# Total Skin-Sparing Mastectomy

## *Complications and Local Recurrence Rates in 2 Cohorts of Patients*

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**Purpose:** Dissemination of the total skin-sparing mastectomy (TSSM) technique is limited by concerns of nipple viability, flap necrosis, local recurrence risk, and the technical challenge of this procedure. We sought to define the impact of surgical and reconstructive variables on complication rates and assess how changes in technique affect outcomes.

**Patients and Methods:** We compared the outcomes of TSSM in 2 cohorts of patients. Cohort 1: the first 64 TSSM procedures performed at our institution, between 2001 and 2005. Cohort 2: 106 TSSM performed between 2005 and 2007. Outcomes of cohort 1 were analyzed in 2005. At that time, potential risk factors for complications were identified, and efforts to minimize these risks by altering operative and reconstructive technique were then applied to patients in cohort 2. The impact of these changes on outcomes was assessed. Logistic regression was used to determine the association between predictor variables and adverse outcomes (Stata 10).

**Results:** The predominant incision type in cohort 2 involved less than a third of the nipple areola complex (NAC), and the most frequent reconstruction technique was tissue expander placement. Between cohort 1 and cohort 2, nipple survival rates rose from 80% to 95% ($P = 0.003$) and complication rates declined: necrotic complications (30% → 13%; $P = 0.01$), implant loss (31% → 10%; $P = 0.005$), skin flap necrosis (16%–11%; not significant), and significant infections (17%–9%, not significant). Incisions involving >30% of the NAC ($P < 0.001$) and reconstruction with autologous tissue ($P < 0.001$) were independent risk factors for necrotic complications. The local recurrence rate was 0.6% at a median follow-up of 13 months (range, 1–65), with no recurrences in the NAC.

**Conclusion:** Focused improvement in technique has resulted in the development of TSSM as a successful intervention at our institution that is oncologically safe with high nipple viability and early low rates of recurrence. Identifying factors that contribute to complications and changing surgical and reconstructive techniques to eliminate risk factors has greatly improved outcomes.

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Despite the viable option of breast conservation, for many women, mastectomy remains the treatment of choice either because of repeated lumpectomy attempts, multicentric disease, prophylaxis, or patient preference. Although reconstruction options are continually improving, mastectomy is a traumatic event, particularly when the native nipple and areola complex (NAC) are excised. Total skin-sparing mastectomy (TSSM) enables the nipple-areola dermal layer to be preserved while the underlying ductal tissue is removed. The skin envelope is left completely intact skin and excellent cosmesis is achieved.

Although the first form of TSSM was performed in 1962,[1] procedures that spare the nipple and areola complex have been recently re-examined by breast surgeons in an effort to provide a better cosmetic outcome. This is in part motivated by recent improvements in reconstructive surgery options[2] and by patient demand to improve mastectomy cosmesis. However, the TSSM procedure raises concerns regarding necrotic complications from instability of the supporting vasculature and risk of recurrence in the small yet unknown quantity of ductal tissue remaining at the nipple tip.

In our previous descriptive analysis of surgical outcomes for the first patient group to receive TSSM at our institution, 43 women who underwent 64 TSSMs, we concluded that the procedure was a viable surgical option in selected patients with breast neoplasms and those undergoing prophylactic mastectomy.[3] We also noted that both the incision used and reconstruction type seemed to impact TSSM complications. This observation led us to modify our operative technique and to start a second cohort of approximately 100 cases. In this study, we describe the changes in surgical technique and associated outcomes of TSSM in the second cohort of patients, cohort 1 is included for the purposes of comparison.

## PATIENTS AND METHODS

Between October 1, 2001, and October 10, 2007, 170 total skin-sparing mastectomies were performed in 115 patients. These cases are divided into 2 chronological cohorts based on the time point April 30, 2005 when the first 64 cases underwent analysis. Cohort 1: the first 64 cases performed by a single surgeon between October 1, 2001 and April 30, 2005.[3] After cohort 1, 3 additional breast surgeons were trained to perform TSSM and a second cohort was initiated. Cohort 2: all subsequent TSSM procedures (n = 106) performed between April 30, 2005, and October 10, 2007, by 4 breast surgeons. Patient characteristics and outcomes were recorded in a prospectively maintained database.

### Patient Selection

Women with indications for mastectomy, clinically normal nipples, and no skin involvement were offered the option to consider TSSM. Magnetic resonance imaging (MRI) was used to preoperatively screen women for absence of tumor involvement within 2 cm of the NAC. At the time of surgery, serially sectioned nipple tissue was obtained to determine if tumor was present at the nipple margin.

TSSM was first initiated at this institution in 2001 specifically for prophylactic mastectomy candidates who would otherwise refuse to undergo mastectomy by traditional technique. As our success increased with this patient population, inclusion criteria were expanded.

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## TSSM Technique

We have previously described the TSSM technique used in the first cohort.[3] This technique was used in all patients of both cohorts and included the inversion and complete excision of the nipple core at the dermal junction, leaving only 1 to 3 mm of intact dermis and an entirely intact breast envelope that included the nipple and areola complex skin. In the first cohort, 5 incision types were used and the NAC was dissected by monopolar cautery on low cutting current or bipolar cautery. In the second cohort, 5 incision types were also used, depending on the size and shape of the native breast (Fig. 1) and the NAC dissection technique was sharp dissection using either several fresh 15 blade scalpels with frequent changes or tenotomy/blepharoplasty scissors. Two broad categories of incision emerged. One involved greater than 30% of the NAC (circumareolar incision with nipple-free graft, nipple-areolar complex crossing, and, in cohort 1 only, mastopexy-type incisions). The second category involved less than 30% of the NAC (lateral/inferolateral incision, inframammary incision, radial incision, and, in cohort 2 only, mastopexy-type incisions that extended over less than 30% of the NAC). Therefore, the mastopexy-type incision in cohort 1 was a larger incision tracing >30% of the NAC along the superior border but was modified in cohort 2 to cover a smaller area along the NAC. In an effort to optimize exposure to the axillary tail, the inframammary incision was modified and moved superior and laterally, creating the lateral/inferolateral incision type in cohort 2.

## Reconstruction Technique

All patients in both cohorts underwent immediate reconstruction that included immediate implant placement, tissue expander placement, or autologous reconstruction. Autologous reconstructions were done in 63 cases (37%) and included 35 transverse rectus abdominis myocutaneous (TRAM) flap recon-

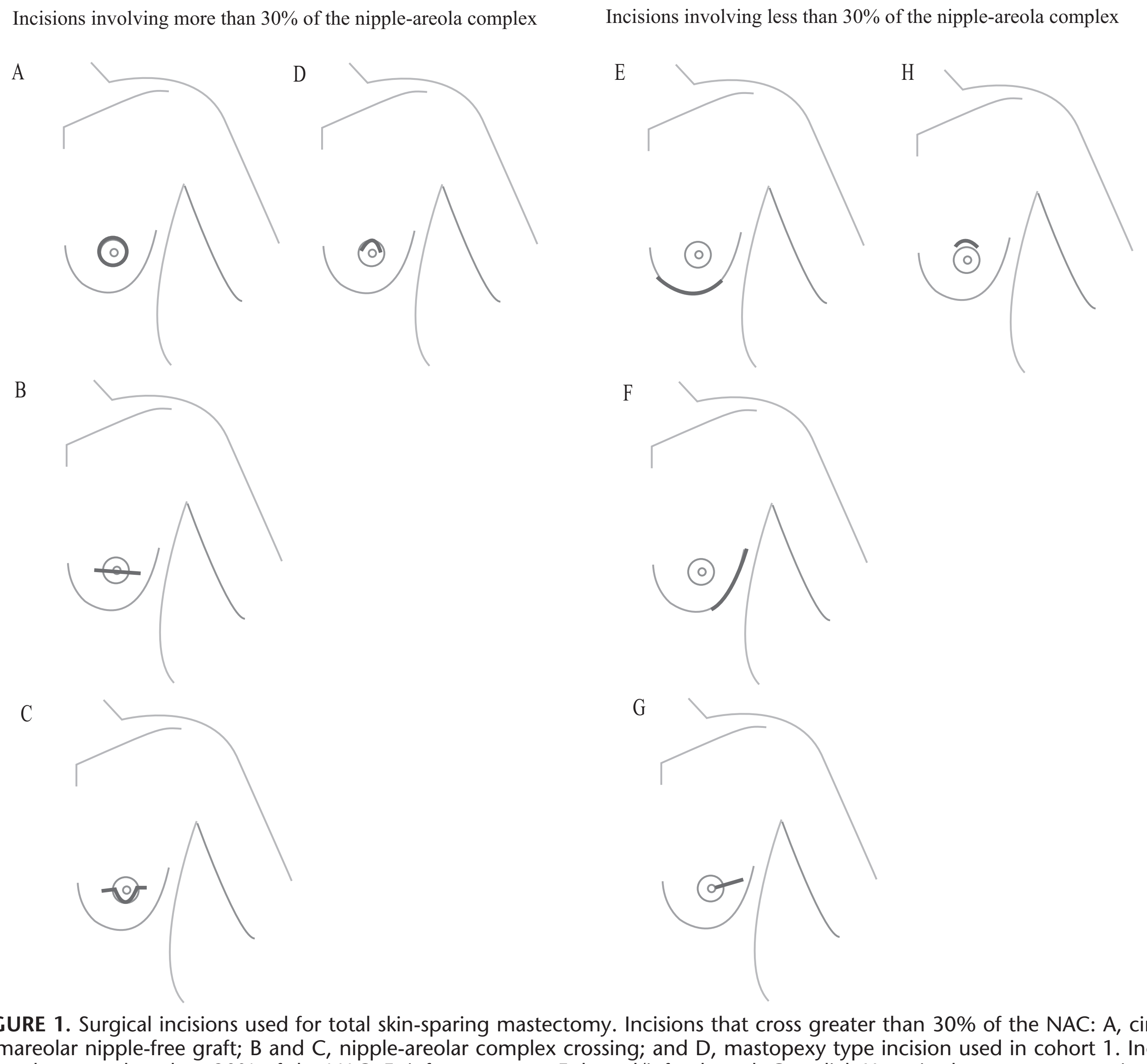


**FIGURE 1.** Surgical incisions used for total skin-sparing mastectomy. Incisions that cross greater than 30% of the NAC: A, circumareolar nipple-free graft; B and C, nipple-areolar complex crossing; and D, mastopexy type incision used in cohort 1. Incisions that cross less than 30% of the NAC: E, inframammary; F, lateral/inferolateral; G, radial; H, revised mastopexy type incision used in cohort 2.

 

structions, 22 deep inferior epigastric perforator (DIEP) reconstructions, 6 combined latissimus dorsi plus implant reconstructions, 3 gracilis flaps, 1 combination DIEP and gracilis flap, and 2 latissimus dorsi reconstructions.

## Surgical Outcomes

Data on NAC skin survival, implant loss, skin flap necrosis, surgical technique, significant infection, local recurrence, and metastasis were recorded in our prospective database. Necrotic complications included skin flap necrosis, partial nipple loss, and complete nipple loss. Skin flap necrosis was defined as a full-thickness skin loss. Implant loss was defined as the removal of an implant without replacement but did not exclude the possibility of future reconstruction. Infections were classified as significant if they required a patient to be hospitalized for intravenous antibiotics or to visit the emergency department for treatment. Erythema that resolved with oral antibiotic treatment was not included as a complication. Superficial epidermolysis that resolved completely within a few weeks after surgery was not coded as a complication.

## Data Analysis

Univariate logistic regression was used to identify those patient and surgical factors related to an adverse surgical outcome. Fisher exact test was used to compare groups that had fewer than 5 cases. Multivariate regression analysis with a stepwise backward elimination of factors with $P > 0.05$ was used to identify independent risk factors for complications. An unpaired 2-tailed $t$ test was used to compare group means. All analyses were performed with Stata 10 (College Station, TX).

# RESULTS

Total skin-sparing mastectomy was performed over a period of 7 years in 115 patients (170 cases) who ranged in age from 26 to 64 (mean 44 years). The 2 patient cohorts were similar with respect to age, surgical indication for mastectomy, and tumor histology (Table 1). In the first cohort, 80% of TSSMs in patients with cancer were done in patients with stage 0 or 1 disease. As TSSM was increasingly used in patients with later stage disease, the percentage of stage 0 and stage 1 disease dropped to 45% in cohort 2. Over both cohorts, 44 of 58 cases (81%) in which TSSM was done for prophylaxis were confirmed to be benign on final pathologic review; ductal carcinoma in situ was detected in 3 (5%) and invasive cancer in 8 (14%).

**TABLE 1.** Comparison of Demographic and Clinical Characteristics for 2 Cohorts of Patients Who Underwent TSSM

| | Cohort 1 | Cohort 2 | P |
|---|---|---|---|
| Mean age (range) | 44 (26–63) | 44 (26–64) | 0.90 |
| Indication | | | |
| Bilateral TSSM | | | |
| Unilateral cancer and contralateral prophylaxis | 15 (23%) | 28 (26%) | 0.67 |
| Bilateral prophylaxis | 4 (6%) | 4 (4%) | 0.47 |
| Bilateral cancer | 2 (3%) | 2 (2%) | 0.61 |
| Unilateral TSSM | | | |
| Unilateral cancer | 16 (25%) | 35 (33%) | 0.27 |
| Unilateral prophylaxis | 6 (9%) | 3 (3%) | 0.08 |
| Prophylactic cases with benign pathology | 21 (33%) | 37 (35%) | |
| Tumor characteristics* | | | |
| Ductal carcinoma in situ | 12 (19%) | 17 (16%) | 0.65 |
| Invasive ductal cancer | 19 (30%) | 38 (36%) | 0.41 |
| Invasive lobular cancer | 3 (5%) | 5 (5%) | 0.99 |
| Invasive ductal and lobular cancer | 1 (2%) | 4 (4%) | 0.42 |
| Mean tumor size (cm), range | 2.5 (0.03–15.0) | 3.9 (0.02–15.2) | 0.07 |
| Patient stage* | | | 0.004 |
| 0 | 14 (33%) | 16 (23%) | |
| 1 | 20 (47%) | 15 (22%) | |
| 2 | 8 (19%) | 27 (39%) | |
| 3 | 1 (2%) | 10 (15%) | |

Univariate logistic regression was used to compare the distribution of mastectomy indication and tumor characteristics between cohorts. Student $t$ test was used to compare mean age and tumor size between cohorts.

*For cancer patients, n = 112. Pathology and staging information unavailable for one cancer case, cohort 2.

Chi-square test was used for indication and tumor characteristics between cohorts. Student $t$ test was used to compare mean age and tumor size between cohorts. Breast cancer was found in 11 mastectomies performed for prophylaxis (3 DGS, 8 IDC).

All patients had immediate reconstruction. Reconstructive procedures included tissue expander or immediate permanent implant placement, autologous tissue reconstruction, or autologous reconstruction with implant (latissimus). Reconstructive profiles varied significantly between the first and second cohorts (Table 2). The difference reflects a deliberate change in reconstruction practice after initial analysis of the first 64 cases showed that immediate implant placement seemed to be associated with necrotic complications and the placement of tissue expanders with little immediate expansion seemed to be protective.[3] Immediate implant placement was halted shortly after analysis of the first cohort was complete, bringing immediate permanent implant reconstructions down from 39% in cohort 1 to 3% ($P < 0.001$) in cohort 2. As success with tissue expanders increased, their use grew from 8% in cohort 1 to 64% in cohort 2 ($P < 0.001$). There was a modest reduction in autologous only reconstructions from 45% to 32% ($P = 0.07$).

Surgical incisions that were not necessarily smaller but crossed less than a third of the nipple-areola complex increased from 59% in cohort 1 to 95% in cohort 2 ($P < 0.001$). The preferred incision type was radial in the first cohort (55%) and inframammary in the second (64%). Radial incisions included extension through the areola to the base of the nipple to hide the scar and improve exposure. This type of incision in the areola did not seem to decrease blood flow within the NAC. The circumareolar nipple-free graft was used only in cohort 1 and was discontinued after 6 cases because 2 of these cases experienced some degree of nipple loss. The lateral/inferolateral incision was used in cohort 2 to optimize access to the axillary tail region. This incision type was discontinued after 6 cases as scarring along the incision that compromised cosmesis was noted. The mastopexy incision was initially an incision that extended over half of the superior border of the NAC, but in cohort 2, was altered to include less than 30% of the NAC tissue. Again these trends reflected deliberate changes in technique as we experimented with different incision types and noted better outcomes when incisions involved less of the NAC border.

Patients who had TSSM and received neoadjuvant chemotherapy, adjuvant chemotherapy, or postmastectomy radiation therapy were more prevalent in cohort 2 (Table 2). Patients who had received prior radiation therapy to the mastectomy breast were evenly distributed between the earlier and later cohorts (n = 7 and 8, respectively; $P = 0.45$). Two patients (4 cases) in cohort 1 had a history of radiation therapy in the distant past for the treatment of Hodgkin lymphoma. The rest had undergone radiation therapy for

**TABLE 2.** Complications and Outcomes in 2 Cohorts of Patients Who Underwent Total Skin-Sparing Mastectomy

| | Cohort 1 | Cohort 2 | P |
|---|---|---|---|
| Total nipple survival | 51 (80%) | 101 (95%) | 0.003 |
| Complications | | | |
| Necrotic complications | 19 (30%) | 14 (13%) | 0.01 |
| Skin flap necrosis | 10 (16%) | 12 (11%) | 0.42 |
| Significant infection | 11 (17%) | 10 (9%) | 0.14 |
| Implant loss (implants only) | 11 (31%) | 7 (10%) | 0.005 |
| Contracture (implants only) | 12 (19%) | 17 (16%) | 0.65 |
| Reconstructions | | | |
| Tissue expander | 5 (8%) | 68 (64%) | <0.001 |
| Autologous only | 29 (45%) | 34 (32%) | 0.07 |
| Immediate implant | 25 (39%) | 3 (3%) | <0.001 |
| Lattisimus dorsi and immediate implant | 5 (8%) | 1 (1%) | 0.05 |
| Incisions | | | |
| Crosses less than 30% of the NAC | 38 (59%) | 101 (95%) | <0.001 |
| Inframammary | 3 (5%) | 68 (64%) | <0.001 |
| Radial | 35 (55%) | 20 (19%) | <0.001 |
| Lateral/inferolateral | 0 (0%) | 6 (6%) | |
| Mastopexy (cohort 2) | 0 (0%) | 7 (7%) | |
| Crosses greater than 30% of the NAC | 26 (41%) | 5 (5%) | <0.001 |
| Nipple-areolar complex crossing | 12 (19%) | 5 (5%) | 0.006 |
| Mastopexy (cohort 1) | 8 (13%) | 0 (0%) | |
| Circumareolar with nipple-free graft | 6 (9%) | 0 (0%) | |
| Exposures | | | |
| Current smoker | 6 (9%) | 2 (2%) | 0.043 |
| Neoadjuvant chemotherapy | 5 (8%) | 28 (26%) | 0.005 |
| Adjuvant chemotherapy | 19 (30%) | 49 (46%) | 0.03 |
| Radiation therapy | 2 (3%) | 25 (24%) | 0.003 |
| Prior radiation therapy | 7 (11%) | 8 (8%) | 0.45 |

the treatment of breast cancer before undergoing TSSM, but dose and regimen were not recorded in our database. Five patients (8 cases) were current smokers at the time of TSSM.

Patients in cohort 2 were 5 times more likely to have total nipple survival; rates increased from 80% in cohort 1 to 95% in cohort 2 (OR 5.15; CI 1.74–15.24; $P = 0.003$). Cohort 2 was much less likely than cohort 1 to experience necrotic complications of any kind (13% vs. 30%; $P = 0.01$). Implant loss dropped significantly, from 17% in cohort 1 to 7% in cohort 2 ($P = 0.034$). The rate of significant infection dropped from 17% to 9% ($P = 0.14$). Rate of contracture did not change substantially from 19% in cohort 1 to 16% in cohort 2.

Our univariate analysis of the factors associated with adverse outcomes in each cohort identified 3 variables as risk factors for necrotic complications: surgical incisions involving >30% of the NAC ($P < 0.001$), reconstruction with autologous tissue ($P < 0.001$), and current smokers ($P = 0.006$) (Table 3). Reconstruction with tissue expanders was associated with lower risk of necrotic complications ($P = 0.001$). Treatment with adjuvant chemotherapy, neoadjuvant chemotherapy, or radiation therapy did not have an impact on the incidence of necrotic complications. Stepwise logistic regression analysis revealed that of 4 potentially relevant variables (autologous reconstruction, tissue expander reconstruction, current smoking, and incisions involving >30% of the NAC), only 2 (autologous reconstruction and incision involving >30% of the NAC) were statistically significant independent risk factors for the development of complete nipple loss, partial nipple loss, or skin flap necrosis (Table 4). Seven patients experienced skin flap necrosis coupled with nipple loss. These cases made up 6% of cohort 1 and 3% of cohort 2. All had received incisions involving >30% of the NAC, autologous reconstruction or immediate implants, and 43% were current smokers.

At final pathologic examination, ductal carcinoma in situ or invasive cancer was found in 4 nipple cores (2.4%). Three had DCIS and 1 had invasive lobular carcinoma. Two were from patients undergoing prophylactic TSSMs, 1 from a stage 1 invasive ductal carcinoma, and 1 from a stage 3 lobular carcinoma. Postoperatively between months 1 and 5, at the time of permanent implant exchange, all 4 cases underwent complete nipple and areola excision with nipple reconstruction.

After a median follow-up period of 13 months (range, 1–65 months), only 1 patient (0.6%) had a local recurrence, which was identified in the axilla at 23 months. Pathologic examination noted that this recurrence was in breast tissue, suggesting that residual axillary tail had been left in the patient at the time of primary excision. Although this patient was not a known mutation carrier, she had extensive DCIS, was young (36 years old), and had a significant family history. Two patients developed metastatic disease: 1 had metastasis to a supraclavicular lymph node and liver at 6 months, and 1 had metastasis to the lung at 16 months.

## DISCUSSION

Indications for mastectomy include risk reduction for BRCA 1 and 2 mutation carriers, extensive in situ or invasive cancer, multicentric disease, or patient preference. By avoiding NAC excision and the resultant loss of anterior projection, TSSM allows for a more rotund breast shape and improved cosmesis in women undergoing mastectomy. In our experience, the majority of women have good to excellent cosmesis with this procedure, as shown in Figure 2.

We have developed and experimented with a variety of techniques that make the TSSM procedure reliable, reproducible, and safe. Surgeons need to have a range of incisional approaches and reconstructive options because the shape and size of native breasts varies.

We found that the use of inframammary incisions is an excellent approach for small or medium-sized breasts, and if enlarged, work well for large breasts as well. In our group experience, the cosmetic result is not optimal when incisions are placed along the lateral border of the breast. Radial incisions are almost always successful, regardless of breast size. The mastopexy incision is a reliable choice if a concomitant mastopexy is planned, as long as it involves less than a third of the NAC tissue. When a significant reduction is required, TSSM may not be the best option because the type of incisions required for reduction and moving of the NAC have not, in our experience, ensured viability of the NAC.

The initial changes in technique were introduced after an analysis of the first 64 procedures demonstrated that necrosis and implant loss occurred in patients who received immediate implants. We hypothesized that excessive skin tension resulted in decreased perfusion to the mastectomy envelope, increasing the risk of necrotic complications. We implemented the use of tissue expanders placed with minimal immediate expansion to avoid skin tension during the initial healing period. This change dramatically increased skin survival and reduced complications. Now, we see more necrosis in TSSM cases where autologous tissue is used, likely because the skin envelope is necessarily expanded after placement of the tissue flap.

 

**TABLE 3.** Univariate Logistic Regression of Factors Associated With the Development of Necrotic Complications (Partial Nipple Loss, Complete Nipple Loss, and Skin Flap Necrosis) in Both Cohorts

| | Total Cases | Cases With Necrotic Complications N (%) | OR | (95% CI) | *P* |
|---|---|---|---|---|---|
| Incision | | | | | |
| Incision crosses greater than 30% of the NAC* | 31 | 14 (45%) | 5.9 | (2.5–14.1) | <0.001 |
| Reconstruction | | | | | |
| Tissue expander | 73 | 5 (7%) | 0.18 | (0.07–0.50) | 0.001 |
| Autologous only | 63 | 23 (37%) | 5.6 | (2.44–12.78) | <0.001 |
| Immediate implant | 28 | 5 (18%) | 0.88 | (0.31–2.53) | 0.82 |
| Latissimus dorsi and immediate implant | 6 | 0 (0%) | | | |
| Exposures | | | | | |
| Current smoker | 8 | 5 (63%) | 7.9 | (1.80–35.3) | 0.006 |
| Neoadjuvant chemotherapy | 33 | 4 (12%) | 0.25 | (0.17–1.58) | 0.25 |
| Adjuvant chemotherapy | 68 | 10 (15%) | 0.59 | (0.26–1.34) | 0.21 |
| Radiation therapy | 27 | 4 (15%) | 0.68 | (0.22–2.13) | 0.51 |
| Prior radiation therapy | 15 | 5 (33%) | 2.3 | (0.72–7.15) | 0.12 |
| Stage | | | | | |
| Stage 0 | 30 | 6 (20%) | Ref | Ref | |
| Stage 1 | 35 | 9 (26%) | 1.38 | (0.42–4.47) | 0.59 |
| Stage 2 | 35 | 2 (6%) | 0.24 | (0.04–1.31) | 0.10 |
| Stage 3 | 11 | 3 (27%) | 1.50 | (0.30–7.43) | 0.62 |

*For cancer patients, n = 112. Staging information available for one case. Incisions involving greater than 30% of the NAC were the circumareolar incision with nipple-free graft, the nipple-areolar complex crossing, and the mastopexy type incision used in cohort one. See Figure 1 for illustrations.

**TABLE 4.** Independent Risk Factors for the Development of Necrotic Complications. Multivariate Logistic Regression

| Variables | Odds Ratio | 95% Confidence Interval | *P* |
|---|---|---|---|
| Autologous only reconstruction | 4.54 | (1.93–10.69) | 0.001 |
| Incision involving >30% of the NAC | 3.84 | (1.55–9.54) | 0.004 |

| Incision Involving >30% of NAC | Autologous-Only Reconstruction | Cases Without Necrotic Complications | Cases With Necrotic Complications | Percent of Cases With Necrotic Complications |
|---|---|---|---|---|
| No | No | 89 | 6 | 6% |
| No | Yes | 31 | 13 | 30% |
| Yes | No | 8 | 4 | 33% |
| Yes | Yes | 9 | 10 | 53% |

However, necrotic complications appear to resolve more successfully in women who have had autologous tissue reconstructions than in those who do not, likely attributed to the presence of healthy, well-perfused, underlying tissue of the autologous flap. It may be worth staging the procedure for very large-breasted women undergoing autologous reconstructions to allow skin perfusion by placing minimally filled expanders for 1 to 2 weeks, followed by a subsequent autologous tissue reconstruction.

Outcomes were greatly improved in our second cohort, which had higher rates of reconstruction using tissue expanders and incisions that included <30% of the NAC. Age, tumor histology, and mastectomy indication were virtually identical between cohort 1 and cohort 2, but cohort 2 had significantly fewer necrotic complications and less implant loss, despite having significantly higher stage disease and being more likely to have had chemotherapy or radiation therapy. Cohort 2 also had fewer infections and contractures, although this trend was not significant. The rate of skin flap necrosis in cohort 2 was 11%, the same as skin flap necrosis rates reported for skin-sparing mastectomy.[4]

Recent studies represent a cumulative experience of approximately 860 cases of TSSM, all of which report high rates of nipple survival, few early recurrences, and very satisfactory cosmesis despite variable patient selection criteria and surgical techniques.[5–13] Rates of early recurrence were reported in 5 series: 0% (mean follow-up: 48 months),[10] 0.9% (mean follow-up: 13 months),[11] 1% (median follow-up: 24.6 months),[13] and 2% (median follow-up: 5.5 years).[6] There is no evidence to date that the TSSM procedure is oncologically unsafe. Follow-up time in our study ranges from 1 month to 5.4 years and there have been no recurrences among the TSSM cases in our dataset that have been followed for greater than 3 years. The study currently reporting the longest median follow-up time (5.5 years) shows a local recurrence rate of

 

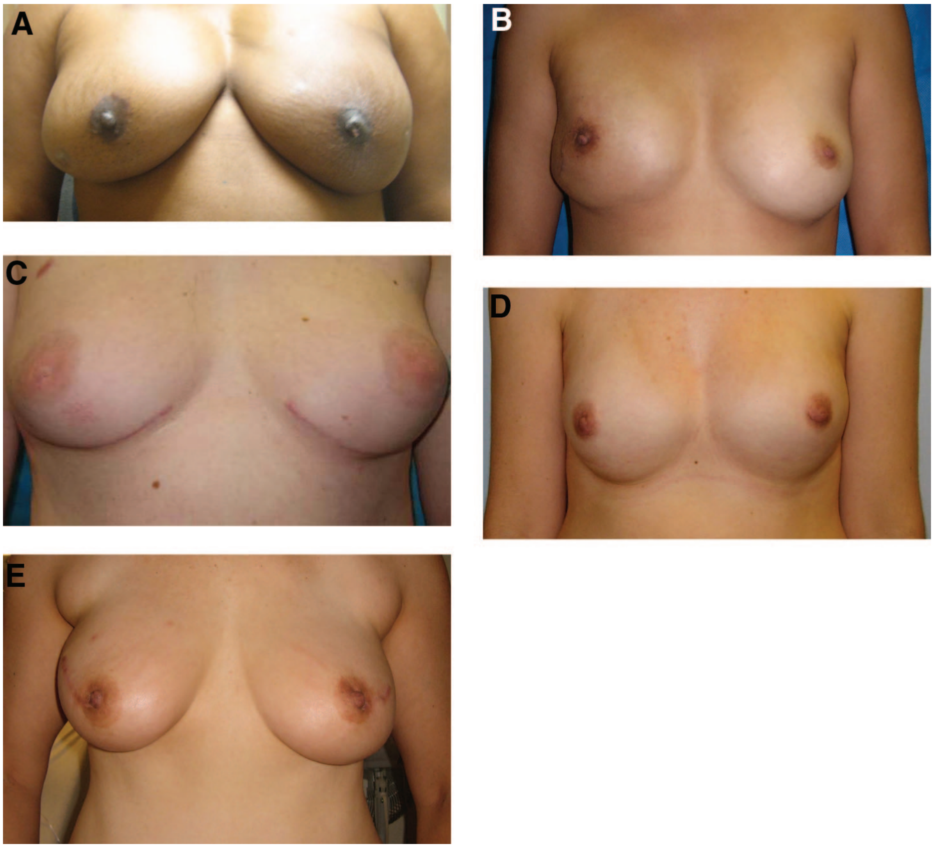


**FIGURE 2.** Cosmetic outcomes of TSSM for a variety of incisional approaches and reconstruction options. A, Left lateral/inferolateral incision with TRAM reconstruction. B, Right nipple-areolar complex crossing incision with tissue expander reconstruction. C, Bilateral inframammary incisions with TRAM reconstruction. D, Bilateral lateral/inferolateral incisions with tissue expander reconstructions. E, Bilateral radial incisions with TRAM reconstruction.

2%.[6] When skin-sparing mastectomy techniques were first introduced to replace the modified radical mastectomy technique, the oncologic community was initially concerned that these new procedures would increase the local recurrence rate. However, 10-year follow-up data demonstrated that there was no increase in local recurrence rate,[14] and our group has shown this to be true for stage 2 and 3 breast cancer patients as well.[15] The learning from this body of work is that preservation of skin uninvolved with cancer does not increase local recurrence risk. We applied this lesson to develop a safe procedure that truly removes the nipple tissue. It is critical to note that our experience is distinct from those that have not removed the underlying nipple tissue.

Several methods have been proposed for preserving the NAC, which vary in the degree of retro-areolar tissue preserved. TSSM is distinct from techniques that do not remove all nipple tissue, such as subcutaneous mastectomy, which is associated with significantly higher local recurrence rates. An older series that spanned the years 1988–1994, describes using a subcutaneous mastectomy surgical technique and leaving a tissue pad 5-mm thick and 2 cm in diameter beneath the NAC.[5] The loco-regional recurrence rate was 16.2% at 5 years of follow-up and 20.8% at 10 years. A more recent series of 124 cases in which a nipple-preserving technique was used demonstrated an 8.1% recurrence rate at 5.1 years of follow-up.[16] These 2 studies report a local recurrence rate at 5 years that far surpasses the rates experienced in TSSM cases with comparable follow-up time.

The TSSM technique retains only the nipple skin. The entire nipple core is removed and minimal if any ductal tissue remains. Recent studies by Rusby et al[17] detailing the nipple's microscopic anatomy with digital reconstruction makes it possible to estimate the quantity of ductal tissue and exact location of the exiting ducts. Most of the ducts are concentrated centrally and below the skin of the nipple tip, well within the area excised during a nipple-sparing procedure. Additionally, duct diameter decreases 10-fold as the ducts approach the skin surface and only half become an exiting duct. Rusby et al found that 96% of ductal tissue lies more than 2-mm deep to the skin surface and 87% is more than 3 mm below the skin surface, whereas greater than 50% of the vasculature is located within this 2- to 3-mm periphery. Although the nipple skin does suffer a decrease in perfusion after total skin-sparing mastectomy, as demonstrated by loss of indocyanine green dye,[18] its generous blood supply favors survival. High nipple survival rates can be achieved using surgical incisions that preserve >50% of the supporting vasculature.

Avoiding cautery that causes collateral damage to the vessels in the 1- to 3-mm layer of dermal tissue may also have contributed to the lower rates of necrotic complications in cohort 2. Cautery in the dermis seemed to increase the chance of NAC loss in our first cohort.

In our series, half of the cases that required nipple re-excision were prophylactic mastectomies in patients without detectable disease who had DCIS of the nipple on final pathology. This should serve as a reminder that prophylactic surgery should consist of the removal of all breast and nipple tissue. Using the TSSM procedure, this can be done safely with preservation of the NAC skin and provide superior cosmetic results.

Challenges still remain. Limitations of our study include a short follow-up time and we did not specifically consider the role of comorbid conditions. In addition, even though we used tissue expanders, our infection rate was 10% and our contracture rate was 22% (resolved after surgical lysis of adhesions and scar). Another problem is that before undergoing full expansion, the unexpanded folds of the implant can put pressure on the thin skin of the TSSM, erode the skin, and cause infection. To resolve these problems, we have recently begun using Alloderm (LifeCell, Houston) to provide complete implant coverage, particularly to protect the inferolateral skin envelope. Alloderm has been reported to be associated with lower rates of infection and contracture; coverage is complete from the edge of the pectoral muscle to the inframammary fold.[19] It is hoped that the skin breakdown rate will be reduced with this modification to the existing tissue expander technique.

In summary, this study shows that technical advancements in the TSSM approach significantly reduced complication rates and improved surgical outcomes, with a nipple survival rate exceeding 95%. We found that surgical incisions result in better outcomes when they do not cross the NAC tissue or, as demonstrated in the revision of the mastopexy incision, involved less than 30% of the NAC. If implants are used, we recommend that only expanders be placed and these should be minimally filled to avoid skin tension and reduced perfusion. Cosmetic results are excellent with TSSM, reconstruction with expandable implants and autologous reconstruction yield equivalent cosmesis in most patients. The local recurrence rate to date seems to be very low even when TSSM is applied to patients with stage 2 or 3 disease. We plan to follow these women for the next 10 years to ascertain the true associated long-term recurrence associated with TSSM. Our only local recurrence occurred in the axillary tail of a young woman. Surgeons should pay particular attention to removal of the complete axillary tail, which can be difficult to visualize when the TSSM technique is used. Acceptable complication rates and low rates of loco-regional recurrence support the use of TSSM as a viable surgical option for most breast cancer patients and those considering prophylactic mastectomy.

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