2.93)
Wald test	13.7 ($p = 0.01$)	8.3 ($p = 0.08$)
BMI		
< 25	Reference	Reference
25–30	2.0 (0.83–4.89)	2.2 (0.63–7.36)
31–35	1.1 (0.33–3.51)	1.4 (0.31–6.62)
≥ 35	2.0 (0.60–6.37)	2.7 (0.57–12.7)
Wald test	3.21 ($p = 0.38$)	2.2 ($p = 0.53$)
Tumor size (cm)		
< 1	Reference	Reference
1.0–1.9	0.7 (0.28–1.65)	0.5 (0.15–1.35)
2.0–2.9	0.6 (0.20–1.82)	0.2 (0.02–1.24)
≥ 3	1.9 (0.61–5.96)	0.9 (0.21–3.87)
Wald test	2.36 ($p = 0.23$)	4.5 ($p = 0.21$)
Breast asymmetry score	1.2 (1.13–1.30)	1.06 (0.96–1.17)
Treatment factors		
Postoperative seroma		
No	Reference	Reference
Yes	1.0 (0.35–2.70)	1.7 (0.44–6.67)
No. of excisions		
1	Reference	Reference
≥ 2	2.0 (0.91–4.21)	1.6 (0.60–4.31)
Radiation therapy		
No	Reference	Reference
Yes	0.1 (0.02–0.24)	0.1 (0.03–0.56)

BMI, body mass index (calculated as kg/m^2).

have used expert opinion to measure esthetic outcomes, our results might be more relevant to changing current clinical practice, as they reflect patient perceptions of their breast appearance. With respect to patient factors, our results suggest that younger women and those with a larger body habitus can be at an increased risk for poor esthetic outcomes after breast-conserving operation. Although women with larger body habitus or breast size might be more frequently counseled to undergo breast conservation, our results are consistent with other studies indicating that higher BMI confers an increased risk of postoperative breast asymmetry.¹⁷ Similarly, younger women might be more likely to be counseled toward breast-conserving operation in an effort to preserve their breast. Younger compared with older women can have different body image

perceptions and can be more sensitive to postoperative changes in their breast appearance.¹⁸ For example, in our study, we noted an independent effect of age on desire for reconstruction, and younger women were more likely to desire and undergo breast reconstruction compared with older women. Although the reasons for this are unclear, such findings might support the theory that breast appearance can be weighted differently by younger women when considering their body image.

Consistent with our findings, previous authors have shown that treatment factors, such as radiation therapy and tumor size, are correlated with poorer esthetic results after breast-conserving operation.^{19,20} There is little existing data about the relationship between reexcision lumpectomy and esthetic outcomes. The effect of increasing tumor size and reexcision lumpectomy on postoperative esthetic outcomes might be related to the total volume of breast tissue removed.^{21,22} Similarly, postoperative seroma can be an indication of a larger tissue specimen removed, resulting in postoperative deformity. Patients with large lumpectomy resections might be candidates for reconstructive techniques, such as a latissimus dorsi muscle flap, for volume restoration. Oncoplastic and reconstructive procedures can often help preserve breast size and prevent breast retraction that is worsened with radiation therapy.

Limitations

This study has several notable limitations. Although we had an excellent patient response rate, nonresponders might have differed in aspects we were unable to discern. Additionally, as this is a single-institution study, the population of breast cancer patients at our center can differ substantially from other centers, and our results might not be applicable to other women. The study sample was relatively homogeneous with respect to sociodemographic characteristics, and we were not likely to capture variation in patient-perceived breast esthetics by race and ethnicity. Finally, these findings reflect the postoperative assessment of asymmetry of patients only. Patients might have had breast asymmetry before their operation, which they were unaware of or attributed to postoperative changes. Patients' recall of their treatment experiences and complications can be influenced by their postoperative esthetic result. It is possible that patients with superior esthetic results are less likely to remember or report complications. Although these effects are difficult to discern in a cross-sectional study, future research using a longitudinal study design might offer insight into the complex interactions between patient memory and postoperative outcomes.

Implications

Surgeons should be aware of the risk factors for breast asymmetry after breast-conserving operation, and should counsel patients who are at an increased risk for poor esthetic results about oncoplastic and reconstructive options. Unfortunately, our data suggest that women who experience breast asymmetry might desire, but not necessarily receive, breast reconstruction. This disparity might relate to financial and educational barriers to breast reconstruction. For example, the 1998 Women's Health and Cancer Rights Act covers reconstructive procedures associated with mastectomy, but not breast-conserving operation.²³ The extent to which insurance carriers deny coverage for postlumpectomy defects is unknown and warrants exploration. In addition, patients might not receive adequate counseling about reconstruction. With respect to mastectomy patients, general surgeons provide limited referrals for reconstructive operation.²⁴ The extent to which this exists in the lumpectomy population is unknown. In addition, educational information and decision aids frequently do not incorporate information about oncoplastic or reconstructive options.^{24,25} Improving educational support and identifying high-risk patients for poor esthetic outcomes can facilitate the decision-making process, improve surgical expectations, and advance the quality of care for breast cancer patients.

Appendix

Survey items assessing breast asymmetry after breast-conserving operation

Items included eight questions from the BCTOS and one additional question regarding breast discoloration.

Please rate the difference between the treated and untreated breast on a scale of 1 to 4 (1 = no difference, 2 = slight difference, 3 = moderate difference, 4 = large difference) for the following items:

1. Your breast size
2. Hardening of your breast
3. Breast skin color
4. Fit of your clothing
5. Fit of your bra
6. Nipple appearance
7. Scar tissue
8. Breast elevation
9. Breast shape

Author Contributions

Study conception and design: Waljee, Alderman
Acquisition of data: Waljee, Hu, Alderman

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Drafting of manuscript: Waljee, Hu, Newman, Alderman

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