Breast Reconstruction following Nipple-Sparing Mastectomy: Predictors of Complications, Reconstruction Outcomes, and 5-Year Trends

Amy S. Colwell, M.D.
Oren Tessler, M.D.
Alex M. Lin, B.S.
Eric Liao, M.D.
Jonathan Winograd, M.D.
Curtis L. Cetrulo, M.D.
Rong Tang, M.D.
Barbara L. Smith, M.D.
William G. Austen, Jr., M.D.

Boston, Mass.

Background: Nipple-sparing mastectomy is increasingly used for treatment and prevention of breast cancer. Few data exist on risk factors for complications and reconstruction outcomes.
Methods: A single-institution retrospective review was performed between 2007 and 2012.
Results: Two hundred eighty-five patients underwent 500 nipple-sparing mastectomy procedures for breast cancer (46 percent) or risk reduction (54 percent). The average body mass index was 24, and 6 percent were smokers. The mean follow-up was 2.17 years. Immediate breast reconstruction (reconstruction rate, 98.8 percent) was performed with direct-to-implant (59 percent), tissue expander/implant (38 percent), or autologous (2 percent) reconstruction. Acellular dermal matrix was used in 71 percent and mesh was used in 11 percent. Seventy-seven reconstructions had radiotherapy. Complications included infection (3.3 percent), skin necrosis (5.2 percent), nipple necrosis (4.4 percent), seroma (1.7 percent), hematoma (1.7 percent), and implant loss (1.9 percent). Positive predictors for total complications included smoking (OR, 3.3; 95 percent CI, 1.289 to 8.486) and periareolar incisions (OR, 3.63; 95 percent CI, 1.850 to 7.107). Increasing body mass index predicted skin necrosis (OR, 1.154; 95 percent CI, 1.036 to 1.286) and preoperative irradiation predicted nipple necrosis (OR, 4.86; 95 percent CI, 1.0197 to 23.169). An inframammary fold incision decreased complications (OR, 0.018; 95 percent CI, 0.0026 to 0.12089). Five-year trends showed increasing numbers of nipple-sparing mastectomy with immediate reconstruction and more single-stage versus two-stage reconstructions ($p < 0.05$).
Conclusions: Nipple-sparing mastectomy reconstructions have a low number of complications. Smoking, body mass index, preoperative irradiation, and incision type were predictors of complications. (*Plast. Reconstr. Surg.* 133: 496, 2014.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Risk, III.

The combination of nipple-sparing mastectomy and immediate breast reconstruction has been gaining traction as a preferred surgical option for therapeutic and prophylactic mastectomy.[1–8] Factors influencing this preference include increased early-stage treatment, prophylactic mastectomies,[9] and improved aesthetic outcomes.[10] Furthermore, current techniques for nipple-sparing mastectomy remove the glandular tissue from the nipple, thus differentiating them from subcutaneous mastectomies of the past, which left a significant amount of breast tissue within and under the nipple.

From the Division of Plastic Surgery, Massachusetts General Hospital, Harvard Medical School.
Received for publication June 14, 2013; accepted September 10, 2013.
Presented at the 82nd Annual Meeting of the American Society of Plastic Surgeons, in San Diego, California, October 11 through 15, 2013; the 58th Annual Meeting of the Plastic Surgery Research Council, in Santa Monica, California, May 2 through 4, 2013; and poster presentation at the 92nd Annual Meeting of the American Association of Plastic Surgeons, in New Orleans, Louisiana, April 20 through 23, 2013.

DOI: 10.1097/01.prs.0000438056.67375.75

Disclosures: *Amy Colwell, M.D., is a consultant for LifeCell Corp. and Allergan, Inc. She is a site investigator for the AirXpander clinical trial. There are no other disclosures.*

Nipple-sparing mastectomy has shown comparable oncologic risk when compared with traditional mastectomy, with a majority of studies reporting a low local recurrence rate of 3 percent or less.[1,2,4,5,11–22] Furthermore, nipple-sparing mastectomy has proven safe in prophylactic mastectomy.[2,11,14,23] These results have been maintained in long-term outcome studies,[24] where nipple-sparing mastectomy shows oncologic outcomes similar to more traditional skin-sparing mastectomies.[11,14,24]

Currently, there are few data in the literature on reconstructive outcomes following nipple-sparing mastectomy. In this article, we review patient and technical variables to determine risk factors for complications in nipple-sparing mastectomy and to determine whether these risk factors influence reconstructive type. Five-year trends are reviewed.

PATIENTS AND METHODS

A retrospective, institutional review board–approved, chart review was performed on 500 consecutive nipple-sparing mastectomy and immediate breast reconstructions performed from June of 2007 until June of 2012. Indications for nipple-sparing mastectomy included no gross clinical, radiographic, or pathologic involvement of the nipple-areola complex. Tumor size, cancer stage, and a specific distance in centimeters from the nipple-areola complex were not considered absolute contraindications. The tissue from under the nipple was removed and sent as a separate section. A positive nipple margin was treated with nipple removal. Nipple-sparing mastectomy was performed to remove the breast tissue through five different access incisions: inferolateral inframammary fold, horizontal radial, inferior radial, periareolar (any incision involving a full-thickness incision along a portion of the areola), and through an extension of a preexisting scar.[25] Patients choosing a prosthetic-based reconstruction were offered an attempt at single-stage reconstruction if their size goals were similar to their preoperative breast size. If a patient wanted a significantly larger size, a two-stage reconstruction was advised. Final determination for implant versus staged expander reconstruction was made intraoperatively after mastectomy with observation of the health of the skin flap and achievement of acceptable symmetry for bilateral cases. The health of the skin was based on observation of skin color, capillary refill, flap thickness, color change with inflation of a saline sizer to the appropriate volume, and experience of the breast surgeon.

Outcome measures examined included complications and the type of implant reconstruction (single-stage/direct-to-implant or two-stage). Complications were defined as infection requiring intravenous antibiotics, mastectomy skin flap necrosis and nipple-areola complex necrosis requiring surgical intervention, seroma, hematoma, and implant/expander loss. Predictive variables included year of study, mastectomy access incision, patient age, body mass index, initial implant volume, smoking status, preoperative and postoperative radiotherapy, previous breast cancer, and preexisting breast scar(s).

Fifty-seven women who attended a seminar on breast reconstruction at the Forces in Hereditary Breast Cancer Conference and who had breast cancer or a strong predisposition toward development of breast cancer were educated on breast reconstruction choices, nipple-sparing mastectomy, and incisions used for nipple-sparing mastectomy. A diagram was used to describe the various incisions for nipple-sparing mastectomy to avoid bias from actual patient photographs where the reconstruction itself may influence preference for incision type. They were then asked to complete a survey with the following questions:

1. The following statement best describes me: a) Breast cancer survivor, b) New diagnosis of breast cancer, c) Strong family history of breast cancer or breast cancer gene (*BRCA*) positive, d) Other.
2. If I have a mastectomy or had a mastectomy, reconstruction of the breast is/was:

Not important 0 1 2 3 4 5 Extremely important.

3. The mastectomy incision I prefer for a nipple-sparing mastectomy is:
   ____Radial lateral
   ____Radial vertical
   ____Under the nipple “periareolar”
   ____Under the breast “inframammary fold”

Statistical Analysis

Data were analyzed using Stata version 11.2 (StataCorp, College Station, Texas). We chose alpha = 0.05 as our level of significance throughout. One-way analysis of variance was used to look for significant correlations between continuous and categorical variables (e.g., incision type, study year, complications). All positive analysis of variance findings were then investigated further with two-sample *t* test using the Bonferroni correction to maintain our alpha at 0.05. Chi-square analysis or Fisher’s exact test was performed to check for

correlations between categorical predictors and outcomes. Univariate analysis was then performed to obtain odds ratios and 95 percent confidence intervals for positive correlations. After discovery of significant relationships between risk factors and outcomes, multivariate regression modeling was analyzed to control for possible confounders and to examine interrelations between variables found to have an impact from initial statistical testing. Values of $p = 0.1$ to $p = 0.05$ are described as a trend approaching statistical significance.

RESULTS

The series consisted of 285 patients, with a mean age of 45.7 years (range, 25 to 78 years) and a mean body mass index of 23.7 (range, 16.9 to 37.8) (Table 1). The mean follow-up was 2.17 years. Of patients undergoing nipple-sparing mastectomy, 98.8 percent underwent immediate reconstruction and served as the source population. Of the 500 planned nipple-sparing mastectomy and immediate reconstructions, 18 mastectomies (3.6 percent) were converted to skin-sparing mastectomies with removal of the nipple-areola complex because of positive pathologic margins either at the time of the original mastectomy (positive intraoperative margins) or if the final pathologic margins were positive. These 18 reconstructions were excluded from the analysis, and the remaining 482 reconstructions (267 patients) served as the source population for comparative outcomes. Two hundred twenty-two mastectomies (46.1 percent) were therapeutic and 260 (53.9 percent) were prophylactic. Four hundred seventeen mastectomies (86.5 percent) were bilateral and 65 (13.5 percent) were unilateral. Six percent of patients were smokers at the time of the reconstruction consultation, and 16 percent of patients received radiotherapy (8.7 percent received preoperative and 7.3 percent received postoperative radiotherapy). Sentinel lymph node dissection was performed in 350 reconstructions and 39 had axillary lymph node dissections. Reconstructions were performed with inferolateral inframammary fold [n = 246 (51 percent)], periareolar [n = 114 (23.6 percent)], extension of existing breast scar [n = 52 (10.7 percent)], horizontal radial [n = 49 (10.2 percent)], and inferior radial [n = 21 (4.4 percent)] incisions (Fig. 1). An acellular dermal matrix sling was used in 340 reconstructions (70.5 percent), 88 (18.3 percent) had partial or total muscle coverage without a sling, and 54 (11.2 percent) had Vicryl (Ethicon, Inc., Somerville, N.J.) mesh.

The total complication rate was 12.4 percent, with a mean follow-up of 2.17 years (range, 0.90 to 5.92 years) (Table 2). Complications included mastectomy skin flap necrosis (5.2 percent), nipple-areola complex necrosis (4.4 percent), infection (3.3 percent), seroma (1.7 percent), hematoma (1.7 percent), and implant loss (1.9 percent). In addition to the nipples removed for ischemia/necrosis, six were later removed for symmetry. Of the complications, 12 required a return to the operating room or readmission within 30 days.

Of the 482 reconstructions, 471 were implant-based and 11 were autologous. Two hundred eighty-six reconstructions were performed in a single stage and 185 were performed using

Table 1. Summary Data for 500 Consecutive Nipple-Sparing Mastectomy Reconstructions

	Value (%)
Patient population	
No. of patients	285
NSM reconstructions	500
Nipple removal for positive margins	18 (3.6)
Total NSM for analysis	482 (96.4)
Follow-up period, yr	
Mean	2.17
Median	1.83
Range	0.90–5.91
Demographics and risk factors	
Age, yr	
Mean	45.7
Range	25–78
BMI	
Mean	23.7
Range	16.9–37.8
Smoking	29 (10.9)
Total radiotherapy	77 (16.0)
Preoperative radiotherapy	42 (8.7)
Postoperative radiotherapy	35 (7.3)
Prior history of breast cancer	65 (13.5)
Previous breast surgery	96 (19.9)
Implant volume (single-stage reconstructions), cc	
Mean	376.3
Range	100–800
Initial TE fill volume, cc	
Mean	124.6
Range	0–500
Sentinel lymph node biopsy	350 (72.6)
Axillary lymph node dissection	39 (8.1)
Indication	
Prophylactic	260 (53.9)
Therapeutic	222 (46.1)
Laterality	
Unilateral	65 (13.5)
Bilateral	417 (86.5)
Mastectomy incision	
Inferolateral IMF	246 (51.0)
Horizontal radial	49 (10.2)
Inferior radial	21 (4.4)
Extension of previous incision	52 (10.8)
Periareolar	114 (23.7)
Pocket	
Acellular dermal matrix–assisted	340 (70.5)
Total or partial submuscular	88 (18.3)
Vicryl mesh–assisted	54 (11.2)

BMI, body mass index; TE, tissue expander; IMF, inframammary fold.

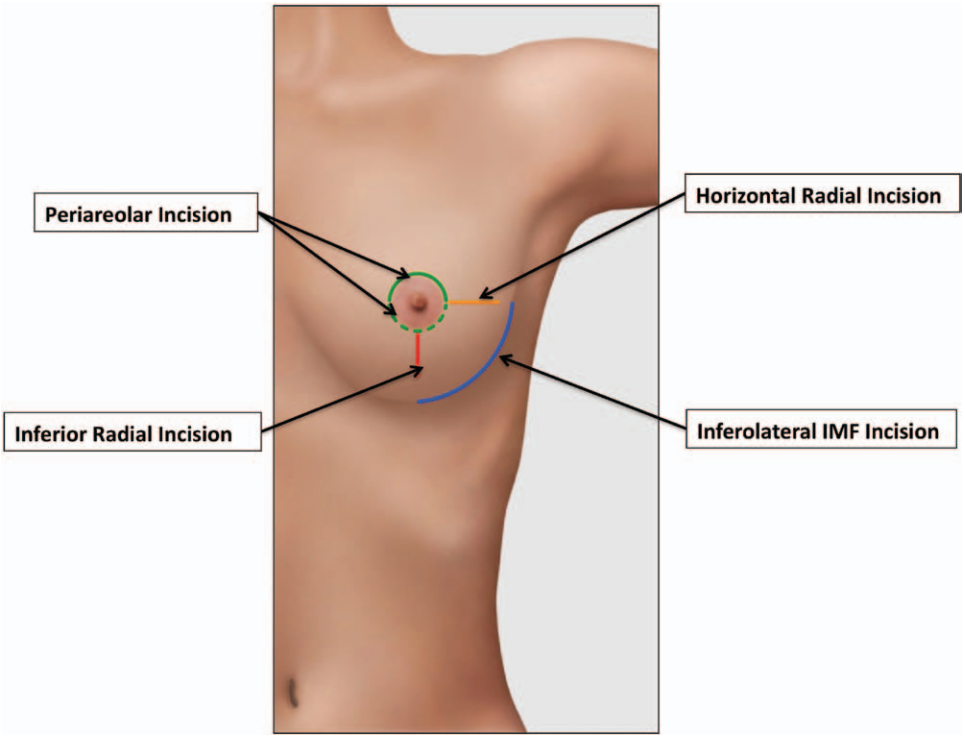

Fig. 1. Diagrammatic display of nipple-sparing mastectomy incisions.

tissue expander-implant two-stage reconstruction (Table 3 and Fig. 2).

In comparing patients who had one or more complications ($n = 60$) to those who did not have complications ($n = 422$), a periareolar incision was associated with the highest rate of total complications, whereas the inferolateral inframammary fold incision had the lowest rate of total complications (Fig. 3). Univariate logistic regression and chi-square tests identified risk factors for one or more complications (Table 4). After multivariate regression, increasing body mass index, smoking, preoperative irradiation, and a periareolar incision were significant predictors of one or more complications (Table 5). Conversely, an inframammary fold incision was a negative risk factor for complications.

In comparing single-stage to two-stage reconstruction, there were no differences in individual or total complications between the two groups (Table 6). There were more inframammary fold incisions used in the single-stage group, whereas there were more horizontal radial and inferior radial incisions in the two-stage reconstructions. Significantly more smokers had two-stage reconstruction and significantly more patients with preoperative radiotherapy had single-stage reconstruction ($p < 0.005$ for each).

The volume of cases for nipple-sparing mastectomy with immediate reconstruction and the percentage of direct-to-implant reconstructions increased significantly over 5 years ($p < 0.05$ for both). There was a trend approaching significance for the decrease of mastectomy skin flap necrosis in year 5 (Fig. 4 and Table 7). Mastectomy access incision proportions differed significantly, with a higher percentage of inframammary fold and corresponding lower percentage of periareolar-based incisions in the final year of the study ($p < 0.001$) (Fig. 5). The mean body mass index and mean implant volume were significantly higher in year 5 ($p < 0.05$ for each).

Table 2. Complications

Complications	No. (%)
Total	60 (12.4)
NAC necrosis	21 (4.4)
Mastectomy skin flap necrosis	25 (5.2)
Infection	16 (3.3)
Hematoma	8 (1.7)
Seroma	8 (1.7)
Implant loss	9 (1.9)

NAC, nipple-areola complex.

Table 3. Type of Reconstruction

Reconstruction	No. (%)
Single-stage DTI	286 (59.3)
Two-stage tissue expander/implant	185 (38.4)
Autologous	11 (2.3)

DTI, direct-to-implant.

Fig. 2. Nipple-sparing mastectomy with inferolateral inframammary fold incision and acellular dermal matrix–assisted two-stage tissue expander implant reconstruction (*left*, preoperative photograph; *right*, postoperative photograph). Photographs were provided by the first author (A.S.C.).

In our patient survey, 74 percent ranked breast reconstruction as extremely important (5 on a five-point scale). When asked their preference regarding incisions, 75 percent listed the inferolateral inframammary fold incision as the preferred approach.

DISCUSSION

Our retrospective review shows that patients who chose nipple-sparing mastectomy have a high rate of immediate reconstruction (98.8 percent) at the time of mastectomy. Of 500 consecutive patients undergoing nipple-sparing mastectomy

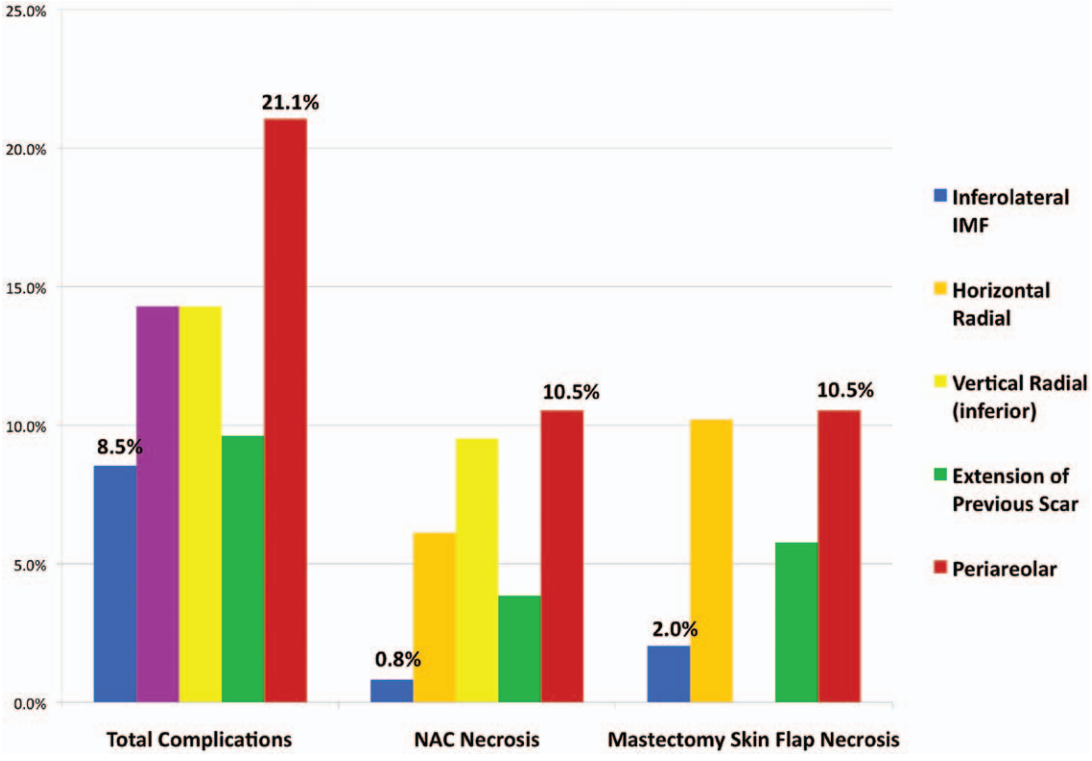

Fig. 3. Total and ischemic complications for each nipple-sparing mastectomy incision. *NAC*, nipple-areola complex; *IMF*, inframammary fold.

Table 4. Predictors of Total and Ischemic Complications: Univariate Analysis

Risk Factor	Outcome	*p*	OR	95% CI
Positive				
BMI	Mastectomy skin flap necrosis	0.041	1.104	1.004–1.215
Smoking	Total complications	0.056	2.401	0.9788–5.891
	Mastectomy skin flap necrosis	0.005	4.510	1.558–13.05
Preoperative radiotherapy	NAC necrosis	0.391	1.803	0.5087–6.393
Implant volume for	Total complications	0.024	1.004	1.001–1.007
direct-to-implant reconstruction	Mastectomy skin flap necrosis	0.004	1.007	1.002–1.012
	NAC necrosis	0.004	1.007	1.002–1.012
Periareolar incision	Total complications	0.001	2.459	1.395–4.334
	Mastectomy skin flap necrosis	0.003	3.213	1.422–7.259
	NAC necrosis	<0.001	4.693	1.923–11.45
Negative				
Inferolateral IMF incision	Total complications	0.008	0.4715	0.2682–0.8287
	Mastectomy skin flap necrosis	0.001	0.2241	0.08265–0.6074
	NAC necrosis	<0.001	0.0936	0.02155–0.4067

BMI, body mass index; NAC, nipple-areola complex; IMF, inframammary fold.

and immediate reconstruction, there was a high nipple retention rate after excluding patients who underwent removal for positive margins (96 percent retention rate) and also excluding patients with nipple removal for necrosis or symmetry, for an overall nipple retention rate of 91 percent.

Early outcomes with nipple-sparing mastectomy demonstrated high rates of ischemic complications to the nipple-areola complex and mastectomy skin flaps, which led to concerns regarding implant loss and reconstructive failure with these procedures.[2,15,26,27] In our series, nipple-sparing mastectomy and immediate reconstruction showed a low overall complication rate (12.4 percent). Our ischemic complications of the nipple-areola complex compare favorably to the published literature (4.4 percent versus 0.2 to 20 percent),[2,11,14–18,23,24,26,28] and our explantation rate was low at 1.9 percent.

Many mastectomy access incisions have been described for nipple-sparing mastectomy, and some are linked to early reconstructive complications.[2,7,29] We found that a full-thickness incision around the areola was a risk factor for nipple-areola complex necrosis, mastectomy skin flap necrosis, and total complications, which is consistent with studies that have shown risk reduction in complications with avoidance of extensive incisions around the areola.[13,17,26,30] The inferolateral inframammary fold incision, as we previously described, provides ease of access for mastectomy and an aesthetically pleasing scar.[25] The incision is made from the 6-o'clock position to the 9-o'clock or 3-o'clock position and thus increases in size as the breast size increases. The average length of our incisions was approximately 14 cm. In this article, it was associated with a decreased risk of total and ischemic complications.

Several factors have consistently been shown to increase early prosthetic-based breast reconstruction complications, including radiotherapy,[9,31–40] body mass index ,[31–34,41–45] smoking,[31–34,42–45] patient age,[31,42–44] and implant volume.[45] In our study, body mass index, smoking, and preoperative radiotherapy were all independent risk factors for one or more complications.

Table 5. Predictors of Total and Ischemic Complications: Multivariate Logistic Regression

Risk Factors	Outcome	*p*	OR	95% CI
Positive				
BMI	Mastectomy skin flap necrosis	0.009	1.154	1.036–1.286
Smoking	Total complications	0.013	3.308	1.289–8.486
	Mastectomy skin flap necrosis	0.001	7.044	2.129–23.298
Preoperative radiotherapy	NAC necrosis	0.047	4.861	1.0197–23.169
Periareolar Incision	Total complications	<0.001	3.626	1.850–7.107
	Mastectomy skin flap necrosis	<0.001	8.328	2.591–26.76
	NAC necrosis	<0.001	22.40	4.471–112.26
Negative	Outcome			
Inferolateral IMF incision	Total complications	<0.001	0.0175	0.0026–0.12089
	Mastectomy skin flap necrosis	<0.001	0.0004	0.0002–0.00875
	NAC necrosis	<0.001	0.0006	0.00002–0.01854

BMI, body mass index; NAC, nipple-areola complex; IMF, inframammary fold.

Table 6. Nipple-Sparing Mastectomy Reconstructions Categorized by Reconstruction Type

	DTI (%)	Two-Stage (%)	*p*
No.	286 (60.7)	185 (39.3)	
Demographics			
Age, yr			
Mean	46.7	44.4	0.005
Range	28–78	25–69	
BMI			
Mean	23.9	23.1	0.014
Range	17.8–37.6	16.9–37.8	
Smoking	7 (2.4)	22 (11.9)	<0.001
Preoperative radiotherapy	35 (12.2)	7 (3.8)	0.003
Postoperative radiotherapy	21 (7.3)	14 (17.6)	0.814
History of breast cancer	44 (15.4)	21 (11.4)	0.350
Previous breast surgery	64 (22.4)	32 (17.3)	0.371
Mastectomy incision			
Inferolateral IMF	163 (57.0)	80 (43.2)	0.035
Horizontal radial	20 (6.9)	28 (15.1)	0.004
Inferior radial	7 (2.4)	14 (7.6)	0.005
Extension of previous incision	35 (12.2)	15 (8.1)	0.155
Periareolar	61 (21.3)	48 (25.9)	1.126
Pocket			
Acellular dermal matrix–assisted	222 (77.6)	118 (63.8)	0.001
Total or partial submuscular	14 (4.9)	63 (34.0)	<0.001
Vicryl mesh-assisted	50 (17.5)	4 (2.2)	<0.001
Complications			
Total	34 (11.9)	26 (14.1)	0.243
NAC necrosis	10 (3.5)	11 (5.9)	0.208
Mastectomy skin flap necrosis	13 (4.5)	12 (6.5)	0.133
Infection	7 (2.4)	9 (4.9)	0.157
Hematoma	4 (1.4)	4 (2.2)	0.167
Seroma	6 (2.1)	2 (1.1)	0.404
Implant loss	4 (1.4)	5 (2.7)	0.313

DTI, direct-to-implant; BMI, body mass index; IMF, inframammary fold; NAC, nipple-areola complex.

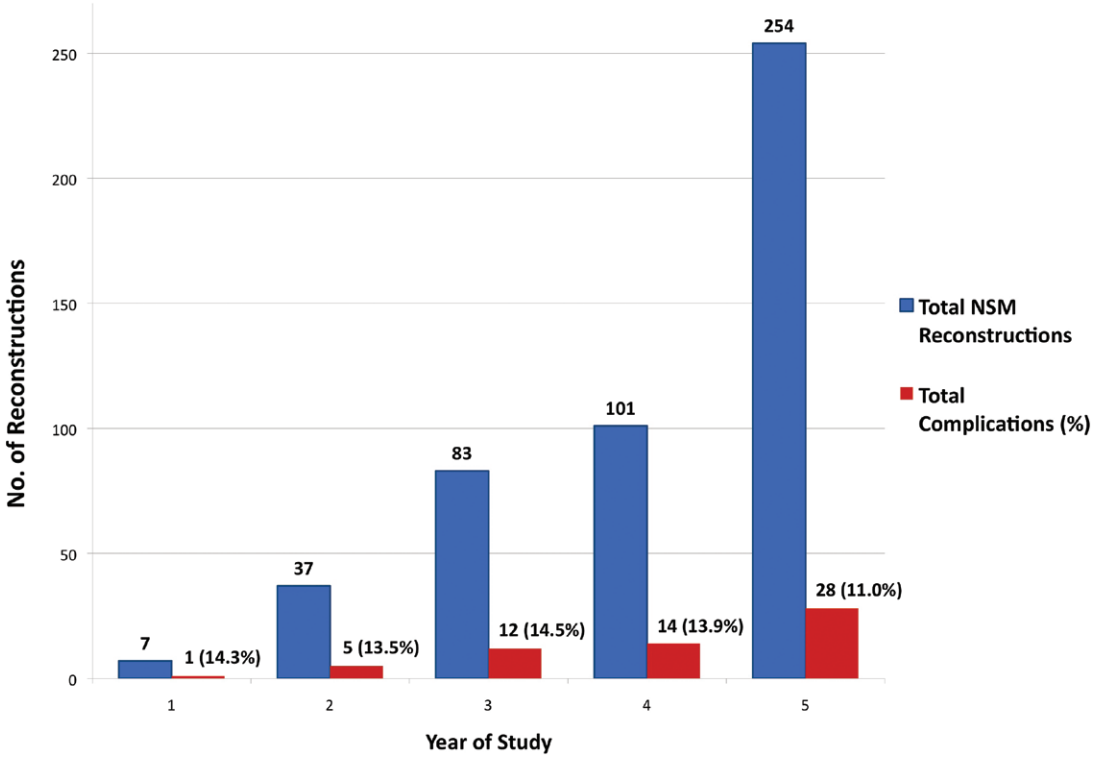

Fig. 4. Trend in reconstruction and complication volume over 5 consecutive years. *NSM*, nipple-sparing mastectomy.

Table 7. Nipple-Sparing Mastectomy Reconstructions Categorized by Year of Nipple-Sparing Mastectomy Study

	Year 1 (%)	Year 2 (%)	Year 3 (%)	Year 4 (%)	Year 5 (%)
Demographics					
No. of reconstructions	7 (1.5)	37 (7.7)	83 (17.2)	101 (21.0)	254 (52.7)
Mean age, yr	46.5	44.1	45.8	45.4	46.1
Mean BMI	21.9	22.8	23.2	23.1	24.2
Smoking	0 (0.0)	0 (0.0)	8 (9.6)	4 (4.0)	17 (6.7)
Preoperative radiotherapy	1 (14.3)	2 (5.4)	7 (8.4)	10 (9.9)	22 (8.7)
Postoperative radiotherapy	0 (0.0)	1 (2.7)	3 (3.6)	9 (8.9)	22 (8.7)
History of breast cancer	2 (28.6)	2 (5.4)	11 (13.3)	15 (14.9)	35 (13.8)
Previous breast surgery	4 (57.1)	4 (10.8)	19 (22.9)	20 (19.8)	49 (19.3)
Mean implant volume, cc	450	340.2	358.7	330	396.1
Indication					
Prophylactic	3 (42.9)	24 (64.9)	51 (61.5)	60 (59.4)	122 (48.0)
Therapeutic	4 (57.1)	13 (35.1)	32 (38.6)	41 (40.6)	132 (52.0)
Laterality					
Unilateral	3 (42.9)	4 (10.8)	7 (8.4)	12 (11.9)	39 (15.4)
Bilateral	4 (57.1)	33 (89.2)	76 (91.6)	89 (88.1)	215 (84.6)
Mastectomy incision					
Inferolateral IMF	0 (0.0)	22 (59.5)	27 (32.5)	37 (36.6)	160 (63.0)
Horizontal radial	1 (14.3)	0 (0.0)	7 (8.4)	19 (18.8)	22 (8.7)
Inferior radial	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	21 (8.3)
Extension of previous incision	3 (42.9)	5 (13.5)	9 (10.8)	16 (15.8)	19 (7.5)
Periareolar	3 (42.9)	10 (27.0)	40 (48.2)	29 (28.7)	32 (12.6)
Complications					
Total	1 (14.3)	5 (13.5)	12 (14.5)	14 (13.9)	28 (11.0)
NAC necrosis	0 (0.0)	1 (2.7)	5 (6.0)	6 (5.9)	9 (3.5)
Mastectomy skin flap necrosis	1 (14.3)	3 (8.1)	5 (6.0)	8 (7.9)	8 (3.2)
Infection	1 (14.3)	0 (0.0)	3 (3.6)	1 (1.0)	11 (4.35)
Hematoma	0 (0)	0 (0.0)	1 (1.2)	7 (6.9)	0 (0.0)
Seroma	0 (0)	2 (5.4)	1 (1.2)	1 (1.0)	4 (1.6)
Implant loss	1 (14.3)	0 (0.0)	0 (0.0)	1 (1.0)	7 (2.8)
Reconstruction type					
DTI	2 (28.57)	23 (62.2)	49 (59.0)	41 (42.3)	172 (67.7)
Two-stage	5 (71.43)	14 (37.8)	34 (41.0)	57 (58.8)	75 (29.5)
Autologous	0 (0)	0 (0)	0 (0)	4 (4.0)	7 (2.8)

BMI, body mass index; IMF, inframammary fold; NAC, nipple-areola complex; DTI, direct-to-implant.

The choice of single-stage or two-stage reconstruction is clearly multifactorial and dependent on patient size goals, breast anatomy, and the quality of the mastectomy skin flaps. Nipple-sparing mastectomy increases the number of patients who are potential candidates for direct-to-implant reconstruction by preserving more overall skin and surface area to place an implant, and by helping to avoid some of the flattening associated with closure of skin-sparing incisions. In addition, we found that smoking and an inferior radial incision were more common in two-stage reconstruction, likely related to the perfusion of the skin flaps and the skin tension from a vertical scar. Although the lateral radial incision was associated with more two-stage reconstructions, the most likely explanation for this finding is that we prefer to use this incision for patients who are at higher risk for nipple or skin flap ischemia to maximize the blood flow to the nipple. There were more single-stage reconstructions in patients with preoperative irradiation, which may come as a surprise to many surgeons. If possible, we prefer to perform a conservative single-stage reconstruction in these patients. Although two-stage reconstruction can be successfully performed in these patients, there is a higher rate of immediate complications in our experience secondary to skin shrinkage around the tissue expander followed by expansion and a second operation. There was no overall difference in complication rates between single-stage and two-stage reconstruction, similar to our previous comparative article.[9]

Our 5-year trends reflect the data presented. A team approach with breast surgical oncology and plastic surgery has led to advancements in the development of successful surgical strategies and techniques. Our breast surgeons avoid vigorous retraction and retractors with sharp teeth. Their plane of dissection is between the anatomical separation of the subcutaneous fat and the breast tissue. We are performing an increasing number of nipple-sparing mastectomy procedures as more breast oncology surgeons become comfortable with the procedure and with expansion of our indications for nipple-sparing surgery. Our

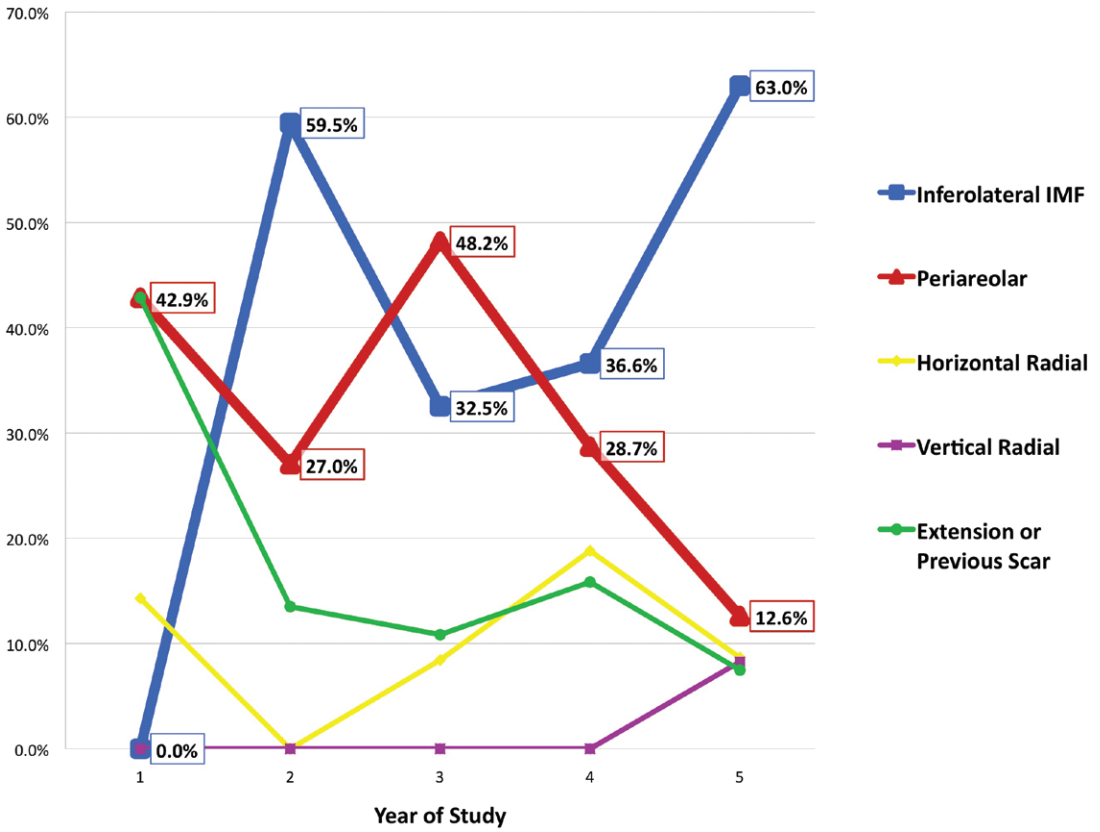

Fig. 5. Trend in nipple-sparing mastectomy incisions over 5 consecutive years. *IMF*, inframammary fold.

data from 2007 to 2011 showed no local recurrences in our prophylactic mastectomy patients and a rate of 2.6 percent in our breast cancer patients, with no patient having involvement of the nipple.[46] Our preferred incision has become the inferolateral inframammary fold incision based on the complication profile and patient preference, which was observed in our survey results but is also expressed daily in our consultations. Our number of direct-to-implant reconstructions went up in year 2 of the study but then decreased as more breast and plastic surgeons gained experience with the technique. In year 5, with experience, single-stage reconstruction is now performed in 68 percent of nipple-sparing mastectomies.

CONCLUSIONS

This retrospective review demonstrates that nipple-sparing mastectomy and immediate reconstruction has a high rate of success and a low rate of complications. In our experience, the inferolateral inframammary fold incision has resulted in superior reconstructive outcomes, is preferable to patients, and can reduce the need for additional procedures by allowing for a greater proportion of direct-to-implant reconstructions. Periareolar incisions increase the odds of ischemia-related complications and should be avoided in inexperienced hands. Other risk factors important to assess in deciding operative strategy include patient body mass index, smoking status, desired implant volume, and preoperative radiotherapy.

Amy S. Colwell, M.D.
Harvard Medical School
Division of Plastic Surgery
Massachusetts General Hospital
Boston, Mass. 02111
acolwell@partners.org

REFERENCES

1. Gerber B, Krause A, Reimer T, et al. Skin-sparing mastectomy with conservation of the nipple-areola complex and autologous reconstruction is an oncologically safe procedure. *Ann Surg.* 2003;238:120–127.
2. Sacchini V, Pinotti JA, Barros AC, et al. Nipple-sparing mastectomy for breast cancer and risk reduction: Oncologic or technical problem? *J Am Coll Surg.* 2006;203:704–714.
3. Pennisi VR, Capozzi A. Subcutaneous mastectomy data: A final statistical analysis of 1500 patients. *Aesthetic Plast Surg.* 1989;13:15–21.

4. Bishop CC, Singh S, Nash AG. Mastectomy and breast reconstruction preserving the nipple. *Ann R Coll Surg Engl.* 1990;72:87–89.
5. Crowe JP, Kim JA, Yetman R, Banbury J, Patrick RJ, Baynes D. Nipple-sparing mastectomy: Technique and results of 54 procedures. *Arch Surg.* 2004;139:148–150.
6. Palmer BV, Mannur KR, Ross WB. Subcutaneous mastectomy with immediate reconstruction as treatment for early breast cancer. *Br J Surg.* 1992;79:1309–1311.
7. Stanec Z, Zic R, Stanec S, Budi S, Hudson D, Skoll P. Skin-sparing mastectomy with nipple-areola conservation. *Plast Reconstr Surg.* 2003;111:496–498; author reply 498.
8. Hayes AJ, Garner JP, Nicholas W, Laidlaw IJ. A comparative study of envelope mastectomy and immediate reconstruction (EMIR) with standard latissimus dorsi immediate breast reconstruction. *Eur J Surg Oncol.* 2004;30:744–749.
9. Colwell AS, Damjanovic B, Zahedi B, Medford-Davis L, Hertl C, Austen WG Jr. Retrospective review of 331 consecutive immediate single-stage implant reconstructions with acellular dermal matrix: Indications, complications, trends, and costs. *Plast Reconstr Surg.* 2011;128:1170–1178.
10. Rusby JE, Kirstein LJ, Brachtel EF, Michaelson JS, Koerner FC, Smith BL. Nipple-sparing mastectomy: Lessons from ex vivo procedures. *Breast J.* 2008;14:464–470.
11. de Alcantara Filho P, Capko D, Barry JM, Morrow M, Pusic A, Sacchini VS. Nipple-sparing mastectomy for breast cancer and risk-reducing surgery: The Memorial Sloan-Kettering Cancer Center experience. *Ann Surg Oncol.* 2011;18:3117–3122.
12. Petit JY, Veronesi U, Orecchia R, et al. Nipple sparing mastectomy with nipple areola intraoperative radiotherapy: One thousand and one cases of a five years experience at the European institute of oncology of Milan (EIO). *Breast Cancer Res Treat.* 2009;117:333–338.
13. Garwood ER, Moore D, Ewing C, et al. Total skin-sparing mastectomy: Complications and local recurrence rates in 2 cohorts of patients. *Ann Surg.* 2009;249:26–32.
14. Spear SL, Willey SC, Feldman ED, et al. Nipple-sparing mastectomy for prophylactic and therapeutic indications. *Plast Reconstr Surg.* 2011;128:1005–1014.
15. Margulies AG, Hochberg J, Kepple J, Henry-Tillman RS, Westbrook K, Klimberg VS. Total skin-sparing mastectomy without preservation of the nipple-areola complex. *Am J Surg.* 2005;190:907–912.
16. Boneti C, Yuen J, Santiago C, et al. Oncologic safety of nipple skin-sparing or total skin-sparing mastectomies with immediate reconstruction. *J Am Coll Surg.* 2011;212:686–693; discussion 693–695.
17. Kim HJ, Park EH, Lim WS, et al. Nipple areola skin-sparing mastectomy with immediate transverse rectus abdominis musculocutaneous flap reconstruction is an oncologically safe procedure: A single center study. *Ann Surg.* 2010;251:493–498.
18. Paepke S, Schmid R, Fleckner S, et al. Subcutaneous mastectomy with conservation of the nipple-areola skin: Broadening the indications. *Ann Surg.* 2009;250:288–292.
19. Mosahebi A, Ramakrishnan V, Gittos M, Collier DS. Envelope mastectomy and immediate reconstruction (EMIR), improving outcome without oncological compromise. *J Plast Reconstr Aesthet Surg.* 2006;59:1025–1030.
20. Kissin MW, Kark AE. Nipple preservation during mastectomy. *Br J Surg.* 1987;74:58–61.
21. Laronga C, Kemp B, Johnston D, Robb GL, Singletary SE. The incidence of occult nipple-areola complex involvement in breast cancer patients receiving a skin-sparing mastectomy. *Ann Surg Oncol.* 1999;6:609–613.
22. Dale PS, Giuliano AE. Nipple-areolar preservation during breast-conserving therapy for subareolar breast carcinomas. *Arch Surg.* 1996;131:430–433.
23. Crowe JP, Patrick RJ, Yetman RJ, Djohan R. Nipple-sparing mastectomy update: One hundred forty-nine procedures and clinical outcomes. *Arch Surg.* 2008;143:1106–1110; discussion 1110.
24. Jensen JA, Orringer JS, Giuliano AE. Nipple-sparing mastectomy in 99 patients with a mean follow-up of 5 years. *Ann Surg Oncol.* 2011;18:1665–1670.
25. Colwell AS, Gadd M, Smith BL, Austen WG Jr. An inferolateral approach to nipple-sparing mastectomy: Optimizing mastectomy and reconstruction. *Ann Plast Surg.* 2010;65:140–143.
26. Wijayanayagam A, Kumar AS, Foster RD, Esserman LJ. Optimizing the total skin-sparing mastectomy. *Arch Surg.* 2008;143:38–45; discussion 45.
27. Komorowski AL, Zanini V, Regolo L, Carolei A, Wysocki WM, Costa A. Necrotic complications after nipple- and areola-sparing mastectomy. *World J Surg.* 2006;30:1410–1413.
28. Radovanovic Z, Radovanovic D, Golubovic A, Ivkovic-Kapicl T, Bokorov B, Mandic A. Early complications after nipple-sparing mastectomy and immediate breast reconstruction with silicone prosthesis: Results of 214 procedures. *Scand J Surg.* 2010;99:115–118.
29. Woods JE. Subcutaneous mastectomy: Current state of the art. *Ann Plast Surg.* 1983;11:541–550.
30. Warren Peled A, Foster RD, Stover AC, et al. Outcomes after total skin-sparing mastectomy and immediate reconstruction in 657 breasts. *Ann Surg Oncol.* 2012;19:3402–3409.
31. Antony AK, McCarthy CM, Cordeiro PG, et al. Acellular human dermis implantation in 153 immediate two-stage tissue expander breast reconstructions: Determining the incidence and significant predictors of complications. *Plast Reconstr Surg.* 2010;125:1606–1614.
32. Nahabedian MY, Tsangaris T, Momen B, Manson PN. Infectious complications following breast reconstruction with expanders and implants. *Plast Reconstr Surg.* 2003;112: 467–476.
33. Cordeiro PG, McCarthy CM. A single surgeon's 12-year experience with tissue expander/implant breast reconstruction: Part II. An analysis of long-term complications, aesthetic outcomes, and patient satisfaction. *Plast Reconstr Surg.* 2006;118:832–839.
34. Ascherman JA, Hanasono MM, Newman MI, Hughes DB. Implant reconstruction in breast cancer patients treated with radiation therapy. *Plast Reconstr Surg.* 2006; 117:359–365.
35. Salzberg CA. Focus on technique: One-stage implant-based breast reconstruction. *Plast Reconstr Surg.* 2012;130(Suppl 2):95S–103S.
36. Israeli R. Complications of acellular dermal matrices in breast surgery. *Plast Reconstr Surg.* 2012;130(Suppl 2): 159S–172S.
37. Kronowitz SJ, Robb GL. Breast reconstruction with postmastectomy radiation therapy: Current issues. *Plast Reconstr Surg.* 2004;114:950–960.
38. Lee BT, A Adesiyun T, Colakoglu S, et al. Postmastectomy radiation therapy and breast reconstruction: An analysis of complications and patient satisfaction. *Ann Plast Surg.* 2010;64:679–683.
39. Spear SL, Onyewu C. Staged breast reconstruction with saline-filled implants in the irradiated breast: Recent

trends and therapeutic implications. *Plast Reconstr Surg.* 2000;105:930–942.
40. Kronowitz SJ, Robb GL. Radiation therapy and breast reconstruction: A critical review of the literature. *Plast Reconstr Surg.* 2009;124:395–408.
41. Chun YS, Verma K, Rosen H, et al. Implant-based breast reconstruction using acellular dermal matrix and the risk of postoperative complications. *Plast Reconstr Surg.* 2010;125:429–436.
42. Lanier ST, Wang ED, Chen JJ, et al. The effect of acellular dermal matrix use on complication rates in tissue expander/implant breast reconstruction. *Ann Plast Surg.* 2010;64:674–678.
43. McCarthy CM, Mehrara BJ, Riedel E, et al. Predicting complications following expander/implant breast reconstruction: An outcomes analysis based on preoperative clinical risk. *Plast Reconstr Surg.* 2008;121:1886–1892.
44. Francis SH, Ruberg RL, Stevenson KB, et al. Independent risk factors for infection in tissue expander breast reconstruction. *Plast Reconstr Surg.* 2009;124:1790–1796.
45. Liu AS, Kao HK, Reish RG, Hergrueter CA, May JW Jr, Guo L. Postoperative complications in prosthesis-based breast reconstruction using acellular dermal matrix. *Plast Reconstr Surg.* 2011;127:1755–1762.
46. Coopey SB, Tang R, Lei L, et al. Eligibility for nipple sparing mastectomy may be safely expanded. Paper presented at: 14th Annual Meeting of the American Society of Breast Surgeons; May 1–5, 2013; Chicago, Ill.

Plastic Surgery Level of Evidence Rating Scale—Diagnostic Studies

Level of Evidence	Qualifying Studies
I	Highest-quality, multicentered or single-centered, cohort study validating a diagnostic test (with "gold" standard as reference) in a series of consecutive patients; or a systematic review of these studies
II	Exploratory cohort study developing diagnostic criteria (with "gold" standard as reference) in a series of consecutive patient; or a systematic review of these studies
III	Diagnostic study in nonconsecutive patients (without consistently applied "gold" standard as reference); or a systematic review of these studies
IV	Case-control study; or any of the above diagnostic studies in the absence of a universally accepted "gold" standard
V	Expert opinion developed via consensus process; case report or clinical example; or evidence based on physiology, bench research, or "first principles"

Find out more from the "Evidence-Based Medicine: How-to Articles" Collection at www.PRSJournal.com