Breast Reconstruction: A Review and Rationale for Patient Selection

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Summary: The importance of good patient selection is becoming increasingly appreciated as a predictor of good outcomes following mastectomy and reconstruction. There are many variables that should be considered when making these decisions. Patient variables include breast characteristics, age, body habitus, comorbidities, and expectations. Oncological variables include tumor size, cancer stage, and perioperative radiation. This article is structured to review the variables that are relevant when deciding upon a particular reconstructive option for a particular patient. (*Plast. Reconstr. Surg.* 124: 55, 2009.)

The importance of patient selection as a determinate of good outcomes in plastic surgery is well accepted. Its importance is becoming increasingly recognized in the patient with breast cancer who is interested in reconstruction. Although reconstructive in nature, the aesthetic importance of breast reconstruction following mastectomy cannot be underestimated. Achieving a highly desirable outcome can be difficult in many women. There are numerous variables that must be considered when selecting the appropriate operation. Patient-related factors include breast size, volume, and contour, as well as body weight and habitus. Oncological factors include tumor size, cancer stage, and previous or future radiation therapy, as well as whether the reconstruction is immediate or delayed. Psychological factors include an assessment of expectations, both realistic and unrealistic, as well as preconceived notions of the reconstructive option desired. Surgeon factors include the technical ability to perform the various reconstructive operations in a predictable and reproducible manner. These variables all contribute to the complexity of the reconstructive process.

It is the intent of this article to review a single surgeon's approach to patient selection. The specific details of the article are based on personal experience dating from July of 2005 to June of 2007; however, the principles and concepts are based on having personally performed breast reconstruction in more than 1000 women over the past 10 years. The goal is to provide a framework for optimizing patient evaluation with the ultimate selection of the reconstructive option that will optimize outcomes.

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PATIENTS

Between July of 2005 and June of 2007, a total of 236 women had primary breast reconstruction following mastectomy. The reconstruction was unilateral in 161 women and bilateral 75 women, totaling 311 breasts. The reconstruction was completed with prosthetic devices in 61 women (25.8 percent) and autologous tissue in 175 women (74.2 percent). Of those women with prosthetic devices, the reconstruction was unilateral in 39 women (63.9 percent) and bilateral in 22 women (36.1 percent), totaling 83 breasts. Of those women who had autologous tissue repair, the reconstruction was unilateral in 122 women (69.7 percent) and bilateral in 53 women (30.3 percent), totaling 228 breasts. The specific type of autologous reconstruction included the muscle-sparing free transverse rectus abdominis musculocutaneous (TRAM) flap in 26 women (34 flaps), the deep inferior epigastric perforator (DIEP) flap in 128 women (172 flaps), superior gluteal artery perforator flap in eight women (11 flaps), and the latissimus dorsi flap in 11 women.

Disclosures: *Dr. Nahabedian serves on the speakers' bureau for LifeCell Corporation (Branchburg, N.J.) and lectures on the use of AlloDerm for breast reconstruction. He is not a consultant. The author has no financial interest to declare in relation to the content of this article.*

PRINCIPLES OF PATIENT SELECTION

Patient selection begins with a thorough evaluation of the history and physical examination, progresses to a review of the reconstructive options, and ends with an understanding of patient expectations and surgeon recommendations. Women are educated and counseled to understand the differences between the various reconstructive options. Some women are interested in a short operation with a rapid recovery, whereas others are less interested in the duration of the procedure or the recovery but more interested in a procedure that will last forever. Some women are interested in autologous reconstruction because they do not want prosthetic materials in their body. It is incumbent upon the plastic surgeon to understand what the patient desires and to review the appropriate options to facilitate the decision-making process.

In a typical consultation, a pertinent history and physical examination are performed. Important details include body weight, patient height, body mass index, and bra size. The importance of symmetry following the first operation or following subsequent operations is determined. In general, most women who seek autologous reconstruction are candidates using the abdomen, the gluteal region, or the posterior thorax. Prosthetic reconstruction is generally used for women who desire a quick recovery with minimal downtime or for women with insufficient donor sites. Many women are curious about the safety of silicone gel implants based on the previous moratorium that limited their use.[1] It is explained that there is significant scientific evidence that supports the safety and efficacy of these devices and that the results following breast reconstruction with silicone gel implantation are usually superior to that of saline implants.

Another important component of the consultation includes a review of schematic illustrations as well as preoperative and postoperative photographs. Typically, the patient is shown a poor result, a good result, and an excellent result. Results are shown at the various stages of the reconstruction (e.g., fresh incision, red scar, breast mound with a nipple, nipple without a tattoo, and so on). Both prosthetic and autologous outcomes and morbidities are demonstrated showing photographs. The morbidities include flap failure, abdominal bulge, delayed healing, rippling and wrinkling, and prosthetic removal. My practice is not to raise one's expectations or to sell a particular operation but rather to convey a realistic picture of what to expect.

PATIENT SELECTION BASED ON CANCER STAGE

The foundation for safe and effective breast reconstruction is to appreciate not only the aesthetic desires of the patient but also her oncological concerns. Several studies have demonstrated that breast reconstruction following mastectomy will not promote cancer growth or interfere with surveillance.[2,3] It is therefore generally accepted that immediate breast reconstruction can be safely performed in women with early-stage breast cancer. In women with advanced breast cancer, however, delayed breast reconstruction is usually recommended.

Occasionally, some women with locally advanced breast cancer will request immediate breast reconstruction. A motivating factor has been to maintain quality of life and femininity. The important question that needs to be raised is whether or not these women should undergo immediate breast reconstruction based on their oncological risks. It is well established that immediate breast reconstruction does not delay the initiation of adjuvant treatments, such as chemotherapy or radiation therapy. However, are the aesthetic and oncological outcomes affected by these adjuvant treatments? In women with locally advanced breast cancer, postoperative radiation therapy is almost always a certainty. Review of the literature demonstrates mixed results when analyzing the effects of radiation on the aesthetic quality of the reconstruction.[4–8] With prosthetic devices, there is an increased risk of capsular contracture, infection, and premature removal.[4,5] With autologous tissue, there is an increased risk of fat necrosis, distortion, and shrinkage, although no change is also a possibility.[6,7] With regard to oncological safety, some studies have concluded that immediate breast reconstruction in the setting of locally advanced breast cancer is safe and effective[7,8]; however, this has not been my personal observation. In a review of 146 women who had breast cancer, mastectomy, and breast reconstruction either before or after radiation therapy, there was noted to be a higher local recurrence rate when the reconstruction preceded the radiation (27 percent) compared with when the radiation preceded the reconstruction (14.9 percent).[9] Local recurrence in the setting of autologous reconstruction was 38 percent when radiation followed immediate breast reconstruction and 14 percent when radiation preceded breast reconstruction

($p = 0.0146$). The recurrence rate associated with implant reconstruction was 10 percent when radiation followed immediate breast reconstruction and 19 percent when radiation preceded breast reconstruction ($p = 0.0424$).

AUTOLOGOUS VERSUS PROSTHETIC

Traditional dogma has dictated that women with small breast volumes are better candidates for reconstruction using prosthetic devices and that women with large breast volumes are better candidates for reconstruction using autologous tissue. Current concepts in breast reconstruction imply that type of reconstruction selected is not as dependent on breast volume alone as previously thought. The reality is that prosthetic or autologous reconstruction can safely be performed in women with a variety of breast sizes and shapes (Table 1).

With the advancements in breast reconstruction, it is not uncommon to reconstruct women with cup sizes ranging from A to D with either a flap or prosthetic device. As previously discussed, an important aspect is the recognition of what a woman's goals and expectations are following the reconstruction. When evaluating women for autologous breast reconstruction, several factors are noted. The abdomen has been the donor site of choice for most women. In general, the most important physical finding is a sufficient quantity of skin and fat to reconstruct the desired breast volume. Most women have experienced previous childbirth and have an excess of abdominal skin and fat.[10] Although a woman may be slender with a paucity of abdominal fat, she may still be a candidate if the reconstructive requirements are low. In women who are overweight or obese, an abdominal flap in the form of a free TRAM or DIEP flap can still be performed; however, the flap must be tailored to sustain its perfusion requirement and to minimize the incidence of fat necrosis.[11–13]

Table 1. Indications for Autologous and Prosthetic Breast Reconstruction

Autologous versus Prosthetic Reconstruction	
Autologous	**Implant**
A, B, C, or D cup	A, B, C, or D cup
Sufficient donor fat volume to obtain desired breast volume	Delayed-immediate reconstruction
Secondary future procedures less likely	Minimal downtime
Primary reconstruction in setting of previous x-ray therapy	Nonobese patient
	Secondary future procedures more likely
	No previous x-ray therapy

The abdomen is usually not considered when there are midline scars that will preclude incorporating the contralateral zones when additional tissue is deemed necessary or there is minimal to no excess fat in the region.

Should the abdomen not be a suitable donor site, then the gluteal region is considered. The superior artery gluteal perforator flap is ideal for women who desire autologous reconstruction, refuse prosthetic reconstruction, and prefer a perforator flap.[14] Most women will have sufficient donor fat in this area and will be candidates. An important caveat about this operation is the appearance of the donor site. It has been observed that some will have significant scalloping of the buttock and/or gluteal asymmetry. This has been a major source of dissatisfaction in some women. In general, I have found that petite women of shorter stature are more prone to these aesthetic issues, whereas taller and slender women are less prone.

When considering women for prosthetic reconstruction, it is important to assess the potential for symmetry. Secondary procedures are more common following prosthetic reconstruction and may involve the ipsilateral or contralateral breast.[15] As a means of minimizing these secondary procedures, ideal candidates for prosthetic reconstruction include those with small to moderate breast volume and with minimal to no ptosis. This is especially true in the unilateral setting in which obtaining symmetry is generally more difficult. In the setting of bilateral reconstruction, the specific characteristics of the breast are less important because the two reconstructed breasts will be very similar. Poor candidates for prosthetic reconstruction are those who have had previous radiation following mastectomy or following breast conservation therapy. Complications such as infection, capsular contracture, distortion, pain, and premature removal are more common in this setting.[4,5]

With the introduction of bioprosthetic materials as a pectoral extender, the percentage of patients who have become candidates for prosthetic reconstruction has increased in my practice. This is because reconstructive outcomes have generally improved and become more predictable and reproducible. There have been increasing questions, however, on which patients are candidates for its use.[16–18] The bioprosthetic that is currently utilized in my practice is AlloDerm (LifeCell Corporation, Branchburg, N.J.), although there are several other materials that are currently available. The primary benefits of AlloDerm have in-

cluded increased initial expansion, compartmentalization of the prosthetic device, and improved aesthetic outcome. AlloDerm has been used in women with a A-cup as well as D-cup breasts. It has been used on women who have received radiation before and after breast reconstruction.

ONCOPLASTIC SURGERY VERSUS SKIN-SPARING MASTECTOMY AND IMMEDIATE RECONSTRUCTION

The desire to preserve the nipple-areola complex cannot be underestimated in women with breast cancer. Current estimates are that nearly two-thirds of women with early-stage breast cancer will opt to have breast conservation surgery. This operation has gained widespread acceptance over the past 20 years. Although natural breast contour is maintained in approximately 80 percent of women, the remainder will experience some degree of a contour abnormality. Thus, as with all operations for breast cancer, proper patient selection is necessary to ensure the safety and efficacy of partial mastectomy as well as skin-sparing mastectomy (Table 2). Another relevant fact regarding breast conservation surgery is that despite equal survival data, the incidence of local recurrence is increased when compared with mastectomy.[19,20] Attempts to decrease the incidence of local recurrence have led to the evolution of oncoplastic surgery. With this technique, a wider margin of tumor excision is obtained to lessen the incidence of recurrence. Therein, the concept of oncoplastic surgery has been introduced.

Many women are now being offered the option of oncoplastic surgery as an alternative to mastectomy. The decision as to which procedure to recommend for a woman with breast cancer can sometimes be difficult (Table 3). There are several operative techniques that fall within the domain of oncoplastic surgery. The selection of the appropriate technique will depend on the shape and volume of the breast. The currently available techniques include adjacent tissue rearrangement, reduction mammaplasty, and partial breast reconstruction with remote tissues. For women with small breasts, adjacent tissue rearrangement may suffice, depending on the amount of parenchyma resected. Larger resections may require remote tissues such as a latissimus dorsi flap. Women with moderate- to large-volume breasts may be candidates for any of the three options. Adjacent tissue rearrangement is perhaps the most common technique utilized, and this is most often performed by the ablative breast surgeon. In women who have a partial mastectomy in the setting of large breast volume, however, a reduction mammaplasty is usually performed. These reduction procedures are usually performed by the plastic surgeon. Another important safety factor when considering oncoplastic surgery is that if the tumor margins are in question, a delayed approach should be considered. This will permit a re-excision if needed 1 to 2 weeks later and a formal reconstruction at that time.

Table 2. Comparison of Benefits between Oncoplastic Surgery and Skin-Sparing Mastectomy with Immediate Breast Reconstruction

Comparison of Benefits	
Oncoplastic Surgery	**Skin-Sparing Mastectomy and Immediate Breast Reconstruction**
Avoids contour abnormality	Decreased incidence of local recurrence
Minimizes number of operations	Negative margins more readily achieved
Can be performed with or without flaps	Reduced patient anxiety
High patient satisfaction	May reduce need for postoperative radiation therapy
Associated with less recurrence compared with breast conservation surgery	Potential for excellent outcomes
Potential for excellent aesthetic outcome	

PATIENT SELECTION BASED ON AGE

Although there are differences in the type of reconstruction that women choose based on age-related demographics, patient age in and of itself is not an indication or contraindication for any one particular type of operation. Advanced patient age (>65 years) is considered by some to be a relative contraindication for breast reconstruction. Personal experience, however, as well as documented literature, has demonstrated that breast reconstruction is safe and effective in properly

Table 3. Indications and Contraindications for Oncoplastic Surgery

Oncoplastic Surgery	
Indications	**Contraindications**
Patient preference	Recurrent breast cancer
Surgeon preference	Multifocal cancer
Large breast (tumor <5 cm)	Small breast (large tumor)
Small breast (small tumor)	Locally advanced breast cancer
Unifocal	Tumor >5 cm
Early stage	Previous breast radiation therapy

selected women over the age of 65.[21,22] As a general rule, all women of advanced age are required to obtain medical clearance from their primary physician. Women with multiple medical comorbidities who have an interest in breast reconstruction are discouraged from pursuing complex microvascular reconstructive procedures and directed more toward simpler methods, such as prosthetic reconstruction. On the other hand, women who are in good general health may be considered for any type of breast reconstruction.

In my personal cumulative experience, 57 women who were 65 years of age or older have chosen to undergo breast reconstruction. Of these, 49 women had unilateral and eight had bilateral reconstruction, totaling 65 reconstructions. The type of reconstruction was highly variable and included autologous tissue in 28 women, prosthetic devices in 28 women, and an oncoplastic approach in one woman. The autologous options included a pedicled TRAM flap in two women, a free TRAM flap in five women, a latissimus dorsi flap in five women, a DIEP flap in 15 women, and a superior artery gluteal perforator flap in one woman. All prosthetic reconstructions were performed in two stages using a tissue expander followed by a permanent implant. The ability to perform microvascular surgery in women who were 65 years of age or older was validated by a successful outcome in 22 of 23 breasts. In the sole failure, a patent venous anastomosis could not be achieved. These data have supported our hypothesis that breast reconstruction in the elderly population is safe and effective when the patients are properly selected and can maintain a desired quality of life.

UNILATERAL VERSUS BILATERAL MASTECTOMY

The topic of unilateral versus bilateral mastectomy has received increasing attention. Unilateral mastectomy has been the traditional paradigm for women with breast cancer; however, this paradigm appears to be changing. More and more women are now electing to have a bilateral mastectomy in the setting of unilateral breast cancer as a method of reducing their risk of developing contralateral breast cancer.

There is another group of women who are choosing to have bilateral prophylactic mastectomy because of a strong family history of breast cancer, fear of developing breast cancer, or because of the results of genetic testing for the *BrCa1* or *BrCa2* gene mutations.[23,24] Regardless of the reasons for bilateral mastectomy, the fact that so many women are choosing to undergo bilateral mastectomy with immediate reconstruction is a testament to the advancements we have made in plastic surgery and to the improved quality of breast reconstruction that we deliver. When counseling women about the reconstructive options in this setting, there are a variety of topics to discuss. The issue of nipple sparing frequently is addressed because there is no cancer. In these cases, the nipple-areola complex may be preserved. In the setting of breast cancer in which the nipple in the cancerous breast is to be removed, however, the prophylactic mastectomy should then also include the nipple-areola complex.

NIPPLE- AND AREOLA-SPARING MASTECTOMY VERSUS SKIN-SPARING MASTECTOMY

One of the major advancements in mastectomy has been the realization that the traditional incision pattern that incorporated a wide skin island around the nipple-areola complex did not reduce the incidence of local recurrence or affect patient survival when compared with a skin-sparing mastectomy in which only the nipple-areola complex was excised. This has tremendously improved our aesthetic outcomes without compromising patient safety (Table 4). Over that past several years, however, there has been an interest in mastectomy with preservation of the nipple-areola complex. With this technique, there is total preservation of the cutaneous envelope of the breast with the potential to achieve a natural aesthetic outcome.

Several publications have examined the feasibility of this technique and attempted to establish guidelines regarding patient selection.[25–29] There are several factors that must be considered when

Table 4. Indications and Contraindications for Skin-Sparing Mastectomy and Immediate Breast Reconstruction

Skin-Sparing Mastectomy and Immediate Breast Reconstruction	
Indications	**Contraindications**
Patient preference	Locally advanced breast cancer
Surgeon preference	Inflammatory breast cancer
Any size breast	Tumor >5 cm
Tumor <5 cm	Metastatic disease
Multifocal cancer	Multiple comorbidities
Failed breast conservation surgery	Poor general health
Previous breast radiation therapy	

a patient requests this method of mastectomy. Oncological factors should always take precedence. In general, this technique may be considered for small primary cancers that are less than 2.0 cm in diameter (T1) and more than 2.5 cm away from the nipple-areola complex.[28] Consideration should not be given to women with recurrent breast cancer, tumors more than 2.5 cm, regionally positive lymph nodes, and previously radiated breasts. Adherence to these criteria can result in a safe and effective operation; however, deviations from these criteria can be associated with poor outcome. Personal experience with this technique in 11 cancerous breasts in which the principal criterion for inclusion was strong patient desire demonstrated a recurrence rate of 27 percent (three of 11 breasts).[25] In that study, there were no strict criteria for patient selection. In studies in which the patient selection criteria were firmly adhered to, the recurrence rate has been approximately 5 percent.[29] When discussing these issues with patients, it is explained that cancers usually arise in the ductal elements of the breast and that all ducts lead to the nipple. Although some surgeons are very enthusiastic about this technique, my thoughts are to proceed with caution in the setting of breast cancer.

In addition to the oncological concerns, aesthetic considerations are also important. Some women believe that preservation of the nipple-areola complex will result in the same appearance and behavior. The reality however, is that the nipple-areola complex is usually asensate due to the transection of all sensory afferent fibers.[25] There may also be delayed healing due to the disruption in blood supply. The nipple-areola complex is perfused in a random fashion, with all vascularity emanating from the periphery of the cutaneous envelope. There was a significant asymmetry that occurred in our series, especially in women who had unilateral prosthetic reconstruction.[25] The redraping of the cutaneous envelope of the breast is distorted when the prosthetic device is placed under the pectoralis major muscle, and the reconstructed breast rarely resembles the opposite breast. The aesthetic outcomes following autologous reconstruction, however, are much more natural, as the excised breast parenchyma is replaced with vascularized fat in the same anatomic location.

PERFORATOR FLAP VERSUS MUSCULOCUTANEOUS FLAP

The decision as to whether to use a perforator flap versus a musculocutaneous can be difficult. This is especially true when considering the abdomen as the donor site. Some surgeons state that all patients have a dominant abdominal wall perforator and as such a DIEP flap can be used. Others are of the opinion that a dominant perforator is not always present and a musculocutaneous flap is sometimes necessary. I have previously reported on my patient selection criteria and algorithm for the DIEP flap or muscle-sparing free TRAM flap.[12,30] The original algorithm was based on breast volume, abdominal fat volume, perforator diameter, number of perforators, patient age, tobacco use, and whether the reconstruction was unilateral or bilateral. In general, a DIEP flap was preferentially performed when the volume requirement was less than 750 cc and the patient had mild to moderate abdominal lipodystrophy. A free TRAM flap was preferentially performed when the volume requirement exceeded 1000 cc or the patient had severe abdominal lipodystrophy. With increasing experience, this algorithm has been modified (Table 5).

The use of ancillary procedures to assist preoperatively with the decision to perform a free TRAM or DIEP flap can be accomplished with computed tomography angiography or duplex ultrasound. This will determine the location and caliber of an abdominal wall perforator. Although not routinely performed at our institution, these tools have been demonstrated to be highly effective.[31–33] Computed tomography angiography is becoming frequently performed at many institutions worldwide. It has essentially replaced two-dimensional duplex imaging based on its clarity of image and precision. Computed tomography angiography can identify and localize perforators throughout the anterior abdominal wall. Preoperative knowledge of this information can assist with the decision as to whether a woman is a candidate for a DIEP flap or not.

The traditional (pedicle) TRAM flap is also considered for autologous reconstruction. Al-

Table 5. Algorithm for Free TRAM versus DIEP Flap

Factor	Free TRAM Flap	DIEP Flap
Breast volume requirements		
<1000	+	++
>1000	++	+
Abdominal fat		
Mild to moderate	+	++
Severe	++	+
Perforators >1.5 mm		
0	+	No
>1	+	++
Bilateral	+	++

Table 6. Principles of Patient Selection

Principles
• Pay attention to comorbidities
• Assess patient expectations
• Assess potential for symmetry
• Be honest
• Diversify your reconstructive options
• Appreciate the effects of radiation therapy
• Review complications

though not routinely performed by this author, this flap remains the most common method of reconstruction using abdominal tissue, at least in the United States. The traditional TRAM flap has been used in situations when there are no suitable recipient vessels and in situations where the inferior epigastric vessels have been previously divided during prior operations incorporating a Pfannenstiel incision.

CONCLUSIONS

Proper patient selection is becoming increasing appreciated as one of the principal determinants of good to excellent outcomes. Understanding the expectations of our patients and trying to establish realistic goals are critical. This can be easily achieved by following several important principles that have been indirectly reviewed in this article (Table 6). Many women ask what I would do if she were my sister. It behooves us to be candid and honest in all situations. Poor outcomes and unhappy patients often arise from poor patient selection.

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