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Breast reconstruction after mastectomy recent advances; benefits and drawbacks

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ABSTRACT

Breast cancer is the most common cancer in women worldwide, with one in eight diagnosed in their lifetime. Treatment often results in significant body image changes, making breast reconstruction a crucial part of comprehensive treatment. Reconstruction can improve psychosocial well-being and quality of life, aiming to do no harm without hindering oncologic treatment or causing recurrence. Patients should be informed about treatment methods and advantages. To have an overview on different modalities of breast reconstruction after mastectomy and highlighting the recent advances in breast reconstruction, their benefits and drawbacks. The review is based on an English language Medline and google scholar search with secondary references obtained from key articles. Breast reconstruction after mastectomy is an important and oncologically safe component of breast cancer overall treatment plan. Immediate reconstruction offers psychological and physical benefits with better quality of life, while delayed reconstruction is tailored to specific cases mainly patients requiring radiotherapy. Breast reconstruction is a multidisciplinary team approach, and there are multiple factors need consideration prior to embarking upon a decision as they determine the timing and technique of breast reconstruction.

Keywords: Breast reconstruction, mastectomy, LDF, TRAM flap

INTRODUCTION

Breast cancer is the commonest cancer in women worldwide, current data suggests that one in eight women in their lifetime will be diagnosed with breast cancer. Unlike the enormous majority of cancers, breast cancer is unique in that the treatment usually yield in significant alteration of the overall body image and disfigurement of the breast, that's why breast reconstruction after mastectomy has become a vital part of comprehensive treatment for patients with breast cancer.

It is established that reconstruction can also boost the psychosocial well-being and quality of life of patients with breast cancer. One of the aims of breast reconstruction is to ‘‘first do no harm’’, it should not hinder the patient’s oncologic treatment, delay the diagnosis of a recurrence, or add an undesirable increase in operative morbidity or mortality. The reconstruction process can be immediate or delayed, and can involve the use of an prosthesis, autogenous tissue, or both. Prior to surgery, patients should be informed about all treatment methods, different techniques of breast reconstruction, their advantages and disadvantages to best personalize it (McLaughlin, 2023) Sacchini *et al.,* 2015; Shenoy *et al.,* 2014).

Types of mastectomy

Breast cancer was generally regarded as incurable, and those methods employed in the hope of a cure, or at the very least for relieving pain and prolonging life, were often horrific and morbid. With regard to the surgical cure of this disease, there has been a giant standard shift, from the disfiguring and horrible surgeries like amputation of breast, super-radical mastectomy to the divine breast ‘conserving ’and oncoplastic surgeries (Beahm and Lang, 2013.

Surgeries performed for treatment of breast cancer are Breast-conserving surgery (BCS), radical mastectomy, modified radical mastectomy (MRM), simple mastectomy, Skin-sparing mastectomy (SSM), and Nipple sparing mastectomy (NSM) (Brennan *et al.,* 2016; Panchal and Matros 2017; Jeong *et al.,* 2017).

A meta-analysis of six randomized controlled trials (RCTs) showed no difference in long-term mortality rates in both (BCS) and mastectomy in patients with operable invasive breast cancer. Only a single study concluded that mastectomy decreased mortality in a significant way. The probability of locoregional recurrence is greatly reduced in mastectomy in comparison to (BCS) Barbieri *et al.,* 2020; Beugels *et al.,* 2018; Hu and Alderman, 2007).

MRM outperforms radical mastectomy in terms of both appearance and function. Studies demonstrate no difference in disease-free or overall survival rates between radical mastectomy and MRM for early-stage breast cancer (McLaughlin, 2023) and with the emergence of sentinel node biopsy simple mastectomy have become more frequently performed then MRM.

Patients undergoing risk-reduction surgery tend to find NSM notably appealing, it has become the default operation in many large centers, with preference over skin-sparing or reducing procedures.

Breast reconstruction timing

During the last century, breast reconstruction after mastectomy has became a vital part of comprehensive treatment for patients with breast cancer, it was originally initiated to diminish chest wall deformities and to decrease complications of mastectomy. Now, however, it is established that reconstruction improves body posture, boost the psychosocial well-being, and quality of life of patients with breast cancer. The optimal time for reconstruction depends on physical examination, the stage of breast cancer, the adjuvant therapy need, the patient’s overall goals and the decision of multidisciplinary team.

It can be performed immediately or delayed after several months or as a staged procedure. Immediate reconstruction advantages include decreased psychological trauma, less operations, expenses, morbidity, and better cosmetic result compared to delayed reconstruction. However, in patients requiring radiotherapy, it can result in capsular contracture in implant-based reconstructions and tissue atrophy in autologous reconstructions.

Delayed reconstruction is Indicated for locally advanced breast cancer, the procedure starts after the adjuvant therapy administration, mastectomy wound healing and stabilization of post-radiation skin changes. The fundamental advantage is the reduction of surgical complications risks, but on the other hand, it yields average cosmetic results, mainly due to loss of crucial anatomic landmarks, previous scarring and quality of tissue that limits the volume and compromise the shape of an implant-based reconstruction, moreover, patient had the stigma of not having a breast for a while, and have to go twice for surgery (Potter *et al.,* 2015).

The staged or ‘‘delayed-immediate’’ approach entails immediate insertion of a tissue expander at the time of mastectomy, the expander is then expanded to create a breast mound and preserve the skin envelope, but deflated during irradiation. 2nd stage is replacing the expander with Prosthetic or autologous reconstruction few weeks after the completion of radiotherapy.

Expander/implant reconstruction

The different techniques for breast reconstruction are, prosthetic devices, autologous tissue reconstructions with flaps or adipose tissue grafts, or both prosthetic and autologous.

There's a rise in the use of implant based reconstruction, A longitudinal analysis of patients undergoing total mastectomy between 1998 and 2008 was performed using the Nationwide Inpatient Sample (NIS) Database showed an increase on average 11% per year (Disa and Patel. 2013; Weichman and Disa, 2023)

Prosthetic reconstruction is most suitable for patients who may have insufficient donor site for other reconstructions, old age patients with medical co-morbidities who may not be able to tolerate a lengthier procedure, it's also preferred for bilateral breast reconstruction cases, patients having skin or nipple sparing mastectomy, and for Small minimally ptotic breasts.

It offers good cosmetic results, in a simple procedure with a shorter operative time and hospital stay without the disadvantage of additional scars and donor-site morbidity (Masia 2022). However, it carries the risk of capsular contracture and extrusion mainly in patients requiring postoperative radiotherapy (Reinders *et al.,* 2020), it has also a less natural appearance specially in unilateral implant breast reconstruction cases where it's difficult to match natural breast ptosis or achieve symmetry.

A newly developed approach to reconstruction is the use of acellular dermal graft (Allo-Derm) in immediate breast reconstruction with implant, it has been used to increase the size of the subpectoral pocket, allowing complete coverage of the implant, most importantly the inferior-lateral pole, which decrease postoperative pain, and improve aesthetic outcomes.

Autologous tissue reconstruction

It involves reconstruction of the breast using the patient's own tissue, either flaps (pedicled or free), or fat graft. Autologous tissue is the best option for patients undergoing radiotherapy as it can better withstand it (Fansa and Heitmann, 2019) Autologous reconstruction offers the most natural looking and durable results with the perfect texture. Besides, it's easier to make breast symmetrical to the contralateral side, as it will become ptotic over time like a normal breast.

Disadvantages are more complicated surgery, longer operative time and hospital stay, donor site morbidity, more scars and the Risk of flap failure.

There are three types of flaps; pedicled, free and perforator flaps. The flap options are: latissimus dorsi (LD), Transverse rectus abdominis (TRAM), Deep inferior epigastric perforator (DIEP) , Superficial inferior epigastric artery (SIEA), superior and inferior Gluteal Artery Perforator (GAP) Flaps and Transverse upper gracilis (TUG) flap (He *et al.,* 2020; Bordianu *et al.,* 2020; Clemens and Nahabedian. 2011; Rozen *et al.,* 2020; Satake, 2020).

Latissimus dorsi flap

The LDF is a reliable flap, and it's proximity to the anterior chest wall makes it an ideal choice for providing the muscle, fat, and skin for use in breast reconstruction with negligible functional deficit. It's commonly used to reconstruct breast defects after partial mastectomy or lumpectomy and for coverage of a prosthetic reconstruction (Down *et al.,* 2021; Sood *et al.,* 2018; Spear and Clemens, 2013).

Disadvantages include patch-like appearance of the skin island, posterior scarring at the donor site, and seroma formation, It also requires an implant to provide sufficient volume for reconstruction.

TRAM flap

TRAM flap is composed of an Elliptical shaped skin and adipose tissue from lower abdomen overlying rectus abdominis muscle, and have a bipedicled blood supply from the deep superior and inferior epigastric arteries. It can be raised either as a uni-pedicled flap, Bipedicled flap based on both ipsilateral and contralateral superior epigastric vessels, or as a free flap based on the deep inferior epigastric vessels.

The free TRAM flap technique provides better perfusion to the flap avoiding flap complications and it necessitates harvesting of a small part of the rectus abdominis muscle, so herniation, abdominal wall weakness and partial flap necrosis are less common in the free TRAM compared to the pedicled TRAM flap, offering the advantage of less pain, shorter hospitalization, and more rapid recovery than patients with pedicled TRAM flap (Elliott *et al.,* 2013).

However, unlike pedicled TRAM flap, Free TRAM requires microvascular skills, equipments, and Intensive postoperative flap monitoring, and it has markedly higher total flap failure incidence when compared with pedicle TRAM.

TRAM flap is a favorable choice for breast reconstruction in patients who are generally healthy and have suitable tissue in the lower abdomen, and the main advantage is creation of a breast that has a shape and consistency close to a natural breast (Namnoum, 2013; Fosnot and Serletti *et al.,* 2013). The drawbacks are; donor site morbidity such as infection, hematoma, seroma, hernia and abdominal wall weakness, and the risk of partial or total flap loss and necrosis.

Deep Inferior Epigastric Artery Perforator (DIEP) flap

Microsurgical perforator flap approach is considered one of the modern advancement in autologous breast reconstruction. Studies have shown that microsurgical breast reconstructions offer a more natural and durable reconstruction leaving the muscle in its native place to serve its original function and minimize morbidity.

DIEP flap is based on the deep inferior epigastric artery and vein (DIEA,V). DIEA divides after passing the accurate line into 3 arrangements; single inferior vessel (27–29%), 2 branches medial and lateral (57–84%), or a subsequent 3 branches rising form inferior vessel (14–16%) (Bordianu *et al.,* 2020)

DIEP flap candidates are mainly those with sufficient lower abdominal subcutaneous fat tissue at the lower abdomen, i's particularly indicated for young, athletic patients who need a near intact abdominal wall and women requiring bilateral breast reconstruction.

The DIEP flap combines all the advantages of the TRAM flap without most of its disadvantages. It offers flexibility in positioning the flap due to the longer pedicle obtained, has minimal donor site morbidity and more quick return to work and physical activities (Rozen *et al.,* 2020). However, the tedious intramuscular dissection of a DIEP flap requires microvascular expertise, longer operative duration than free TRAM flap.

Superficial Inferior Epigastric Artery (SIEA) flap

It is based on the superficial inferior epigastric artery which courses superficial to Scarpa's fascia. The advantage of this flap over the other abdominal free flaps is that it does not require a fasciotomy or myotomy which eliminates any abdominal donor-site motor weakness (Grünherz *et al.,* 2020). An important consideration is that the diameter of the SIEA must be 1.5 mm. associated with a high failure rate.

Gluteal Artery Perforator (GAP) Flaps

GAP is an important alternative for DIEP flap. For patients who have insufficient lower abdominal tissue or have had previous abdominal surgery

Superior gluteal artery perforator flap (SGAP) and Inferior gluteal artery perforator flap (IGAP) are based on superior and inferior gluteal arteries and veins. As the IGAP flap has a longer pedicle than that of the SGAP IGAP is easier to dissect (Aziz and Rose, 2021; Satake, 2020). IGAP has also the advantage of well-hidden donor site scar and more abundant tissue even in thin patients compared to SGAP. Yet, it carries the risk of sciatic nerve exposure during dissection causing postoperative discomfort, and dehiscence of the incision due to it's site, so sitting may be restricted following the operation for several days.

GAP flaps has several advantages, the increased fat to skin ratio with abundance of adipose tissue in gluteal region even in thin patients, the well-hidden scar in gluteal crease, and the preserved integrity of the gluteus maximus muscle. It also gives an excellent projection to the breast due to the quality of the buttock tissue. still, The procedure is technically challenging, with the need for repositioning, and the firmer and less lax buttock tissue offers a limited amount of tissue available for harvest and make it difficult to shape in reconstructed Breast.

Transverse upper gracilis flap (TUG)

It is delineated transverse to the longitudinal axis of the gracilis muscle as a semilunar skin paddle in the inner thigh, based on the medial circumflex femoral artery.

The TUG flap technique is relatively straightforward and reliable and aesthetically superior to abdominal reconstruction in many ways, these include low donor-site morbidity, a concealed donor scar, constant anatomy with large-diameter vessels, the potential for

a neurosensory flap as well as a large skin paddle with better quality of inner thigh tissue, being soft and similar to breast tissue unlike the firm, fibrous texture of buttock flaps. It also offers immediate natural areolar reconstruction negating the need for secondary surgery being easier to cone the flap into a projecting breast than for abdominal flaps Drawbacks include, tendency for the drains to stay in for 2–7 weeks with prolonged drainage, the infection rate is around 20%, transient lower leg eodema, and distortion of the external genitalia or inferior migration of the scar.

Autologous fat graft for breast reconstruction

Early applications of fat grafting in breast reconstruction were for contour correction or filling defects after breast conservation therapy, and for secondary refinements of the shape of reconstructed breasts. However, there have been reports of complete breast reconstruction after NSM being accomplished by fat grafting with good results (Hanson *et al.,* 2021; Stark *et al.,* 2018). It takes 3-4 sessions of fat grafting spaced 4 months apart for total breast reconstruction with fat.

More recently, the regenerative qualities of adipos-ederived stem cells were found to have dramatic treatment implications for patients with radiation-induced injury. As it can reverse the fibrotic changes of radiation damage.

Drawbacks of this approach is the Mammographic abnormalities, in the form of coarse or fine microcalcifications from areas of fat necrosis. They can usually be distinguished from suspicious patterns by an experienced radiographer. Limited number of studies with few cases showed was no interference with breast cancer detection. Still, more studies are needed to confirm these findings.

Engineered fat grafting based on the addition of stromal vascular fraction (SVF) or platelet-rich plasma (PRP) to injected fat. A preliminary study with follow-up after 30 months showed with instrumental imaging the absence of calcification or microcalcification which suggests that engineered fat grafting is effective and safe (Gentile *et al.,* 2012).

Breast reconstruction and adjuvant therapy

Immediate reconstruction is safe and does not lead to omission of adjuvant chemotherapy, but was associated with delay in initiating it, and can cause a significant delay if reconstruction complications occurred (Eck eta l., 2015).

Irradiation of the reconstructed breast is associated with technological difficulties. Because of the distorted architecture of the chest wall, radiation ports must be adjusted. The treatment is more difficult, particularly irradiating the internal mammary lymph nodes. This may result in changing the depth of tangential fields resulting in increased volume of irradiation to lung or heart.

Post Mastectomy Radiation therapy (PMRT) has a negative impact on all forms of breast reconstruction. In implant based reconstruction, it causes capsular contracture and fibrosis resulting in breast shape distortion and chronic chest pain, it's also associated with higher incidence of expander/implant loss.

A systemic review of 25 observational studies of patients who underwent autologous reconstruction concluded comparable rates of complication and revision surgery in both radiated and non-radiated patients. Yet, radiated patients had a higher rate of fat necrosis.

Aesthetic results are imperfect, and are generally worse when PMRT is required. Yet, most patients are very satisfied not just accepting their results, with competently low decisional regret.

Outcomes of breast reconstruction

To date, the benefits of breast reconstruction have been mainly associated with the improvement of breast appearance, quality of life, and emotional and psychological well-being. It also considerably decreases the amount of divergence from normal body posture, which may cause long-term spinal deformation, circulatory and respiratory insufficiency, and motor organ deformities.

Outcomes of implant based reconstruction showed satisfaction range from 78% to 61%, despite a decline is noted in aesthetic satisfaction from an initial rate of 86% at 2 years to 54% at 5 years after implant reconstruction (Nava *et al.,* 2013). Total complications 5.8%–49%, Explantation 2.7%–3.8%, Major complications as mastectomy flap necrosis, capsular contracture or implant migration 4%–30.4% (Platt *et al.,* 2011), and Infection resulting in implant loss as high as 40%.

The median complication rate following ADM-assisted IBR was 18%, compared with 14% for standard two-stage expander–implant procedures.

A study to investigate and compare the incidence of various complications in different reconstruction methods concluded that the DIEP group had the highest incidence of overall complications (50.0%) and the highest incidence of fat necrosis (18.3%), skin necrosis (22.1%), and incidence of reoperation for complications (26.9%) compared to the other reconstruction methods. The incidence of late complications was 46.2% for DIEP, 66.4% for LD, and 62.9% for implant (Thorarinsson *et al.,* 2016)

Moore reviewed their experience in 170 patients who had their breast reconstructed with the latissimus dorsi musculocutaneous flap and found a 90% patient satisfaction.

For TRAM flap, noninfectious wound complications may be as high as 28–43%, Fat necrosis ranges 3.3-22.4%, and total flap loss is rare 0.2–4.7% of the time, with higher incidence of ischaemia complication in pedicled than free TRAM. Abdominal wall dysfunction is higher in pedicled TRAM 23%, compared to free TRAM 18%.

In a review of 492 GAP flaps performed for breast reconstruction, the overall take-back rate for vascular complications was 6%, (venous 4% and arterial 2%.) The total flap failure rate about 2%. Donor site seroma 15%, and donor site revision 20%. Breast flap contour asymmetry requiring fat grafting or revision in 10% of cases.

For the TUG flap, Prolonged drainage is noted, Distortion of the external genitalia or inferior migration of the scar is a known complication.

Retrospective reviews of autologous fat graft have found good–excellent results in 85-86.5% and moderately–good results in an additional 13.5% with only minor complications (Wilson and Spear, 2013) Groen et al found in a study included 6260 patients who had autologous fat transfer for breast reconstruction, an overall complication rate of 8%, cyst formation in 7%, hematoma in 6%, fat necrosis in 4%, and infection in 1% of cases.

CONCLUSION

Breast reconstruction after mastectomy is an integral, safe part of breast cancer overall treatment. It restores the patient's psychological and physical well-being specially when immediately done at time of mastectomy. Delayed or staged procedure is preferred for patients undergoing radiotherapy. Autologous breast reconstruction provides natural appearing breast and better quality reconstruction than implant while carrying a higher risk of total flap failure. Perforator flaps allow safe, reliable tissue transfer from a variety of sites and provide ideal tissue for breast reconstruction, with minimal donor site morbidity, but requires microvascular experience and longer operative time. The challenges are correct patient selection and counselling, and the provision of surgery by the multidisciplinary team to make the optimal approach available in a timely manner. Patient-reported outcomes and quality-of-life instruments are needed to scientifically support decision-making.

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