

## **Versatility of Microvascular “Deep Inferior Epigastric Perforator” (DIEP) Flap in Breast Reconstruction**

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### **ABSTRACT**

The transverse rectus abdominis myocutaneous (TRAM) flap has been the gold standard for breast reconstruction until recently. Not only autologous but also immediate reconstruction is now preferred to offer the patient natural and cosmetically acceptable results. Aside from existing advantages for reconstruction of the breast with a free versus a pedicled TRAM-flap, small parts of the muscle still must be sacrificed to secure blood perfusion of the flap. The deep inferior epigastric perforator (DIEP) flap was recently introduced to overcome this disadvantage. Morbidity of the donor site should be minimized since this technique avoids fascia or muscle defects. Between June of 1997 and December of 1999, a total of 25 breast reconstructions were performed using the free DIEP-flap, by the technique described by Lantierri et al. All patients were collected prospectively and no patients were excluded from this study. Fourteen breast reconstructions were immediate and eleven were delayed. Hernia occurred in one patient. All patients were able to resume their daily activities. Patient satisfaction with the reconstructed breast and the donor site was rated high. We found that the free DIEP-flap is, therefore, a new but reliable, safe and valuable method of autologous breast reconstruction. It offers the patient the same advantages as the TRAM-flap and discarded the most important disadvantages. The donor site morbidity was decreased, post-operative pain was less and recovery was quicker. The more tedious flap dissection, did not affect the overall outcome and was balanced by the permanent and gratifying results achieved.

### **INTRODUCTION**

Breast reconstruction has been proposed since the beginning of the last century by precursor authors, however, it took its real place in current practice only with the appearance of the musculocutaneous flaps. Many techniques ap-

peared, among which the free flaps had a badly defined place, but the importance of which increased over the past years [1]. It indeed offers a broad choice of donor sites for the surgeon and the patient which enables to obtain a natural breast shape because of the autologous transfer, without the constraints of distance by pedicled flaps [2-4].

Although women with congenital aplasia or developmental malformation of the breast are also possible candidates for breast reconstruction, the majority of candidates for breast reconstruction consults are those with an iatrogenic mutilation of the breast(s) in the form of partial or total mastectomy or radiation damage. Major changes took place in ablative breast surgery during the last century [5]. In the last 25 years, the techniques of breast reconstruction have considerably improved and became a fundamental element in the approach of the treatment of breast cancer patients [6]. Transverse rectus abdominis myocutaneous flap, either free or pedicled, has become the gold standard in autologous breast reconstruction over the last two decades [2,3].

Finally, it became possible to liberate the nourishing vascular pedicle to the overlying skin paddle without harvesting any muscle in the direction of the muscle fibers around the perforators and hence, a new generation of flaps called “perforator flaps” was developed [2-4].

Our aim was to define the specific role of breast reconstruction by free flaps with emphasis on the indications, contraindications, advantages

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and disadvantages of the techniques, with special care to point to the latest technique we used which was the free DIEP-flap in breast reconstruction.

### PATIENTS AND METHODS

This study included 25 patients having breast cancer which necessitated removal of their mammary glands and reconstruction of their breast was performed using the Deep Inferior Epigastric Perforator (DIEP) free flap. This study was conducted partially at the Plastic Surgery Unit, El-Minia University Hospital and Cairo University Hospital. It was performed in the period between June of 1997 and December of 1999.

*Patients:* Twenty-five patients had unilateral breast reconstruction after mastectomies, using the free DIEP-flap, with a total of 25 flaps. Fourteen breast reconstructions were immediate and 11 were delayed. All patients were collected prospectively and no patients were excluded from this study. Seventy percent of patients had one or more risk factor for using the Transverse Rectus Abdominis Muscle (TRAM) flap reconstruction, as obesity (20%), smoking (20%), radiotherapy (24%) and abdominal scars (35%).

*Method:* The surgical technique described by Lantieri et al., was adopted throughout this study [7].

*Preoperative marking:* the patient was marked in the standing position on the night before surgery. These markings are the same as for conventional free TRAM-flap. They should include a small part of the peri-umbilical region to include the important peri-umbilical perforators. For delayed reconstruction, the infra-mammary fold was marked in correspondence to the healthy contralateral breast. For immediate reconstruction, the infra-mammary fold must be preserved as an important landmark for pleasing results. For subcutaneous mastectomies, breast removal may be performed through an extended circumareolar incision. This same incision can be used to fill the skin envelope with a de-epithelialized DIEP-flap (Fig. 1).

*Technique:* The patient was placed in the supine position with both arms abducted. A two-team approach was used in most cases. While the first team was raising the flap, the second team was either performing the mastectomy in case of immediate reconstruction, or excising

the scar of the previously performed mastectomy in case of delayed reconstruction. The second team prepared the skin pocket, which will receive the flap and also prepared the recipient vessels in the axilla.

Dissection of the flap started from lateral to medial with the lateral border of the rectus muscle and keeps all perforators. The midline was dissected after coagulating the perforators of the contralateral side. Then, a larger perforator was chosen to start the dissection by opening the anterior rectus sheath. One perforator after the other was dissected along the course of the deep inferior epigastric artery. Then, the inferior epigastric vessels were dissected towards their origin from the iliac vessels and the rectus muscle was dissected away from the vessels. Then, the skin island was connected to the deep inferior epigastric artery through generally two to three good-sized perforators. The flap could be harvested by transecting the vessels at origin and the pedicle was passed through a window created by splitting the muscle fibers. Donor site was closed without tension, simultaneously while performing the microvascular anastomosis, following standard abdominoplasty closure of the skin flaps with umbilicoplasty (Fig. 2).

The circumflex scapular vessels were utilized as the recipient vessels in all cases. The flap was secured to the mastectomy incision. The vein was anastomosed first, then the artery. The flap was then tailored to achieve the desired breast size and shape. The wounds were closed with suction drains. No anticoagulants were given during or after surgery. Post-operatively, the flap was closely monitored.

### RESULTS

The average age of the patients was 44 years (range, 31 to 66 years) and the average weight was 77.5 kg (range, 55 to 100 kg). Fourteen breast reconstructions were immediate and 11 were delayed. Average flap harvesting time was 120 minutes, average total operative time was 360 minutes in cases of immediate reconstruction (time for both mastectomy and reconstruction) and 280 minutes for delayed reconstruction. The average ischemia time was 60 minutes (Table 1).

*Circumflex scapular vessels variations:* The diameter of the circumflex scapular artery (CSA)

varied from 1.5-3 mm and systematically matched with the diameter of the deep inferior epigastric artery. The CSA was a branch of the sub-scapular system in 22 dissections (88%) and in three cases (12%) the artery was a direct branch of the axillary artery. The length of the available pedicle from the axillary vessels and the distal part where it can be divided (between scapular and parascapular vessels) was  $76 \pm 13$  mm for the artery and  $72 \pm 12$  for the vein. There was a dual venous system in 13 cases (52.0%), but in 9 cases, one of the two veins was dominant and in the other four cases for which the veins were dual and of equivalent diameter, the epigastric veins were also dual and allowed second anastomosis. Twenty of the flaps were based on two perforators, three were based on one large perforator and two flaps were based on three perforators (Table 2).

#### *Flap complications:*

Total flap loss occurred in one flap (4.0%) due to postoperative arterial thrombosis despite of revision and partial necrosis occurred in another flap (4.0%) due to venous congestion. Fat necrosis was found in one flap (4.0%). Hematoma formation under the flap occurred in one patient (4.0%) which did not require surgical intervention (Table 3).

#### *Donor site complications:*

Abdominal wound infection occurred in one patient (4.0%) which resolved with antibiotics and daily dressings and did not require surgical re-intervention. Post-operative abdominal wall examination revealed hernia in one patient (4.0%) which needed surgical correction. All patients were able to resume their daily activities (Table 3).

#### *Anastomosis complications:*

There was one venous thrombosis (4.0%) which was treated by revising the anastomosis and did not compromise late results. There were two cases of arterial thrombosis (8.0%), both were treated by revising the anastomosis but unfortunately, the flap was lost in one of the two cases (Table 3).

#### *Aesthetic result:*

Most of the patients were satisfied with the results (80%). Twelve patients (48%) commented on the results as excellent, eight patients (32%) commented that these were good results, three

patients were just satisfied (12%) and two patients (8%) were not totally satisfied, due to their poor results (total or partial necrosis) (Table 4).

Table (1): Demographic data.

	Average	Range
Age (ys)	44.0	31-66
Weight (Kg)	77.5	55-100
Flap harvesting time (mint)	120	100-140
Total operative time (mint)		
Immediate	360	300-420
Delayed	280	210-290
Ischemia time (mint)	60	45-70

Table (2): Feeding perforators for each flap.

One perforators	3	12.0%
Two perforators	20	80.0%
Three perforators	2	8.0%
Total flaps	25	100.0%

Table (3): Complications.

<i>Flap complications:</i>		
Total flap loss	1	4.0%
Partial necrosis	1	4.0%
Fat necrosis	1	4.0%
Hematoma under flap	1	4.0%
<i>Donor site complications:</i>		
Abdominal wound infection	1	4.0%
Post operative hernia	1	4.0%
<i>Anastomosis complications:</i>		
Arterial thrombosis	2	8.0%
Venous thrombosis	1	4.0%

Table (4): Aesthetic results.

Excellent	12	48%
Good	8	32%
Fair	3	12%
Poor	2	8%
Total	25	100%

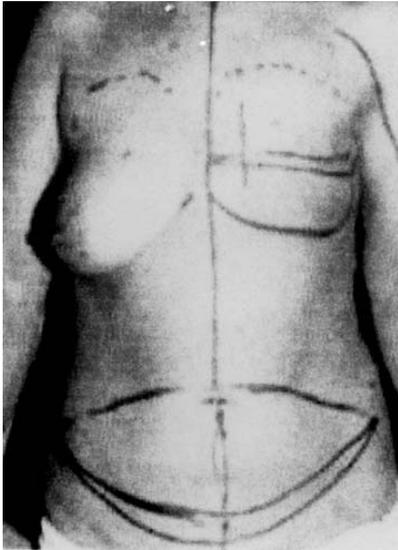


Fig. (1): Pre-operative markings.

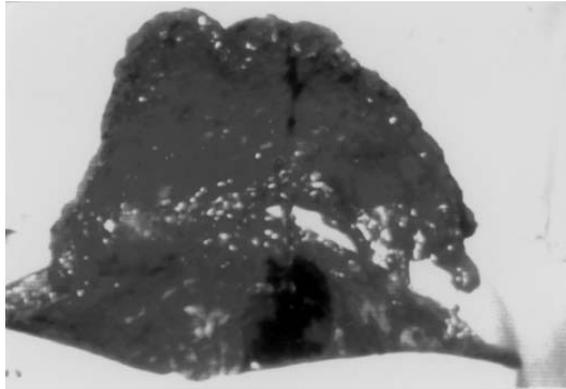


Fig. (2): The DIEP-flap totally dissected prior to division of the deep inferior epigastric artery (based on three perforators).

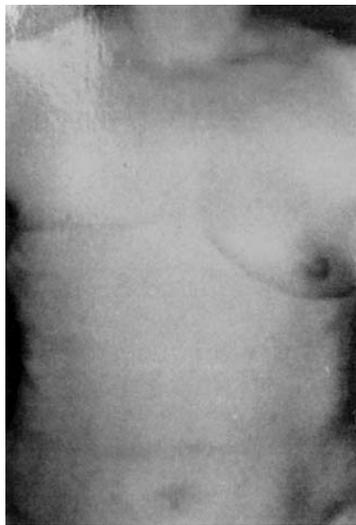


Fig. (3-A): 43-year-old woman presenting for secondary breast reconstruction after having undergone modified radical mastectomy 6 month earlier.

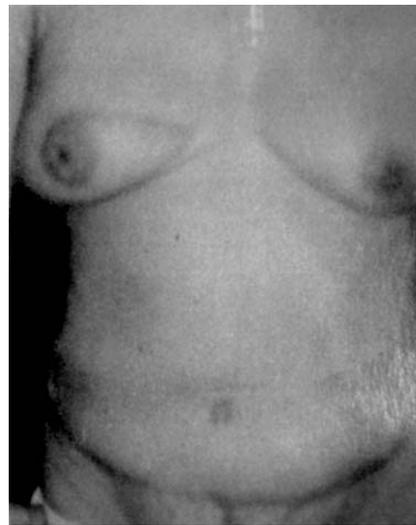


Fig. (3-B): DIEP-flap reconstruction was done. Early post-operative view.

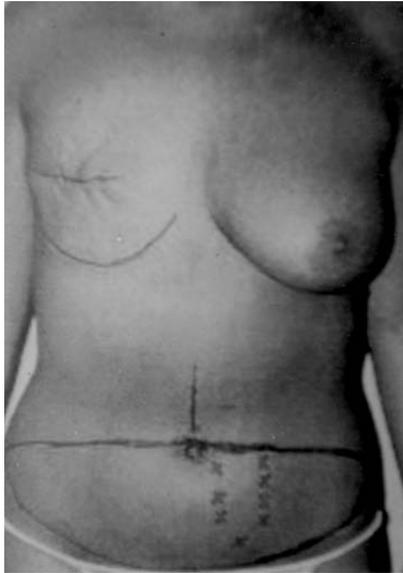


Fig. (4-A): A 54-year-old patient who had Lt side modified radical mastectomy and breast reconstruction using a prosthesis with unpleasant cosmetic results.



Fig. (4-B): After removal of the prosthesis and reconstruction using the DIEP-flap and mastopexy of the Rt breast.



Fig. (5-A): Pre-operative view.

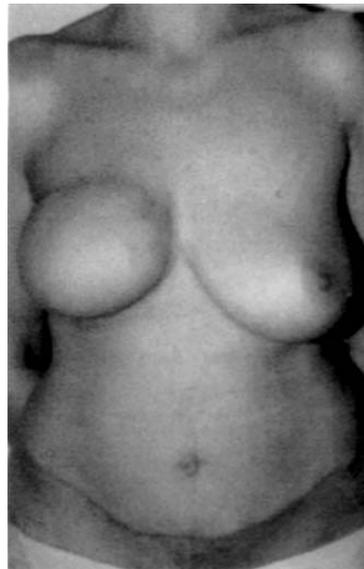


Fig. (5-B): Post-operative view. A 36-year-old woman after secondary Rt breast recozstruction with DIEP-flap.

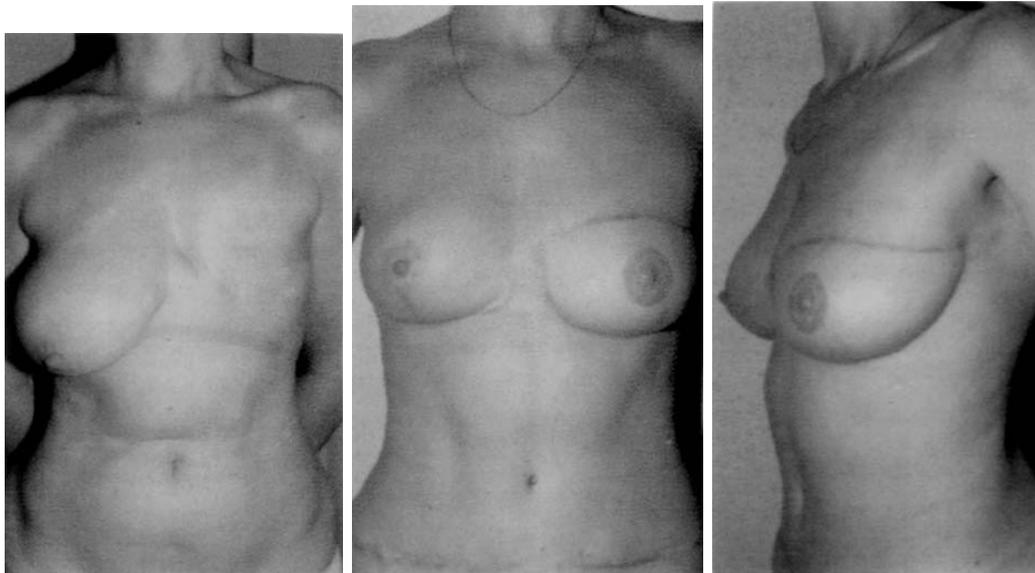


Fig. (6-A)

Fig. (6-B)

Fig. (6-C)

Fig. (6-A,B,C): A 41-year-old patient, who has undergone secondary breast reconstruction with DIEP-flap on the Lt side after Lt radical mastectomy. A Rt breast reduction was done to achieve breast symmetry.

### DISCUSSION

Every woman undergoing ablative breast surgery should at least have the opportunity to be informed pre-operatively about the different breast reconstruction techniques [1]. Secondary or late breast reconstruction offers a number of distinct advantages. Despite these benefits, nowadays primary or immediate reconstruction is preferred to decrease fear of mastectomy with better preservation of body image and self-esteem [1,6,8]. It decreases length of hospital stay, number of interventions, anesthesia and resource costs [9]. The total number of post-operative complications is less or equal to secondary reconstruction or mastectomy alone. There is improved esthetical outcome without delay or exclusion of chemo- or radiotherapy as post-operative adjuvant treatment. Additionally, primary reconstruction has proven to be an "oncologically safe" procedure both for reconstruction with implants and with autologous tissue [10,11].

Breast reconstruction with implants is an easy surgical procedure, which does not involve additional scarring at possible donor sites. The total number of complications and the limited life span of implants make this a sub-optimal choice, especially in younger women. Despite

these considerations, a breast implant can still be a valuable option to reconstruct small sized non-irradiated breasts, or can also be offered to patients who are not willing or able to undergo a long and extensive surgery (high age and poor prognosis) [8,12].

On the other hand, autologous breast reconstruction provides ample amounts of soft, warm and pliable tissues that imitate the normal anatomy more accurately. The long-lasting character of the results with natural ptosis and better definition of the infra-mammary crease, add to better cosmetic results and subsequently higher patient satisfaction. Also, the possibility to add supplementary skin to a tight mastectomy scar is a unique feature that avoids over-stretching of the skin with subcutaneous expanders [1,2,6]. At the donor site, an aesthetic improvement of the body contour can be achieved by an abdominoplasty for the TRAM-flap or a buttock lift for the gluteal flap. The lower cost of autologous tissue is mainly due to a decreased amount of long-term complications and surgical revisions [12]. The volume and shape of an autologous reconstruction will follow body weight changes and spontaneous return of sensation is possible. They also offer a valuable solution for partial mastectomies and post-mastectomy chest contour

irregularities, a problem difficult to solve with implants [7]. Additionally, autologous tissue is preferred if adjuvant chemo- and/or radiation therapy is expected to be combined in the cancer treatment [13,14].

The first time to use of the lower abdominal tissue for breast reconstruction was reported in 1979 and the use of the pedicled TRAM-flap was popularized in the early 80's [15,16]. Despite all advantages, there was considerable weakening of the abdominal wall, ill-defined infra-mammary crease, inconsistent results and a high number of partial flap and fat necrosis [17,18]. The free TRAM-flap has superb cosmetic results with lower total complication rate [19]. For these reasons, the TRAM-flap, either free or pedicled, has become the gold standard in autologous breast reconstruction over the last two decades [20].

In 1989, it was reported, for the first time that it was feasible to harvest the same amount of lower abdominal skin and fat as the TRAM-flap without sacrificing the muscle. One or more perforators were dissected out after vertical splitting in the direction of the muscle fibers; hence, a new generation of flaps called "perforator flaps" was developed [21].

The present study included twenty-five patients having breast cancer, which necessitated removal of their mammary glands and reconstruction of their breasts was performed using the DIEP-flap. Fourteen breast reconstructions were immediate and 11 were delayed. Because the mentality of our patients is somewhat difficult in accepting the concept of delayed reconstruction, immediate reconstruction was proposed for most of our cases. If we could not persuade them before mastectomy, it is difficult to get them back for secondary reconstruction.

The fact that the muscle is only split and not cut, reduces post-operative pain and allowed early mobilization and patient can walk independently after 48 hours, with reduction of the hospital stay compared to TRAM-flap patients [17,22]. In the long run, the financial losses of the prolonged operating time will be reimbursed by a reduced number of re-intervention for abdominal wall incompetence. We had only one patient who developed post-operative hernia that was passing lateral to the rectus muscle at the lower part of the opening of the rectus sheath

due to faulty technique of closure. This patient was treated surgically with reduction of the hernia and the placement of a prolene mesh with no recurrence of hernia at follow-up. All our patients were able to resume their daily activities.

By dissecting the vascular pedicle from the anterior rectus fascia down to the external iliac vessels, the length of the pedicle is considerably increased. This offers increased freedom and flexibility in positioning and rotating the flap for ideal breast mound shaping [23]. A free DIEP-flap with a bilateral vascular pedicle could be harvested in bilateral reconstruction or if large flaps were required, but no bilateral flaps were encountered in this series [22].

By anastomosing one of the pure sensory branches of the segmental nerves of the abdominal flap to the anterior ramus of the lateral branch of the 4th intercostal nerve, the sensory innervation could be restored in the flap and this makes it the only free flap for breast reconstruction to be sensate [1,2,24]. But we did not do any neural anastomosis in this series.

The DIEP-flap therefore, preserves all the intrinsic advantages of TRAM-flap but discard, its most important disadvantages. The main disadvantage of the DIEP-flap is a more difficult pedicle dissection specially the inter-muscular portion of the pedicle, which increases the operating time. This dissection requires more patience than skill. Once acquainted with this dissection technique, one can move fairly quickly with the combination of blunt dissection and ligation of side branches [1,3]. This tedious flap dissection did not affect our overall results.

We found that the free DIEP-flap with its complication rate is safe and reliable technique which is comparable to the experience of others [1-4,23,25]. Although still a very low risk is involved, specially total flap loss (we had only one flap out of 25), free perforator flap surgery for breast reconstruction is the surgical technique in which the least peri- and post-operative complications are involved. Additionally, by sparing the donor site muscle, the normal breast anatomy is imitated in the best possible way and except for the donor site scar, no other damage is caused to the body. It offers the patient the best long-term aesthetic outcome [1-4,26]. Most of our patients (80%) were satisfied with their results.

We consider the free DIEP-flap to be the first choice for breast reconstruction because of the inherent characteristics of the lower abdominal wall tissues. Other perforator flaps as the Gluteal Artery Perforator flap can be used only in salvage cases or when the DIEP-flap is not available [4].

#### Conclusion:

The free DIEP-flap provides a better way to perform autologous breast reconstruction, compared to the free TRAM-flap. It is a safe and reliable technique and is not related to a higher complication rate than other techniques of free flap breast reconstruction. Its donor site morbidity is lower than the free TRAM-flap. So, the DIEP-flap is recommended as the first choice for autologous breast reconstruction.

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