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Reducing the Risk of Nipple Necrosis: Technical Observations in 340 Nipple-sparing Mastectomies

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■ **Abstract:** Optimizing cosmesis is a common goal of breast surgery. In support of immediate breast reconstruction, nipple-sparing techniques have evolved. There is still a lack of agreement on the optimal technique and skin flap necrosis can be problematic. In this study, we review our experience with 340 NSM. Between March 2006 and February 2011, 340 NSMs were performed. Mammography, ultrasonography and magnetic resonance imaging were reviewed. Patient demographics and surgical techniques were reviewed. Anatomic observations were made and supported by breast images. A total of 340 NSMs in 231 patients by a single surgeon (AJS) were reviewed. Risk reduction was the indication for surgery in 59% with 50 patients (21.6%) testing positive for a BRCA1/2 gene mutation. There were two flap losses and 14 hematomas. Complete nipple necrosis occurred in three cases (0.8%) and partial loss in six patients. Recommendations are made to reduce the risk of nipple necrosis included the following: (a) preserving major perforating vessels (b) elevating skin flaps in the plane between the subcutaneous fat and the breast glandular tissue (c) the use of incisions that do not devascularize the nipple-areola complex. Nipple-sparing mastectomy can be performed with an acceptably low risk of nipple necrosis. Attention to detail including preserving major perforating vessels, elevating skin flaps in the appropriate plane and careful attention to incision planning are all required for a consistently good cosmetic outcome. ■

Key Words: Breast Cancer, Mastectomy, Nipple Sparing, Reconstruction

Increasing number of women are choosing mastectomy as surgical treatment for breast cancer as well as for risk reduction (1–3). Although explanations for this trend are clearly multifactorial, less radical surgery with good cosmetic outcomes must certainly be high on the list. Skin-sparing mastectomy has become a standard technique in both the risk reduction and cancer treatment setting. The use of nipple-sparing mastectomy (NSM) in these settings is clearly increasing (4–7). In both nipple and skin-sparing setting, the goal of the breast surgeon is to remove the breast glandular tissue while maintaining a viable skin envelope. Because surgical experience with NSM is limited, discussions of technique and technical outcomes are still an important part of our initial learning experience. In 2008, we reported our experience with our first 82 NSM cases (8). With the experience now in excess of 300 cases, this represents an update of our experience, focusing upon the technical aspects of this procedure.

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METHODS

In 2006, a data base was established based on the medical records of patients undergoing NSM by a single surgeon (AJS). When available, mammography, ultrasonography and magnetic resonance images (MRI) were reviewed. Between March 1, 2006 and February 18, 2011, 726 mastectomies were performed on 491 patients for both cancer and risk reduction. In 231 of the 491 patients (47.0%), NSM was performed at the surgeon's discretion. In 109 cases, bilateral NSMs were performed for a total of 340 nipple-sparing procedures. It is these 340 cases that make up the study population.

Absolute contraindications to NSM included cancer within 2 cm of the base of the nipple and biopsies demonstrating cancer in the tissue beneath the nipple or in the nipple core. Tobacco use was also an absolute contraindication for NSM. Relative contraindications included cancer >4 cm, multicentric cancer, extensive lympho-vascular invasion, and extreme

breast ptosis. Morbid obesity was a relative contraindication for NSM, but no exact BMI value was used in evaluation. Ptosis was not a contraindication for NSM. The exact degree of ptosis was not available for evaluation, but patients with grade 2 and 3 ptosis were common in the study. Diabetes was not a contraindication.

Magnetic resonance imaging (MRI) was used on a case-by-case basis in newly diagnosed breast cancer cases. In patients undergoing elective surgery for risk reduction, an attempt was made to have patients undergo MRI within 6 months of the planned procedure.

Technique

Incisions were planned in all instances after collaboration with the reconstructive plastic surgeon. Following incision, skin flaps were raised in most instances using electrocautery. More recently, the Peak Plasmablade (Peak Surgical, Palo Alto, CA) has been used for skin flap development. No preset flap thickness was used. An attempt was made to develop a plane between the subcutaneous fat and the breast glandular tissue. Lighted retractors (Lightmat by Lumitex Inc., Strongsville, OH) were frequently used.

The nipple-areola complex (NAC) was elevated just beneath the level of the deep dermis. The central ducts were transected at the base of the nipple and marked with a suture. Following breast removal, the nipple was inverted and the ducts at the base of the nipple were excised using sharp scissors or scalpel dissection. Frozen sections of the tissue beneath the nipple were obtained early in the series and then abandoned when we failed to see any positive results. Frozen sections were never obtained on the nipple-coring samples.

In cases where abdominal or thigh flaps were utilized for reconstruction, surgery on the breast and abdomen or thigh was begun simultaneously by the reconstructive team. Otherwise the mastectomies were completed prior to the plastic surgeons initiating reconstruction.

RESULTS

Incisions

Vertical incisions were used in 228 cases (67%) whereas lateral incisions were used in 97 (29%) and inframammary in 15 (4%; Fig. 1). In patients with a short distance from the nipple to inframammary fold, a lazy S incision was used to increase working distance (Fig. 1). Vertical incisions were particularly useful incisions in patients with ptotic breasts who were likely to require a mastopexy at some time in the future. In this way, the mastectomy incision could be excised during reduction.

Indications for Surgery

The indications for surgery can be seen in Table 1. Risk reduction accounted for the largest number of patients (59%). Approximately half of all patients having risk reduction surgery (65/136) were treated for cancer simultaneously with contralateral mastectomy, which was not nipple sparing. BRCA1/2 testing was carried out in 131 patients, 50 of which tested positive for a deleterious mutation.

Breast cancer was the indication for surgery in 93 patients (40%). Fifty-two patients were diagnosed with invasive ductal and 10 with invasive lobular carcinoma. The remaining 31 patients had DCIS without invasion. There was a single case of both atypical ductal hyperplasia and lobular carcinoma in situ.

Of those patients with breast cancer, only three (3.2%) were found to have cancer in the tissue sampled beneath the nipple. Two of the three patients have subsequently had the nipple removed while the other patient is completing chemotherapy prior to removal.

Breast Reconstruction

Saline or gel implants were used in only 10% of patients (Table 1). Autologous flaps were used in the remaining 90%. Deep inferior epigastric perforator

Figure 1. Incisions used in the study (a) vertical (b) lateral (c) inframammary fold (d) lazy S vertical.

Table 1. Indications for Surgery, Reconstruction Technique and Major Complications

	Number (%)
Indications	
Risk reduction	137 (59)
BRCA+	50
Invasive cancer	62 (27)
In situ cancer	32 (14)
Reconstruction	
DIEP	237 (70)
GAP	39 (11)
TUG	13 (4)
Hip	18 (5)
Implant	33 (10)
Major complications	
Flap loss	2
Nipple loss	9
partial	6
complete	3
Hematoma	14
Vein occlusion	1
Replace Doppler wire	2

flap (DIEP) was used in a majority of patients (66%). The remaining autologous reconstructions included stacked DIEP, gluteal artery perforator flaps, and transverse upper gracilis flaps.

Complications

Complications can be seen in Table 1. Wound infections responding to antibiotic therapy and not requiring surgical intervention were not included. There were nipple complications in nine procedures (2.6%). In only three (0.8%) procedures was the nipple lost completely. Three of the six partial nipple losses represented nipple-tip necrosis. In all three instances, an eschar formed and then healed without further intervention.

There were two flap losses. Both were DIEP flaps and both were replaced with second flaps. One received a delayed GAP flap and the other underwent a TUG flap on the third postoperative day. Hematomas were identified in 14 patients, seven of which required reoperation. Two patients required reoperation to replace a faulty Doppler wire, one of which had caused a venous obstruction. One patient had to undergo surgery to repair the venous anastomosis.

DISCUSSION

The problem of skin flap necrosis did not begin with nipple-sparing mastectomy, but has been an issue since the days of radical mastectomy (9–11). As we moved from standard mastectomy incisions with relatively short flaps to skin-sparing incisions, the ability to maintain good blood supply became more difficult and in some ways, more important. With NSM, incisions are in most instances shorter, and working space more confining, making skin flap dissection even more difficult than skin-sparing or standard mastectomy. Moreover, patients undergoing immediate reconstruction *expect* good cosmetic outcomes. Whether performing a skin-sparing or nipple-sparing mastectomy, maintaining a healthy skin envelope is crucial. In this study, 2.6% of our patients had complications related to the nipple and complete nipple loss occurred in less than 1%. This compares favorably with other series in the literature (4,6,7,12,13).

In most instances, new surgical procedures require both technical adjustments and changes in instrumentation. Even small changes in technique can result in substantial gains in surgical outcomes. This applies of course to improvements in surgical instruments such as lighted and well-designed retractors. Just as important, however, is an intimate familiarity with the surgical anatomy. Prior to the advent of nipple-sparing surgery, the NAC was removed in its entirety. Most surgeons therefore had little practical experience on the relationship of the breast glandular tissue to the NAC; and how removing the breast from this area may impact its viability. Reviews of countless mammograms, ultrasounds, and MRIs are an integral part of a breast surgical practice. In most instances, the focus is on the diagnosis and extent of disease. However, a more careful inspection of these studies can yield a great deal about the anatomy. The following observations and recommendations were based on this experience with over 300 NSMs as well as review of the anatomic structures as demonstrated by radiographic breast images.

Preserving Major Vessels

Rusby et al., carefully described the vascular supply with the nipple papilla (14). They pointed out that at least 50% of blood supply is located in the periphery of the nipple. Therefore, "coring" the nipple should still allow adequate blood supply for nipple viability. However, as noted by Van Deventer, the small vessels feeding the NAC are in turn fed by much larger vessels, the most prominent of which are the internal mammary artery (internal thoracic) and the lateral thoracic artery (Fig. 2) (15). Based on the work of van Deventer as well Palmer and Taylor, it would

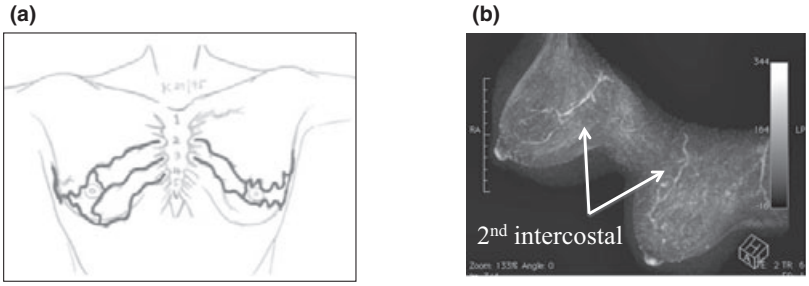

Figure 2. (a) Common configuration of blood supply to the nipple-areola complex(from van Deventer PV, Aesthetic Plastic Surgery 2004; 28:393–8, with permission (b) intercostal perforator seen on MRI.

appear that the 2nd intercostal perforator off of the internal mammary artery is the most prominent of all vessels supplying the NAC (16). Palmer and Taylor in fact noted that the 2nd intercostal perforator was the principal perforator in 85% of cases (15,16). These conclusions are reinforced by maximum intensity projection images taken from breast MRIs (see Fig. 2).

It is therefore of important that 2nd intercostal perforators be spared whenever possible. The 2nd intercostal exits the pectoralis major muscle outside of the breast parenchyma, but is easily damaged as skin flaps are developed. It has been our experience that the 2nd intercostal perforator never exits the chest wall within the breast parenchyma, allowing for its preservation except in cases where a breast tumor abuts this area. In our experience, this is not the case with the 3rd and 4th intercostal perforators which frequently penetrate the breast parenchyma. Therefore, great care should be taken when elevating skin flaps over the medial breast. The 2nd intercostal can be used for free flap vascularization (17). But, because it appears to be such an important vessel for skin perfusion, its use for free flaps is not recommended until more data are available examining its effect on the risk of skin flap necrosis.

Other perforating vessels off of the internal mammary artery are also important in NAC vascularization. These emerge from the 3rd and 4th interspaces (Fig. 2). Those that arise more medially into the substance of the breast are sacrificed to achieve complete breast removal. However, in many instances they arise adjacent to the sternum and can be preserved by taking care not to extend the skin flap over the sternum.

Skin Flaps

There are few subjects in breast surgery as contentious as where and how to raise the mastectomy skin flap. Whether to use cautery, knife or scissors, whether to make thin or thick flaps or whether to use or not use tumescence all have their supporters and detractors. In our series, an attempt was made to develop the plane between the subcutaneous fat and the breast glandular tissue. Figure 3 shows both an MRI and a breast ultrasound, where in the presence of extremely dense breast, this plane is clearly discernable. This is not always the case. It is our experience that in patients with very dense breasts, that the plane is frequently visible throughout the dissection. However, in those patients with more fatty replaced breast, the plane is still visible, but only intermittently so. Because flap thickness differs from patient to patient, we recommend no predetermined flap thickness. Figure 4 shows three mammograms with well-defined surgical planes between the subcutaneous fat and the breast glandular tissue. In each instance, flap thickness

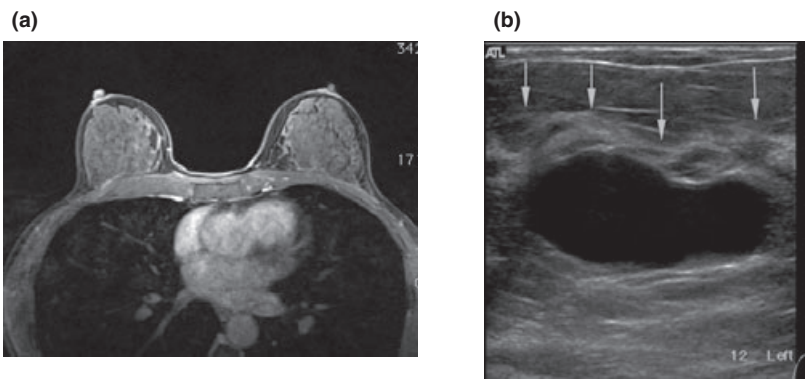

Figure 3. MRI (a) and breast ultrasound (b) showing dense breast tissue and a clear plane between the breast and the subcutaneous fat.

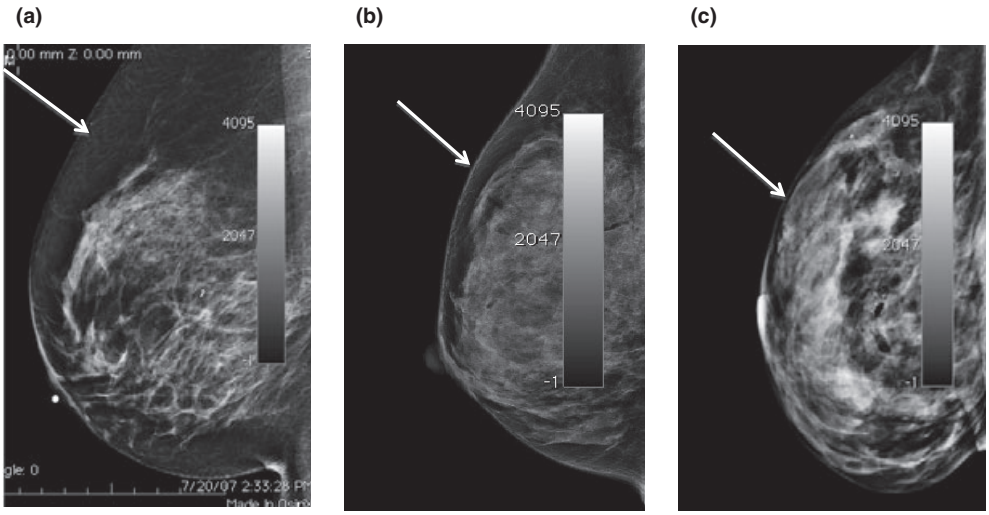

Figure 4. MLO views showing different thicknesses of subcutaneous fat and therefore different flap thicknesses.

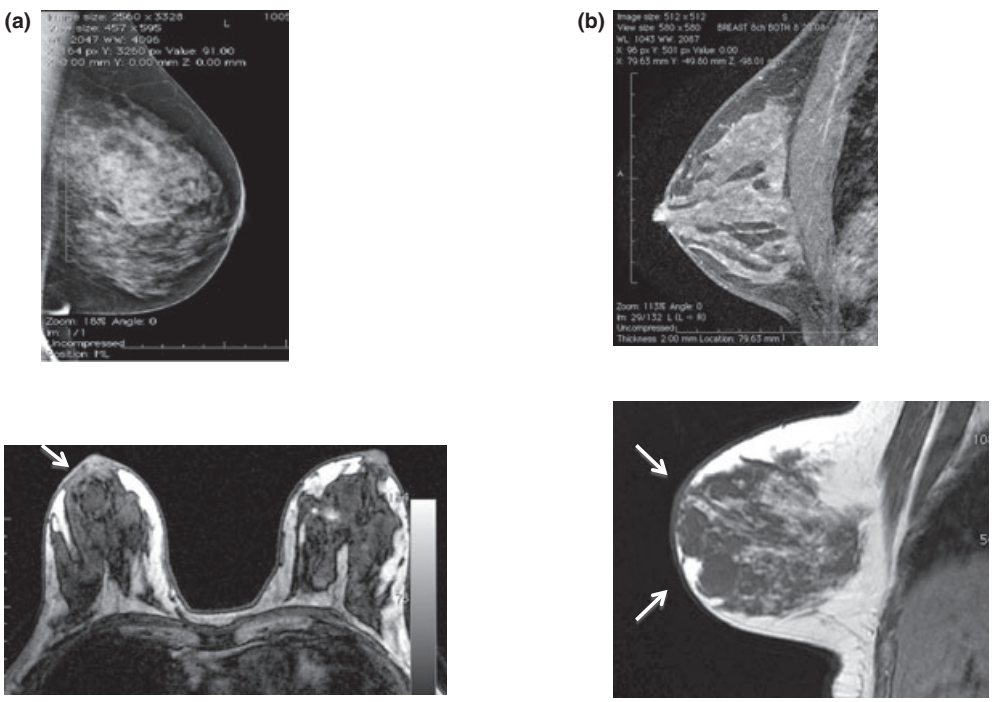

Figure 5. (a) MRI demonstrating close proximity of breast to the NAC (b) MRI demonstrating the crucial angle at which the plane deepens as the breast moves away from the NAC.

could vary depending on the thickness of the subcutaneous fat layer. In 4A flaps would be relatively thick compared to very thin flaps in 4C.

It should also be noted that the subcutaneous fat layer is commonly not uniform in thickness and therefore the flap thickness will also not be uniform (Fig. 5a, b). Beginning at the NAC, the breast glandular tissue closely adheres to the overlying dermis with little or no fat interposed (Fig. 5c). As one moves away from the NAC the gland moves away from the skin and it is in this region that a variable amount of fat is interposed between the breast gland and the skin. It is also at this point (Fig. 5d), as the gland moves away from the NAC, that great care should be taken to carefully identify this new plane. Continuing in the same plane would create extremely thin skin flaps increasing the risk of

devascularizing the NAC. In many instances, the skin flap thickens as it moves away from the NAC.

Incisions

Many incisions for NSM have been considered (7,8,18–20). Incisions fit into one of the several categories: radial incisions (lateral and vertical), periareolar incisions with medial or lateral extensions, and crease incisions (inframammary and lateral). Our preference and largest experience is with radial incisions, both lateral and vertical (Fig. 1a). As noted in Figure 1b, a lazy S vertical incision is used in women with who have ptotic breast with short nipple to inframammary crease distance, and who are likely to require delayed mastopexy. Garwood et al. demonstrated that periareolar incisions over 30% of the circumference of the areola are at an increased risk of NAC necrosis (13). Based on this data, great care is taken not to have the incisions extend over a quarter of the areola circumference.

Inframammary fold incisions made up only a small percentage of cases in this study. However, most have been done in the last 6 months of the study period and is now being considered more frequently, particularly in a smaller breast. Examining the blood supply to the NAC using images from breast MRIs, the vascularization of the lower breast skin appears less robust than what is seen in the upper breast. Proano and Perbeck who measured skin circulation in 69 patients using laser Doppler and fluorescein flometry lend clinical support to this observation (21). They compared skin circulation in patients having either an inframammary fold incision or a lateral lazy S incision. They found a significant reduction in flow to an area of skin 2 cms below the NAC. It is not as yet known whether this will have any practical significance. Many of the larger NSM series using inframammary fold incisions also commonly use implants for breast reconstruction (18,22). Insertion of implants should have no adverse effects of blood flow to the lower skin flap from the perforating vessels in the 4th and 5th intercostal spaces. Free flaps, however, usually require access to the internal mammary vessels (23). If access is gained through the fourth or fifth interspace, there is at least theoretical concern that flow through the perforating vessels may be adversely affected thereby compromising vascularity to the lower skin flap. Future studies will likely determine whether or not these fears are well founded.

CONCLUSIONS

The number of NSMs being performed is clearly increasing. Patient selection is clearly critical in both the cancer and risk-reduction setting. Most importantly, patients expect not only good outcomes with respect to cancer treatment and prevention but it would seem reasonable that they also desire and expect a good cosmetic result. Aside from the flap failure or loss of a synthetic implant, nothing affects the cosmetic outcome more than skin and or nipple necrosis.

It is likely that NAC necrosis cannot be entirely avoided. However, to minimize these complications, the breast surgeon must pay attention to detail. Incisions must be planned in coordination with the reconstructive surgeon to minimize vascular compromise to the skin and NAC. Major perforating vessels, particularly the 2nd intercostal perforator should be preserved whenever possible. Although not always possible, great care should be taken to dissect the breast in the plane just above the breast glandular tissue. We have found it helpful to carefully review breast imaging prior to surgery, not just to evaluate the extent of disease but to help define the appropriate anatomic planes of dissection.

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