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Breast cancer reconstruction

Rohit Sharma[1*], Nitish Raghav[2], Kunika[3], Bhawna Kakar[3]
[1] Department of Microbiology, Guru Nanak Dev University, Amritsar, Punjab, India
[2] Department of Nanomedicine, Swansea University, Swansea, Wales, United Kingdom
[3] Department of Bioscience and Biotechnology, Banasthali Vidyapith, Vanasthali, Rajasthan, India

Abstract
Breast cancer is one of the most common malignancy in women worldwide. Worldwide, there are approximately 2.1 million diagnosed breast cancer cases in 2018. Breast cancer treatments have dramatically increased over the past decade. The surgical removal of whole breast is known as mastectomy and for this reason, women undergo breast reconstruction. Breast reconstruction is a careful procedure to restore breast size and shape during a mastectomy or lumpectomy. There are many different options for the procedure of breast reconstruction. Immediate reconstruction is done at the same time of mastectomy whereas delayed reconstruction is done months or years after the mastectomy. The risk of surgical complications is less in delayed reconstruction as compared to the immediate reconstruction. To reduce the risk of recurrence of breast cancer, many women are treated with radiation therapy after mastectomy. In this chapter of breast cancer reconstruction, we outline the timings and methods of breast reconstruction, factors influencing the breast reconstruction, current trends and role of radiotherapy.

Keywords: breast reconstruction, timings, techniques, factors, radiotherapy

Introduction

Among women, the most common malignancy worldwide is the breast cancer (Panchal & Matros, 2017) [23]. Breast cancer being the most commonly diagnosed cancer, is one of the major leading cause of cancer death (Bray *et al*., 2018) [3]. In 2012, new cases of breast cancer were estimated to be 1,671,149 and deaths due to breast cancer were estimated to be 521,907 (Ghoncheh *et al*., 2016) [10]. In 2017, it was estimated by the North American Association of Central Cancer Registries American Cancer Society that there were nearly about 40,610 deaths due to breast cancer (Panchal & Matros, 2017) [23]. According to Globocan 2018, [3] nearly 2.1 million women were diagnosed with breast cancer which accounts for approximately 11.6% of the total cancer incidence burden (Sat & Kaur, 2020) [29]. It has been estimated that women with aged 70-84years diagnosed with breast cancer may increase upto approximately 35% by 2030 (Sada *et al*., 2019) [28].

As the number is increasing for women diagnosed with breast cancer, the current trends which are required may include breast conservation surgery (BCS), mastectomy, and breast cancer reconstruction (Panchal & Matros, 2017) [23]. The major treatment for breast cancer may include surgery. When Women's Health and Cancer Rights act was passed in 1998, the rate of breast reconstructive surgery was slightly increased due to certain health plans and individual health insurance policies. Many trials have been done with lumpectomy and mastectomy for the treatment of early phase breast cancer. In a study, it has been reported that there is an gradual increase in the mastectomy rate (Howard-McNatt, 2013) [16]. The women may undergo breast conservation therapy, but many women are unhappy with their cosmetic result. Mostly, mastectomy provides the chance for cure and reconstruction provides a woman a better aesthetic result (Serletti *et al*., 2011) [31].

Breast reconstruction is one of the safest methods and leads to satisfactory results (Platt *et al*., 2011) [25]. In this method, a new shape or mound of breast is created using surgery. It can be done either after the mastectomy or breast conserving surgery (Della Croce & Wolfe). Mastectomy refers to the removal of the whole breast (Guideline, 2020) [12]. Breast conserving surgery also known as lumpectomy, refers to the removal of breast cancer and a small amount of healthy tissue around it (*Breast-Conserving Surgery*, 2020). There are mainly two different classification of breast reconstruction, the reconstruction type (alloplastic vs autologous) and timing of breast reconstruction (immediate vs delayed) (Thamm & Andree, 2018) [36]. If breast reconstruction occurs just after the mastectomy, then it is known as immediate reconstruction. However, if it occurs after some period of time, then it is considered as Delayed reconstruction. They can be accomplished by undergoing autologous tissue flaps or prosthetic breast implants (Chevray, 2008) [6]. Any large scale randomized trial has not been conducted in order to determine the relative safety as well as benefits of immediate vs delayed reconstruction. Wellisch *et al*. found similar approval of women undergoing immediate and delayed reconstruction, which implied that it wasn't necessary for a patient to experience postmastectomy deformity before accepting the results of reconstruction. Published in 1985, in a series of 148 cases, 72 had immediate and 76 had delayed procedures and wound infection in immediate group (22 vs 8%) was at an increased rate. But despite it, no delay was there in starting adjuvant chemotherapy. So, since there are no results from randomized trials, this data favours immediate

reconstruction in the women undergoing mastectomy [13].It is important for the women to have real expectation of outcome before undergoing breast reconstruction. The women should know that the reconstructed breast will never look and function as a normal breast but it can restore the image of body and confidence (Kaya & Serel, 2006) [19]. Reconstructed breasts do not have a nipple, but nipple reconstruction is also possible by surgery(DellaCroce & Wolfe). Nipples are reconstructed by using nipple-areola complex reconstructive techniques which include local flap, distant graft, injectable fillers, engineered tissue substitutes or combinations (Gougoutas *et al*., 2018) [11]. Scars left after breast reconstruction often gets faded over time, but the portion from where the tissue has been taken look different after surgery. When someone choose what type of breast reconstruction method is best suited, one should discuss or take prescription form doctor discussing about certain factors related to health and personal preferences. Moreover, patient can consult someone who had undergone it before finalizing their decision (Whether *et al*., 2014) [38]. Breast reconstruction can be influenced by certain factors like Patient-related factors which includes age, socioeconomic status, and location; Cancer-related factors which include stage of cancer and adjuvant therapies; and Physician-related factors describing about practice setting and physician attitude (Platt *et al*., 2011) [25]. It becomes a great challenge for a surgeon to do radiation therapy if patient have undergone it before breast reconstruction. Radiotherapy can increase the rate of infection and moreover certain implants-based methods become problematic. Radiotherapy can reduce the wound healing capacity and can leave permanent scar on body (Platt *et al*., 2011) [25]. The neoadjuvant radio-chemotherapy is a safest method for patients who are suffering from breast cancer. This treatment is best for the patients with local advanced breast cancer (LABC) [11].Studies have proven that breast cancer does not come back after the breast reconstruction but it can be easily treated if cancer occurs again (Whether *et al*., 2014) [38].

Timings of Breast Reconstruction

Patient who are suffering from early-stage breast cancer undergo mastectomy followed by breast reconstruction. Timing of breast reconstruction depend upon the postmastectomy radiation therapy. If postmastectomy radiation therapy is needed then patient can undergo immediate reconstruction whereas if not required, then delayed reconstruction will take place (Kronowitz *et al*., 2004) [20].

Immediate Breast Reconstruction

Studies have revealed that patients who are not considered for adjuvant radiotherapeutic treatment can undergo immediate breast reconstruction because it can provide a more natural shape and size to the reconstructed breast (Filip *et al*., 2017) [9]. Overall cost of immediate breast reconstruction is lowas compared to the delayed reconstruction (Al-Ghazal *et al*., 2000) [1]. Implant-based method is the most accepted technique and in USA, 75% breast reconstruction are performed with this method. This popularity is brought by a number of reasons like: the expansion in number of both therapeutic and prophylactic mastectomies in the setting of careful method refinements like nipple-sparing or skin-saving mastectomy, and also provide better aesthetic outcomes (Roth *et al*., 2005) [26]. Studies have proved that implant based method have higher complication rates than autologous reconstructions because of very large breast size (>750g), high volume of implant (>400ml), diabetes, smoking status etc (Filip *et al*., 2017) [9]. Breast reconstruction may involve transfer of autogenous tissue alone, insertion of prosthesis or a combination of tissue transfer and prosthesis (figure1). The main goal of breast reconstruction is to obtain symmetry. Therefore, corrective surgery of the contralateral breast is sometimes required, especially when implants are used. To achieve a predictable result, the use of expandable implants has become increasingly popular (Jahkola *et al*., 2003) [17].

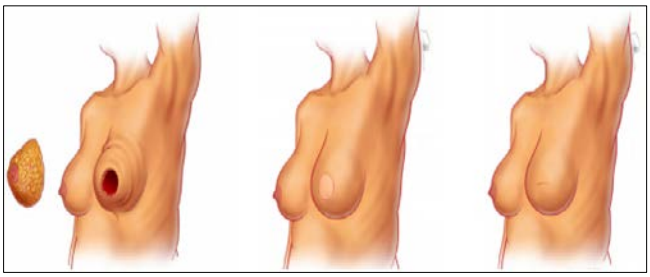
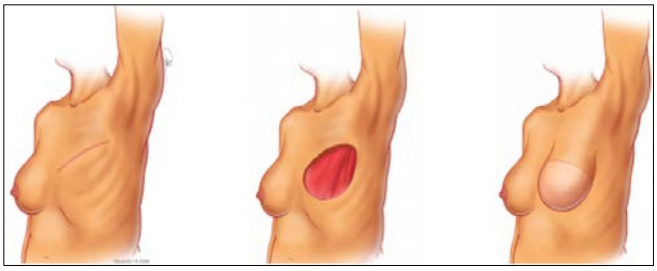


Fig 1: (A) During mastectomy surgery, breast tissue is removed with some skin remaining. **(B)** Tissue flap recreates the breast mound immediately with a small patch of skin visible**. (C)** Tissue expander (or implant) recreates a breast mound with a resulting horizontal scar(Crosby, nd.)**.**

Delayed Breast Reconstruction

When breast reconstruction occurs after month or year, it is called as delayedbreast reconstruction. It has lower risk of surgical complications as compared to the immediate reconstruction but the cosmetic result are not good as immediate reconstruction (Chevray, 2008) [6]. One reason behind delayed reconstruction is that people are so depressed for their cancer treatment that they do not thinkabout breast reconstruction. Moreover, within the first two year or mastectomy, there are much chances of recurrences of cancer (Thamm & Andree, 2018) [36]. Autologous breast reconstruction contains a wide range of flaps, from the latissimus dorsi flap, the transverse rectus abdominis flap, the deep inferior epigastric perforator flap to the less elected flaps like the gluteal artery perforator flap or the upper gracillis flap and tissue flap and implants are placed with the help of a surgery (figure2) (Filip *et al*., 2017) [9]. In a study, there were 38 immediate breast reconstruction patients with 83 delayed reconstruction patients and it was noted that immediate reconstruction has better body image and shape as compared to the delayed ones. The patient who undergo delayed reconstruction can have greater anxiety, depression, hypertension (Chevray, 2008) [6]. Three groups of women were observed by Harcourt *et el*, first group were of those who only received mastectomy whereas other two groups were occupied by those who had immediate breast reconstruction after mastectomy and delayed reconstruction respectively. He noticed that all three groups showed improvement in quality of life and psychological functioning within the first year after surgery (Roth *et al*., 2005) [26]. Complication rate of immediate reconstructionis higherthan delayed reconstruction(Sullivan *et al*., 2008) [35].



A B C

Fig 2: (A): During mastectomy, surgery breast tissue and skin is removed and there is no breast mound left.**(B):**To form the breast mound, tissue flap and implant are placed with the help of an additional surgery.**(C):** After the reconstructive surgery, a larger patch of skin from the tissue flap is visible on the breast(Crosby, nd.)**.**

Techniques for Breast Cancer Reconstruction

Techniques for Immediate Breast Reconstruction: The main goal of breast reconstruction is to attain symmetry. Various types of procedures to reconstruct the breast are as follows:

- Breast Reconstruction using Implants
- Breast Reconstruction using autologous tissues (FLAP Methods)
- Reconstruction of Nipple and Areola after breast surgery

Implant-Based Breast Reconstruction

The first "implant"-based breast reconstruction was carried out by Vincenz Czerny in 1895. After the tumor removal, he used a patient's lipoma from the lumbar region to reconstruct a post-surgical asymmetry (Schmauss *et al*., 2016) [30]. Implant-based reconstruction is the most acceptable type of breast reconstruction, accounting for approximately 80% of any reconstruction. In the United State, 10-year of data analysis indicates that within 1998 and 2008 immediate implant-based breast reconstruction increase annually by approximately 11%, whereas autologous reconstruction remained stable(Thamm & Andree, 2018) [36].

Simple Insertion of an Implant

In this technique, the prosthesis is placed either directly in the subcutaneous space or under the pectoralis major muscle. Earlier prostheses were placed under the skin flaps after a mastectomy without skin-sparing technique and resulted in high incidence of flap necroses, wound dehiscence, implant extrusions, infections and peri-implant contractures. After the simple insertion of the prosthesis, better cosmetic results are obtained. To gain more volume, implants are placed under the LD-flap(Jahkola *et al*., 2003) [17].

Tissue expanderimplant

In breast reconstruction, tissue expanders are normally used. This was designed in 1976 and used after six years by Chedomir Radovan. He was successful in reconstructed breast which looks like a normal breast. Tissue expander plays an important role in maintaining the shape, size, and textures of reconstructed breast (Schmauss *et al*., 2016) [30]. The most common way to reconstruct the breast is by using expander and an implant. At the time of the mastectomy, a tissue expander which looks like a "balloon" is placed beneath the (pectoralis muscle) of the chest covering the upper portion of the tissue expander, and the lower portion is covered with the help of acellular dermal matrix. This bio-material act as a sling which holds the expander. Later, by using the syringe and needle the balloon is filled with saline through a small porthole. This help in the stretching of skin like a women belly during pregnancy (figure3). This process takes about six weeks and when skin has been created, tissue expander is removed and permanent breast implant is carried out to obtain a better shape and size of breast (Jahkola *et al*., 2003) [17].

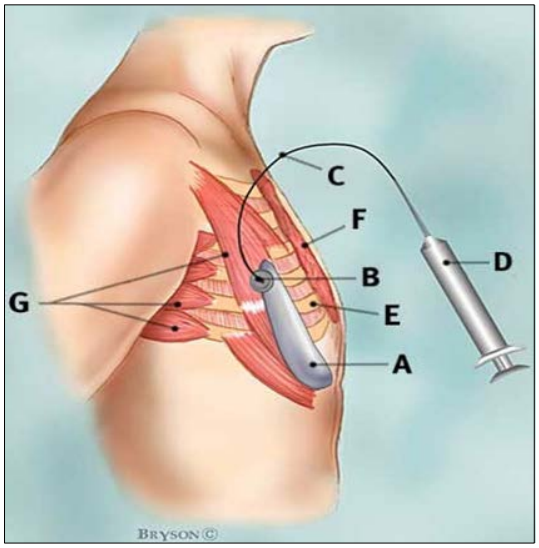


Fig 3(A): Unfilled tissue expander

A Tissue expander – unfilled
B Port
C Catheter
D Syringe
E Ribs
F Pectoralis major muscle
G Other muscles of the chest wall chestwall (*Tissue Expander. Pdf*, nd.)**.**

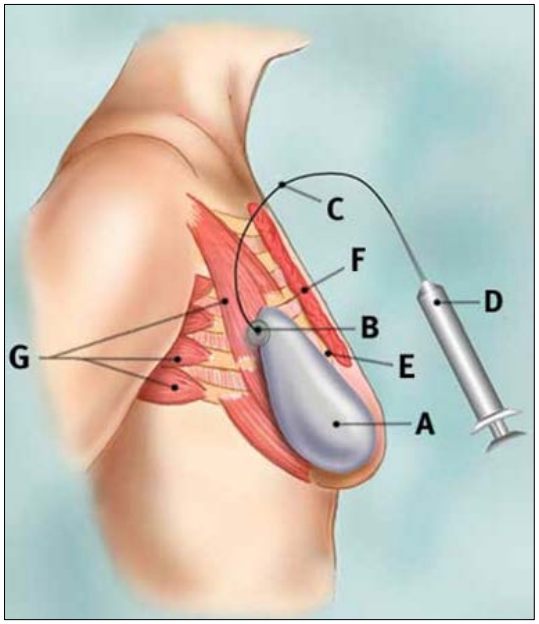


Fig 3(B): Filled tissue expander

A Tissue expander –filled
B Port
C Catheter
D Syringe
E Ribs
F Pectoralis major muscle
G Other muscles of the

Autologous Reconstruction

Using autologous tissues for reconstruction is considered to have several advantages over implant based reconstruction. It can reconstruct a skin defect. The main advantage is the absence of a foreign body with a long-lasting result that seems more natural. A large amount of own body tissue is available, it is suited for patients who do not want implants, improved wound healing and can withstand postoperative radiotherapy(Malata *et al*., 2000) [21]. Depending upon the defect, various types of autologous flaps are involved, that includes TRAM, LD flap, abdomen based flaps (e.g. DIEP), or gluteal and thigh-based flaps (Homsy *et al*., 2018) [15].

Transverse Rectus Abdominis-Muscle (TRAM) flap

It is known as TRAM flap because it uses the rectus abdominis muscle (large tummy muscle). TRAM flaps can be free or pedicled:

- **Free Flap:** It is most commonly used flap. This flap is completely detached and then reattached. In this flap, the skin, muscle and fat are completely removed from the abdomen and breast is shaped from this tissue. Blood vessels which supply the flap are then connected to blood vessels in the area of reconstructed breast by the use of microvascular surgery (figure4). Free flap TRAM could be a more complex procedure and has more risk of complications as compared to pedicled flap.

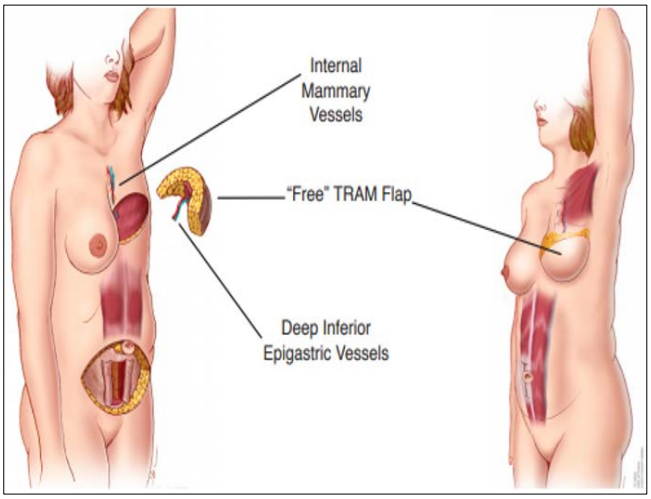


Fig 4: (A) The "free" TRAM flap is removed from its blood supply. (B) The "free" TRAM flap is attached to the blood supply in the chest (Crosby, n.d.).

- **Pedicled Flap:** In this, the flap remains attached at one end to the original anchoring point and original blood supply. In this flap, the rectus abdominis muscle, fat, skin and blood supply aretunnelled underneath the abdominal and chest skin and taken out to the region where the new breast will be made (figure5).Both methods of TRAM flap operation can result in weakening of abdominal wall, so during operation, surgeon put 'mesh' in the abdomen in order to provide strength to muscles and avoid hernia (DellaCroce & Wolfe).

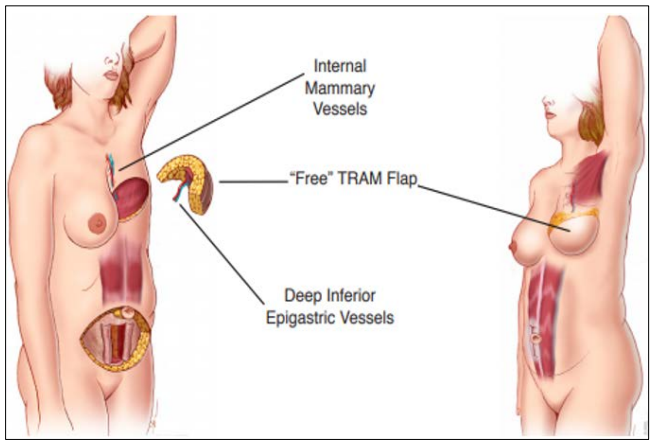


Fig 5: (A) The rectus abdominis muscle is rotated on its blood supply ("pedicled" TRAM) to the chest. (B) The missing breast is replaced by "Pedicled" TRAM flap (Crosby, nd.).

Latissimus Dorsi (LD) Flap

The LD myocutaneous enables the placement of healthy skin on the anterior wall of chest with only 1% risk of flap necrosis, so it is justifiably the workhorse of breast reconstruction (figure6). It is specifically useful when reconstruction is to be performed after salvage mastectomy in patients who had radiotherapy as a part of breast conservation therapy. In most cases, sufficient tissue bulk is not there, so implant is necessary. The later aspect of submuscular pocket has to be secured, in order to avoid lateral dislocation into the axilla.When LD flap is performed, the common short-term complication is donor-site seroma collection. Chronic pain can occur in up to 30% of patients following mastectomy with axillary surgery, and this raises to 50% if an LD is also done. Although there are these potential problems, but LD flap still remains the simplest and widely available procedure of successful breast reconstruction (Kaya & Serel, 2006) [19].

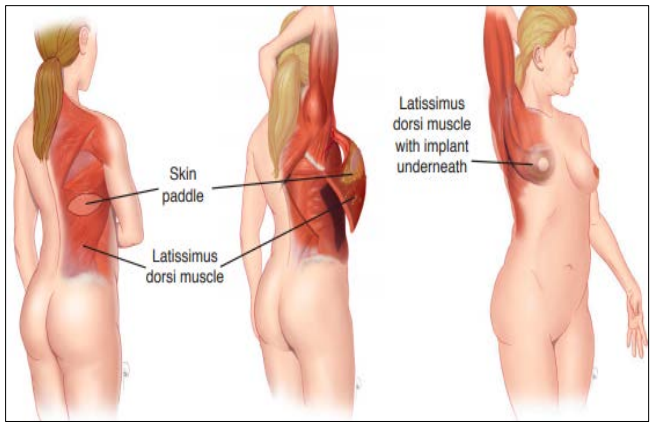


Fig 6: Latissimus Dorsi (LD) flap (Crosby, n.d.).

Free Deep Inferior Epigastric Perforator Flap (DIEP)

In DIEP flap, the perforating vessels through the rectus muscle are dissected. As the flap is composed only of skin and fat, which are essential parts required for breast reconstruction, so the rectus muscle and sheath are preserved. The risk of abdominal hernia is minimal because no muscle has to be removed in this method (figure7) (Jahkola *et al*., 2003) [17].

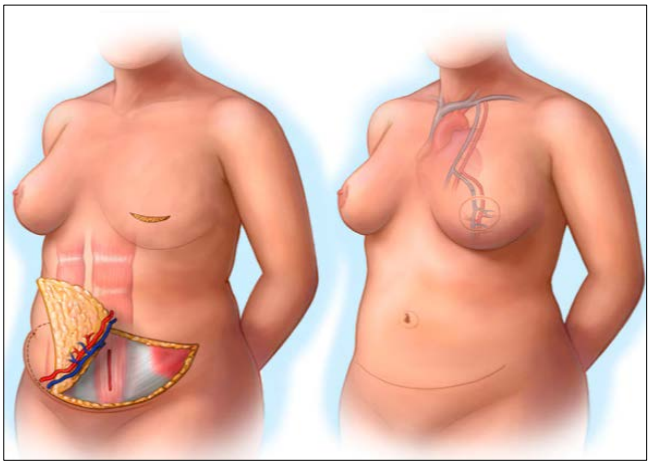


Fig 7: A section of abdominal skin and fat is removed, along with the associated blood vessels. With the help ofcomplex microsurgical techniques, the blood vessels are attached to the ones in your chest, whereas skin and fat are used to create a breast(*Breast Reconstruction with Flap Surgery*, 2019)**.**

Superior Inferior Epigastric Artery Flap (SIEA)

It is quite similar to DIEP flap because it also uses only skin and fat from the lower abdomen and do not use muscle, but unlike DIEP flap where deep vessels are used, in SIEA, the vessels taken are superficial (nearer to the surface)(figure8).To avoid the risk of complications, the person should have a good overall health because the blood supply might not be always enough to have this procedure(DellaCroce & Wolfe).

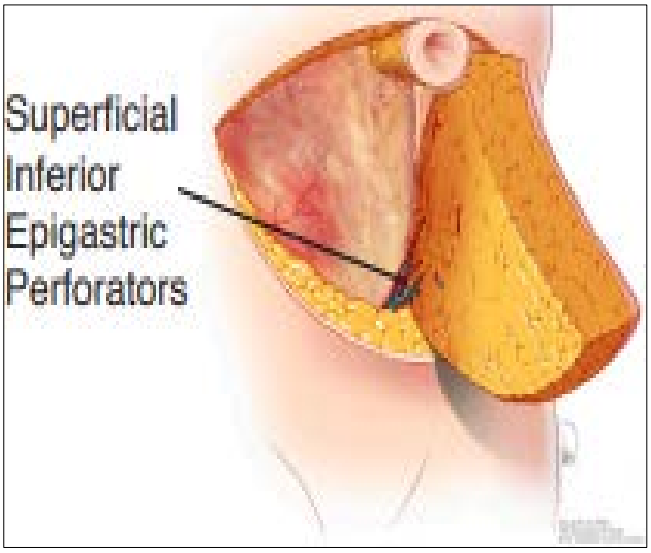


Fig 8: SIEA flap (Crosby, n.d.).

Superior Gluteal Free Flap

The superior gluteal artery and vein are used in the superior gluteal free flap. In most females, the gluteal tissue is available in excess and by using microsurgical techniques, the vascularized fat and overlying skin can be reliably moved to the chest wall for the reconstruction of a new breast (figure9) (Malata *et al*., 2000) [21].

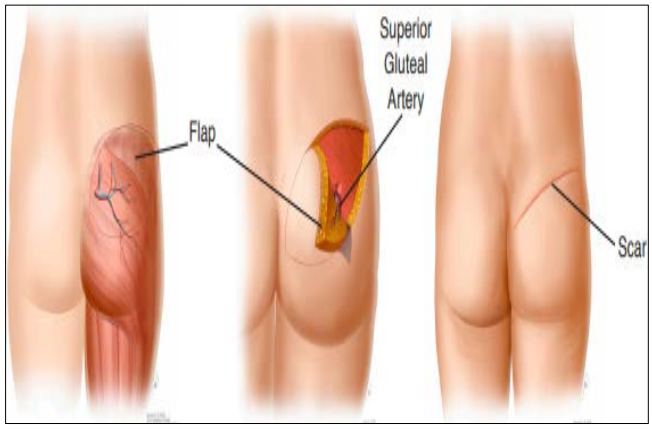


Fig 9: Gluteal free flap surgery (Allen *et al*., 2013) [2]**.**

Inferior Gluteal Free Flap

Because of its longer vascular pedicle (that is easier for dissection), and because it has more available tissue even in thin patients, the inferior gluteal free flap is referred to as "superior version". It has brilliant vascularity and only a little amount of muscle is required to provide musculocutaneous perforators for larger overlying skin and fat. The donor site scar can be painful in this case(figure10)(Malata *et al*., 2000) [21].

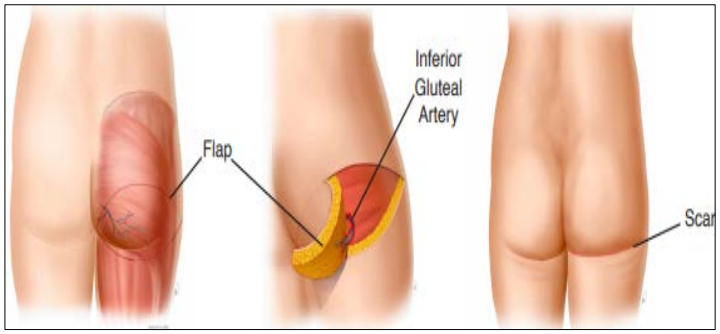


Fig10: The IGAP flap is taken from the lower portion of the buttock. The resulting scar is often hidden in the skin fold at the bottom of the buttock (Crosby, nd.)**.**

Inner Thigh or Transverse Upper Gracilis (TUG) Flap

This is a new option, in which muscle and fatty tissue is used from along the bottom of buttock extending to inner thigh. The muscle, skin and blood vessels are cut and are taken to the chest and new blood supply connection is given to the small blood vessels. Those women having thin thighs do not have much tissue here, so this method is best suited for the women whose inner thighs touch and who wants as smaller or medium sized breast(figure11). Profunda Artery Perforator (PAP) flap is a similar procedure, but muscle is not removed in this method (Whether *et al*., 2014) [38].

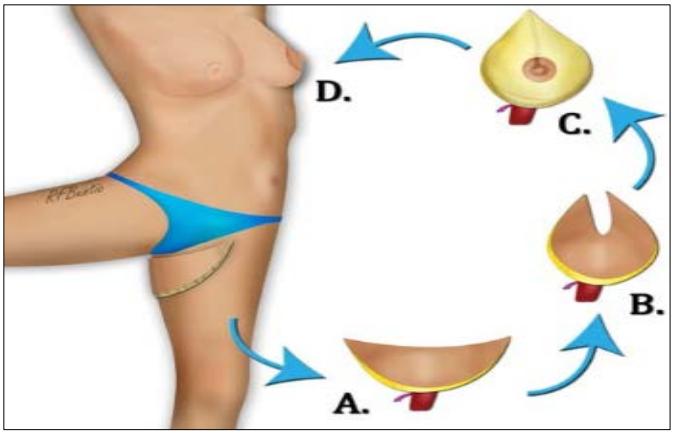


Fig 11: Transverse upper gracilis free flap surgery (Allen *et al*., 2013) [2].

Nipple and Areola Reconstruction

The reconstruction of nipple and areola is the final phase of breast reconstruction. Although nipple reconstruction may be done at the same time as the breast surgery but it is generally done after 3-4 months after surgery in order to provide time to the reconstructed breast to heal. Although the reconstructed nipple won't feel the same as a natural nipple and it will have no sensation but it can improve the appearance of the new breast. Various methods are there for nipple reconstruction (DellaCroce & Wolfe).

There are many techniques including grafting from skin, buccal mucosa, labia minora or majora, thigh, buttocks, groin, upper eyelids, or earlobes. There are some variations in the techniques but the overall principle remains the same to give colour, texture, size, and shape as per the women desires (Serletti *et al*., 2011) [31].The skin of new breast can be used to construct the new nipple by folding the skin to create a new nipple. Sometimes part of nipple from the other breast can also be used (figure12). For making the skin to match the shade of natural nipple and areola, micropigmentation is done, which helps in nipple and areola region to look more realistic. The procedure may require local anaesthetic and it takes about half an hour (DellaCroce & Wolfe).

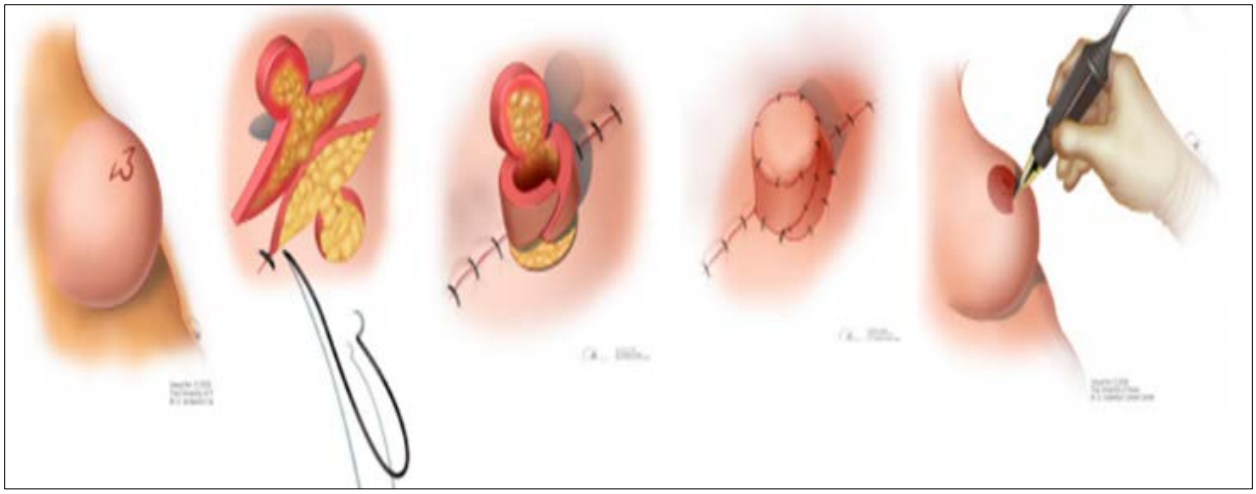


Fig 12: A surgeon can reconstruct a new nipple and areola after the breast gets healed from mastectomy. The new nipple is formed by making a star shaped incision and then adds a tattoo to shade in the new areola (Crosby, nd.)

Techniques for Delayed Breast Reconstruction

Breast reconstruction occur months or year after a mastectomy. There is low risk or surgical complications if patient undergo delayed breast reconstruction (Chevray, 2008) [6].

Delayed reconstruction with breast implant

There is lower complication rate of delayed breast reconstruction with tissue expanders and implants as compared to immediate reconstruction. Moreover, there is low risk of complications and infection if mastectomy and lymph node evaluation surgery are done previously. Due to absence of axillary lymph node dissection, there is less chances of seroma formation. This type of breast reconstruction produces low cosmetic results due to somewhat contraction of breast after mastectomy and internal scarring inhibit the tissue, and the tissue expansion process results in irregular breast shape and size (Chevray, 2008) [6].

Autologous Breast Reconstruction with Autogenous Implants

When delayed breast reconstruction is done by using autologous tissue, then the original skin that is left after mastectomy contracts, due to which less surface area of skin is available to envelope a reconstructed breast in future. Moreover, skin sparing mastectomy is quite uncommon in absence of immediate breast reconstruction. During delayed breast reconstruction, the remaining original upper breast and skin of chest superior to upper mastectomy skin flap can cover the upper region of new breast. Generally, the skin flap of lower mastectomy has no longer sufficient large area, and it is also not elastic enough to envelop a new breast. So, the skin flap of lower mastectomy is usually discarded, split, or left there as it is and de-epithelialized to be covered by the flap, which in turn results in larger flap skin paddle on the surface of lower region of the new breast. And the flap's skin paddle is generally lighter in colour than the surrounding original breast skin (Chevray, 2008) [6].

Table 1: Characteristics of common procedures for breast reconstruction (Platt *et al*., 2011) [25].

Type	Example	Indications	Contraindications	Advantages	Disadvantages
Implant-based	-Tissue expander or implant under the pectoralis major muscle.	-Small breasts with minimal ptosis -Insufficient donor tissue (e.g., from the abdomen) -Patient preference	-Previous or anticipated radiation therapy	-There is no morbidity at donor site. -There is short time period of operation and recovery	-Capsular contracture, implant malposition. -It has very low outcomes for patient who require radiation therapy
Autologous	-Pedicled transverse rectus abdominus muscle. -Free transverse rectus abdominus muscle. -Othergluteal flap, thigh flap.	-Redundant tissue at the donor site -Patience preference.	-Lack of reductant donor tissue	-It appears and feels like more natural. -Volume and size is perfect. -It is best for those patients who needs radiation therapy.	-It took longer time for operation, admission. -More blood loss is there as compared to implants based. -Complications are seen on the donor site.

Factor Influencing the breast cancer reconstruction

There are mainly three main categories that influence the rate of breast reconstruction: Patient-related factors, Cancer related factors, Surgical related factors (Platt *et al*., 2011) [25].

Patient-Related Factors

There are many patient-related factors such as age, socioeconomic, ethnic background and location that affect the use of breast reconstruction after mastectomy (Sousa *et al*., 2019) [33],(Platt *et al*., 2011) [25].

- **Age:** 6 out of 14 studies found age as a crucial factor, in which 3 studies identified thatolder patients possess higher levels of sexual and physical well-being after breast reconstruction. One study found that young patients possess higher life quality, but with low effect sizes. 2 studies identified that higher quality of life is possessed by older people and remaining studies didn't find any significant differences between younger and old patients(Platt *et al*., 2011) [25].

- **Socioeconomic Status:** In a study, it was found that there were different RATES of breast reconstruction in many countries. Like in US, patients whose family income was more than 40,000$ has to pay more for breast reconstruction as compared to those whose income was less than 40000$. It was also found that Christian also pay less to undergo breast reconstruction in countries like Denmark, Australia, England (Sousa *et al*., 2019) [33].

- **Race:** Significant differences favoured black women for physical and sexual well-being. In a population based study by Morrow and colleagues, it was observed that black women underwent breast reconstruction less frequently as compared to white women(Platt *et al*., 2011) [25].

- **Geographic Variation:** Studies conducted in US and Canada provided information about the variation in the rate of breast reconstruction with respect to geographical locations. Breast reconstruction frequency was found to be twice as compared to the rest of province. In Nova Scotia, breast reconstruction rate was higher (4.8%) in women living in urban areas as compared to a rate of 3.7% in women living in rural areas (Platt *et al*., 2011) [25].

- **Work Status:** Three out of four studies stated that active women (especially who are working in part-time jobs) reported higher levels of overall life quality (Sousa *et al*., 2019) [33].

Cancer-Related Factors: The cancer stage and radiation therapy affect the rate of breast reconstruction (Sousa *et al*., 2019) [33].

- **Stage of Cancer:** The stage of cancer is one of the most significant clinical factors linked with rate of breast reconstruction. According to a US based study among 200,000 women suffering from breast cancer, there only 42.1% women with ductal carcinoma in situ or stage 1, but reported for 87.6% of all breast reconstruction surgeries. Similarly, trends were identified in other US based studies. According to a Canadian study conducted in Nova Scotia, it was observed that an advanced cancer stage was linked with lower breast reconstruction rate(Platt *et al*., 2011) [25],(Sousa *et al*., 2019) [33].

- **Radiation Therapy:** In a study, it has been seen that radiotherapy is highly associated with decreased rates of breast reconstruction (Sousa *et al*., 2019) [33].

Surgical-Related Factors

A number of factors were reported as variables which affect patient's quality of life. These variables include type of mastectomy, method of breast reconstruction and type of implants (Platt *et al*., 2011) [25].

- **Regarding Method of Mastectomy**: According to three out of four studies, it was found that women who went through nipple-sparing mastectomy possessed higher psychosocial and sexual well-being as compared to women who underwent non-nipple-sparing surgeries(Platt *et al*., 2011) [25].

- **Regarding the Breast Reconstruction Procedures**: Six out of eleven studies didn't reported any significant differences between immediate and delayed methods. Two studies reported that women who went through delayed procedure reported higher emotional, physical and sexual well-being, whereas three studies reported these benefits in the favor of immediate procedures. Nine out of Twenty studies favoured better psychosocial and sexual well-being among patients who underwent reconstruction through autologous procedures (Platt *et al*., 2011) [25],(Sousa *et al*., 2019) [33].

- **Regarding Choice of Implants:** It was reported that silicone implants resulted in better physical and sexual well-being as compared to saline implants(Platt *et al*., 2011) [25].

Current Trends of Breast Reconstruction: In last 25 years, a great improvement is seen in breast reconstruction which provides patients with better autologous and implant-based options. The trends of breast reconstruction are now turned to skin and nipple-areolar complex preservation, which results in improved aesthetics. Despite the improvements in reconstruction, recent studies reported that only 43% of patients who went through mastectomy opted for reconstruction. Despite all the innovations and new techniques, most important barrier is the limitation of patient access to plastic surgeons. Nipple sparing mastectomy (NSM) has given the most significant outcomes as this method preserves skin envelope as well as nipple-areolar complex, which resulted in quite natural looking reconstructed breast where the scar is hidden in inframammary fold (Spiegel *et al*., 2020) [34]. Postmastectomy breast reconstruction plays a major role in improving the quality of life in the patients who choose to undergo breast reconstruction. Many studies reported that after mastectomy, women experienced some longterm psychological problems which includes lower self-esteem, distorted body image and sexual dysfunctions. Under Women's Health and Cancer Rights Act of 1998(WHCRA), women who choose to have breast reconstruction with mastectomy are provided with health plans. In 2014, The National Accreditation Program of Breast Centres added that every patient willing for mastectomy must be offered a consultation with a plastic surgeon to discuss about breast reconstruction after mastectomy (Siotos *et al*., 2020) [32]. In the past decade, it has been observed there are increasing numbers of women who seek post-mastectomy breast reconstruction. Although studies have reported the physical, emotion, psychosocial and functional advantages of breast reconstruction, but some studies have reported the effects of procedure choice on these outcomes. Current studies compared and evaluated the psychosocial results of three of the most common procedures used for reconstruction: Implant/Tissue Expander, pedicle TRAM and free TRAM methods. Patients undergoing through breast reconstruction after mastectomy for the first time with the abovementioned procedures were observed from 12 centres in the US and Canada. Patients were evaluated through questionnaires before reconstruction and after 1 year of reconstruction, which includes the questions regarding their social, physical and emotional well-being, mental health and body image. Preoperative scores and differences between preoperative and postoperative scores of different reconstruction methods were compared by the use of t-tests. Both preoperative (before reconstruction) and postoperative (1 year after reconstruction) surveys were conducted from 273 patients. In 250 patients, procedure type was reported, 56 of them underwent through implant reconstructions, 128 received pedicle TRAM flaps and 66 of them received free TRAM flaps. 161 of them underwent through immediate procedures and 89 through delayed ones. In case of women who underwent immediate reconstruction, significant improvements were reported in all psychosocial variables, except body image, whereas women who received delayed reconstruction possessed enhanced emotional well-being, general mental health and also the body image, which didn't improve in women who received immediate procedures. However, most of these outcomes weren't significantly affected by choice of technique, but significant differences were reported among the types of procedures for three psychosocial subscales. A significant improvement in vitality and social well-being was observed in women who underwent expander/implant reconstructions as compared to when who received delayed TRAM procedures. But greater improvement in body image was reported in women who received delayed TRAM over the women receiving delayed expander-implant reconstruction. So, it was concluded by the authors that both immediate as well as delayed procedures provides significant psychosocial benefits for mastectomy patients. However, the choice of procedure didn't seem to significantly affect improvement in psychosocial variables with immediate procedure, but the data concludes that when it comes to body image and vitality, procedure type does effect significantly for women receiving delayed procedures (Mazuquin *et al*., 2020) [22]. For women with sufficient abdominal, thigh or gluteal adipose tissue volume, especially women having high BMI, autologous reconstruction is a good option. Lymphedema is a prevalent complication from axillary dissection. In recent time, vascularized lymph node transfers in conjugation with autologous reconstruction are performed. Lymph nodes can be transferred either as a separate microsurgical anastomosis to different blood vessels or as a part of DIEP flap (Spiegel *et al*., 2020) [34].

Radiotherapy and Breast Cancer Reconstruction

Radiotherapy is the essential therapy, using ionizing radiations for the treatment of breast cancer (Rozen & Ashton, 2012) [27].For treatment of breast cancer, radiotherapy is usually done by external beam radiations, involving chest wall and lymph node area. The main aim of breast reconstruction is to attain a new breast which is symmetrical to the old breast. So, there are two types of breast reconstruction patients, one who are given radiotherapy before breast reconstruction and one who are given radiotherapy after breast reconstruction, but radiotherapy can negatively affect the symmetry and pigmentation of the reconstructed breast (Jugenburg *et al*., 2007) [18]. With the use of adjuvant radiotherapy, there are less chances of recurrence after mastectomy and overall survival rate is enhanced (Rozen & Ashton, 2012) [27].Thus, most of the patients now receive postmastectomy radiotherapy (PMRT). As per guidelines of American Society of Clinical Oncology in 2001, PMRT can be used in patients who have large tumors and four or more lymph nodes involved(TB. Ho *et al*., 2019) [14]. According to studies done, data from 2000 to 2010 showed that patients who undergone immediate implant reconstruction followed by PMRT were increased from 27% to 52%, while patients with immediate autologous reconstruction decreased from 56% to 32%. It has been evidenced that patients who undergo breast reconstruction before PMRT are at high risk of long-term complications (Yun *et al*., 2018) [39]. Implant-based breast reconstruction constitutes about 80% of the reconstruction which is usually performed after mastectomy. In the setting of PMRT, implant- based reconstruction has been widely used. By using immediate implant-based reconstruction, within single day, there is immediate recreation of the breast mound and then patients may undergo radiotherapy just after that. It reduces the operation time

as well as duration of stay in the hospital. Patients who undergo this immediate implant reconstruction are at high risk for long-term complications (TB. Ho *et al*., 2019) [14], (Yun *et al*., 2018) [39].In the setting of PMRT, some patients may also undergo delayed or two-stage implant based reconstruction. By the 2017 National Comprehensive Cancer Network guidelines, the most common approach is two-stage implant based reconstruction (AY. Ho *et al*., 2017) [13]. A delayed-immediate reconstruction is a two-stage procedure in which a tissue expander is placed first at the time of mastectomy. Then tissue expander is fully inflated during surgery followed by radiation therapy. The main disadvantage of using a tissue expander is that it can rupture easily, but on the other hand, this method usually minimise the rate of complications which are associated with PMRT (TB. Ho *et al*., 2019) [14], (AY. Ho *et al*., 2017) [13]. When immediate and delayed-immediate implant based reconstruction was compared in the setting of PMRT, it was found that there were very good aesthetic outcomes for delayed-immediate reconstruction as compared to immediate reconstruction (Yun *et al*., 2018) [39]. Many studies have been done on immediate implant reconstruction and delayed-immediate implant reconstruction and it has been found that risk of capsular contracture and rate of infection is high in patients (as high as 37%) who had PMRT as compared to those who did not receive it (TB. Ho *et al*., 2019) [14]. In autologous breast reconstruction, patient's own tissue is taken from another site of the body, which is having excessive fat content, to reconstruct the breast after mastectomy (AY. Ho *et al*., 2017) [13]. It is mostly used in those patients who do not want to have implants and it also gives good cosmetic outcomes. In the setting of PMRT, autologous reconstruction can lead to fat necrosis, contracture, volume loss and wound issues (TB. Ho *et al*., 2019) [14]. A study done on immediate free TRAM flap reconstruction followed by PMRT, reported that PMRT done after immediate reconstruction is really safe and have good cosmetic results when compared to those who did not received PMRT (Yun *et al*., 2018) [39].When immediate and delayed autologous reconstruction were compared, may studies have reported that there are less complications for delayed autologous reconstruction. Among autologous flaps, DIEP flaps are more superior than TRAM flaps, and more relevant for PMRT. LD flaps can also be used. Delayed autologous reconstruction is better for high-risk patients, but the timing to delay surgery after radiotherapy is still unknown. According to 2018 National Comprehensive Cancer Network guidelines, the most preferred option of breast reconstruction for patients with PMRT is autologous reconstruction (TB. Ho *et al*., 2019) [14].Autologous reconstruction with PMRT leads to less complications and better quality of life as compared to implant-based reconstruction with PMRT (Yun *et al*., 2018) [39].

Limitations of Breast Reconstruction

Although many women are satisfied with the results of breast reconstruction, but some women are not satisfied as they more conscious about their breast. A reconstructed breast will never feel or look as a normal breast as it will be of different size and shape and numbness can also be felt sometimes. When women gain or lose weight, natural breast is affected, but the reconstructed breast will not at all be affected. After breast reconstruction, women may have some scars on her body, which may or may not go away with time. A normal breast usually changes over time when women become old, but a reconstructed breast (especially with implants) will not change the same way. If women after breast reconstruction, go for radiotherapy, the appearance of the reconstructed breast is very much affected. For good cosmetic results, patient have to visit the hospital many times and many operations are required. Reconstructed breast do not usually have a nipple, but nipple reconstruction is also possible later on with the help of a surgery. When breast reconstruction occurs with tissue flaps, there may be weakness in the muscles from where tissues were taken. With time, many differences are seen between a natural breast and reconstructed breast, but symmetry can be restored with the help of surgeries. Despite of these limitations, women are now accepting and feeling confident about their new breast after the breast reconstruction (Della Croce & Wolfe),(Zuckerman *et al*., 2019) [40].

Conclusion

Breast cancer reconstruction is now becoming very popular and is preferred by many women after the treatment for breast cancer (Serletti *et al*., 2011) [13]. The major of breast reconstruction is restoration of breast mound and maintaining quality of life (Peter G. Cordeiro, 2008) [24]. The main advantages may include improved body image, well-being, self-confident and high survival rate (Howard-McNatt, 2013) [16].There are many factors related to breast cancer, and it has been found that patient-related factors and cancer-related factors are mainly related to low rates of breast reconstruction (Platt *et al*., 2011) [25]. Breast reconstruction is one of the accepted technique by women undergoing mastectomy, and a physician can guide the patient to have either immediate or delayed breast reconstruction by telling them both about risks and benefits (Howard-McNatt, 2013) [16]. Nipple reconstruction can also be done, once the breast has been reconstructed and adjuvant therapy is received(Peter G. Cordeiro, 2008) [24].Autologous breast reconstruction gives better aesthetic and natural results as compared to implant-based reconstruction (Malata *et al*., 2000) [21]. The primary goal in the treatment of patient who have undergone breast reconstruction and received PMRT is to minimize the rate of complications and to enhance the quality of life and survival rate (AY. Ho *et al*., 2017) [13].

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