

# Breast Reconstruction

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## KEYWORDS

- Breast reconstruction • Mastectomy • Breast implant
- Superior gluteal artery perforator flap • Lumpectomy
- Deep inferior epigastric perforator flap • Breast cancer

## KEY POINTS

- A collaborative approach within the diagnostic, oncologic, and surgical team with the reconstructive specialist is essential to develop a treatment plan that optimizes the patient's care from the very beginning.
- Only 33% of women who are otherwise candidates for immediate reconstruction at the time of mastectomy choose reconstruction.
- The type of mastectomy the patient undergoes directly influences the reconstructive outcome and aesthetics.
- Careful handling of the skin, gentle retraction, pristine dissection between the gland and the overlying subcutaneous fat layer, minimized cautery settings, and an understanding of the associated thermal plume are essential to reliably healthy skin flaps.

## INTRODUCTION

An estimated 300,000 women are affected by breast cancer every year in the United States, and another 2.6 million are living posttreatment. As diagnostic technology has progressed and the understanding of the disease process has evolved, the number of mastectomies performed in the United States has increased. Breast reconstructive techniques have commensurately become more sophisticated along the same timeline. The result is that those facing mastectomy have the potential to simultaneously retain physical beauty and wholeness. Despite these advances, only 33% of women who are otherwise candidates for immediate reconstruction at the time of mastectomy choose reconstruction. The 2 reasons most attributed to this remarkable statistic are failure of the treatment team to refer the patient to a plastic surgeon at the time of diagnosis/decision for mastectomy and the resultant lack of understanding on the patient's part regarding her reconstructive options.

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A collaborative approach within the diagnostic, oncologic, and surgical team with the reconstructive specialist is essential to develop a treatment plan that optimizes the patient's care from the very beginning. One facet of this team-based mindset is the mastectomy itself. Where will the incision be placed? What portion of the breast skin will be preserved? Will we reconstruct at the time of mastectomy or not? Will we preserve the nipple-areolar complex?

The type of mastectomy the patient undergoes will directly influence her reconstructive outcome and aesthetics. Mastectomy planning has become a surgical art in this regard. This procedure begins with incision placement. The convention of large horizontal incisions has become archaic in centers that use team-based planning before mastectomy. Incision placement that allows adequate exposure for mastectomy and simultaneous maximized reconstructive outcome may vary from vertical incision from nipple to fold, lateral incision from nipple to flank, straight, serpentine, fold hidden, and anywhere in between. The rule is complete preservation of the skin envelope in all but those with advanced disease or tumor cells near the skin surface. Even in these cases, the design may be carried out in a way that preserves peripheral landmarks in the breast and avoids a large medial extension that would otherwise be visible in drop-neck clothing. Basic considerations, such as preservation of the inframammary fold are a given, but the surgical oncologist must approach the breast skin as though it were a facelift. Careful handling of the skin, gentle retraction, pristine dissection between the gland and the overlying subcutaneous fat layer, minimized cautery settings, and an understanding of the associated thermal plume are essential to reliably healthy skin flaps. Perhaps even more important within these considerations is the avoidance of dissection beyond the peripheral boundaries of the breast because the medial and lateral intercostal blood flow is critical to meaningful perfusion of preserved breast skin.

Nipple-sparing mastectomy is a concept in evolution and one more level of sophistication with respect to mastectomy planning. For those who are candidates, this approach further elevates the standard, allowing outcomes that reach toward an "untouched" look after mastectomy. These concepts push the reconstructive result and in many cases, can produce a superior aesthetic to "breast preservation" (lumpectomy) protocols.

Tissue expander/implant reconstruction remains the most common form of reconstruction because of quicker recovery potential, avoidance of donor site morbidity, ease of procedure for the operating surgeon, and resultant wide availability. The implant or expander is placed beneath the pectoralis muscle to camouflage its upper pole and help protect the overlying skin. Acellular dermal matrix may be used to complete this pocket and further support the implant position and add thickness to the lower pole coverage.

Concerns with tissue expander/implant reconstruction include capsular contraction, infection, deflation, and the need for resultant additional surgery.

Autologous reconstruction allows one to use the patient's own tissue to reconstruct her breast. The pedicled transverse rectus abdominis myocutaneous (TRAM) flap, developed over 30 years ago, was the most significant step forward in autologous reconstruction. At present, autologous tissue breast reconstruction has evolved allowing free tissue transplantation to recreate the breast. These techniques no longer require use or loss of the rectus or other musculature and may be taken from any place on the body where musculo/fascio cutaneous perforating vascular pedicles enter overlying fat.

Most commonly, the abdomen is the source of tissue for autologous reconstruction with several options including pedicled TRAM, free TRAM, or deep inferior epigastric

perforator (DIEP) flaps. Other options include gluteal artery perforator (GAP) flaps, latissimus flaps, and transverse gracilis (TUG) flaps. Considerations with autologous tissue reconstruction include donor site morbidity, increased complexity of the procedure, longer operative times, an added 2 days hospitalization (on average), and less widespread availability.

## BACKGROUND

Breast cancer affects 1 in 8 women in the United States. Often, the treatment plan includes mastectomy, which may offer a chance for cure, but has a tradeoff of scars and disfigurement. Modern breast reconstruction allows women facing mastectomy not only to avoid disfigurement but also, in many cases, to achieve an outcome that may enhance the beauty of the breast and the overall body shape. Breast reconstruction helps these women retain their femininity, physical wholeness, and emotional sense of well-being.<sup>1</sup> Reconstruction is an important part of the healing process; it avoids leaving an injured look as a consequence of treatment and thereby occupies an integral place in the overall treatment strategy for breast cancer.

There has been an increase in the number of mastectomies in the United States for a variety of reasons. The advent of genetic testing for *BRCA1* and *BRCA2* allows women with a genetic predisposition to breast cancer to understand their risk and address it should they choose. Women with *BRCA1* mutation have a 65% chance of developing breast cancer by the age of 70 years, and women with *BRCA2* have a 45% risk.<sup>2</sup> In addition, many women are electing prophylactic mastectomies whether it is for genetic reasons or for their own personal cancer history and the associated desire to reduce the chance of experiencing breast cancer for a second time.<sup>3</sup> Prophylactic mastectomy has been demonstrated to be an effective strategy to minimize the risk of developing breast cancer in patients with high-risk genetic profiles.<sup>4</sup> Add to this, the improvements made in diagnostic imaging, a better understanding of multifocal disease patterns, and improvements in reconstructive techniques that restore a lost breast in the same operation and the reasons for an increased number of mastectomies recommended becomes more clear.

There has been much progress and evolution in the techniques used to provide the patient with an aesthetic result indistinguishable from the natural breast. The ultimate goal of reconstruction is symmetry between the native breast and the newly reconstructed breast or symmetry between 2 newly created breasts. The art of breast reconstruction has undergone significant evolution over the past 20 years.

Because the goal of breast reconstruction is creating a natural appearing and symmetric outcome, the surgeon must consider the size of the reconstructed breast. The plastic surgeon must make an estimate of the volume that will be required to reconstitute the breast shape and projection when mastectomy is complete. The surgeon may weigh the removed breast tissue and the tissue used for reconstruction to help achieve symmetry during the operation, but the reconstructive plan must be fully developed before entering the operative suite. To achieve symmetry in a unilateral reconstruction, the opposing breast may need to be altered with mastopexy, implant addition, or reduction. The Federal Women's Health and Cancer Right Act of 1998 states that surgery performed to produce a symmetric or balanced appearance must be covered by insurance if they offer coverage for the mastectomy.

Patients have multiple options for reconstruction including alloplastic techniques such as tissue expanders/implants or autologous reconstruction and the many variations that are found within each of these 2 major approaches. The choice of reconstruction is largely dependent on the dialogue between the patients and their plastic

surgeon. Immediate reconstruction should be considered the standard. Delayed reconstruction may be more appropriate for patients with advanced disease or patients not committed to the process. Many patients will present to the plastic surgeon well informed on the various options, and it should be the goal of the surgeon to direct them in a way best suited for their particular situation. It is the job of the diagnostic and oncologic team to provide information and referral to a plastic surgeon for in-depth discussion of their options before mastectomy so that outcomes may be optimized.

## **MASTECTOMY**

Reconstruction begins with the mastectomy. The incision placement and portion of skin/nipple-areolar complex that are preserved determine, in large part, how natural the new breast will look. The traditional mastectomy and the modified radical mastectomy involve removal of an ellipse of skin including the nipple-areolar complex, with a horizontal pattern that extends the scar into the medial breast leaving a visible signature in all but the most carefully chosen apparel. This approach remains commonly used, even though it is rarely the best choice from an aesthetic standpoint. The skin-sparing mastectomy preserves the skin envelope of the breast with a more limited incision that typically involves removal of the nipple/areola. The nipple-sparing mastectomy allows for preservation of not only the breast skin but also the nipple/areola with an incision placed vertically, laterally, or in the inframammary fold. Careful handling of the skin, gentle retraction, pristine dissection between the gland and the overlying subcutaneous fat layer, minimized cautery settings, and an understanding of the associated thermal plume are essential to reliably healthy skin flaps. Avoidance of dissection beyond the peripheral boundaries of the breast is also critical because the medial and lateral intercostal blood flow is imperative if skin necrosis is to be avoided.

## **ALLOPLASTIC RECONSTRUCTION**

### ***History***

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The silicone breast implant was introduced in 1961 by Thomas Cronin and Frank Gerow. This implant was intended to be used only for breast augmentation, but eventually its use in breast reconstruction evolved. Modern implants are filled with either silicone or saline, and most reconstructive surgeons prefer silicone because they tend to have a more natural overall texture. Saline implants typically have more palpable wrinkling particularly in the lower pole of the breast. Implants are placed beneath the pectoralis major with or without completing the submuscular pocket with a sheet of collagen (Alloderm [Lifecell Corporation, Bridgewater, NJ, USA], Allo-max [Davol, a BARD Company, Warwick, RI, USA], Stratus [Lifecell Corporation, Bridgewater, NJ, USA], etc).

Tissue expanders are used when skin has been excised during the mastectomy to an extent that closure of the skin over the desired implant is not possible. Expanders may also be used in an immediate reconstruction when the reconstructive surgeon is concerned about the vitality of the skin after mastectomy. The skin is subsequently expanded postoperatively, and once an adequate pocket is developed, it is exchanged to a definitive implant in a separate procedure. Implant reconstruction remains more common than autologous reconstruction based on 2008 statistics by the American Society of Plastic Surgeons.<sup>5</sup> This fact may be attributed to a shorter recovery potential compared with flap procedures, avoidance of donor site morbidity, technical simplicity for the operating surgeon, and resultant wide availability.

### ***Advantages/Disadvantages***

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Tissue expander/implant reconstruction is less complex than autologous reconstruction and does not carry donor site morbidity potential. This procedure offers surgical simplicity for the operative team with a reduced operative time and a more rapid recovery. Modern flap techniques allow for solutions in the thin patient, so implants are not the only choice in that scenario. Women with smaller breast size tend to heal more uneventfully after implant reconstruction than those with large breasts.

Complications after implant reconstruction can occur. Use of an artificial device under a compromised skin covering opens the potential for extrusion and infection. If a wound forms in the skin over an implant, it may need to be removed for a period to allow the soft tissue to recover before further attempts at reconstruction are undertaken. In addition, aesthetic results may be compromised by capsular contracture and implant failure, possibly prompting implant exchange.<sup>6</sup> Other less appealing facets of implant reconstruction include frequent clinic visits for expansion followed by a second surgery to replace the expander with the implant. It may be more difficult to match the ptosis and pliability of a natural breast when a one-sided implant reconstruction has been performed as well. Implant reconstruction is generally not considered for patients who will or have previously undergone radiation therapy because the soft tissue fibrosis limits the outcome potential and increases the rate of capsular contracture dramatically. It has been found that there is a higher patient aesthetic satisfaction rate with autologous reconstruction compared with implant reconstruction.<sup>7</sup>

### ***Acellular Dermal Matrix***

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It is preferable to perform implant reconstruction at the time of the mastectomy. This timing offers the benefit of a preserved skin envelope without the need for expansion in those undergoing skin-sparing mastectomy. Expansion may be a painful process, and limiting the need for a subsequent exchange from an expander to an implant is an important benefit. The “straight to implant” or “dermal-matrix-assisted implant” reconstruction is used for women with healthy preserved skin envelopes with no need for skin expansion. The implant is placed at the time of the mastectomy in a subpectoral pocket that is completed from the lower border of the pectoralis to the inframammary fold with a sheet of acellular collagen matrix. This procedure avoids the need for expander placement and the associated painful fill sessions in the clinic and allows the patient to sidestep an exchange procedure. The dermal sheeting allows the implant to be supported with respect to positioning in the breast pocket and provides a layer of thickness that helps camouflage the implant’s palpability.<sup>8,9</sup> When a tissue expander is placed, it is serially inflated over several weeks and then replaced by the definitive implant at a second surgery.

### ***Surgery***

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The mastectomy is performed with gentle technique, preserving the peripheral boundaries of the breast and the associated blood supply to the skin. The implant is then placed beneath muscle to add coverage for the implant and soften the appearance of the upper pole. Attempts at complete muscular coverage by elevating the serratus anterior as well as placing the expander beneath these muscles has largely been supplanted by adding a sheet of dermal matrix from the pectoralis down to the inframammary fold. The pocket should never be dissected too medially or cross the midline. Drains are typically left in the axilla and mastectomy space.

When tissue expansion is required, the process begins 2 to 3 weeks postoperatively with injection of approximately 50–100 mL of sterile saline every 1 to 2 weeks until the

desired volume is reached. Tissue expanders have been shaped anatomically to expand the lower pole of the breast to create a natural ptosis. About 1 to 2 months after the final expansion, the expander should be exchanged for the implant, which may require capsulectomy for the desired cosmesis to be achieved.

### ***Acellular dermal matrix***

Acellular dermal matrix is basically a sheet of collagen with intervening cellular content. In breast reconstruction, it is used as a soft tissue replacement to cover the tissue expander or implant. Acellular dermal matrix is used to maintain the implant position and inframammary fold height and offers better overall control of the implant.<sup>9</sup> This matrix compartmentalizes the implant and helps to improve aesthetic outcomes.

### ***Complications***

Common complications of tissue expander/implant reconstruction are infection, capsular contraction, skin flap necrosis, and deflation. Infection can result in implant loss. It has been suggested that use of acellular dermal matrices may have a higher rate of infection, although this is disputed.<sup>10</sup> Infections need to be aggressively treated with antibiotics, but they typically require removal of the implant to eliminate the infective process. Capsular contraction rates may be decreased by using textured implants and may increase in patients who require radiotherapy. Skin flap necrosis may result in full-thickness excision of eschar prompting additional surgery to achieve good cosmesis. Patients should be counseled that implants are not to be considered lifetime devices and that they may need to be replaced for leakage or other problems at some point.<sup>11</sup> The cosmetic outcome of implants seems to deteriorate over time, resulting in less-satisfied patients at 5 years as opposed to 2 years postoperatively.<sup>12</sup>

## **AUTOLOGOUS RECONSTRUCTION**

### ***Background***

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Autologous reconstruction offers some distinct benefits over alloplastic reconstruction for women with breast cancer. Most importantly, it allows the patient to use her own tissue, which is as close a replacement for breast tissue as modern technology provides. Free tissue transfer was first used in 1976 by Fujino.<sup>13</sup> The pedicled TRAM flap used by Hartrampf<sup>14</sup> in 1982 was the most significant step toward producing an aesthetic result indistinguishable from the native breast. This step was followed by free perforator flaps that were originally pioneered in Japan in 1989 by Koshima.<sup>15</sup> These flaps have reduced donor site morbidity compared with TRAM and latissimus flaps because they do not sacrifice the underlying muscle. Currently, there are many techniques available for use in autologous reconstruction, and the decision of which type to use should be based on the patients' anatomy and the surgeons' experience with the particular methods.

### ***Types of Flaps***

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Flaps may be musculocutaneous containing both the vascularized muscle with the overlying fat and skin. The flaps may be used as pedicled flaps, where they are transposed into position with the vascular supply intact, or as free flaps, where the vascular supply from the donor tissue is anastomosed to the internal mammary or the thoraco-dorsal vessels. The perforator-free flaps are based on the same vascular supply but spare the underlying muscle to decrease donor site morbidity.

Pedicled TRAM flaps have served as the basis of today's autologous reconstruction. The flap is composed of an ellipse of skin and subcutaneous tissue with the rectus muscle. The vascular supply comes from the superior epigastric vessels. The

flap is rotated into the breast pocket with the rectus attached at the costal margin. One or both rectus muscles may be used depending on the volume of tissue required. Pedicled TRAM flaps have a higher partial flap loss rate than any other flap option. The design flaw results from the fact that there must be a reversal of flow through “choke vessels” in the rectus abdominus; in addition, there is potential for kinking or compression of the pedicle at the subcostal rotation point. Blood flow insufficiency in a pedicled TRAM flap may be addressed by “supercharging” the flap with an extra microvascular anastomosis from its distal pedicle to the thoracodorsal or internal mammary system. The blood supply may also be augmented by using a preliminary delay procedure, where the inferior epigastric vessels are ligated before the reconstruction, causing the superior epigastric vessels to dilate due to the hypoperfusion. The free version of this flap detaches the tissue from the lower abdomen and insets it into the mastectomy site with anastomosis of the vessels.

The latissimus dorsi flap, which is also a pedicled flap, is tunneled through the axilla leaving the thoracodorsal artery and vein intact as the vascular pedicle. The flap itself does not usually have adequate volume to serve as the reconstruction alone. Many times it is combined with an implant or tissue expander to provide the volume and projection needed to create an aesthetically pleasing reconstruction. These flaps may also be used in patients to repair defects created by lumpectomy and radiation therapy or in cases of partial tissue loss from previous autologous tissue reconstruction.

Multiple free flaps have been developed to reconstruct the breast after mastectomy. The abdomen is the first choice for autologous breast reconstruction. The DIEP is based on the deep inferior epigastric system that penetrates the rectus abdominus and its fascia. These vessels provide the vascular pedicle for the flap without sacrificing the rectus abdominus or requiring mesh placement in the abdomen as is required with the TRAM flap. The incision placement is aesthetically favorable, and usually the soft tissue volume is adequate. The superficial inferior epigastric artery (SIEA) flap uses the same fatty abdominal tissue with reliance on the superficial inferior epigastric pedicle for its vascular supply. Occasionally, the flow from the SIEA may be more robust than its deep counterpart. The SIEA is used as an alternative to the deep inferior epigastric artery when the perforators of the deep artery are judged to be of insufficient size or the deep artery cannot be used because of previous surgeries. The superficial artery is usually much smaller in caliber and more tortuous, making its anastomosis to recipient vessels and inset of the flap more difficult.

Patients who do not have enough abdominal tissue or have had prior abdominoplasty or other prohibitive surgery may be candidates for GAP flaps. These flaps evolved as a refinement of the gluteal myocutaneous flap first described by Fujino in 1975.<sup>16</sup> These flaps were originally used for the management of sacral pressure sore.<sup>17</sup> There is typically a substantial amount of fatty tissue even in very thin patients, and the avoidance of the gluteal muscle decreases morbidity and shortens recovery time. This flap may be based on the superior or the inferior gluteal artery. The inferior flap is not used as often because of the additional dissection required around the sciatic nerve and the potential morbidity associated with this. More importantly, taking fat from the lower buttock can defat weight-bearing surfaces and square of the gluteal shape leaving a masculine appearance. Historically, this flap has been regarded as more technically complex because of the delicate nature of the pedicle dissection. For experienced microsurgeons, this procedure serves as a powerful second option when the abdominal tissue is not available.<sup>18</sup>

Additional options for the thin patient include the stacked DIEP free flap. This procedure allows 2 independent flaps to be linked to one another and layered into the breast reconstruction site. The technique although technically demanding, is reproducible

and safe for patients seeking autologous breast reconstruction with otherwise inadequate abdominal adipose tissue.<sup>19</sup>

When bilateral reconstruction is necessary in a thin patient, the stacked abdomen/hip flap allows for a DIEP flap to be layered with a GAP flap for patients with inadequate volume in the abdominal and gluteal donor regions.<sup>20</sup>

### ***Advantages/Disadvantages***

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Advantages include a natural texture and appearance to the new breast. Once healed, flap procedures are considered a lifetime solution compared with implants, which may require maintenance surgeries over time. The operative time may be longer, and longer hospital stays are required, but the payoff of long-term result durability often outweighs these issues. Musculocutaneous flaps have the additional disadvantage of donor site morbidity including weakness and potential for abdominal contour bulges and/or overt hernia. The need for mesh placement in the abdominal donor site also reduces the appeal of the TRAM flap compared with the DIEP flap.

### ***Contraindications***

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Patients who have had procedures that may have injured the vessels that perforate the rectus sheath such as abdominoplasty are not candidates for DIEP or SIEA flaps. Abdominal procedures such as hysterectomy, appendectomy, laparoscopic cholecystectomy, and cesarean deliveries are not contraindications. Smoking, although not an overt contraindication, is prone to cause wound healing delays, and patients should discontinue their habit at least 3 weeks before surgery.<sup>21</sup> In addition, patients who are morbidly obese or have diabetes need close postoperative follow-up because their healing particularly in the donor site may be slow.

### ***Surgery***

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#### ***TRAM***

There are 2 dominant vascular pedicles in the TRAM flap: the superior and the inferior epigastric arteries. The pedicled TRAM flap relies on the superior vessel, whereas the free TRAM flap relies on the inferior epigastric arteries. The harvest of the flap is approached the same in both flaps with the dissection of a transverse skin flap down to the fascia. The anterior rectus fascia is entered, which exposes the rectus muscle, and the vascular pedicle of interest is dissected. For the pedicled TRAM flap, the lower rectus is transected and tunneled subcutaneously to the chest wall defect leaving the superior portion anchored to the costal margin. The free TRAM flap completely transects the lower rectus abdominus, and the inferior epigastric vessels are anastomoses to the internal mammary or thoracodorsal vessels using microsurgical technique.

#### ***DIEP flap***

The harvest of the free flap is similar to that of the TRAM flap. The skin is marked with an elliptical incision, and harvest begins along the lower half of the arc to identify and inspect the SIEA and veins to determine if the superficial system is more dominant. Next, the upper arc of the incision is completed and the flap is elevated in a plane superficial to the fascia. The lateral row of perforators is encountered. If it is well developed, it is used as the supplying vasculature; otherwise the medial perforators are used. The dissection then continues to the deep inferior epigastric trunk through a fascial incision. The muscle is gently teased away from the pedicle, and then the flap is harvested via ligation and transection of the pedicle at its proximal origin point. The fascial incision is then closed followed by the abdominal wound. The internal

mammary vessels or the thoracodorsal vessels are then exposed and prepared, and the microvascular anastomosis is completed. The flap is then contoured and inset to create the new breast mound. The nipple and areolar reconstruction is completed in the following weeks in those who have not undergone nipple-sparing mastectomy.

### ***Superior gluteal artery perforator flap (SGAP)***

The patient is initially placed in the prone position, and the perimeter of the flap is defined with electrocautery. The superficial fascia of the gluteus maximus is incised, and perforators are identified in the subfascial plane. The dominant perforators are chosen and followed through the muscle and the deep gluteal fascia to reach the larger vessels in the subgluteal fat pad where they emerge from the sacral foramina. The superior GAP flap chosen is then ligated and transected. The flaps are harvested and passed off the field, and donor sites are closed. The patient is then returned to the supine position, and the flaps are contoured and deepithelialized followed by completion of the microvascular anastomosis to the internal mammary vessels. The flaps are then inset, and nipple-areolar complex reconstruction takes place in the following weeks along with recontouring of the donor site to produce a smooth and aesthetically proper gluteal shape.

### ***Nipple-areolar complex***

Typically, the nipple-areolar complex is created 3 to 4 months after the initial reconstruction. The complex may be recreated in a variety of manners with the most common being local skin flap rearrangement followed by tattooing.

### ***Complications***

Wound-related complications are composed of simple infections, seromas, hematomas, skin flap necrosis, and delayed healing of the donor or recipient site. Ischemic complications may occur, resulting in partial flap necrosis or fat necrosis, particularly with the pedicled TRAM flap. Complete flap failure is usually due to venous or arterial thrombus. Experienced teams have flap failure rates of less than 3%. Seromas are typically treated by simple aspiration. Neoadjuvant therapy and obesity may contribute to wound healing complications.<sup>22</sup> Donor site morbidity is greater in flaps in which the muscle is harvested with the flap.

## **SUMMARY**

Breast reconstruction is a very important part of the healing process for patients with breast cancer. The options are vast and should be decided in combination with the patient's surgeon. Patients generally have a high level of satisfaction with the option they choose, contributing to a feeling of overall recovery and physical and emotional wholeness.

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