Buried Flap Reconstruction after Nipple-Sparing Mastectomy: Advancing toward Single-Stage Breast Reconstruction

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Background: Recent evolutions of oncologic breast surgery and reconstruction now allow surgeons to offer the appropriate patients a single-stage, autologous tissue reconstruction with the least donor-site morbidity. The authors present their series of buried free flaps in nipple-sparing mastectomies as proof of concept, and to explore indications, techniques, and early outcomes from their series.

Methods: From 2001 to 2011, a total of 2262 perforator-based free flaps for breast reconstruction were reviewed from the authors' prospectively maintained database.

Results: There were 338 free flaps performed on 215 patients following nipple-sparing mastectomy, including 84 patients who underwent breast reconstruction with 134 buried free flaps. Ductal carcinoma in situ and *BRCA*-positive were the most common diagnoses, in 26 patients (30.9 percent) each. The most common flaps used were the deep inferior epigastric perforator (77.6 percent), transverse upper gracilis (7.5 percent), profunda artery perforator (7.5 percent), and superficial inferior epigastric artery flaps (3.7 percent). An implantable Cook-Swartz Doppler was used to monitor all buried flaps. Fat necrosis requiring excision was present in 5.2 percent of breast reconstructions, and there were three flap losses (2.2 percent). Seventy-eight flaps (58.2 percent) underwent minor revision for improved cosmesis; 56 (41.8 percent) needed no further surgery.

Conclusions: Nipple-sparing mastectomy with immediate autologous breast reconstruction can successfully and safely be performed in a single stage; however, the authors are not yet ready to offer this as their standard of care. (*Plast. Reconstr. Surg.* 132: 489e, 2013.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Decades ago, the high mortality rate of breast cancer patients resulted not only from the disease itself but also from mutilating and disfiguring surgery for deterrence. Since this time, treatment for breast cancer and the options for reconstructive surgery have evolved, striving to maintain the goal of a safe, disease-free, and aesthetically pleasing outcome. The

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radical mastectomy has been replaced by more modulated treatments—modified radical mastectomy, breast conservation therapy, sentinel node sampling, skin-sparing mastectomy and, more recently, nipple-sparing mastectomy.[1–8]

Nipple-sparing mastectomy is a refinement of the skin-sparing mastectomy in which the nipple-areola complex is spared. Designed to retain all surface landmarks of the breast, the most obvious potential advantage is preserving the nipple itself for its physical properties of color, texture, projection, shape, and volume, thereby improving the aesthetic outcome of the reconstruction. The nipple and areola combined represent a significant amount of valuable skin located in a prime location on the most projecting portion of the breast. As with skin-sparing mastectomy, there is concern that retaining the nipple-areola complex increases the likelihood of disease recurrence; however, the available experience suggests that this is not the case.[9–12] To achieve optimal cosmetic results with oncologic safety, nipple-sparing mastectomy should be performed only on carefully selected patients. On clinical assessment, the tumor should be less than 3 cm in diameter, 2 cm away from the center of the nipple, with a negative axilla, no skin involvement, and no inflammatory breast cancer. The final decision to spare the nipple is based on frozen and definitive pathologic section.[11,13–15] With the above criteria and negative frozen-section, the risk of occult tumor still present in the nipple can be as low as 4 percent.[15] In addition, with the ability to diagnose breast cancer earlier and to stage it more accurately with the aid of improved mammography, magnetic resonance imaging, and preoperative subareolar mammotome biopsy, surgeons can offer nipple-sparing mastectomy to the properly screened patient, with a high level of confidence.

TECHNICAL CONSIDERATIONS OF THE NIPPLE-AREOLA COMPLEX

Technical considerations of the nipple-areola complex are essential when considering immediate reconstruction with a buried free flap, as the donor tissue will not provide a skin component to the reconstruction. Choosing the best incision site and the techniques with which to create optimal mastectomy skin flaps have been discussed extensively in the literature. Today, most surgeons use radial and lateral incision sites for optimal exposure during breast tissue resection, and to avoid nipple-areola complex necrosis and provide the best cosmetic outcomes.[16] The ultimate incision location is based on size of breast, grade of ptosis, and breast surgeon comfort with the incision. In small breasts with minimal ptosis, inframammary incisions are usually preferred, but vertical and lateral work as well, depending on the surgeon's comfort level. The lateral incision is the easiest for most of our breast surgeons. In larger and more ptotic breasts, a future lift or reduction may be necessary, and in these patients, a vertical incision is best, as the lift/reduction will eventually require a vertical incision.

RISK-REDUCTION MASTECTOMY

The risk of breast cancer by age 70 years is approximately 65 percent in patients with the *BRCA1* mutation and approximately 45 percent in *BRCA2* mutation carriers.[17,18] The oncologic risk reduction of undergoing bilateral prophylactic mastectomy if a woman is a high-risk, moderate-risk, or *BRCA* gene–positive patient is 80 to 95 percent, with an increased life expectancy of 2.9 to 5.3 years and a decrease in emotional concern over developing breast cancer by 74 percent.[19] Because of this risk reduction, nipple-sparing mastectomy with immediate reconstruction can be used for the prophylactic case. In fact, 90 percent of the 639 patients in a series of prophylactic mastectomies preformed at the Mayo Clinic were nipple-sparing mastectomies. They demonstrated no statistically significant difference in the cancer-preventing benefit whether the nipple was removed or retained.[20]

EVOLUTION OF BREAST RECONSTRUCTION WITH AUTOLOGOUS TISSUE

A mastectomy can be a mutilating operation that creates a physical and sometimes psychological shock that compounds the awareness of having cancer. Breast reconstruction after mastectomy, therefore, is part of the treatment of breast cancer, with the objective of restoring breast volume, symmetry, and the nipple-areola complex. The evolution of breast reconstruction techniques has allowed women suffering from cancer to regain bodily integrity.

The earliest attempt of autologous breast reconstruction was reported in 1887, when Aristide Verneuil described the use of breast tissue transferred on a pedicle from a healthy breast on one side to the diseased breast on the other.[21] The use of muscle flaps for immediate postmastectomy breast reconstruction was first reported by Louis Ombredanne in 1906, using a pectoralis minor muscle flap.[22] Multistage procedures with tubed pedicle grafts began with contralateral composite breast tissue in 1950[23] and advanced to incorporate both abdominal and extended thoracoabdominal tubed grafts.[24–26] Single-stage breast reconstruction was developed and popularized in the later part of the twentieth century, using donor sites from the omentum,[27] latissimus dorsi,[28] and deep superior epigastric artery.[29] In the 1970s, free microvascular tissue transfer broadened the scope of new options for breast reconstruction.[30,31] The first free flaps included transverse rectus abdominis myocutaneous (TRAM) flaps,[32] deep circumflex iliac artery (groin) flaps,[33] lateral thigh (tensor fasciae latae) flaps,[34] superior and inferior gluteal musculocutaneous flaps,[35,36] gracilis flaps,[37,38] triceps flaps,[39] and others. The advent of perforator flaps, originally pioneered by Koshima and Soeda in 1989,[40] further refined these techniques, minimizing the donor-site morbidity associated with the harvest of muscle in musculocutaneous flaps. Free perforator flaps currently used for breast reconstruction include the deep inferior epigastric artery perforator (DIEP) flap,[41] the superficial inferior epigastric artery (SIEA) flap,[32] the latissimus dorsi perforator flap,[42] the superior and inferior gluteal artery perforator flaps,[43,44] the thoracodorsal artery perforator flap,[45] the transverse upper gracilis flap,[38] and the profunda artery perforator flap.[46,47] Perforator flaps have also been used after unsatisfactory implant reconstruction.[48]

PATIENTS AND METHODS

Patient Selection and Indications

When evaluating women for single-stage autologous breast reconstruction, several factors should be considered. The patient must first meet the requirements of the oncologic surgeon to be a candidate for nipple-sparing mastectomy. Because the perforator flap in this case is completely deepithelialized, the patient and surgeon must acknowledge that any opportunity to resurface breast skin with this flap is relinquished. For this reason, risk factors that increase mastectomy flap necrosis such as current smoking, connective tissue disorders, and history of adjuvant radiation therapy should be considered relative contraindications to the attempt at single-stage surgery. Furthermore, this technique should be attempted only when working with a mastectomy surgeon who reliably leaves healthy skin flaps.

Breast ptosis is an important factor in evaluating a patient for nipple-areola complex. Ideal patients are small breasted and have minimal ptosis. However, a small breast with grade 3 ptosis is a candidate, because after the mastectomy the entire breast envelope can be redraped over a larger flap to lift the skin envelope. Discrepancies between the skin envelope and projected flap mass need to be addressed in the preoperative evaluation. In our experience, the breast envelope shrinks over time to better accommodate the flap. Sometimes, this conflict is what necessitates a second stage, with fat grafting performed at the time of the breast lift to achieve the fill. Patients are counseled on this before surgery and realize that they may need fat grafting to correct for size. Stacked flaps are also performed to avoid this problem during the initial operation.[49]

Heavier patients with larger flaps are at greater risk for mastectomy skin flap problems. Patients were counseled on this preoperatively and, in some cases, not offered buried flaps to allow for excision of native mastectomy skin.

Flap Selection

The abdomen is the preferred donor site for the majority of breast reconstructions, namely, DIEP and SIEA flaps. The majority of our cases were performed using the DIEP flap (Table 1). The reliability and quality of the perforating vessels, and the decreased donor-site morbidity (compared with the muscle-sparing TRAM flap), make the DIEP flap our most frequent choice. When the abdomen is not available as a donor site because of either a paucity of tissue or prior surgical intervention, the thigh is our next choice. Initially, we favored the transverse upper gracilis flap[38] and then the deep femoral artery perforator flap for our thigh-based flaps.[50] However, we now prefer the profunda artery perforator flap[46,47] as our first choice in the thigh. We have found the aesthetic results of the profunda artery perforator flap donor scar to be superior to the transverse upper gracilis and deep femoral artery perforator. In addition, we have not encountered postoperative lower extremity lymphedema with the profunda artery perforator flap (Allen RJ, Sadeghi A, unpublished data). In instances when the patient elects not to use the profunda artery perforator donor site or when body mass distribution is unfavorable, we offer a superior[44] or inferior gluteal musculocutaneous perforator[43] flap. All patients undergo preoperative imaging using magnetic

Table 1. Patient Demographics

Characteristics	No. (%)
Total no. of patients	84
Total no. of flaps	134
Patient diagnosis	
BRCA-positive	26 (30.9)
DCIS	26 (30.9)
Invasive ductal carcinoma	23 (27.3)
LCIS	1 (1.2)
Lobular carcinoma	4 (4.7)
Atypical lobular hypoplasia	4 (4.7)
Flap type	
DIEP	104 (77.6)
TUG	10 (7.5)
IGAP	2 (1.5)
PAP	10 (7.5)
SGAP	2 (1.5)
SIEA	5 (3.7)
DFAP	1 (0.7)
Incision type	
Vertical	70 (52.2)
Lateral	45 (33.6)
Inframammary	19 (14.2)
Monitoring	
Cook Doppler	134 (100)

TUG, transverse upper gracilis; IGAP, inferior gluteal artery perforator; PAP, profunda artery perforator; SGAP, inferior gluteal artery perforator; DFAP, deep femoral artery perforator; DCIS, ductal carcinoma in situ; LCIS, lobular carcinoma in situ.

resonance angiography[51] or computed tomographic angiography to evaluate the perforator location, caliber, and number.

Operative Technique

DIEP,[41] SIEA,[52] profunda artery perforator,[46] deep femoral artery perforator,[50] transverse upper gracilis,[38] superior gluteal artery perforator,[44] and inferior gluteal artery perforator[43] flaps are all harvested as described previously.

Flap Monitoring

The concept of buried free flaps has been around for years, and buried flaps continue to pose a significant monitoring problem. In our series, we used the Cook-Swartz implantable Doppler probe for all (100 percent) postoperative free flap monitoring. For placement, the probe was secured with two small microclips or fibrin glue. We also used less specific methods for postoperative flap monitoring, including transcutaneous Doppler and physical examination findings such as flap turgor, breast swelling, and drain output, as these methods can detect early warning signs of venous congestion.

Statistical Analysis

Statistical analyses were conducted using descriptive statistics such as frequencies.

RESULTS

Complications and Early Outcomes

In review of the 134 buried free flaps performed by our unit for single-stage breast reconstruction immediately following nipple-sparing mastectomy, the incidence of significant complications was low. Our most common complication was infection (7.4 percent) (in the form of cellulitis of the mastectomy flap or donor site) requiring antibiotics. Major fat necrosis (>2 cm) occurred in seven patients (5.2 percent); however, only five flaps (3.7 percent) underwent surgical excision of the fat necrosis. There were seven instances of donor-site seroma (5.2 percent), which were mostly managed conservatively except for one seroma in a transverse upper gracilis flap reconstruction that was drained and excised on postoperative day 5. Five patients (3.7 percent) had delayed healing of their mastectomy flaps necessitating local wound care. All of these healed well. Four flaps (2.9 percent) underwent reexploration for venous obstruction. In one case, the vein was revised and the flap was salvaged. The other three flaps (2.2 percent) ultimately failed and were débrided. Tissue expanders were placed at the time of the flap take-back. Two failed flaps were ultimately replaced with implants and the other flap underwent transverse upper gracilis flap reconstruction (Table 2). We had no nipple necrosis in our series; however, loss of projection of nipples is seen in almost all patients, as the breast surgeon usually cores out the ducts at the nipple. Nipples usually undergo some loss of pigmentation, but this was not measured clinically.

The average weight for all flaps was 413 g (range, 165 to 1012 g). A significant portion of patients from this series remained satisfied with a single-stage reconstruction, requiring no further surgery (Figs. 1 through 3 and Table 3). However, 58.2 percent of our flaps required second-stage revision for improved cosmesis (Fig. 4 and Table 3). Revisions included excision of fat necrosis, unilateral or bilateral fat grafting for breast

Table 2. Complications

Complications	No. (%)
Venous obstruction/salvage	4 (2.9)
Hematoma	8 (5.9)
Seroma	7 (5.2)
Fat necrosis	7 (5.2)
Delayed mastectomy flap healing	5 (3.7)
Infection	10 (7.4)
Failure	3 (2.2)

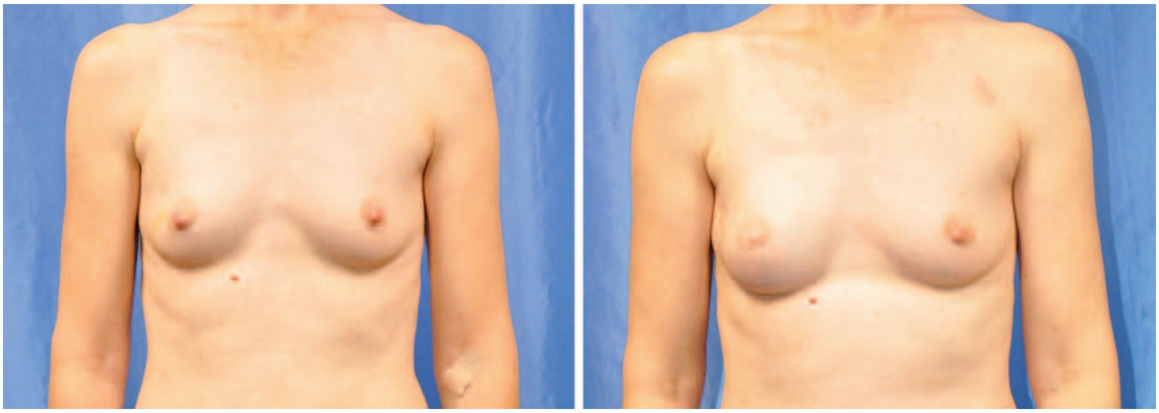

Fig. 1. Preoperative (*left*) and postoperative (*right*) photographs of a 48-year-old woman with stage II cancer of the right breast who underwent single-stage buried perforator flap reconstruction. She underwent a right nipple-sparing mastectomy through a lateral incision and transverse upper gracilis flap reconstruction. The postoperative photograph (*right*) was obtained 19 months after surgery.

symmetry, donor or recipient-site scar revision, and excision of dog-ear deformities.

DISCUSSION

Breast reconstruction is now a recognizable part of the treatment of known breast cancer and prophylactic mastectomy. For this reason, breast surgeons have evolved techniques that maximize the aesthetic result of a reconstructed breast. Our advances in breast reconstruction have striven to provide the most natural results, with the least morbidity, in the fewest number of operations. For these reasons, we offered single-stage buried perforator flap (and SIEA) reconstruction to patients undergoing nipple-sparing mastectomy.

The reasons for maintaining a skin paddle on the free flap during breast reconstructions are to resurface the mastectomy skin flap and to monitor the free flap. In nipple-sparing mastectomy, no additional skin is required, which leaves flap

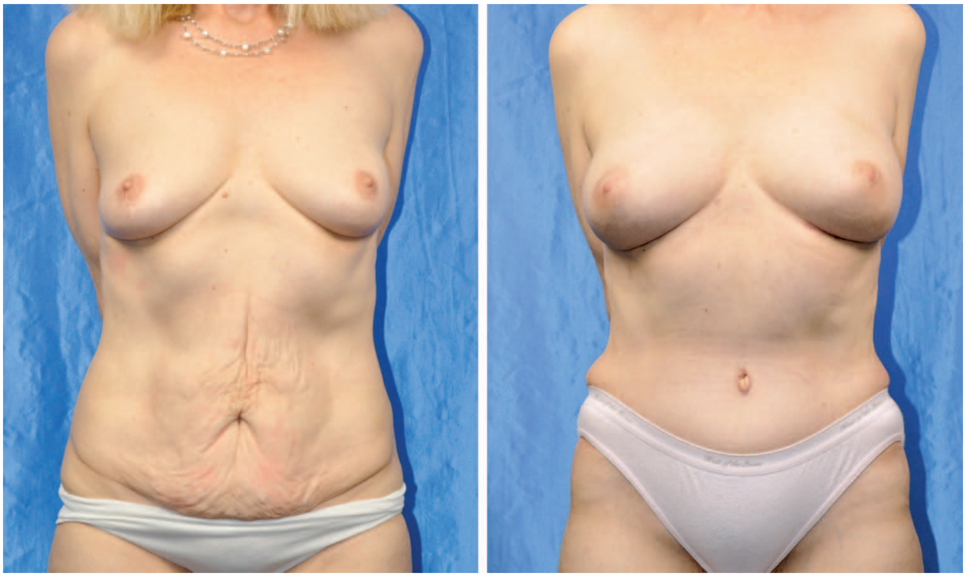

Fig. 2. Preoperative (*left*) and postoperative (*right*) photographs of a 53-year-old woman with stage I cancer of the left breast who underwent single-stage buried perforator flap reconstruction. She underwent bilateral nipple-sparing mastectomies by means of inframammary incisions and bilateral DIEP flap reconstruction. The postoperative photograph (*right*) was obtained 6 months after surgery.

Fig. 3. Preoperative (*left*) and postoperative (*right*) photographs of a 46-year-old woman with stage II cancer of the right breast who underwent single-stage buried perforator flap reconstruction. She underwent bilateral nipple-sparing mastectomies by means of inframammary incisions and bilateral DIEP flap reconstruction. The postoperative photograph (*right*) was obtained 6 months after surgery.

monitoring as the only indication for using a skin paddle. The decision to use a free flap without a skin paddle should be based on the take-back rates that are contingent on the information gained from the skin paddle. The free flap take-back rate and the failure rate for breast reconstruction are very low in experienced hands.[53–56] There are certainly situations when a congested skin paddle is the first indication of flap congestion. However, an expanding hematoma is often the first sign of venous outflow obstruction. In our experience, we believed that the incidence of flap salvage secondary to skin paddle diagnosis of venous congestion was small enough to forgo its use.

In our series of 134 flaps, four flaps were taken back for evaluation for venous thrombosis. In two instances, the implantable Doppler probe had created a kink in our vein. One was secondary to a kink in the implantable flow coupler (Synovis Micro Companies Alliance, Birmingham, Ala.) that was directly related to a kink at the anastomosis from the thick wire. A transverse upper gracilis flap was performed in this patient. Another flap had a similar situation with a Cook-Swartz Doppler (Cook Medical, Bloomington, Ind.). In this patient, the silicone cuff had narrowed and eventually kinked the vein where it thrombosed. A tissue expander was left in this patient, and she went on to an implant-based reconstruction. Another patient was returned to the operating room on postoperative day 2 after a change in the venous Cook-Swartz Doppler signal. Of note, this patient had a history of a subclavian vein thrombosis. On exploration, the vein was thrombosed and the flap was not salvageable. A tissue expander was left in this patient, and she went on to undergo implant-based reconstruction. A third flap underwent reexploration because of loss of the Cook-Swartz Doppler signal. On exploration, the anastomosis was patent. A fourth flap had a delayed presentation of venous thrombosis on postoperative day 5. This patient had a Cook-Swartz implantable Doppler distally placed on the flap artery and vein at the time of initial surgery. An additional external Doppler signal was located and marked on the mastectomy skin flap, which was perceived to be the Doppler signal of the free flap positioned under the skin. We usually assess the transcutaneous Doppler signal by temporarily clamping the flap's vascular pedicle intraoperatively to ensure that the signal is indeed transmitted from the free flap. However, this technique was not performed in this instance, as we used the Cook-Swartz implantable Doppler for primary flap monitoring as an alternative. The patient was discharged on postoperative day 3, as is the same for nearly all of our patients. At that time, the Cook-Swartz wires were cut externally for definitive removal in the office. However, within the week, breast swelling ensued and necessitated take-back for exploration and thrombectomy. A second anastomosis from an

Table 3. Outcomes

Early Outcomes	No. (%)
No revisions	56 (41.8)
Revisions	78 (58.2)

Fig. 4. Preoperative (*left*) and postoperative (*right*) photographs of a 42-year-old woman with stage 0 cancer of the left breast who underwent buried perforator flap reconstruction that required second-stage revision. She underwent bilateral nipple-sparing mastectomies through lateral incisions and bilateral DIEP flap reconstruction. The postoperative photograph (*right*) was obtained 15 months after initial reconstruction and 6 weeks after second-stage fat grafting to both breasts with 240 cc to the right breast and 290 cc to the left breast.

unused flap vein to a second internal mammary vein was performed and the flap was salvaged. Of note, the marked transcutaneous Doppler signal on the mastectomy skin flaps were determined to be unrelated to the flap and appeared to originate from the second intercostal artery perforator. (**See Video 1, Supplemental Digital Content 1**, which demonstrates an audible Doppler signal in the mastectomy flap that is related not to the flap pedicle but rather to an intercostal perforator, ***http://links.lww.com/PRS/A837***.)

Because implantable Doppler devices may fail, we also use less specific monitoring, including transcutaneous Doppler and physical examination findings such as flap turgor, breast swelling, and drain output, because these methods can detect early warning signs of venous congestion. We recognize that these methods are expected to be less sensitive in detecting arterial or venous insufficiency than more conventional methods (i.e., skin paddle monitoring, direct Doppler signal). With this in mind, we discuss with our patients preoperatively that the lack of skin paddle may have an added risk of inability to detect flap problems. However, given the high success rates of our buried flaps thus far, both the surgeons and the patients in this series felt comfortable enough to assume the risk.

Video 1. Supplemental Digital Content 1 demonstrates an audible Doppler signal in the mastectomy flap that is related not to the flap pedicle but rather to an intercostal perforator ***http://links.lww.com/PRS/A837***.

Another uncertainty to address is whether accomplishing a single-stage reconstruction in aesthetically feasible. We recognize that a number of our patients for whom we pursued a single-stage reconstruction ultimately required secondary procedures. If a significant number of patients require secondary surgery to achieve satisfaction, it stands to reason that we should indeed leave a small skin paddle for monitoring purposes. It is simple enough to remove the skin paddle at the time of the secondary procedure.

Our data suggest that single-stage perforator flap breast reconstruction is possible in patients undergoing nipple-sparing mastectomy. However, despite our successful series, we have yet to be convinced that this method should be routinely offered to all qualifying patients. This is primarily because of the high rate of minor secondary procedures needed for improved cosmesis. We also remain uncertain about skin paddles yielding improved outcomes in free flap breast reconstruction. Like many interventions in free flap breast reconstruction, the relevance of the skin paddle is difficult to interrogate because of the universally high success rates of fasciocutaneous flaps. We do believe that a future goal of the breast reconstruction community should be single-stage perforator flap reconstruction. To accomplish this, we encourage future exploration to identify the methodology of flap monitoring (e.g., transcutaneous Doppler, implantable Doppler, skin color, swelling, temperature, spectroscopy, angiography) that is principally responsible for triggering a take-back. These data will help us quantify the utility of the skin paddle as it relates to flap monitoring and flap salvage.

CONCLUSIONS

With improvements in technology and technique, we propose that immediate single-stage breast reconstruction following nipple-sparing mastectomy represents the next generation in the evolution of breast cancer reconstruction, with the primary benefits of a natural appearing breast and little donor-site morbidity after a single operation. However, this method is not applicable to all patients, and proper patient selection is essential. We conclude that nipple-sparing mastectomy with immediate autologous breast reconstruction can successfully and safely be performed in a single stage; however, we are not ready to offer this as our standard of care and will continue to collect more data to thoroughly evaluate the risks and benefits of this operation.

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