Microsurgical Breast Reconstruction for Nipple-Sparing Mastectomy

Neil Tanna, M.D., M.B.A.
P. Niclas Broer, M.D.
Katie E. Weichman, M.D.
Michael Alperovich, M.D.
Christina Y. Ahn, M.D.
Robert J. Allen, Sr., M.D.
Mihye Choi, M.D.
Nolan S. Karp, M.D.
Pierre B. Saadeh, M.D.
Jamie P. Levine, M.D.

New York, N.Y.

Background: Nipple-sparing mastectomy warrants thorough preoperative evaluation to effectively achieve risk reduction, high patient satisfaction, and improved aesthetic outcome. To the authors' knowledge, this review represents the largest series of microsurgical breast reconstructions following nipple-sparing mastectomies.

Methods: All patients undergoing nipple-sparing mastectomy with microsurgical immediate breast reconstruction treated at New York University Medical Center (2007–2011) were identified. Patient demographics, breast cancer history, intraoperative details, complications, and revision operations were examined. Descriptive statistical analysis, including *t* test or regression analysis, was performed.

Results: In 51 patients, 85 free flap breast reconstructions ($n = 85$) were performed. The majority of flaps were performed for prophylactic indications [$n = 55$ (64.7 percent)], mostly through vertical incisions [$n = 40$ (47.0 percent)]. Donor sites included abdominally based [$n = 66$ (77.6 percent)], profunda artery perforator [$n = 12$ (14.1 percent)], transverse upper gracilis [$n = 6$ (7.0 percent)], and superior gluteal artery perforator [$n = 1$ (1.2 percent)] flaps. The most common complications were mastectomy skin flap necrosis [$n = 11$ (12.7 percent)] and nipple necrosis [$n = 11$ (12.7 percent)]. There was no correlation between mastectomy skin flap or nipple necrosis and choice of incision, mastectomy specimen weight, body mass index, or age ($p > 0.05$). However, smoking history was associated with nipple necrosis ($p < 0.01$).

Conclusions: This series represents a high-volume experience with nipple-sparing mastectomy followed by immediate microsurgical reconstruction. When appropriately executed, it can deliver low complication rates. (*Plast. Reconstr. Surg.* 131: 139e, 2013.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Nipple-sparing mastectomy is being increasingly performed in practice, for both therapeutic and prophylactic indications.[1–3] The rise in nipple-sparing mastectomy marks the latest stage in the evolution of extirpative surgery for breast cancer. In the appropriately selected breast cancers, the potential aesthetic benefits of preserving the nipple-areola complex are obvious. The advantages extend beyond cosmetic results, as nipple-sparing mastectomy can impact functional outcomes and patient satisfaction.[4] As it is difficult to match the native nipple's projection, size, color, shape, texture, position, and sensation, varying degrees of patient dissatisfaction can exist with sacrifice of the nipple-areola complex in other types of mastectomies.[3]

Preservation of the nipple-areola complex is a procedure that warrants serious consideration and preoperative evaluation, despite its increasing popularity.[5–17] Multiple centers have reported their experience and indications for prophylactic and therapeutic nipple-sparing mastectomy.[1,2,18–22] Preservation of the nipple-areola complex in breast cancer patients has been advocated for early disease when clear margins are obtained under the nipple-areola complex.[23–25] Spear and colleagues have reported that nipple-sparing mastectomy can be safely used in oncologic cases with smaller (tumor

From the Institute of Reconstructive Plastic Surgery, New York University.
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size <3 cm), peripheral breast cancers (>2 cm from the nipple-areola complex), with clinically negative lymphadenopathy.[1,2] For prophylactic indications, many centers have similarly reported no untoward oncologic sequelae with the use of nipple-sparing mastectomy.[23–25] Aside from the inclusion criteria, many other factors influence the outcome of patients undergoing nipple-sparing mastectomy. These can include the experience of the surgical team, choice of incision, location of disease, breast size, degree of breast ptosis, and how effectively breast tissue is removed from behind the nipple and areola.

Breast reconstruction following nipple-sparing mastectomy is just as challenging, with its own set of considerations and principles. Managing the mastectomy skin envelope, controlling the nipple position, and determining the number of reconstructive stages are just some of the challenges. Furthermore, both prosthetic and autologous reconstructions each have their own specific set of considerations. The degree of intraoperative expansion, the role of acellular dermal matrix, and the decision regarding direct implant placement are just some of the issues that surround implant-based reconstruction. Flap selection, use of a skin paddle, and the method of postoperative free flap monitoring are important decisions to make with autologous reconstructions.

There are various reports detailing experience with prosthetic reconstruction following nipple-sparing mastectomy.[1–3] However, there is a paucity of studies examining autologous reconstruction (in particular, microsurgical breast reconstruction) following preservation of the nipple-areola complex. Those that do exist are limited in volume. The authors review their experience with nipple-sparing mastectomy and its reconstruction at a single institution. To our knowledge, this patient cohort represents the largest series of autologous breast reconstructions following nipple-sparing mastectomies.

PATIENTS AND METHODS

All patients treated with nipple-sparing mastectomy at the Institute of Reconstructive Plastic Surgery at New York University were identified. From this cohort, women who underwent immediate microsurgical autologous reconstruction were selected for further examination. The study period extended from October of 2007 to November of 2011. A multidisciplinary team evaluated all patients. Patients with less than 6 months' follow-up were excluded from the study.

Nipple-sparing mastectomy was presented to eligible women with breast cancers amenable to nipple-sparing mastectomy or as a prophylactic option for risk reduction in selected patients. The indications, benefits, risks, and alternatives to nipple-sparing mastectomy were discussed. This occurred between the patient and extirpative surgeon and was reinforced by the reconstructive surgeon.

With institutional review board approval, the charts and records of all these patients were reviewed. Patient demographics, breast cancer history, intraoperative details, complications, and revision operations were all examined. Demographic information included age, body mass index, and race. Medical comorbidities and smoking history were also examined.

Risk factors for breast cancer, including *BRCA* positivity, were documented. In oncologic cases, the stage of cancer and need for chemotherapy or radiation treatments was noted. History of prior breast operations was also elicited.

Intraoperative details included type of free flap, recipient vessel choice, mastectomy specimen weight, and flap size. Although mastectomy specimen and flap weights were reviewed, degree of preoperative breast ptosis was not routinely recorded and therefore not assessed. Charts were reviewed for postoperative complications, including partial or total flap loss, nipple necrosis, mastectomy skin flap necrosis, infection, hematoma, and fat necrosis. Donor-site complications were also documented. Revision operations performed within the study period were all recorded. Recipient- and donor-site revisions were for contour deformities or irregularities. Hernias and abdominal wall morbidity were noted as complications.

Statistical analyses were descriptive (mean, SEM, and range). When appropriate, comparisons were made using the *t* test. Regression analysis was used to determine the influence of mastectomy specimen weight, body mass index, smoking history, and incision type on complication rates.

RESULTS

During the study period (2007–2011), 51 patients were identified as having nipple-sparing mastectomy with immediate microsurgical breast reconstruction at the Institute of Reconstructive Plastic Surgery at New York University. In these 51 patients, 85 breasts received 85 free flap breast reconstructions. Seventeen patients had unilateral reconstructions (17 flaps), and 34 patients had bilateral flaps (68 flaps). Of the 85 reconstruc-

tions, five flaps were performed in the years 2007–2008, eight flaps were performed in the years 2008–2009, 24 flaps were performed in the years 2009–2010, and 48 flaps were performed in the years 2010–2011 (Fig. 1). Tables 1 through 3 summarize the data.

Demographics

The mean age of the patients was 47.8 ± 8.0 years (range, 35 to 60 years). The average body mass index was 24.6 ± 3.4 kg/m^2 (range, 18 to 34 kg/m^2). The majority of flaps were performed in Caucasian women [n = 73 flaps (85.9 percent)]. The others were performed in African Americans [n = 4 flaps (4.7 percent)], Hispanics [n = 4 flaps (4.7 percent)], and Asians [n = 4 flaps (4.7 percent)]. At the time of surgery, none of the patients were smokers. However, a minority of flaps [n = 16 flaps (18.8 percent)] were performed in patients who were former smokers. Former smokers were defined as those who had a smoking history but who had not smoked in the 6 weeks immediately preceding their operation. Nicotine levels were checked in these patients.

Breast Cancer History

The majority of flaps were performed for prophylactic indications [n = 55 flaps (64.7 percent)]. Almost half (43 percent) of these flaps were in women who were *BRCA*-positive (n = 24 flaps).

Of the flaps that were performed for reconstruction following oncologic extirpations [n = 30 flaps (35.3 percent)], the majority of flaps were for stage 0 breast cancers [n = 19 flaps (22.4 per-

Table 1. Patient Demographics

	Value
No. of flaps	85
Unilateral	17
Bilateral	34
Mean age	48 yr
Mean BMI	24.6 kg/m^2
Race, no. of flaps (%)	
Caucasian	73 (85.9)
Black	4 (4.7)
Hispanic	4 (4.7)
Asian	4 (4.7)
Smoking history, no. of flaps (%)	
Nonsmoker	69 (81.8)
Former smoker	16 (18.8)
Smoker	0 (0)

BMI, body mass index.

Table 2. Surgical Procedure

	Value
NSM incision, no. of breasts (%)	
Vertical	40 (47.0)
Lateral	24 (28.2)
Inverted-T pattern	15 (17.6)
Inframammary	6 (7.1)
Flaps, no. (%)	
DIEP	57 (67.1)
MS-TRAM	5 (5.9)
SIEA	2 (2.4)
Stacked DIEP	2 (2.4)
PAP	12 (14.1)
TUG	6 (7)
SGAP	1 (1.2)
Mean weight, g	
Mastectomy specimen	406.9
Flap	481.7

NSM, nipples-paring mastectomy; MS, muscle-sparing; TRAM, transverse rectus abdominis musculocutaneous; SIEA, superficial inferior epigastric artery; PAP, profunda artery perforator; TUG, transverse upper gracilis; SGAP, superior gluteal artery perforator.

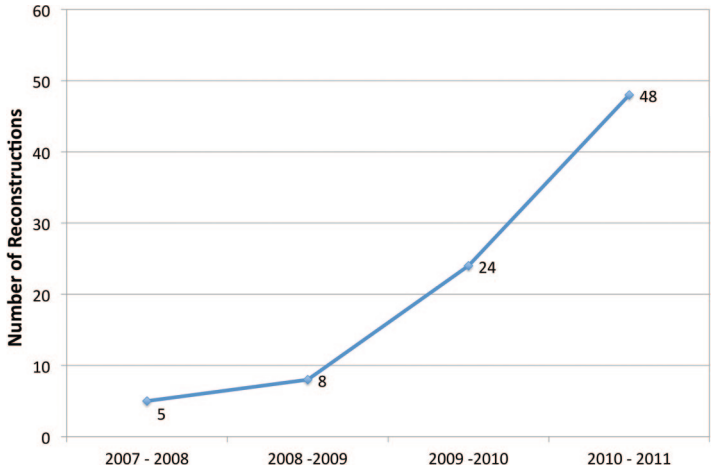

Fig. 1. The number of microsurgical reconstructions performed for nipple-sparing mastectomies per year at the Institute of Reconstructive Plastic Surgery during the study period.

Table 3. Complications

	No. of Cases (%)
Mastectomy skin flap necrosis	11 (12.7)
Partial nipple necrosis	7 (8.2)
Complete nipple necrosis	4 (4.7)
Fat necrosis	6 (7.6)
Infection	2 (2.4)
Abdominal wound dehiscence	1 (1.2)
Hematoma	1 (1.2)

cent)]. The remainder were performed for stage 1 [$n = 5$ flaps (5.9 percent)], stage 2 [$n = 3$ flaps (3.5 percent)], and stage 3 [$n = 2$ flaps (2.4 percent)] breast cancers. There was one flap (1.2 percent) performed after extirpation of a phyllodes tumor.

One flap (1.2 percent) was performed after a history of previous breast irradiation, whereas two flaps (2.4 percent) received adjuvant radiation. Two flaps (2.4 percent) were performed after neoadjuvant chemotherapy, whereas adjuvant chemotherapy was administered after three flaps (3.5 percent).

Surgical Procedure

In reconstructions following nipple-sparing mastectomy, mastectomy incisions are drawn cooperatively with the extirpative surgeon. Incision placement in the majority of breasts undergoing nipple-sparing mastectomy was a vertical one starting from the inferior nipple edge and extending below it [$n = 40$ breasts (47.0 percent)]. The remainder of nipple-sparing mastectomies were performed through lateral ($n = 24$ breasts (28.2 percent)], inverted-T pattern [$n = 15$ breasts (17.6 percent)], or inframammary [$n = 6$ breasts (7.1 percent)] incisions. Lateral incisions started from the lateral edge of the nipple and extended laterally. The length of the incisions varied among the patients. In ptotic or large-volume breasts, longer incisions were used for ease of recipient-site exposure and managing the mastectomy skin envelope.

The reconstructive plastic surgeons at the Institute of Reconstructive Plastic Surgery can offer the full range of microsurgical breast reconstruction, including a wide spectrum of alternatives to the deep inferior epigastric artery perforator flap (DIEP). Nonetheless, the majority of flaps performed were abdominally based [$n = 66$ flaps (77.6 percent)]. Of these 66 free flaps, 57 were DIEP, five were muscle-sparing transverse rectus abdominis musculocutaneous, two were superficial inferior epigastric artery, and two were stacked DIEP flaps. When abdominal tissue was not available or contraindicated, alternative flaps included profunda artery perforator [$n = 12$ flaps (14.1 percent)], transverse upper gracilis [$n = 6$ flaps (7.0 percent)], or superior gluteal artery perforator [$n = 1$ flap (1.2 percent)] flaps.

Recipient vessels in all 85 flaps were the internal mammary artery and vein. Thoracodorsal vessels were not needed in any of the cases. All microvascular anastomoses was performed with an operating microscope. In the majority of flaps, recipient-site exposure was performed through resection of the third rib [$n = 65$ flaps (76.5 percent)]. The mean mastectomy specimen weight was 406.9 ± 186.5 g (range, 190 to 935 g), and the mean flap weight was 481.7 ± 193.7 g (range, 192 to 1010 g).

Complications

Examination of adverse events following 85 autologous reconstructions demonstrated that mastectomy skin flap necrosis was the most common complication [$n = 11$ cases (12.7 percent)]. This was followed by partial nipple necrosis [$n = 7$ cases (8.2 percent)], complete nipple necrosis [$n = 4$ cases (4.7 percent)], fat necrosis [$n = 6$ cases (7.6 percent)], infection [$n = 2$ cases (2.4 percent)], abdominal wound dehiscence [$n = 1$ case (1.2 percent)], and hematoma [$n = 1$ case (1.2 percent)]. Of the 11 reconstruction cases complicated by mastectomy skin flap necrosis, five (5.9 percent) had both mastectomy skin flap and partial/complete nipple necrosis. There were two cases (2.4 percent) of breast cancer detected on histopathologic examination of a subareolar biopsy specimen. These patients required postoperative nipple-sparing mastectomy extirpation. Postoperatively, flap reexploration was needed in one case of venous thrombosis (1.2 percent). This was salvaged in the operating room, within 24 hours postoperatively. There were no partial or total flap losses.

Analysis failed to demonstrate a relationship between nipple/mastectomy skin flap necrosis and age, incision placement, mastectomy specimen weight, or body mass index ($p > 0.05$). For mastectomy skin necrosis, there was no influence of smoking history. However, there was a correlation between smoking history and nipple necrosis ($p < 0.01$), as former smokers were more likely to have nipple ischemia.

Revision Surgery

Donor-site revision was performed after 30 flaps (35.3 percent), whereas revision of the re-

constructed site was performed in 38 breasts (44.7 percent). Fat grafting was used in 25 reconstructed breasts (29.4 percent). The mean volume of fat augmentation was 163.6 ± 117.2 ml (range, 45 to 564 ml).

DISCUSSION

Nipple-sparing mastectomy represents the latest in extirpative breast cancer surgery. At the Institute of Reconstructive Plastic Surgery, nipple-sparing mastectomy is gaining popularity. Each year during the study period, the number of autologous reconstructions for nipple-sparing mastectomies increased (Fig. 1). Nipple-sparing mastectomy also shows increasing prevalence for prophylactic indications, as the majority [n = 55 flaps (64.7 percent)] of reconstructions in this series were for prophylactic cases. This is similar to the results reported by Spear et al. and Chen et al., in which the majority (70 percent and 65 percent, respectively) of their reconstructions were following prophylactic nipple-sparing mastectomies.[1–3]

Ensuring optimal outcomes, including risk reduction and nipple-areola complex preservation, requires vigilant preoperative evaluation and attentive execution. Multiple centers have reported on inclusion criteria for oncologic cases. Discussion of these criteria extends beyond the scope of this report.[1,2,18–22] However, the decision to perform nipple-sparing mastectomy is a collaborative one at New York University, including a thorough discussion among the patient, extirpative surgeon, and reconstructive plastic surgeon. Aside from inclusion criteria, there are other factors, unique to nipple-sparing mastectomy, that can influence the outcome. These include the experience of the surgical team, choice of incision, breast size, degree of breast ptosis, and how effectively breast tissue is removed from behind the nipple and areola.

Breast reconstruction following nipple-sparing mastectomy has its own set of factors that can influence the outcome of the reconstruction. Managing the mastectomy skin envelope and controlling the nipple position are critical to the aesthetic outcome. For patients undergoing reconstruction with free tissue transfer, the choice of flap, use of a skin paddle, and the method of postoperative free flap monitoring are additional considerations to ensure optimal results.

The cohort of patients in this report represents a series of solely autologous reconstructions performed at a single institution. The large volume of 85 flaps in 51 patients, to our knowledge, represents the largest reported series of microsurgical breast reconstructions following nipple-sparing mastectomies. From this high volume of patients come important data that help shed light on the factors influencing outcome in reconstruction of nipple-sparing mastectomy extirpations.

Incision Placement, Breast Size, and Ptosis

Incision placement in nipple-sparing mastectomy influences mastectomy exposure, access to subareolar tissue, and ease of autologous reconstruction. In this series, the majority of nipple-sparing mastectomies and immediate autologous breast reconstructions were performed through vertical [n = 40 breasts (47.0 percent)] or lateral [n = 24 breasts (28.2 percent)] incisions. This is similar to the experience of other institutions.[3] These incisions were preferred, as they allowed the extirpative surgeon to access the breast and possibly perform a sentinel lymph node biopsy or axillary lymphadenectomy. These approaches also allowed preservation of breast contour and modification of the mastectomy skin envelope. For the ptotic or large breasts, the extensions also enabled reduction of the skin flaps. At the time of microsurgical reconstruction, no concomitant mastopexy procedures (i.e., deepithelialization around the nipple-areola complex) are performed. To address these patients, Spear and colleagues have described a staged mastopexy or reduction, performed initially to reduce the skin envelope and reposition the nipple-areola complex.[1,2] The planned nipple-sparing mastectomy follows weeks or months later.

The inframammary approach was the least frequently used in our series [n = 6 breasts (7.1 percent)]. The incision has aesthetic advantages; however, the authors believe that it is most appropriate in smaller breasts. In larger, more ptotic breasts, superomedial and superolateral visualization afforded by the inframammary approach can be challenging. This can make visualization of the recipient site and subsequent microsurgery difficult.

Nipple Positioning and Mastectomy Skin Envelope

The mobility of skin flaps can make control of postoperative nipple position challenging. This is especially true in larger, more ptotic breasts. In this series of nipple-sparing mastectomy reconstructions, the mean flap weight (481.7 g) was higher than the mean mastectomy specimen weight (406.9 g). Therefore, the flap often fills the skin envelope, thus preventing nipple-areola complex migration. However, there may be cases of

mismatch between the mastectomy skin envelope and the reconstruction volume. In this event, the nipple-areola complex position can be controlled with an absorbable stitch from the subareolar tissue to the flap.

Preoperative nipple-areola complex asymmetries should be identified to the patient. Preexisting irregularities add an additional variable in the challenge of controlling postoperative nipple position. In this series, the average reconstructed breast was larger than the mean mastectomy specimen weight. Consequently, any preoperative asymmetries could be accentuated, contributing to patient dissatisfaction.

Mastectomy skin flap necrosis can be a challenging postoperative complication to manage. In this series, there were 11 autologous reconstructions (12.7 percent) complicated by ischemia and necrosis of the mastectomy skin envelope. These occurred early in the study period as the surgical team gained experience with nipple-sparing mastectomy. For institutions embarking on nipple-sparing mastectomy, this issue requires careful consideration. If there is an in-

Fig. 2. (*Above*) The patient is shown before left prophylactic nipple-sparing mastectomy. (*Below*) Patient's appearance 1 month after immediate reconstruction with a left profunda artery perforator flap.

traoperative suspicion of ischemia resulting from clinical examination or fluorescent angiography, the reconstructive surgeon may wish to delay complete deepithelialization of the flap. Flap skin under areas of compromised mastectomy flaps can remain until these worrisome areas have declared themselves. At a later stage, 7 to 10 days, the patient can be brought to the operating room for removal of either necrotic mastectomy envelope or unwanted flap skin. This was performed in two patients.

Flap Type and Postoperative Monitoring

The full spectrum of donor sites for microsurgical breast reconstruction was performed in this series, including DIEP, muscle-sparing transverse rectus abdominis musculocutaneous, superficial inferior epigastric artery, profunda artery perforator, transverse upper gracilis, and superior gluteal artery perforator flaps. In all 85 of these flaps, there was one case (1.2 percent) of microvascular thrombosis. The venous thrombosis was detected within postoperative day 1, and the flap was salvaged. There were no cases of partial or total flap loss. As previously demonstrated, experience with microvascular surgery is indispensable to good outcomes in autologous breast reconstruction.[26]

Expertise in alternative donor sites is just as important as having experience with abdominally based flaps. The mean body mass index in this series was 24.6 and the lowest body mass index was 18. In addition to inadequate abdominal adiposity, patients can present with other contraindications (i.e., subcostal scar or previous abdominal surgery). Nineteen of the 85 breast reconstructions (22.4 percent) were from alternative donor sites. There is no criterion standard alternative donor site. Rather, the decision is based on evaluating the various alternative donor sites (e.g., posterior thigh, medial thigh, buttock). The region that can provide the most tissue with the least donor-site morbidity is selected.

Intraoperatively, the choice to bury the flap or leave a small skin paddle can have implications for postoperative flap monitoring. When internalizing the flap, monitoring will be dependent on an implantable Doppler probe. Other, less specific postoperative parameters that can be followed include drain output, breast size, and percutaneous Doppler examination. Choosing to externalize a skin paddle from the flap can allow for means of traditional monitoring, including color, capillary refill, and pencil Doppler examination. As in our series, this decision was ultimately influenced by the surgeon's comfort and the institutional experience.

Complications

The most common complication in this series was mastectomy skin flap necrosis. All cases occurred early in the study period and may reflect early institutional experience with nipple-sparing mastectomy (Fig. 1). Further analysis failed to reveal any relationship between mastectomy flap necrosis and incision placement, mastectomy specimen weight, body mass index, or smoking history. The latter was an unexpected finding, as smoking history correlated with nipple necrosis but not mastectomy skin flap necrosis.

Nipple ischemia and necrosis were similarly prevalent. In this cohort of reconstructions, there were seven cases (8.2 percent) of partial and four cases (4.7 percent) of complete nipple necrosis.

Fig. 3. (*Left*) Preoperative view and (*right*) postoperative appearance after bilateral nipple-sparing mastectomies and immediate deep inferior epigastric artery perforator flap reconstruction.

These rates of nipple loss are commensurate with those reported in other series.[3,27–29] Reconstructions troubled with partial nipple necrosis were allowed to heal by secondary intention. Complete nipple necrosis needed conventional nipple reconstruction.

There have been reports that choice of incision placement in nipple-sparing mastectomy can influence nipple necrosis rates. When using a lateral or radial incision, Stolier and colleagues have noted no cases of nipple necrosis.[30] In this series, there was no correlation between incision placement and nipple necrosis. Similarly, there was no relationship between nipple ischemia and mastectomy specimen weight, body mass index, or age. However, patients with a history of smoking were more likely to have nipple necrosis.

Limitations

This report reflects the outcomes following the largest reported series, to date, of autologous breast reconstructions for nipple-sparing mastectomies. Various donor sites are used in the patient cohort, including those from the abdomen, buttock, and medial and posterior thigh. Demographic data, breast cancer data, intraoperative details, and complications are examined to elucidate factors that influence nipple-sparing mastectomy and its reconstruction. There are, however, some limitations to the study. The methodology did not enable prospective evaluation of nipple sensation, patient satisfaction, or aesthetic outcomes. Despite these limitations, the authors believe the findings in this report positively contribute to the growing body of literature surrounding reconstruction following nipple-sparing mastectomy.

CONCLUSION

Nipple-sparing mastectomy followed by microsurgical reconstruction, for carefully selected patients, can be safely performed with low complication rates (Figs. 2 and 3).

Jamie P. Levine, M.D.
530 First Avenue, Suite 8Y
New York, N.Y. 10016
jamie.levine@nyumc.org

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