16 Breast Reconstructive Surgery

Yash J. Avashia, Amir Tahernia, Detlev Erdmann, and Michael R. Zenn

16.1 Introduction

Breast reconstruction following mastectomy can be achieved by a variety of techniques using alloplastic implants, autogenous tissues, or both. The established paradigm for breast reconstruction is to rebuild an identical and possibly symmetrical breast mound after mastectomy. In the last 30 years, breast reconstruction has progressed from a rarely requested procedure to one that has become an integral part of patient management. The modern era of breast reconstruction began in 1963 with the introduction of the silicone gel prosthesis. In 1972, Radovon described the use of tissue expansion for breast reconstruction [1]. The early introduction of free tissue transfer by Daniel and Taylor in 1973 broadened the scope of autologous breast reconstruction [2]. This technique allowed patients with more significant skin deficits to benefit from reconstruction. In the early 1980s, the use of autologous tissue for breast reconstruction was revolutionized by Hartrampf with the introduction of the transverse rectus abdominis muscle (TRAM) flap [3]. Later advances in microsurgical free tissue transfer reopened the door to a new range of options for autologous breast reconstruction. The advent of perforator flaps has now further refined microsurgical techniques, Donor site morbidity is minimized by perforator flaps by not requiring the violation or harvesting of abdominal musculature. Case example: DIEP vs Free TRAM Flap. The perforator flap allows us to harvest the skin/subcutaneous tissues with the vascular pedicle dissected through the fascia and muscle. The abdominal wall integrity is preserved compared to the TRAM flap. Furthermore, we can increase the number of donor sites based on perforators since there are a larger number of perforators throughout the body. With these developments, patients have benefited from improvements in cosmetic outcome, operative recovery, operative morbidity, and the overall expected outcomes.

Experience over time has also shown breast reconstruction to be an oncologically safe component of the overall treatment plan. Perhaps most importantly, breast reconstruction yields psychological benefits for women, offering a sense of normalcy, a "return to wholeness," and a way to leave the cancer experience behind them. Women gain the freedom to wear a variety of clothing, without the need for external prosthesis, which may be cumbersome and embarrassing.

Historically, almost all breast reconstructions were delayed for months or years after mastectomy. It was feared that immediate breast reconstruction would compromise adjuvant treatments and that it would increase postoperative complications. There were concerns of masking locoregional recurrences and rendering treatment of such disease as difficult. Today, studies not only have shown no increased risk for complications or oncologic risk but also have shown a psychological benefit and cost-effectiveness. In the right clinical scenario, patients can undergo immediate breast reconstruction with a minimum compromise to their overall cancer management and a maximum benefit.

Breast reconstruction has become an integral part of the multidisciplinary approach to breast cancer. In order to optimize results, patient selection is critical. Factors that need consideration prior to embarking upon a reconstruction include stage of the cancer, patient comorbidities, possible adjuvant radiotherapy, availability of autologous tissue, and, most importantly, the patient's own desires [4]. A certain group of women with early disease have the option of breast conservation therapy (BCT) instead of undergoing mastectomy. Prior studies have demonstrated an equivalent survival when comparing BCT with radiation to mastectomy. While the ultimate decision remains with the patient, both the oncologic surgeon and plastic surgeon should have a chance to counsel the patient.

Y.J. Avashia (✉) · D. Erdmann · M.R. Zenn
Surgery, Duke University Medical Center, 40 Duke Medical Circle, Durham, 27710, NC, USA
e-mail: yja@duke.edu

A. Tahernia
Plastic and Reconstructive Surgery, 9735 Wilshire Blvd, Suite 421, Beverly Hills, 90212, CA, USA

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In this chapter, we will review the indications, timing, principles, and techniques of breast reconstruction following mastectomy. We will also review the role of radiation and chemotherapy in breast reconstruction and how it impacts surgical decision-making.

16.2 Indications for Reconstruction

Patients who are candidates for breast reconstruction are those who have undergone mastectomy for cancer extirpation. However, with advances in the understanding of the genetic basis of breast cancer and identification of BRCA1 and BRCA2 genes, more patients with familial history of breast cancer are undergoing prophylactic mastectomies. Therefore, breast reconstruction is not only limited to patients with a diagnosis of breast cancer. Regarding indications for prophylactic mastectomy, the Society of Surgical Oncology updated their statement in 2007 with the following guidelines (Fig. 16.1).

Patients with metastatic disease are not candidates for reconstruction, and in those who have significant medical comorbidities, mastectomy may be the only reasonable surgical intervention, as the stress of reconstructive surgery may be prohibitive. Furthermore, there is no advantage to immediate reconstruction in the setting of mastectomy for inflammatory breast cancer (IBC) due to the high risk of recurrence, aggressive nature of the disease, and need to proceed expeditiously to adjuvant radiotherapy.

16.3 Skin-Sparing Mastectomy

The technique of skin-sparing mastectomy has greatly improved the esthetic outcomes of autologous breast reconstruction. It is an oncologically safe procedure in patients with stage I and II cancers. It allows the mastectomy to be performed with preservation of most of the natural breast skin envelope and inframammary fold.

The skin-sparing mastectomy technique involves a peri-areolar incision with or without some type of lateral extension for exposure and removal of breast tissue (Fig. 16.2). With the goal to minimize separate scars on the breast mound (for aesthetic purposes), designing the mastectomy scar to incorporate prior scars on the breast mound is done. This is with the understanding that the mastectomy is taking place after a prior breast biopsy which is the normal scenario here in the US. Although more time-consuming than traditional cancer ablation methods, this technique permits maximal preservation of skin and provides excellent cosmetic results. Several studies have validated its oncologic safety, and no studies have shown any statistically increased risk of tumor recurrence or compromised local control of the disease following skin-sparing mastectomies [5].

The use of complete skin-sparing mastectomy successfully reduces scar burden and skin color discrepancies, allows for optimal preservation of the preoperative breast shape, and may minimize the need for a contralateral procedure to achieve breast symmetry. The success of this procedure is dependent upon proper patient selection and ability of the oncologic surgeon to safely perform extensive skin flap mobilization in a precise plane through limited exposure and adequately remove all breast parenchyma. Patients with previous radiation, cup size larger than C, or surgeons unfamiliar with the technique should not have skin-sparing mastectomy [6].

The reconstruction of lumpectomy defects remains controversial. These patients have often received irradiation, which complicates revisional surgery. In most cases, if cosmesis is unacceptable, patients require completion mastectomy and reconstruction from scratch, removing the problematic irradiated tissues.

Suggested Indications for Prophylactic Mastectomy by the Society of Surgical Oncology

Women with no prior history of breast cancer
- Atypical hyperplasia
- Family history of premenopausal bilateral breast cancer
- Dense breats associated with atypical hyperplasia or family history of premenopausal bilateral breast cancer or both

Women with unilateral breast cancer
- Diffuse microcalcifications
- Labular carcinoma in situ
- Large breast,difficult to evaluate
- History of lobular carcinoma in situ followed by unilateral breast cancer
- History of atypical hyperplasia,primary family history, age at diagnosis < 40 y

Fig. 16.1 Table indications for prophylactic mastectomy

16.4 Nipple-Sparing Mastectomy

Nipple-sparing mastectomy (NSM) preserves the entire skin envelope of the breast, including the nipple–areola complex (NAC). This often includes intraoperative pathological assessment of the nipple. While neoplasia of the nipple is most often from Paget's disease of the breast, nipple involvement may also occur with ductal carcinoma in situ (DCIS) or invasive breast cancer. With earlier detection of disease and less tumor burden and with the increased popularity of prophylactic mastectomy, NSM is becoming the gold standard in properly selected patients.

Indications for NSM include prophylactic mastectomy and NSM in the treatment of breast cancer [7]. Optimal

Fig. 16.2 Skin-sparing mastectomy incisions: varying incisions used in skin-sparing mastectomy. The incision is in part determined by the areas of previous biopsy. The goal is to minimize the area of scar on the skin envelope by incorporating biopsy incisions

candidates for NSM are those with tumors 4 cm in diameter or less, 2 cm away from the nipple, clinically negative axilla or sentinel node negative, no skin involvement, and no inflammatory breast cancer [8]. The final decision to spare the nipple in cases of active disease must await frozen and then definitive pathologic section. With the caveat of an accepted false-negative rate for frozen section, the permanent pathology results will later provide definitive information to dictate management.

A plastic surgeon should screen possible candidates for NSM to make certain that it is technically realistic. Patients with larger or more ptotic breasts will be more likely to encounter nipple and/or flap necrosis. In cases where the skin flaps would be too long, such as cup size larger than C cup or ptosis greater than grade 2 (inferior displacement of the nipple–areola complex below the IMF), the nipple should not be saved and a SSM approach should be used. Regarding technique, reports have suggested that the best incisions are lateral, radial, lateral mammary fold (LMF), and inframammary fold (IMF). The IMF incision provides the best cosmesis but may be difficult for some oncologic surgeons to reach the upper portion of the breast safely [9]. Reconstructive options remain the same in these patients, but may be technically more challenging due to smaller incisions limiting exposure.

16.5 Timing of Breast Reconstruction

While most patients are candidates for "delayed reconstruction" following the completion of their breast cancer treatment, many patients are eligible for "immediate reconstruction" during which they undergo breast reconstruction at the time of their mastectomy. Factors influencing this decision include the patient, disease, and treatment-related factors. In the past, combining a reconstructive procedure with the mastectomy presented several concerns with the possibility of increased complications and possible delays in postoperative delivery of adjuvant treatment. These concerns, however, have been shown to be unwarranted. In some cases, the reconstruction may be performed a few weeks after the mastectomy to allow pathologic examination of the specimen and surgical "delay" of ischemic skin flaps to strengthen them. This technique has been termed "staged-immediate" [10].

Immediate reconstruction is usually reserved for stage I and some stage II breast cancer patients [11]. Immediate reconstruction is more convenient for patients as it limits the number of exposures to anesthesia and has psychological benefits. With immediate reconstruction, esthetics is improved, since incisions tend to be shorter and there is less skin removal. Immediate reconstruction is not an alternative for the patient not psychologically prepared for a reconstructive procedure. Some patients are simply overwhelmed by their new diagnosis and cannot make decisions beyond cancer treatment.

Immediate reconstruction is contraindicated in a patient with skin ulceration or inflammatory breast cancer. Furthermore, if the patient is planned to receive postmastectomy radiation therapy (PMRT), immediate reconstruction with autologous tissue should be avoided due to the negative effects of radiation on the reconstruction. Radiation therapy to an implant or expander causes problematic sequelae of capsular contracture and may lead to breakdown of the incision site overtime with prosthesis exposure. As references, a common technique used to avoid increased insult to the mastectomy flap is to deflate the expander prior to radiation. This will release any pressure on the skin flap during radiation therapy. By leaving the expander in place, it still preserves the pocket for resuming expansions after radiation therapy [12].

Delayed reconstruction may be the only option in some patients for various reasons. Some may not have access to a reconstructive surgeon at the time of the mastectomy. Others may feel that they need to deal individually with each step of the cancer treatment protocol. This will allow them to weigh all their options with regard to type of reconstructive method and selection of a reconstructive surgeon. As mentioned previously, delayed reconstruction is recommended for patients with advanced disease who will require PMRT. Some of the problems radiotherapy may produce include fat necrosis, shrinkage of autogenous tissue flaps, thinning of overlying chest skin, and periprosthetic capsular contracture. These patients should be reassured that a delayed reconstruction is in their best long-term interest and that esthetic results can be equal to immediate reconstruction. Most delayed reconstructions can be initiated 4 months after the completion of chemotherapy and 6 months after radiation therapy [13].

16.6 Alloplastic Versus Autogenous Reconstruction

16.6.1 Alloplastic Reconstruction

Today, most mastectomy patients are candidates for tissue expander/implant reconstruction. In general, the best results are seen in patients with moderate breast size and minimal ptosis (inferior displacement of the nipple–areola complex). The best candidate for implant-based breast reconstruction is one who is not obese, with moderate-sized breasts, and with mild or no breast ptosis [14]. These patients may also be considering contralateral augmentation or mastopexy as part of their reconstruction.

Morbid obesity is considered a relative contraindication for breast reconstruction with tissue expanders and implants. In these patients, the breast “footprint” is wide and there will be significant volume below the projected surface of the chest wall making even the largest implant reconstruction suboptimal. The delivery of radiotherapy before breast reconstruction with prosthetic devices is also a relative contraindication as the skin will simply not stretch due to radiation changes. While occasionally successful, attempts to perform prosthetic reconstruction after PMRT result in an unacceptable rate of severe complications with implant extrusion, capsular contracture, or implant displacement [15].

All breast reconstructions require more than one operation, and the process may extend over many months. Alloplastic reconstruction with the use of tissue expanders/implants is the simplest technique and the one chosen by over 75 % of patients who undergo breast reconstruction. Potential advantages of expander/implant reconstruction over other techniques include the following: (1) relative simplicity of the surgical procedure, (2) the use of adjacent tissue of similar color, texture, and sensation, (3) elimination of distant donor site morbidity, (4) minimal incisional scarring, and (5) reduced operative time and postoperative recovery compared to tissue reconstruction. Many women may choose prosthetic breast reconstruction so that they may resume physical activities quicker or with little disruption. In addition, these patients will continue to remain candidates for autologous reconstruction in the event of prosthetic failure or personal preference.

While implant reconstruction yields the best results in patients with moderate breast volumes (500 g or less), reconstruction of the large breast can be accomplished. In patients with large or markedly ptotic breasts, matching surgery on the contralateral breast may be necessary in order to achieve symmetry. This would be accomplished with breast reshaping, either by a breast reduction or by a breast lift (mastopexy). In some cases, a “Wise pattern” mastectomy may allow for single-stage reconstructions with symmetrical inverted-T scars with the contralateral breast reduction.

Prosthetic reconstruction can be performed in many ways, but the most common include (1) single-stage reconstruction with the use of primary implants, (2) two-staged reconstruction with the use of initial tissue expanders followed by the exchange for permanent implants, and (3) implants combined with tissue procedures [16]. Before looking at each of these modalities, a brief review of the technique of implant placement will allow for a better understanding of the anatomic considerations which are essential to optimal outcomes. Breast implants or tissue expanders traditionally are placed in the submuscular position (Fig. 16.3). This is due to the fact that after a mastectomy, no gland remains and

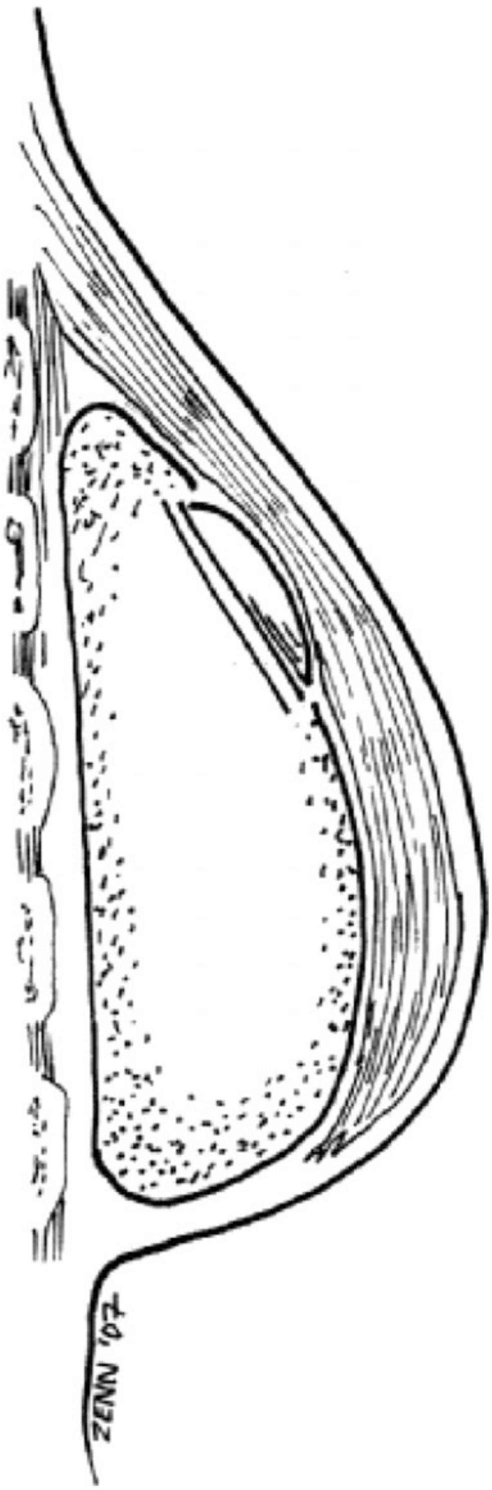

Fig. 16.3 Implant/expander placement: Tissue expanders can be placed in a subpectoral or submuscular position. This figure demonstrates a subpectoral prosthesis with most of the implant covered with pectoralis major muscle. In a true submuscular position, the rectus abdominis and serratus anterior muscles would be covering the inferomedial and inferolateral aspects of the prosthesis, respectively

so healthy vascularized soft tissue coverage is lacking. All implants induce a foreign body reaction and formation of a discrete fibrous shell or capsule. Under the influence of a variety of factors, this capsule may undergo the process of capsular contracture which can distort breast shape. Submuscular placement helps cover the implant with healthy tissue which hides capsular distortion and may help prevent it. Many variables can influence the development of capsular contracture and they include type of implant surface, implant placement, infection, and the use of radiation. We will revisit the issue of capsular contracture later in the Complications of Implant Reconstruction section. The key landmark for any breast reconstruction is the inframammary fold (IMF). Every effort is made to recreate a natural fold that matches the contralateral fold in position and symmetry. The critical measurement to consider when selecting an implant is the base diameter of the breast. Other factors to be considered are the height and projection of the breast. These factors are all accounted for preoperatively with the appropriate marks made on the patient's chest before the creation of the submuscular pocket. After the completion of the mastectomy, the viability of the mastectomy flaps is assessed. Poorly perfused tissue is excised, and if there is any doubt as to the adequacy of soft tissue coverage, the reconstruction should be delayed. If all looks well, an area under the pectoralis muscle is dissected forming a submuscular pocket for the implant. This dissection involves identification and elevation of the lateral border of the pectoralis major muscle and release of the muscles from its origin on the 5th rib. Dissection can sometimes be carried laterally, elevating the serratus anterior muscle. The location of the pocket will ultimately determine the level of the IMF.

16.6.2 Implant Types

The silicone gel-filled breast implant was first developed in 1963 for women with small breasts who desired augmentation. This was later applied to breast reconstruction to restore shape and contour in women following mastectomies. The implants that are currently available vary in shape, surface texture, size, and filler material. All implants, regardless of whether they are saline- or silicone gel-filled, have a silicone outer shell. The most commonly available shapes are round and anatomic or teardrop-shaped implants. Both shapes are commonly used and achieve excellent results. Choice is largely physician-driven. Placement and fixation of an anatomic implant is critical as it forms the entire mound and can be noticeable if mispositioned. Round implants are more forgiving as they can look the same even when rotated. This is not true with anatomic implants which need to stay in the position originally placed without rotation. Textured surface implants generally have more tissue ingrowth and tend to hold their position better. They have been shown to be less associated with capsular contracture, theoretically due to disorganized scarring around the implant that the textured surface induces. All shapes and textures are used regularly with excellent results. In 1992, the US Food and Drug Administration established a moratorium on the use of silicone gel-filled implants until 2005 in the USA. These implants were only available under the protocol for reconstructive purposes. The concern with the silicone implants was presumed to be in association with connective tissue disorders as well as metachronous development of breast cancer. Multiple retrospective studies over the past 20 years have shown this to be invalid, and as such, these implants were reapproved for use in the USA by the FDA in 2005.

Following the 1992 FDA moratorium on silicone gel implants, there was an expected surge in the use of saline-filled implants. An advantage with these implants is that a desired volume can be achieved with intraoperative instillation of saline into an empty implant. The advantages of saline implants include smaller scars for placement, customization of fill volume, and lack of silicone exposure if the implant ruptures. Several problems have been associated with saline implant use such as firmness, wrinkling of the implant, and complete deflation of the mound upon rupture. In comparison, newer silicone implants are softer, have a more natural appearance, and are filled with cohesive gel which maintains its shape upon outer shell failure [17].

16.6.3 Two-Stage Expander/Implant Reconstruction

Two-stage reconstruction using an initial expander followed by secondary permanent implant placement is the gold standard for implant reconstruction. It is especially desirable when there is insufficient tissue after mastectomy or when the desired size and shape of the breast cannot be safely and consistently achieved with a single-stage procedure [18]. The two-stage approach allows adjustments to the implant pocket at the time of the second procedure, allowing a more consistent reconstruction of the moderately sized breast with mild ptosis. Prosthetic reconstruction in patients with large breasts and significant ptosis requires a contralateral reduction or mastopexy to achieve symmetry, a symmetry that will only occur in clothes.

The procedure for expander placement creates a submuscular pocket of pectoralis and sometimes serratus muscles. Expander selection is based on the height and width of the desired breast. Most plastic surgeons favor textured expanders with integrated valves. They allow direct instillation of fluid through insensate mastectomy skin, which is not painful to the patient. Following skin closure, a magnet is used to identify the port and an initial volume of saline is instilled, from zero to 300 mL or more. Additional expansion continues postoperatively 2 weeks after expander placement. The patient is seen in clinic, and 50–100 cc is instilled every 2–3 weeks. Usually, this is carried out over a 2-month period until the desired amount of expansion has occurred. Most surgeons overexpand by 10 % as there is some retraction of the soft tissue once the expander is replaced with the permanent implant. If the patient is receiving chemotherapy, the exchange procedure is delayed up to 4 weeks after the completion of treatment to avoid issues with wound healing that may result. Following the completion of expansion, the exchange of the expander for a permanent implant involves reopening of the access incision, removal of the expander, adjustments of the pocket and IMF, and permanent implant placement (Fig. 16.4). Suction drains are placed, and patient is placed in support bra for 10–14 days to keep the implant properly oriented. If postoperative radiation therapy is planned, the expander is irradiated at final volume and exchange is delayed from 4 to 6 months, depending on radiation-induced edema and induration. Some radiation oncologists require deflation of the expander for optimal chest wall irradiation, and after the 5-week therapy, the expander is reinflated quickly over 2 weeks and then exchanged at 9 months.

16.6.4 Single-Stage Reconstruction with Implants

When nipple-sparing mastectomy is selected, immediate breast reconstruction may take place by replacing the excised mammary parenchyma with a similarly sized permanent implant. Depending on the nipple viability, either a final implant or tissue expander is placed. ICG laser angiography (SPY) can be useful in helping the surgeon evaluate viability [19]. For high-risk patients (i.e., previous surgery or radiation), delayed nipple-sparing mastectomies have been described that have shown to improve nipple vascularity at the time of the second-stage NSM.

With skin-sparing mastectomy of a small breast, placement of an implant can be done immediately. The goal is to maintain the breast envelope and fill it with volume. Since the skin after mastectomy is thin and relatively ischemic, healthy vascularized muscle is required to ensure implant longevity. In the one-stage approach, tissue expansion of the pectoralis does not occur and so effective muscle coverage must be obtained in another way. This is accomplished with either latissimus dorsi muscle transfer or an ADM sling (acellular dermal matrix). Currently, most surgeons will use ADM rather than sacrifice muscle. That said, at the time of mastectomy, the latissimus can be harvested via an open or endoscopic approach and rotated to the anterior chest where it drapes over the final breast implant. Immediate

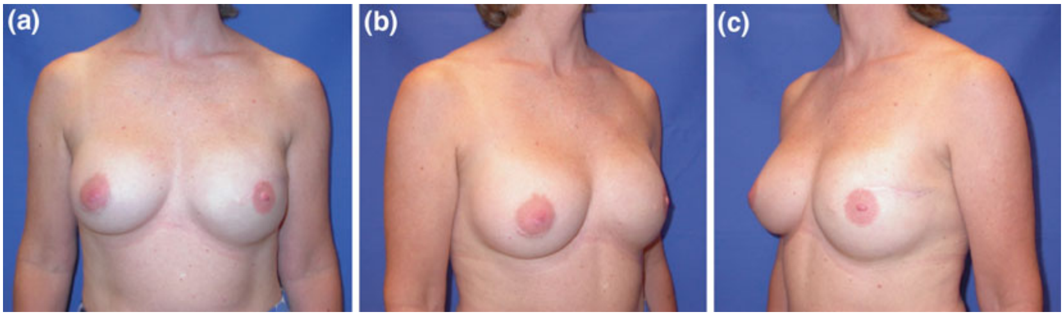

Fig. 16.4 Tissue expansion/exchange: This is a 45-year-old patient who underwent immediate placement of a tissue expander on the left, subsequent expansion, and exchange for an implant. At the implant exchange, she had a contralateral breast augmentation for better symmetry. These photographs represent her 9-month postoperative visit

single-stage reconstruction is best suited for patients with small, round breasts with a resection weight of about 300 g. The implant is traditionally placed in a subpectoral pocket. Newer techniques not involving muscle are currently being tried (see “pre-pectoral” below).

16.6.5 Permanent Tissue Expander/Implant Reconstruction

One-stage breast reconstruction with permanent expander implants was introduced in 1984 with expandable double-lumen silicone gel/saline-filled prosthesis. This technique is largely of historical interest only. The implant can be partially filled at the time of reconstruction and gradually inflated postoperatively over a 3–6-month period, until symmetry is achieved. The device is placed in a similar manner as previously described. The major drawback of breast reconstruction with anatomic expander implants is that it is hard to get the skin to expand in a breast shape. This is the advantage of having a second stage—better shape. Disadvantages of this approach include superficial infection and discomfort often associated with the port. In addition, a second procedure is needed to remove the port.

16.6.6 Prosthetic Reconstruction with Acellular Dermal Matrix

Achieving the total muscle coverage of the implant and natural ptosis is a key technical challenge. In the past decade, the use of acellular dermal matrices has been adopted to supplement the pectoralis major muscle at the lower and lateral aspects for implant coverage. The reported benefits of ADM compared to total muscle coverage techniques include improved lower pole expansion, increased intraoperative fill volume for tissue expanders, and reduced number of expansions. Throughout its use, concerns with the use of ADM have been raised. Despite variability in study design and sample size, numerous studies have sought to evaluate the observed incidence and complication profile (infection and seroma rate) of ADM-assisted techniques. Both direct-to-implant and two-stage ADM-assisted immediate breast reconstruction have been described and are commonly used today in practice. “Pre-pectoral ADM-assisted breast reconstruction” where no muscle is used and full coverage of the implant is achieved with ADM only is coming into vogue. The obvious advantages include no muscle dysfunction, less postoperative pain, and no “animation” deformities when the pectoralis muscles are flexed.

16.6.7 Complications of Implant Reconstruction

As would be expected with any foreign body, there are certain risks associated with the use of implants. Infection, extrusion, malposition, and capsular contracture are among the most common. The incidence of infection of breast implants is generally around 2 %, but studies have shown an increased risk in the setting of chemotherapy, radiation, and previous axillary node dissection [20]. As a result, the incidence implant infection in the setting of breast reconstruction is higher, with some studies reporting infection in up to 10 % of patients. Treatment of implant infection or extrusion requires removal of the implant followed by antibiotic therapy. A period of 4–6 months should pass before embarking on a secondary reconstruction. Extrusion of implants can be secondary to infection or poor soft tissue coverage. For this reason, many surgeons prefer “total muscle” coverage of the implant at the time of surgery. It is thought that covering the entire implant with muscle will still protect the implant in the setting of a skin dehiscence, which would otherwise potentially expose an implant that has less soft tissue coverage. Poor tissue coverage will sometimes necessitate tissue flap coverage.

All implants induce a foreign body reaction and formation of a discrete fibrous shell or "capsule." Deformity can occur when the capsule thickens and contracts, leaving the implant space smaller and creating visible ripples in the reconstruction. Many variables influence the occurrence of significant capsular contracture, such as implant type, textured surface, filler substance, submuscular placement, and subclinical infection. Capsular contracture is classified based on severity. The Baker classification categorizes this as follows:

Grade 1: The breast is soft and natural appearing.
Grade 2: The breast is less soft with palpable distortion but still appears natural.
Grade 3: The breast is firm with visible distortion.
Grade 4: The breast is firm, painful, and visibly distorted.

Using this classification as a guide and evaluating each patient individually, severe cases of contracture (grades 3 and 4) may require surgery for removal of the capsule and replacement of the prosthesis (Fig. 16.5). Factors that have been shown to reduce the incidence of this complication include submuscular placement of the implant and use of a textured surface implant.

A less common but worrisome complication of implant use is anaplastic large cell lymphoma (ALCL). In January 2011, the FDA announced a safety communication, pointing out a possible association between breast implants and ALCL [21]. Breast implant ALCL (BI-ALCL) is distinct from primary breast lymphoma, which is a disease of the breast parenchyma and predominantly B cell in origin. BI-ALCL is a T cell lymphoma arising from an effusion or scar capsule surrounding the breast implant. Since the first report of BI-ALCL in 1997, greater than 90 cases have been published. Knowledge about BI-ALCL has evolved over the past 2 decades with a better understanding and recognition of this disease process. Patients with concerning findings should have tissue and fluid specimens sent for pathology review. Operative management includes removal of the implant and entire capsule with lymph node dissection. Adjunctive treatment modalities have been described and are now under further investigation. These include chemotherapy, radiation therapy, immunotherapy, and stem cell transplantation.

Fig. 16.5 Capsular contracture: This is a 57-year-old patient 5 years after right implant reconstruction and left implant reconstruction with a latissimus flap due to radiation. Note the distorted shapes of the breasts and thinning skin envelope

16.7 Autogenous Reconstruction

Advances in breast reconstruction during the past 30 years offer women the option of undergoing breast reconstruction with their own tissue and without the need for breast implants or expanders. The first application of autogenous transfer for breast reconstruction occurred in 1977 with the use of the latissimus dorsi muscle flap [22]. Myocutaneous flaps permit the movement of additional skin, underlying fat, and muscle for reconstruction of the breast. The most common donor sites for autogenous tissue are the lower abdomen, back, thighs, and gluteal regions. These areas are considered to have tissue excess and can be contoured to produce a more esthetic appearance. Flap reconstructions are particularly useful when there is a significant skin deficiency following mastectomy. With immediate breast reconstruction, the use of a flap can permit the creation of a breast that is relatively symmetrical with the contralateral breast with similar tissue characteristics.

The transfer of myocutaneous flaps is possible due to the blood supply to the overlying skin and subcutaneous tissue from the underlying muscle via musculocutaneous perforators. The transfer of myocutaneous flaps can be accomplished as pedicled flaps or free flaps. Pedicled flaps refer to tissue blocks that are transferred from the lower abdomen or back to the mastectomy site following elevation of the myocutaneous unit from its bed. The pedicle, consisting of an artery and a vein(s), may be skeletonized, but is left intact and serves as the axis of rotation of the flap. Free tissue transfer relies on the technique of microsurgery and in breast reconstruction applies to the transfer of tissue from remote regions of the body to the chest wall. This involves elevating the tissue needed, identifying its major vascular pedicle and dividing it. This is followed by the relocation of the tissue to the chest along with microvascular anastomosis of the donor vessels to the recipient vessels. In breast reconstruction, the most common recipient vessels are the internal mammary vessels and the thoracodorsal vessels.

Autogenous reconstruction can be performed in both the immediate and delayed settings. Today, when patients are felt to be at very high risk for radiotherapy, autogenous reconstruction is performed in a delayed fashion. Immediate reconstruction should occur when the risk of postoperative radiation is low, such as when sentinel node sampling reveals no evidence of lymph node metastasis or tumor size is small. Overall, autogenous breast reconstruction yields the most durable and natural appearing results with the greatest applicability. It has several advantages over implant reconstruction:

1. A large volume of the patient's tissue is available.
2. Prosthesis is not required, obviating problems such as implant infection, prosthesis, contracture, and extrusion.
3. It offers versatility in shaping the new breast with the creation of natural ptosis and fill of the infraclavicular hollow and anterior axillary fold.
4. It can withstand postoperative radiotherapy much better than implant reconstruction.
5. The excellent vascularity of the tissues allows for improved wound healing, especially in an irradiated chest wall.

The autogenous tissues available in decreasing order of frequency of use are the abdomen (pedicled TRAM flap, free TRAM flap, DIEP, SIEA), latissimus dorsi flap, superior and inferior gluteal flaps, upper thigh flaps (TUG, PAP), lateral transverse thigh flap, and deep circumflex iliac artery (DCIA) flap. Each of these flaps can be raised as a myocutaneous flap or a perforator flap, which spares the accompanying muscle and only lives off the perforating blood vessels in the flap. These flaps require microsurgical expertise. We will review these flaps and adjunctive methods available for optimal reconstructive outcomes.

16.7.1 Pedicled TRAM Flap/Unipedicled Flap

The pedicled TRAM flap was first described in 1982 by Hartrampf. Since then, the procedure has gained popularity and it remains the most commonly performed method of autologous breast reconstruction [23]. A lower abdominal transverse skin island is designed overlying the rectus abdominis muscles. This is the same tissue removed during an abdominoplasty, hence its appeal. The overlying skin and subcutaneous tissue receive their blood supply from perforating vessels from the underlying rectus muscle.

The rectus abdominis muscle receives a dual blood supply from the superior and inferior epigastric vessels. The pedicled flap is based on the superior epigastric vessels due to a better point of rotation to reach the chest. The vessels are the continuation of the internal mammary vessels and are distant from the lower abdomen. This means the degree of perfusion of the overlying skin and fat is limited and care must be exercised in deciding how much tissue to carry. It does not require microsurgical skills and is therefore more applicable to most plastic surgeons. The muscle with its overlying adipose tissue and skin is simply tunneled through the upper abdomen to the chest wall into the contralateral or ipsilateral mastectomy defect (Fig. 16.6).

The concept of perfusion becomes relevant when looking at flap survival and partial flap loss called "fat necrosis." Fat necrosis manifests as a subcutaneous or deep firmness, which often compromises the esthetic outcomes of the reconstruction. In addition, it causes anxiety in patients and surgeons in view of its differential diagnosis as a cancer recurrence. A simple way of thinking about this is that the risk of fat necrosis increases as the distance from the muscle perforators increases. The concept of angiosomes was first introduced by Taylor over 30 years ago [24]. An angiosome represents a three-dimensional tissue unit supplied by a source artery. Each source artery directly supplies perforators to the muscle and skin of a discrete area called the primary angiosome. A neighboring area may still be supplied by this source artery through secondary, less reliable "choke vessels," and these areas are secondary angiosomes. The primary blood supply territory of the superior epigastric artery is the upper abdomen. The lower abdomen is supplied in a pedicled TRAM flap by connections between the superior epigastric system (secondary) and the inferior

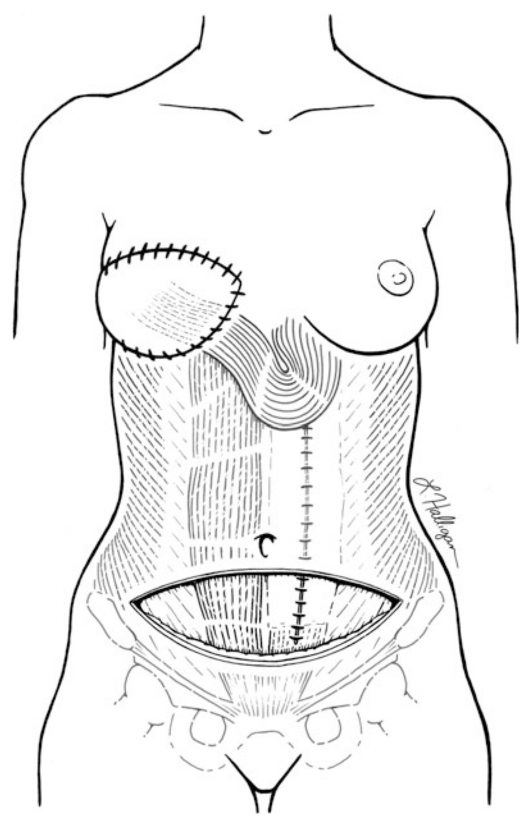

Fig. 16.6 Unipedicled TRAM flap: This picture demonstrates the unipedicled TRAM flap. This flap has been transposed to the contralateral chest. The pedicled TRAM flap can also be transferred onto the ipsilateral chest (Duke University Department of Surgery)

epigastric system (primary to the lower abdomen) (Fig. 16.7). Intuitively, the best supplied tissues are present over the rectus muscles in direct continuity with the muscular perforators. This is referred to as Zone 1 of the TRAM flap (Fig. 16.8). As shown in the figure, there are a total of 4 zones of a TRAM flap. Zone 2 represents the area medial to the elevated rectus across the midline, and Zone 3 represents the area lateral to elevated rectus. Zone 4 is the furthest from the elevated rectus, representing the area with the most tenuous blood supply present in the TRAM flap. The risk of fat necrosis is higher in patients with the history of COPD, diabetes mellitus, hypertension, obesity, and smoking history. In these patients, the pedicled TRAM may not be the best choice for reconstruction. Free TRAM transfer, bipedicled TRAM, and pedicled TRAM after delay may be more appropriate in these settings.

Following harvest and transposition of the flap to the mastectomy defect, the TRAM flap is inset or positioned in place. Attention is turned to recreating a symmetrical breast, with IMF at the same level and breast volume and projections also being similar. Often the volume of TRAM is in excess of what is needed, and in this setting, the zones furthest from the pedicle, demonstrating the poorest perfusion, can be partially resected down to the volume desired.

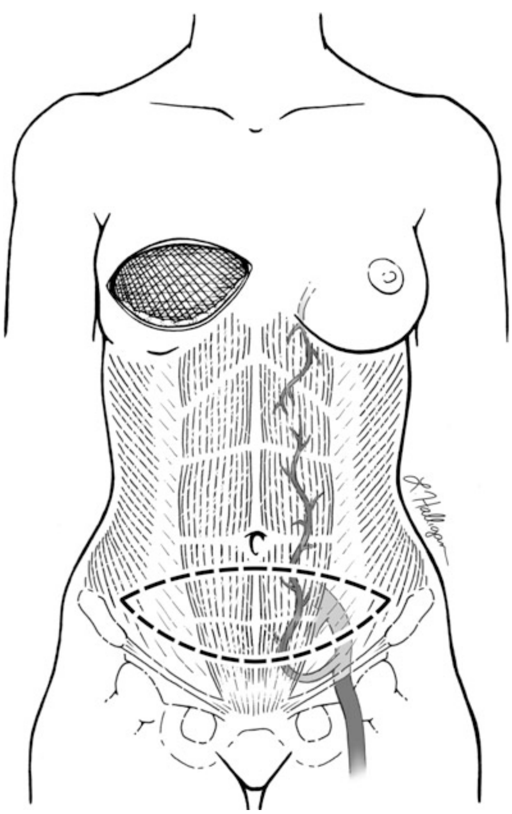

Fig. 16.7 Unipedicled TRAM flap: This picture demonstrates the vascular supply (superior epigastric artery) that runs superficial to the rectus fascia (Duke University Department of Surgery)

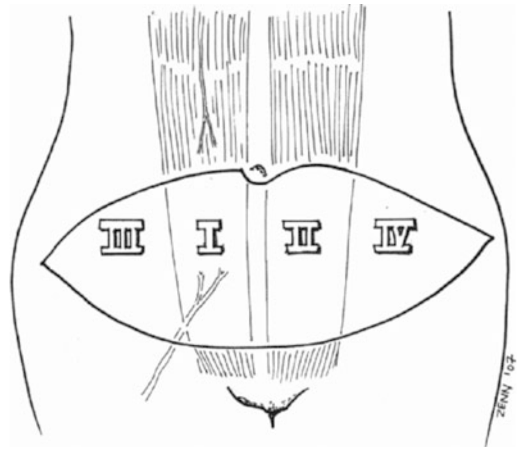

Fig. 16.8 TRAM vascular zones: The lower abdominal tissue that is transferred in a TRAM flap is divided into 4 zones based on the degree of perfusion. Zone 1 has the best perfusion as it is the area directly over the deep inferior epigastric artery. Zone 2 is the area directly medial and has the second best perfusion. Zone 3 is the area lateral to Zone 1 with a less robust blood supply than Zone 2. Zone 4 is the area farthest from the pedicle and thus has the most tenuous blood supply. Because of its relatively poor perfusion, Zone 4 is the first area discarded in flap transfer if debulking of the tissue block is necessary prior to inset

The skin of the flap can also be de-epithelialized to leave behind enough epidermis to only bridge the mastectomy skin defect.

The donor site also needs careful attention to avoid hernias and bulges. With the rectus muscle harvested on one side, the chance of hernia is about 5 %. For this reason, mesh reconstruction of the muscle defect should be considered when primary closure is not possible or is tenuous. Despite these adjunctive procedures, up to 30 % of patients still experience a bulge or hernia in the lower abdomen with full muscle harvest. The clinical significance of this is debated.

16.7.2 Bipedicled TRAM Flap

The use of the two rectus muscle pedicles increases the blood flow to the overlying skin and fat, thereby increasing the reliability and size of the flap. However, indications are limited because of the morbidity associated with abdominal wall damage from the loss of both rectus muscles. It is used primarily to augment circulation in obese patients, smokers, and diabetes. It is also used in patients with limited abdominal tissue; hence, all zones are required for reconstruction and in patients who are unwilling to undergo reduction of the contralateral breast. It has been shown that patients who undergo unipedicled reconstruction have a 40 % decrease in abdominal muscle strength compared to a 64 % decrease in bipedicled flaps. With previous abdominal midline scars, some surgeons have reported acceptable results in these patients using the bipedicled TRAM. In larger centers, free flap reconstruction has largely supplanted the use of the bipedicled TRAM.

16.7.3 Midabdominal TRAM Flap

In the morbidly obese patients who would be considered high risk for the standard lower abdominal TRAM flap, the midabdominal TRAM represents an acceptable alternative. In this variant, the horizontal location of the abdominal ellipse is moved upward toward the midabdomen in order to increase the blood flow to the overlying skin and fat. The supplying superior epigastric vessels are not so distant, and perfusion of the tissue, now a primary angiosome, is improved. It is ironic that the obese patient with a significant abdominal pannus is a poor candidate for a standard TRAM. This is because the tissues, though significant, are poorly vascularized and edematous. The use of the ample mid- or upper abdomen avoids the use of these poorer tissues in the reconstruction, avoiding complications. Abdominal closure is facilitated by the large pannus. The main disadvantage, the highly visible scar in the mid- or upper abdominal area, is less of a concern for the morbidly obese patients, who benefit somewhat from the reduction of abdominal redundancy.

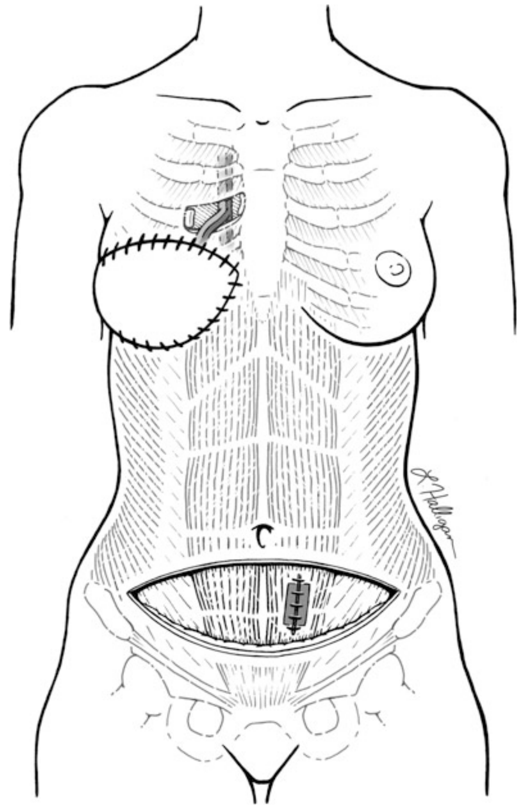

Fig. 16.9 Free TRAM flap: This figure demonstrates a muscle-sparing free TRAM flap where only a small portion of the rectus muscle and fascia surrounding the deep inferior epigastric pedicle is included. The pedicle can be co-apted to either the thoracodorsal or internal mammary system. Here, the anastomosis is to the internal mammary vessels that is often exposed by removing a portion of the 3rd rib cartilage (Duke University Department of Surgery)

16.7.4 Free TRAM Flaps

The free TRAM flap utilizes the primary blood supply of the lower abdomen, the deep inferior epigastric vessels. It thus has better vascularity and less risk of ischemia in the peripheral zones (abdominal zones 2, 3, and 4). Because of this improved tissue perfusion, there is a lower incidence of fat necrosis when compared to the pedicled TRAM flap. Additionally, this flap reliably carries a larger amount of skin and adipose tissue than the pedicled TRAM. Since it is not possible to pedicle a flap based on the inferior epigastrics to the chest, these vessels must be divided and microscopically reconnected.

These vessels are connected with either the thoracodorsal or the internal mammary vessels (Fig. 16.9). In immediate breast reconstruction, the thoracodorsal vessels are usually targeted since they are usually fully exposed by the oncologic surgeon during axillary node dissection. In the delayed setting, the internal mammary vessels are more often chosen for the microvascular anastomosis. This recipient site has the advantage of being free of previous scarring around vessels, being centrally located facilitating microsurgery, and allowing a more medial positioning of the flap.

Studies from numerous cancer centers show distinct advantages of the free TRAM over its pedicled counterpart. There is a less than 10 % chance of fat necrosis with free flap reconstruction compared to 30 % with the pedicled TRAM [25]. As in the pedicled TRAM, the free TRAM flap is also associated with abdominal wall bulges and hernias, but less so. One study quoted the incidence of hernia to be 12 % in the pedicled TRAM and 3–6 % in the free TRAM flap [26]. The free TRAM also avoids the bulge in the epigastrium and the disruption of the IMF that is required by the tunneling of the pedicled flap from the lower abdomen. Free flaps do not require tunnel formation, and a sharply demarcated IMF is possible during the first operation.

For the free TRAM flap, muscle-sparing variations have been described. In the muscle-sparing TRAM variant (Fig. 16.10), only the central portion of muscle surrounding the deep inferior epigastric pedicle is taken with the flap leading to less disruption of the rectus fibers as compared to the conventional free TRAM, where the complete transverse width of the muscle is removed. Comparing the degrees of muscle spared, the rate of fat necrosis gradually increases from complete transection of the rectus muscle in a free

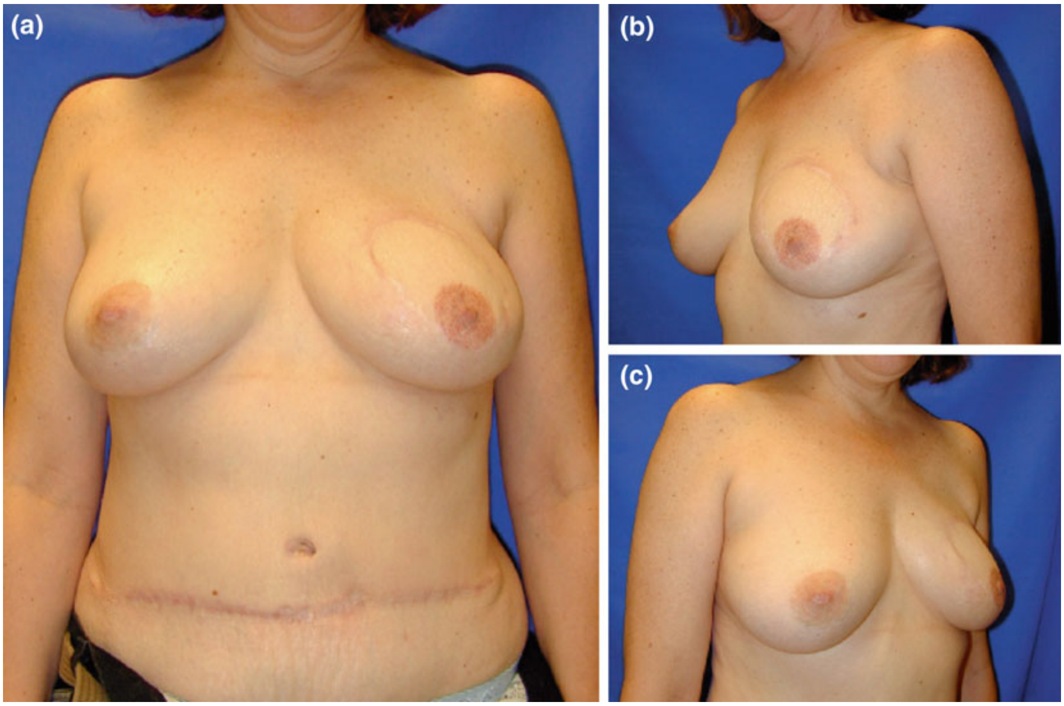

Fig. 16.10 Pedicled TRAM: This is a 43-year-old patient who underwent immediate breast reconstruction with a pedicled TRAM. These are 1-year postoperative photographs. The areola was reconstructed with tattoos and the nipple by nipple sharing from the contralateral nipple

TRAM to a perforator-based abdominal flap which theoretically spares the entire muscle. This is related to the number of perforators used with each technique. Muscle sparing uses all perforators present, while a perforator flap isolates just a few. In the muscle-sparing TRAM, muscle continuity is maintained as is a significant portion of the muscle innervation, so the rates of hernia and bulge are less. In contradistinction, pedicled flap reconstruction mandates elevation of the entire rectus muscle leaving behind a large area of the lower abdomen often requiring mesh reinforcement. Although sacrificing the rectus muscle will not leave a patient completely disabled, patients may notice a considerable difference in flexion strength and abdominal contour when the rectus muscles are sacrificed. Objective measures of abdominal wall strength after pedicled or free TRAM reconstruction have consistently shown a deficit in strength which may persist long term. Several comparative studies have not shown a significant difference in long-term abdominal wall function between these two techniques.

16.7.5 Abdominal Perforator Flaps

Perforator flaps represent the newest generation of free flap reconstruction. The concept of a perforator flap emphasizes the blood vessels, not the muscles. The skin island and accompanying fat are isolated on perforating vessels that come through muscle from the source artery, leaving intact innervated muscle. In breast reconstruction, the dominant perforator flap used is the deep inferior epigastric perforator (DIEP) flap. The superficial inferior epigastric artery (SIEA) perforator flap has also been used; however, it is less available due to the anatomic variability seen in patients [27].

The DIEP flap preserves the whole rectus muscle and its sheath (Fig. 16.11). It can be based on a single large perforator or as many as 4 or 5 perforators (Fig. 16.12). When skeletonizing the perforators, the rectus sheath above and below the perforator is incised for a short distance to identify the vessel connection with the deep inferior epigastric system. The advantages of the DIEP flap include avoidance of muscle sacrifice and decreased abdominal wall morbidity, decreased postoperative pain, and decreased hospital stay. It usually also avoids the problems of a tight fascial closure and can preclude the need for synthetic mesh. Although the DIEP, based on a few perforators, has less perfusion than a free TRAM flap which is based on all perforators, the incidence of fat necrosis is similar and perfusion is still superior to a pedicled TRAM. One of the disadvantages of the DIEP flap is the technically more challenging dissection.

The free SIEA flap provides the same abdominal skin and fat for reconstruction as the DIEP flap. The SIEA flap is not a true "perforator" flap as the vessel is a primary branch of the femoral system [28]. Of the two flaps, the SIEA causes less donor site morbidity. Since the superficial epigastric vessels are superficial to rectus fascia, no incision must be

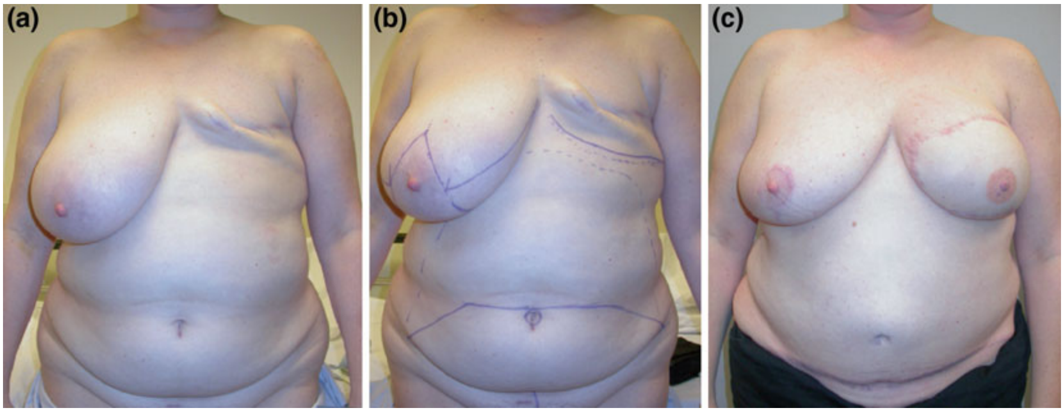

Fig. 16.11 Breast reduction with free TRAM: This is a 40-year-old patient who underwent delayed reconstruction. (**a**, **b**) Preoperative defect and markings. Her right breast was too large to match, so she had a reduction *on the right* and a muscle-sparing free TRAM flap *on the left* (**c**, **d**). These photographs are at 1-year follow-up

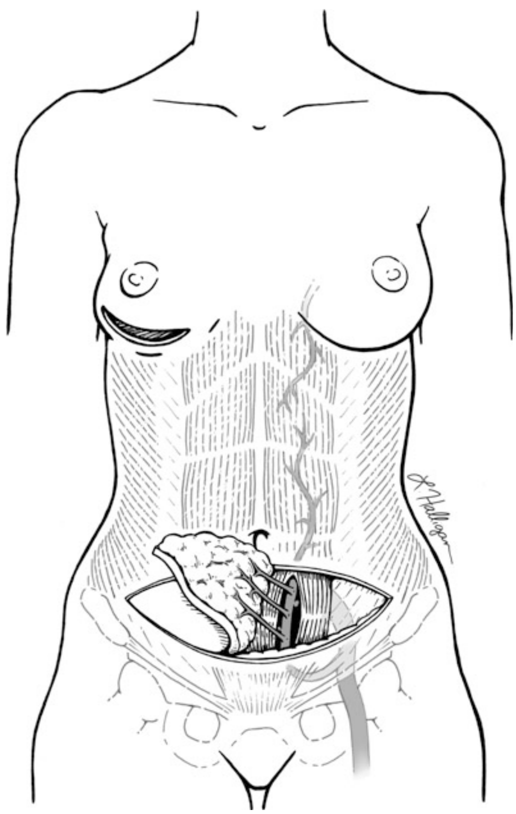

Fig. 16.12 DIEP flap: This figure demonstrates the split rectus abdominis muscle from which emanates the deep inferior epigastric artery perforator supplying vasculature to the abdominal adipocutaneous flap. The recipient site in this figure is the left breast as demonstrated by a nipple-sparing mastectomy incision (Duke University Department of Surgery)

made in the abdominal fascia and no vessel dissection is performed through the rectus abdominis muscle. The flap, however, is limited by the variability in its vascular anatomy. The SIEA and vein are only inconsistently present in sufficient caliber to reliably support sufficient tissue for breast reconstruction. Disadvantages of the SIEA flap are a smaller pedicle diameter and shorter pedicle length than TRAM or DIEP flaps. The SIEA pedicle can be a valuable source of blood supply when the proposed flap requires a bipedicle approach (blood supply from both sides of the abdomen for a single flap). When performed successfully, esthetic results of SIEA flap breast reconstruction are indistinguishable from a TRAM or DIEP flap [29].

16.7.6 Latissimus Dorsi Musculocutaneous Flap

As previously alluded to, the latissimus dorsi muscle can be used for autogenous breast reconstruction. It is often combined with implant reconstruction in patients with moderate-sized breasts, and in those with smaller breasts, it can be used alone. With this operation, skin and muscle from the back are transferred to the mastectomy defect. It is safe with a reliable blood supply. The blood supply to the pedicled latissimus flap is the thoracodorsal vessels. In the event that these vessels are injured during surgery, the latissimus can still be raised based on the serratus branch of the thoracodorsal vessel. In this situation, retrograde flow from the intercostal system through the serratus branch maintains tissue perfusion.

The indications for use of the latissimus dorsi muscle in breast reconstruction include (1) primary reconstruction with or without implant/tissue expander; (2) patients with inadequate abdominal tissue, or patients who are unwilling to have an abdominal scar; (3) secondary reconstruction with implant after radiation therapy; and (4) as a salvage procedure for implant or tissue reconstruction when failure of reconstruction has occurred.

The skin paddle on the back over the muscle is quite healthy and is well perfused when placed directly over the latissimus muscle (primary angiosome). A patient who has undergone a skin-sparing mastectomy may require mainly muscle and only a small circle of skin to replace the nipple–areola complex. The latissimus muscle flap is usually used in combination with implant/expanders to achieve a desired breast volume to match the contralateral breast. In some patients who need added volume but do not want implants, the extended latissimus dorsi flap can be used. With this method, a more aggressive fat and skin harvest increases the bulk of flap and forms a larger breast. Disadvantages of this technique include the high incidence of seroma at the donor site and a large scar deformity on the back.

16.7.7 Gluteal Musculocutaneous and Perforator Flaps

Gluteal tissues are a distant second or third choice for total autogenous breast reconstruction. They are a distant choice due to the popularity of the abdominal tissue donor site and the difficulty of the gluteal vessel dissection. The gluteus maximus myocutaneous free flap was first described in 1983. Muscle is no longer harvested with these flaps as they are raised as perforator flaps. The superior gluteal free flap is based on the superior gluteal vessels (S-GAPs), and the inferior gluteal flap is based on the inferior gluteal vessels (I-GAPs) [30]. This has the added benefit of a longer vascular pedicle for ease of flap inset and microanastomosis. For any flap, the width of the skin island may be up to 13 cm and allow a primary donor closure, while the length varies from 10 to 30 cm. While there is ample adipose tissue to allow for reconstruction in the gluteal region, gluteal fat is more fibrous than abdominal wall fat. This can make shaping of the tissue more difficult during insetting of the flap and limit the final appearance of the reconstruction. Important anatomic differences exist between the superior and inferior gluteal flaps (Fig. 16.13). The superior gluteal artery is shorter and must be connected to the internal mammary system for the tissues to be placed properly on the chest. The inferior gluteal artery is longer and can reach the thoracodorsal vessels if needed. Dissection of the inferior gluteal artery can put the inferior gluteal and posterior femoral cutaneous nerves at risk, not an issue with the superior gluteal artery dissection. While harvest of the gluteal tissue can leave a deformity of the buttock, the superior flap mimics more a buttock "lift" and is better tolerated. Ultimately, the choice of superior versus inferior will depend on the distribution of the gluteal fat. For both gluteal flaps, dissection of the pedicles is more tedious when compared to the dissection of vessels in a free TRAM flap and often requires position changes for harvest and/or inset.

Newer perforator flaps are beginning to become more popular as our understanding of the anatomy improves and more surgeons become comfortable with microsurgery. These flaps (i.e., profunda artery perforator or PAP) and new flaps yet discovered will have in common the harvest of excess tissues in another part of the body based on perforating blood vessels for use in building a breast mound with minimal donor site morbidity [31].

16.8 Secondary Breast Reconstruction

16.8.1 Nipple–Areola Reconstruction

Creating a nipple–areola complex is an integral part of the breast reconstruction. It enhances the final cosmetic result and creates a more natural-looking reconstructed breast. It is typically performed 3 months after the mound reconstruction. It is delayed in the setting of a reconstruction that is to be radiated. It is the last step in the process of postmastectomy surgical rehabilitation [32].

The nipple can be reconstructed with local tissue of the reconstructed breast or as a nipple graft from the contralateral breast. When utilizing local tissue, flaps can be designed to wrap skin and fat into conical shapes to recreate a projecting nipple. Examples of such flaps include the skate, C-V, bell, and tab flaps, among others. All local flaps suffer from shrinkage during the healing phase and may not match the contralateral nipple [33]. Large nipples can best be matched with "nipple sharing" when the contralateral nipple is bisected, half used as a free nipple graft for reconstruction.

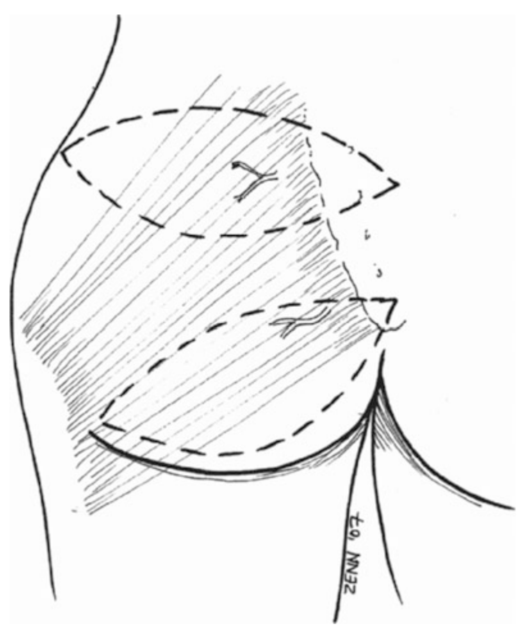

Fig. 16.13 Gluteal artery flaps: This figure demonstrates the zones of the superior and inferior gluteal artery flaps. These flaps can be harvested as musculocutaneous or perforator flaps

This reduces the large nipple and creates an opposite twin from like tissue.

The areola is reconstructed so that it is symmetrical and similar in color and diameter to the areola of the opposite breast. Methods used for reconstruction include skin grafts, areolar sharing from the other breast, and tattooing. Tattooing is the most common method as it is simple and avoids the need for a skin graft. If skin grafting is performed, further intradermal tattooing may be required to achieve symmetry to the opposite nipple–areola complex.

16.8.2 Autologous Fat Grafting

In pursuit of improving reconstructive shape, contour, and symmetry of the breast, autologous fat grafting has been adopted as the most common secondary reconstructive procedure performed for revision over the course of the past decade. This growth in popularity stems from it, being a reliable technique with low morbidity and improved esthetic results. Indications for fat grafting in breast reconstruction as a secondary procedure are expanding but involve improving contour, shape, and volume [34]. The harvesting and injection technique includes low-pressure syringe liposuction with small aliquot injections at the necessary sites. Implant-based reconstructions can benefit from upper pole injection to aid the transition from implant to upper chest wall and for implant rippling often associated with implants. In addition, abdomen-based flaps may benefit from contour irregularities and volume deficiencies. As with all autologous fat grafting, there is a certain amount of resorption that is encountered. Reported volume loss has been between 40 and 60 % within the first 4 to 6 months. Due to its low morbidity, fat grafting may be repeated as necessary to maximally improve final results.

16.8.3 Contralateral Breast

While breast reconstruction can nicely replace a breast lost to mastectomy, it rarely produces a breast that is symmetrical with the unaffected contralateral breast. As a result, the patient with a unilateral reconstruction may require alteration of the opposite breast to achieve symmetry. The options available for the contralateral breast include mastopexy, breast reduction, implant augmentation, and prophylactic mastectomy with reconstruction [35].

Mastopexy, or a breast lift procedure, is performed to correct a ptotic breast. The procedure involves lifting of the nipple–areola complex and reshaping of the breast cone to match the reconstructed breast in size and position. Breast reduction can effect similar changes but also reduces the volume of the contralateral breast (Fig. 16.10). In patients who have a reconstructed breast that is larger than their native breast and the patient prefers this size, augmentation mammoplasty of the opposite breast can be performed. Lastly, patients who request contralateral mastectomy must understand that a reconstruction can achieve a reasonable breast form but is not an equal substitute for a natural breast.

16.9 Radiation and Breast Reconstruction

Irradiation is known to cause permanent damage to cells involved in wound healing and as such can negatively impact healing of a flap or graft. Following the milestone publications in 1997 in the *New England Journal of Medicine* of randomized clinical trials performed in Denmark and British Columbia which demonstrated a survival benefit in patients with postmastectomy radiation (PMRT), the use of radiotherapy in the appropriate setting has become standard of care. Current indications for PMRT include (1) tumors with positive margins, (2) tumors that are T3 or greater (>5 cm), and (3) the presence of 4 or more positive axillary nodes. Although the role of PMRT in breast cancer patients has been well defined, its reported effects on breast reconstruction are variable. Radiation therapy subjects the skin surface to progressive change through a chronic inflammatory process. Early effects occur within 90 days and include skin dryness, epilation, pigmentation changes, and erythema. Late effects manifest with a progressive induration and thinning of the skin, fibrosis, and edema. Microscopic examination of radiated tissues demonstrate signs of vascular obliteration and chronic ischemia. A number of studies have looked at the long-term outcomes of radiation therapy on both implant and autologous reconstruction.

A review by Spear et al. of 40 patients who underwent implant reconstruction followed by PMRT showed that over 45 % of patients required revisional surgery with either implant replacement or autogenous tissue as compared to 10 % in patients who did not receive radiation [16]. They showed a 33 % rate of capsular contracture in the irradiated group compared to 0 % in the control group. Cosmetic outcomes are also considered inferior in the irradiated reconstructed breast. The risk of implant exposure and infection is higher following PMRT. Autogenous reconstruction is also negatively impacted by irradiation. A study by MD Anderson compared irradiation of immediate TRAM flaps to irradiation of delayed TRAM flaps. The study demonstrated a similar incidence of early complications. These included vessel thrombosis, partial flap loss, and mastectomy flap necrosis. However, the immediate TRAM flap group had a higher incidence of late complications (fat necrosis, volume loss, and contracture) with 28 % of patients requiring revisional surgery. Recent studies of postmastectomy irradiation of free TRAM and DIEP flaps showed a higher rate of fat necrosis with DIEP flaps, possibly reflecting their relative vascularity [36]. With PMRT in the setting of implant reconstruction, another consideration is the delivery of the radiation. The implant/expander can cause technical problems with the design of the radiation fields, particularly as it pertains to the internal mammary nodes. Therefore, the presence of an implant may result in the exclusion of the internal mammary chain with increasing doses delivered to the lung and heart.

Due to the high incidence of complications, most reconstructive surgeons will not pursue implant reconstruction in the patient who will need radiation. Most will perform a delayed reconstruction after completion of radiation. It is, however, often difficult to predict preoperatively who will be a candidate for immediate breast reconstruction and who will need radiation. In patients who are undergoing prophylactic mastectomies, immediate reconstruction can be pursued. In breast cancer patients, if the tumor is greater than 5 cm, then the patient will need PMRT and immediate reconstruction should be avoided. In patients without clear indications for PMRT, the ultimate need for radiation is unknown. In this situation, when immediate reconstruction is required, a separate sentinel lymph node sampling procedure can be performed. If the sentinel lymph node is negative, most reconstructive surgeons will pursue immediate reconstruction, assuming that it is the wish of the patient. As described previously, patients with plans for PMRT with sufficient skin envelope after skin-sparing mastectomy may have the option for immediate reconstruction using a tissue expander, with the understanding that this expander may need to be deflated prior to radiation.

As indications for postmastectomy radiation and other treatment modalities continue to change, the approach to breast reconstruction needs to adapt to maintain an appropriate balance between minimizing the risk of recurrence and providing the most durable and best esthetic reconstructive outcome. Delayed reconstruction is typically performed 6 months after the cessation of PMRT to allow full healing of the chest to limit healing difficulties [37].

16.10 Chemotherapy

As part of the postmastectomy regimen, patients with breast cancer may need chemotherapy. It is well known that certain chemotherapeutic agents can hinder wound healing and this can impact the breast reconstruction in the immediate postoperative period. Once the wound is healed (typically 3–4 weeks), chemotherapy can be initiated. In the long term, the effect of chemotherapy on breast reconstruction is negligible, and a history of previous chemotherapy has virtually no adverse effects. However, development of a chronic, non-healing wound after an immediate reconstruction can delay the administration of chemotherapy until the wound has healed. For this reason, in patients undergoing breast reconstruction who are scheduled to undergo chemotherapy, secondary procedures such as exchange of tissue expanders for implants or tissue flap revision are delayed 2–3 months after the cessation of adjuvant chemotherapy.

16.11 Conclusion

Modern breast reconstruction techniques provide a reliable source of rehabilitation and return to normalcy for patients following treatment for breast cancer. It has become an integral aspect of breast cancer management. As a member of the multidisciplinary breast cancer team, the reconstructive surgeon provides valuable input on the appropriate timing and techniques for reconstruction. Breast reconstruction can be done safely and effectively at the time of mastectomy or as a delayed procedure.

Irrespective of the timing of reconstruction, a spectrum of techniques is available from which the patient and surgeon can choose. These can involve breast implants, autologous tissue, or both. Implant reconstruction is a relatively simple and effective method of breast reconstruction, but may not be suitable for all patients, particularly those who need or have had radiation therapy. Autologous methods in contrast are more surgically demanding, but they consistently yield better esthetic results than implant reconstruction, particularly when combined with skin-sparing mastectomy.

The goal of breast reconstruction is to restore the size, shape, and appearance of the breast as closely as possible after mastectomy. This aids in the restoration of body image and makes it possible for patients to wear virtually all types of clothing with confidence. As we see further refinements in microsurgical techniques, it becomes possible to reconstruct a breast with a minimum morbidity and a lifetime benefit.

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