Hypothesis: Dissection of subnipple tissue to spare the entire skin envelope of the breast (total skin-sparing mastectomy) is a feasible option in appropriately selected patients and yields an excellent final cosmetic outcome.

Design: Prospective surgical technique outcomes study.

Setting: University-based breast care referral center.

Patients: Total skin-sparing mastectomy with preservation of the nipple-areola complex was performed in 64 breasts in 43 women. Indications for total skin-sparing mastectomy included prophylaxis (n=29), invasive carcinoma (n=24), and ductal carcinoma in situ (n=11).

Interventions: Preoperative magnetic resonance imaging was used to select patients and to confirm absence of disease within 2 cm of the nipple. Nipple tissue was serially sectioned at pathologic analysis. Circumareolar/nipple-areola free graft, inframammary, crescentic mastopexy, areola crossing, and radial incisions were used. Immediate reconstruction was performed with implant or tissue expander placement or latissimus dorsi muscle, transverse rectus abdominis muscle, or deep inferior epigastric perforator muscle flaps.

Main Outcome Measures: Nipple-areola complex skin survival, implant loss, skin flap necrosis, wound infection, and occult neoplasm.

Results: Nipple-areola complex skin survival was complete in 80% of patients (n=51) and partial in 16% (n=10); it was highest with the radial incision at 97% survival (n=34). Occult ductal carcinoma in situ in the nipple-areola complex was found in 2 patients (3%), and the affected nipple-areola complex was subsequently removed. Other complications included implant loss, total skin-sparing skin flap necrosis, and infection. Although follow-up is limited, no patients have exhibited cancer recurrence.

Conclusions: Total skin-sparing mastectomy is a viable surgical option in selected patients with breast neoplasm and those who choose prophylactic mastectomy, and may increase the willingness of women to consider mastectomy to reduce their risk of breast cancer.


Mastectomy is indicated in individuals who have 2 invasive carcinomas or more in separate quadrants of the breast or extensive ductal carcinoma in situ (DCIS), for those in whom tumor-free margins cannot be achieved with lumpectomy alone, or when there are contraindications to radiation therapy.

See Invited Critique at end of article

Mastectomy is also chosen by women who prefer this option to breast-conserving surgery with or without radiation therapy. The decision to undergo mastectomy is often influenced by the choice of reconstruction options.

The prospect of having a mastectomy is a psychologically difficult experience for most women. In particular, women find losing the nipple-areola complex (NAC) distressing. There are several techniques for removing the subductal tissue while preserving the dermal layer, thereby allowing the outward appearance of an intact nipple. However, how these techniques affect nipple-skin viability is unknown. To determine whether total skin-sparing mastectomy (TSSM) is a feasible option in appropriately selected patients, we conducted a prospective surgical technique outcomes study of women who underwent this procedure at our institution.
Patients were assessed preoperatively with physical examination, mammography, and breast magnetic resonance imaging (MRI). They were excluded from undergoing TSSM if they had large centrally located tumors or involvement of the skin or if imaging (mammography or MRI) showed evidence of carcinoma within 2 cm of the nipple. Patients were offered TSSM if they were mastectomy candidates. The initial group of 20 patients who underwent TSSM had in situ disease in more than 1 quadrant or 2 or 3 previous lumpectomies with positive margins, or were at high risk for developing breast cancer. Initially, we offered TSSM to women if loss of the NAC was the obstacle that was preventing them from undergoing mastectomy. Once we found that NAC viability was in the range of 80% (20 cases) at our institution, the procedure was offered to women undergoing prophylactic mastectomy or if their disease was not within 2 cm of the nipple. Patients were informed of our institution's experience and success rates and that the long-term effect of NAC skin preservation was unknown but could potentially increase risk of cancer recurrence by 1% to 2%.

**PREOPERATIVE MRI**

Preoperative MRI screening was used to exclude patients with disease in ductal tissue near the nipple (Figure 1). Therefore, all patients underwent high-resolution MRI with fat suppression on a 1.5-T magnet using a–3 time point technique.

**SURGICAL TECHNIQUE**

Total skin-sparing mastectomy was performed using 1 of 5 incisions (Figure 2): circumareolar incision with nipple-areola free graft, inframammary incision, crescentic mastopexy incision, areola-crossing incision, or radial incision. In all 5 incisions, the dermis of the nipple and areola was dissected away...
from the underlying duct tissue using bipolar cautery. The nipple skin was inverted to ensure complete removal of all ductal tissue. Completion mastectomy was performed using the traditional skin-sparing technique with monopolar cautery, leaving a skin layer with an approximate thickness of 2 to 3 mm. Breast reconstruction was performed with immediate implant placement in 30 cases (47%), tissue expanders in 5 cases (8%), transverse rectus abdominis muscle flaps in 17 cases (27%), deep inferior epigastric perforator muscle flaps in 11 cases (17%), and latissimus dorsi muscle flaps in 6 cases (9%). The type of reconstruction was determined according to patient preference after a thorough discussion of options, risks, and benefits.

**PATHOLOGIC EVALUATION**

The mastectomy specimen was removed en bloc, preserving the subdermal nipple ductal tissue. The nipple tissue was marked with a suture, removed, and serially sectioned as a separate specimen by the pathologist as part of the microscopic evaluation.

**RESULTS**

Forty-three women who underwent TSSM ranged in age from 26 to 63 years (mean age, 43.7 years). Almost half of the TSSMs (46%) were performed for prophylaxis. In women with malignant lesions, 21% had stage 0 tumors (DCIS) or stage I or II disease (Table 1). Three of 6 patients with stage II disease received neoadjuvant therapy, and all 6 received chemotherapy. The results of the different techniques of skin-sparing mastectomy are given in Table 2. The complications and success of TSSM depend on the incision used and the reconstruction type. Complications and survival of the nipple tissue were independent of the indication for surgery, that is, invasive cancer vs DCIS vs prophylaxis (data not shown). Of the 5 smokers in our series, 3 (60%) had nipple loss, which was partial in 2 patients and complete in 1 patient.

All incisions provided access to the ductal tissue under the nipple-areola skin (Figure 2). The total skin-sparing inframammary incision was used only in women with small breasts because we were concerned about limited exposure to the upper part of the breast in women with larger breasts. The dermal plane of the nipple tissue was easiest to identify using the NAC-crossing incision. However, all patients in whom the NAC-crossing incision was used had at least focal necrosis of the nipple skin, and the NAC survived in only 2 of 11 procedures (18%). The mastopexy incision, which was successful in 7 of 8 procedures, enabled good exposure to the subnipple duct tissue and allowed the breast to be lifted but was only successful if it spanned less than one-third of
the circumference of the areola. Incisions that spanned more than one-third of the circumference seemed to compromise the blood supply, leading to loss of nipple-areola skin. The radial incision provided the best access for performance of the traditional skin-sparing mastectomy and had the greatest likelihood of maintaining viable nipple and areola skin (34 of 35 procedures [97%]).

Immediate breast reconstruction was performed in all women after mastectomy. Reconstruction results after immediate implant placement and use of a mastopexy incision are shown in Figure 3. A right-sided TSSM performed through a radial incision and reconstructed with a transverse rectus abdominis muscle flap is shown in Figure 3B. The cosmetic results are excellent when the NAC skin survives and the shape of the breast is natural. Complications from the reconstructions are listed in Table 3. Thirty-six percent of cases experienced 1 complication or more including implant loss (9% of total, 24% of those who underwent immediate implant placement), wound infection (9%), and skin flap necrosis (9%). Implant losses and wound infections occurred in the setting of immediate implant placement. Although the number of cases is small, no infections or implant losses were noted with the use of expanders. Patients with skin necrosis and flap procedures had full recovery of the skin. One patient required a skin graft. Other complications included loss of nipple projection and loss of areola skin pigment (data not presented).

In the entire series of 64 mastectomies, the nipple-areola skin survived in 51 cases (80%), partially sur-
vived in 10 cases (16%), and was lost in 3 cases (5%). It was common for the NAC skin to develop epidermolysis or partial-thickness skin necrosis. Most of these patients healed by day 21. Cosmesis continues to improve over the long term. An example of skin necrosis and early regrowth is shown in Figure 4C and D.

Two specimens in 2 patients were found to have microscopic DCIS in the subnipple ductal tissue at serial pathologic sectioning. The nipple-areola skin was subsequently removed, and no evidence of residual carcinoma or DCIS was identified in these specimens. Both patients were mutation carriers undergoing prophylactic mastectomy. It can be appreciated in Figure 4B that the subdermal tissue of the nipple is completely removed in this procedure; thus, this technique is distinctly different from a subcutaneous mastectomy, in which the tissue under the nipple and areola is retained.

**COMMENT**

Prophylactic mastectomy reduces the incidence of breast cancer in BRCA1 and BRCA2 mutation carriers, women whose entire breast tissue is at high risk for cancer (≥85% estimated risk). Modeling has shown that mastectomy confers a substantial decrease in mortality in mutation carriers younger than 50 years. Thus, women with inherited mutations that predispose to breast and ovarian cancer often seek consultation about prophylactic surgery. Because of the substantial physical effect of mastectomy, only 15% to 20% of women find prophylactic mastectomy acceptable in this situation. As more young women discover that they are at profound risk for developing breast cancer, more acceptable prophylactic surgical and reconstructive techniques need to be identified until other preventive alternatives are found. We believe that TSSM is one such technique because it preserves the entire skin envelope of the breast, resulting in a more natural shape. In addition, preservation of the dermis of the nipple and areola results in a more natural appearance than an artificially reconstructed nipple, although some loss of pigmentation can occur. Psychologically, the ability to maintain one’s own nipple and areola skin seems important to patients.

Without long-term outcome data, we cannot say definitively how much risk remains by leaving the dermis of the NAC. The reports of tumor found in the nipple duct tissue when the breast is serially sectioned ranges from 0% to 58%, but far fewer cases of invasive cancer are found in the NAC (approximately 10%). After subcutaneous mastectomy, the occurrence of cancer is similar to that after traditional mastectomy. In women who are carriers of BRCA1 or BRCA2 mutations, bilateral mastectomy results in a 95% reduction in risk of developing breast cancer. We used this information to help us project the additional risk that might be conferred by removing all of the nipple duct tissue but leaving the dermis. If 0% to 58% of nipple involvement with tumor occurs and removal of all tissue results in 95% reduction of risk, then the additional risk of local recurrence in the nipple would likely be in the range of 0% to 2.9%. Skin-sparing techniques for mastectomy do not increase local recurrence rates, even in the setting of more advanced cancers. Long-term follow-up will demonstrate the true risk of local occurrence or recurrence, but it is reasonable to assume that recurrence with complete removal of the nipple duct tissue is, at most, 1% to 2%, and may even be less, particularly if careful preoperative planning is performed with MRI and the nipple tissue is serially sectioned and examined.

Rather than using frozen sections to confirm the absence of tumor in the nipple tissue, as described by others, we used preoperative assessment with MRI and found that it helped us exclude patients with disease near the nipple. In our series, the nipple tissue was free of disease at final, pathologic analysis of formalin-fixed specimens in 97% of patients. If malignancy was found, the NAC was removed as a separate surgical procedure. The combination of MRI with detailed final confirmatory pathologic evaluation is our standard assessment of subnipple ductal tissue and should minimize the possibility of leaving occult cancer behind. Margulies et al described a technique of using frozen sections in the operating room and found that as much as 8% of nipple tissue contained tumor. Magnetic resonance imaging is a technique for patient selection that averts intraoperative evaluation of the nipple tissue after performing a total skin-sparing procedure and minimizes the chance of finding unrecognized disease in the nipple tissue.

Our successes and complications with TSSM led us to modify our operative technique over time. Our first attempts at TSSM involved free grafting of the NAC, which was the method reported in Europe. Although the initial results were promising, with NAC survival in the first 2 cases, the NAC did not survive in the next 2 cases and took 2 months to reepithelialize in 2 other cases. We,

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**Table 3. Breast Reconstruction and Complication Rates**

<table>
<thead>
<tr>
<th>Type of Breast Reconstruction</th>
<th>No. of Breasts</th>
<th>% of Cases</th>
<th>Implant Loss Rate, %</th>
<th>Wound Infection Rate, %</th>
<th>Skin Flap Necrosis Rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate implant placement</td>
<td>25</td>
<td>39</td>
<td>24</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Tissue expanders</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TRAM flaps</td>
<td>17</td>
<td>27</td>
<td>NA</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>DIEP muscle free flap</td>
<td>10</td>
<td>16</td>
<td>NA</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Gracilis muscle free flap</td>
<td>1</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Latissimus dorsi muscle flaps alone or combined with implant</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: DIEP, deep inferior epigastric perforator muscle; NA, data not available; TRAM, transverse rectus abdominis muscle.
therefore, explored other types of incisions to improve the outcome. The inframammary incision provided a relatively large opening for performing the procedure; however, we were concerned about the ability to access the upper portion of the breast in women with large breasts and limited this approach to women with very small breasts. In addition, early in the evolution of our technique, 1 patient in whom an inframammary incision was used developed necrosis of the skin between the nipple and the inframammary fold. However, a recent report of this technique suggests that it is safe and effective even in women with larger breasts. The authors of that report recommended using an incision of at least 10 cm. Subsequent to the preparation of the present article, we have had recent success with the inframammary technique because the larger incision enables us to more easily evert the skin for improved visualization of sub-NAC tissues.

Nipple-areola complex–crossing procedures were abandoned because of the low survival of the NAC skin, although the procedures were technically easier to perform and the dermal plane of the nipple was much easier to identify. The mastopexy incision seems to have an acceptable rate of NAC skin survival, but our experience suggests that incisions that extend over more than 33% of the circumference of the NAC were the ones that resulted in NAC loss. In larger-breasted women, the surgeon may have to choose between a traditional skin-sparing procedure that lifts the breast using a reduction incision and a total skin-sparing procedure with a more minimal lift. The radial incision, which we used when we were not trying to lift the nipple, provides good ac-

Figure 4. Nipple skin loss and regeneration after total skin-sparing mastectomy with a nipple-areola–crossing incision, with immediate deep inferior epigastric perforator muscle flap reconstruction. A, Preoperative view of the left breast in a good candidate for total skin-sparing mastectomy. B, Example of a total skin-sparing mastectomy that shows that the subdermal nipple duct tissue (arrow) is evident and intact. Nipple tissue is submitted separately for pathologic evaluation. C, Total nipple necrosis 3 weeks after total skin-sparing mastectomy with deep inferior epigastric perforator muscle flap reconstruction. D, At 12 weeks postoperatively, reepithelialization from underlying dermis is seen, with no interim intervention. The areola skin fully regenerated but the nipple was lost. The patient subsequently underwent nipple reconstruction using her areolar skin.
cess to the ductal tissue under the NAC and the entire breast tissue and resulted in the most consistent, successful outcome. The NAC skin survived in 34 of 35 cases (97%). The radial and inframammary incisions disrupt the blood supply of the NAC less than any other incision. The lateral (radial) incision was used by Crowe et al., with reported survival of the NAC in 100% of 45 patients. Our study also shows that the radial incision is a reliable technique for TSSM. Although nearly all patients had some degree of epidermolysis of the nipple postoperatively, regardless of incision type, this completely resolved within 3 weeks in patients in whom the radial incision was used, yielding healthy underlying tissue. With the radial incision, we found that smaller incisions resulted in trauma to the skin flap from aggressive retraction used to provide a good view of the surgical field. An incision length of at least 5 cm was optimal to provide exposure and limit trauma.

Our complication rate from reconstructions was high but not out of the range reported in the Michigan Outcomes Study. While the use of immediate implants can reduce the discomfort and repeated visits associated with expanders, they should be used with caution in the setting of TSSM because of the skin necrosis that consistently develops for a time after TSSM. Certainly, implants placed immediately should not be expanded beyond the original breast size. Expandable implants (ie, Becker breast implants; Mentor Corporation, Santa Barbara, California) with partial filling minimize skin tension and seem to be associated with lower infection and implant loss. We currently adopted the use of expandable implants. Our results continue to improve over time.

CONCLUSIONS

Our study results show that TSSM is a viable surgical option in selected patients with breast neoplasms and in those who undergo prophylactic mastectomy. Preoperative MRI enables prediction of disease-free NAC, and detailed pathologic evaluation of the subnipple ductal tissue confirms absence of neoplasm. We and others have shown that the radial incision produces the most reliable results. With time, we have improved the technique and learned how to minimize complications. Patients have expressed great satisfaction with the preservation of both appearance and sensation. Although TSSM is technically challenging and time-intensive, it can yield spectacular cosmetic results in carefully selected patients and may increase the willingness of women at very high risk to consider mastectomy for breast cancer risk reduction.

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REFERENCES

Wijayanayagam and colleagues describe their evolving experience with TSSM. This work adds to a growing literature confirming the feasibility of TSSM for both prophylaxis and therapy. In addition to the reported results, several issues raised by this article deserve comment.

First, the authors emphasize the need for documentation of no tumor near (defined as 2 cm by these authors and others) the NAC. In this series from San Francisco, MRI was used to estimate this preoperatively, with confirmation at final pathologic analysis. Others have recommended intraoperative frozen-section analysis, but the gold standard is the final pathologic findings. If this is the case and if returning the patient to the operating room to resect the NAC is of little consequence, perhaps it would be more cost-effective in most practice settings to rely primarily on the final pathologic findings.

Second, the authors point out that they are not presenting long-term follow-up data, but they extrapolate that TSSM increases the risk of local recurrence by, at most, 1% to 2%. A recent review of all series with follow-up of 4 years or longer showed that the locoregional recurrence rates for skin-sparing mastectomy range from 2% to 20%. Long-term data for TSSM are lacking, in part, because it is a relatively new technique. Breast surgeons, however, should continue to observe their patients closely and consider the development of a national registry to further study the long-term outcomes for TSSM.

Third, the authors have, perhaps without realizing it, performed a practice-based improvement. They noticed early on, by continuously assessing their outcomes, that there was an opportunity to improve their technique to decrease the rate of complications and, in particular, NAC skin loss. They documented a marked decrease in skin loss with changing the placement of the incision. All surgeons should use this as an example of how continuously assessing their own results can lead to their own practice-based improvement.

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