Breast Reconstruction with Free Flaps

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37.1 Introduction

In 1973, Taylor and Daniel used the term "free flap" to describe the distant transfer of an island flap by microvascular anastomosis [1, 2]. They also carried out a detailed anatomical description of many of the more common free flap donor sites still in use to date [3].

The modern era of autologous breast reconstruction began with the free abdominoplasty flap introduced by Holmström in 1979 [4] and with the transverse rectus abdominis myocutaneous (TRAM) flap by Hartrampf in the early 1980s [5]. Both used the common pedicle flap concept to transfer autologous tissue from the abdomen to the chest wall for breast reconstruction using the inferior epigastric artery for the former and the superior epigastric artery for the latter with the rectus abdominis muscle as a carrier [4, 5].

Because of the complications correlated with the use of transverse rectus abdominis muscle such as abdominal wall weakness, abdominal bulging, frank herniation, and abdominal and lumbar back pain, the concept of donor-site muscle-sparing techniques was then embarked upon. On this basis Koshima used the skin territory overlying the rectus abdominis muscle to reconstruct head and neck defects [6]. The flaps were based on a single paraumbilical perforator vessel from the deep inferior epigastric artery. The perforator vessels were dissected meticulously leaving an intact rectus abdominis muscle and followed toward the deep inferior epigastric vessels to achieve adequate pedicle length. The resulting flap was thin, composed only by the skin and the vascular pedicle. The goal of muscle preservation became more apparent, and the next significant step was related to the work on perforator flap of the authors' group at Louisiana State University Medical Center. They injected fresh abdominoplasty specimens assessing that the skin and fat could be transferred without the use of the rectus abdominis muscle. This led to the realization of the first deep inferior epigastric perforator (DIEP) flap for breast reconstruction by Allen in 1992 [7]. By the use of this original procedure, 15 breasts were successfully reconstructed offering the same benefits as the TRAM flap but reducing the abdominal wall morbidity. The beginning of free tissue transfer allowed an infinite range of possibilities to appropriately match donor and recipient sites.

It is known that the type and timing of reconstruction is a multifactorial decision. It is based on the size and shape of the native's breast, location and type of cancer, patient's characteristic, patient's expectations whether adjuvant radiation and/or chemotherapy are needed, and the surgeon's preferences and skills. The commonly used autologous tissue flaps for breast reconstruction are free TRAM (muscle sparing) flap, DIEP flap, superior gluteal artery perforator (SGAP) flap, inferior gluteal artery perforator (IGAP) flap, transverse upper gracilis (TUG) flap, and superficial inferior epigastric artery (SIEA) flap. The alternative flaps, e.g., Ruben's flap (DCIA), anterolateral thigh (ALT) flap, and transverse fascia lata (TFL) flap, are occasionally used for breast reconstruction.

37.2 Free Flaps from Abdomen

37.2.1 Free TRAM Flap

The skin paddle of the TRAM flap is drawn between the umbilicus and pubic region and from the front of the iliac bone. Both deep superior and inferior epigastric vessels supply the muscle, while the skin and fat tissue are vascularized by perforators through the rectus abdominis muscle. The flap can be harvested either in a free microvascular or in a pedicled form. In the pedicled form, the caudal portion of the muscle is detached. Still left connected to the rest of the muscle, the flap is moved under the skin up to the mastectomy

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site to reconstruct the breast. The modern free TRAM as "free abdominoplasty flap" for breast reconstruction was described first by Holmström in 1979 [4]. As a free microvascular flap, the TRAM flap is harvested with a small cuff of the rectus abdominis muscle and brought to the mastectomy site reestablishing the blood supply by microsurgical anastomoses between the deep inferior epigastric pedicle and the scapular circumflex vessels. Based on the amount of rectus abdominis muscle spared [8], the free TRAM is classified into four types: in MS0, full width (partial length) of the rectus abdominis muscle is harvested; in MS-1, lateral segment is preserved and as a result the innervated lateral rectus muscle is left intact. The middle/medial rectus muscle just enough to support the perforators with a narrow strip of anterior sheath is harvested with the flap. In MS-2, lateral and medial segment is preserved, while MS-3 is equivalent to DIEP flap because the entire muscle is left attached. The abdominal complications are significantly reduced with this technique compared to the pedicled TRAM flap as both the lateral innervated muscle and rectus sheath are preserved. Compared to the pedicled TRAM flap, reconstruction of breasts with the free TRAM flap offers a lower complication rate at the mastectomy site and a low donor-site morbidity rate as reported by Kroll [9] even if the ability to do sit-up from supine position was best retained in free TRAM (63%), followed by pedicled TRAM (57%) and free bilateral TRAM (46.2%), and worse in pedicled bilateral TRAM.

In literature, a lot of studies reported the impact of free flap breast reconstruction on the abdominal wall in order to minimize donor-site morbidity [10–14].

The planning of the free TRAM flap is similar to the DIEP flap. All details are reported in the next subheading.

37.2.2 DIEP Flap

The flap harvesting includes the identification of at least one reliable perforator. The average pedicle length is 8–15 cm and diameter is 2–3.6 mm. The first step is to assess the amount of skin and subcutaneous adipose tissue that should be transferred from the abdomen to the mastectomy site to achieve symmetry in ptosis and volume with the opposite breast. A simple pinch test can help the surgeon to estimate the amount of excess tissue available for reconstruction. The use of a complementary device in surgeon evaluation such as the BREAST-V [15] can be useful to predict preoperatively the volume of the breast that has to be reconstructed. An app entitled BREAST-V for both iOS and Android devices is currently available for free download in the Apple Store and Google Play Store.

Preoperative markings are done with the patient in upright position. The general surgeon indicates the oncological planning and the breast skin area that has to be removed with the mammary gland. Plastic surgeon then can plan the DIEP flap harvest. Standard abdominoplasty markings are made in the sitting or standing position, while the flap markings included vascular zones I–III for unilateral and zones I–II for bilateral reconstructions according to Holm et al. [16]. The side of the abdomen contralateral to the side to be reconstructed is usually preferred as it allows simultaneous operating by two teams. The inferior incision is marked in the natural suprapubic crease and extended to the level of the anterior superior iliac spine (ASIS) on both sides, while the superior incision is made joining the two ASIS passing over the umbilicus. The umbilicus is first dissected and the superficial inferior epigastric vein is identified and preserved if significant in size. Depending on the type of mastectomy that should be performed, the flap can be de-epithelialized during this step as planned. Then the flap dissection starts in a lateral-to-medial direction above the deep fascia until the first reliable perforator of the lateral/medial row is visualized. The number of selected perforators depends on the perforator's position, vein diameter, and flap volume to be transferred. The superficial inferior epigastric vein can be preserved and included in the flap as an extra-venous outflow.

Rectus sheath is opened around the perforator to facilitate further dissection following its course until its origin. Only the part of the rectus abdominis muscle that is found among the vessel is sacrificed in order to identify and dissect the course of the deep inferior epigastric pedicle running under the muscle until its origin from the external iliac vessels. Care is taken to preserve any intercostal nerves innervating the medial aspect of the muscle that might cross the pedicle. The superior end of the pedicle is divided above the perforator, and the zone IV of the flap is discarded. Once the recipient vessels are ready, the inferior end of the pedicle is ligated. The flap is then weighed and transferred, rotated 180°, and fixed temporarily to the chest wall. Great care is taken for the flap pedicle position without any twists or kinks; both arterial and venous end-to-end anastomoses are performed, while a second team carries out donor-site closure. The anterior rectus sheath is repaired with interrupted 1-0 vicryl sutures, and the umbilicus is relocated at a level above the ASIS. The Scarpa's fascia is approximated with interrupted 2-0 vicryl sutures, while the abdominal skin is sutured in two layers. The abdominal wall is supported by an elastic band, and the patient is positioned on the bed in half-sitting position in the immediate postoperative period. Next, the flap insetting is completed while the contralateral procedure is performed if already planned (Figs. 37.1, 37.2, 37.3, 37.4, and 37.5).

Although good and long-term aesthetic outcomes can be obtained in unilateral DIEP flap reconstruction, contralateral procedures are often required to achieve breast symmetry. Stevenson and Goldstein compared TRAM flap and immediate contralateral breast reduction/mastopexy with TRAM flap alone observing a satisfactory aesthetic result [17]. Haykel and Gay reported a single-stage autologous reconstruction by the use of both pedicled flaps and free

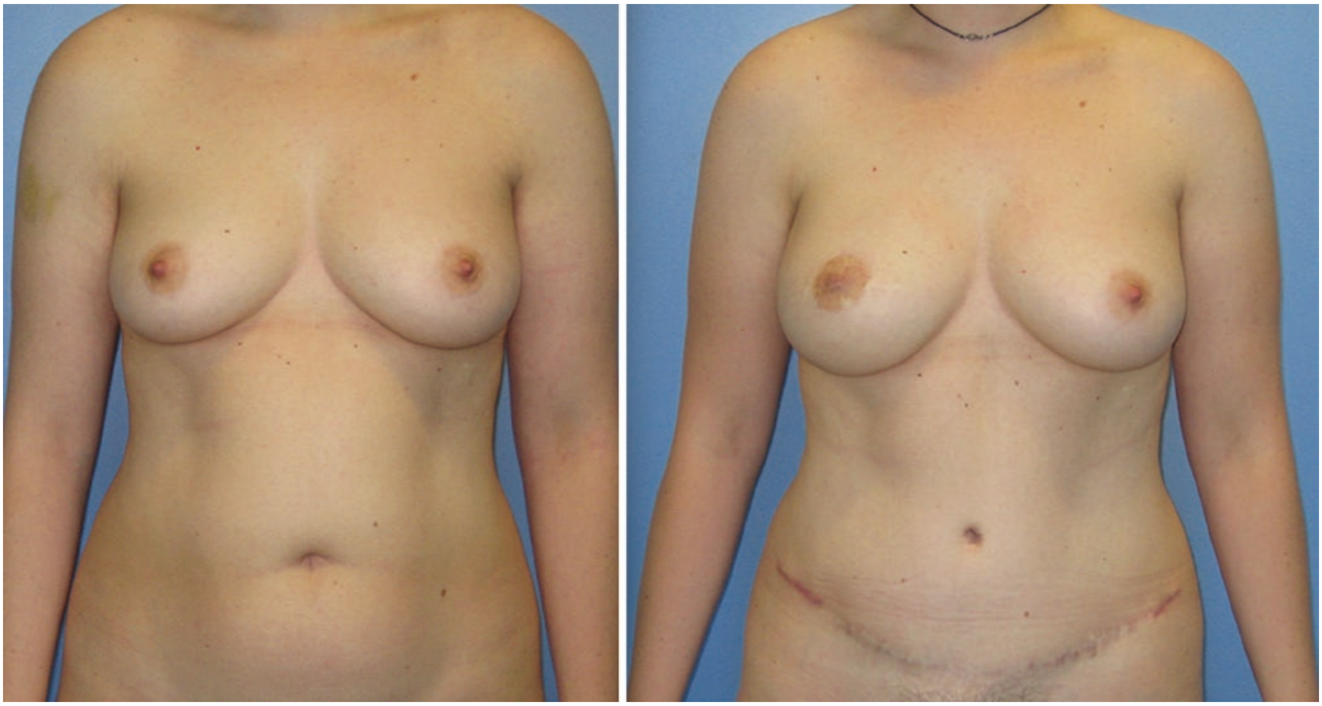

Fig. 37.1 A woman underwent immediate one-stage DIEP flap reconstruction following right nipple-sparing mastectomy. Preoperative (*left*) and postoperative (*right*) frontal view

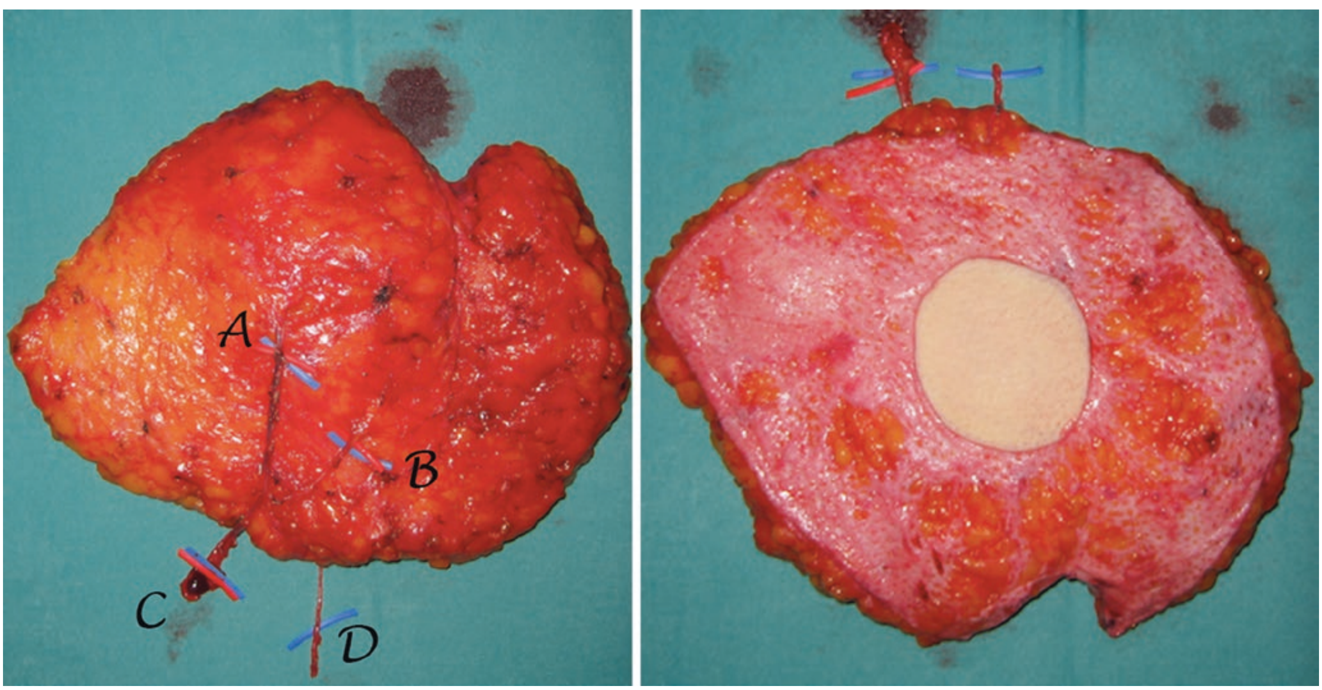

Fig. 37.2 Intraoperative DIEP flap. Posterior view (*left*) showing two perforators, superficial epigastric vein and deep inferior epigastric pedicle. Anterior view (*right*) showing sentinel skin island

flaps. They observed 11.3% of postoperative aesthetic complications in 141 patients by means of volume excess (5.7%), malposition (2.1%), volume loss due to weight loss (1.4%), shape asymmetry (1.4%), and volume deficiency (0.7%) [18].

Huang et al. observed greater patient satisfaction, minimal increase in operative time, and no increase in complication rates comparing clinical and aesthetic outcomes in immediate and staged contralateral surgery in DIEP and superficial inferior epigastric artery (SIEA) flap reconstruc-

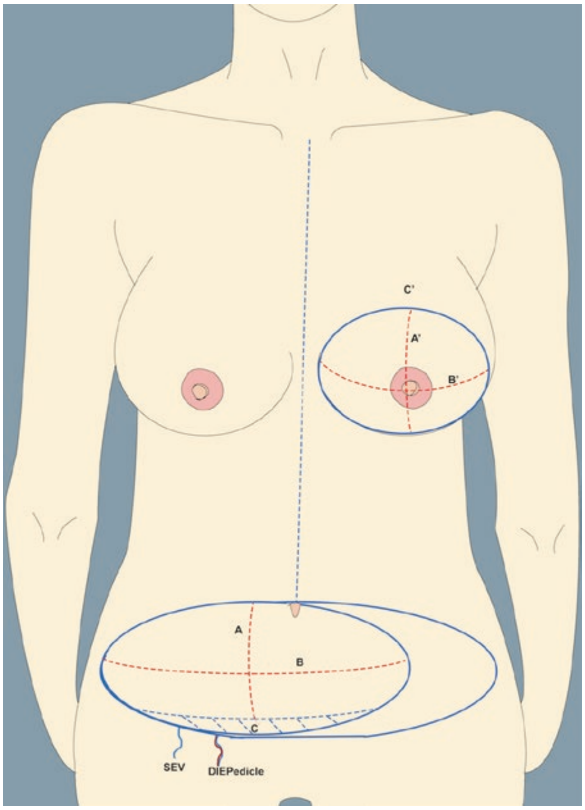

Fig. 37.3 DIEP flap breast reconstruction planning. Modified radical mastectomy is drawn on the affected breast (A = vertical axis, B = horizontal axis). DIEP flap markings with a skin paddle (A′ = vertical axis, B′ = horizontal axis) to match the mastectomy pattern (A = A′, B = B′) and the de-epithelialized area of the flap (C, C′). *SEV* superficial epigastric vein, *DIEPedicle* deep inferior epigastric pedicle

tion [19]. One-stage DIEP flap reconstruction by means of the symmetrization algorithm was also described resulting in comparable aesthetic outcomes and patient satisfaction to a staged procedure [20].

37.2.2.1 Recipient Vessel Selection

The choice of recipient vessels is one of the key points in microvascular breast reconstruction, and it is largely up to the reconstructive surgeon and usually based on comfort level and experience, flow characteristics, chest topography, and patient comorbidities. In the recent literature, there is no unanimously agreed upon recipient sites for anastomoses. Both internal mammary vessels (IMV) and axillary vessels such as thoracodorsal (TDV) and circumflex scapular vessels (CSV) are usually easy to expose and of suitable caliber, allow an end-to-end anastomosis, and have demonstrated advantages and disadvantages in this setting. Some surgeons advocate the use of IMV as recipient vessels of choice [21–24], while others observed unpredictable quality and inconsistency of the internal mammary vein diameter at the level of the fourth rib, difficult anastomosis due to respiratory movements, risk of pneumothorax, and contour deformity due to rib cartilage excision [24]. Time for vessels' dissection and exposure in immediate reconstruction represents an issue in favor of the axillary vessels. The general surgeon following the lymphadenectomy or sentinel lymph node biopsy performs the preparation of these vessels, while the access to the IMV usually needs an extra "step" [25].

Previous reports have demonstrated that the flow rate of the flap is correlated to its size and therefore its flow rate is

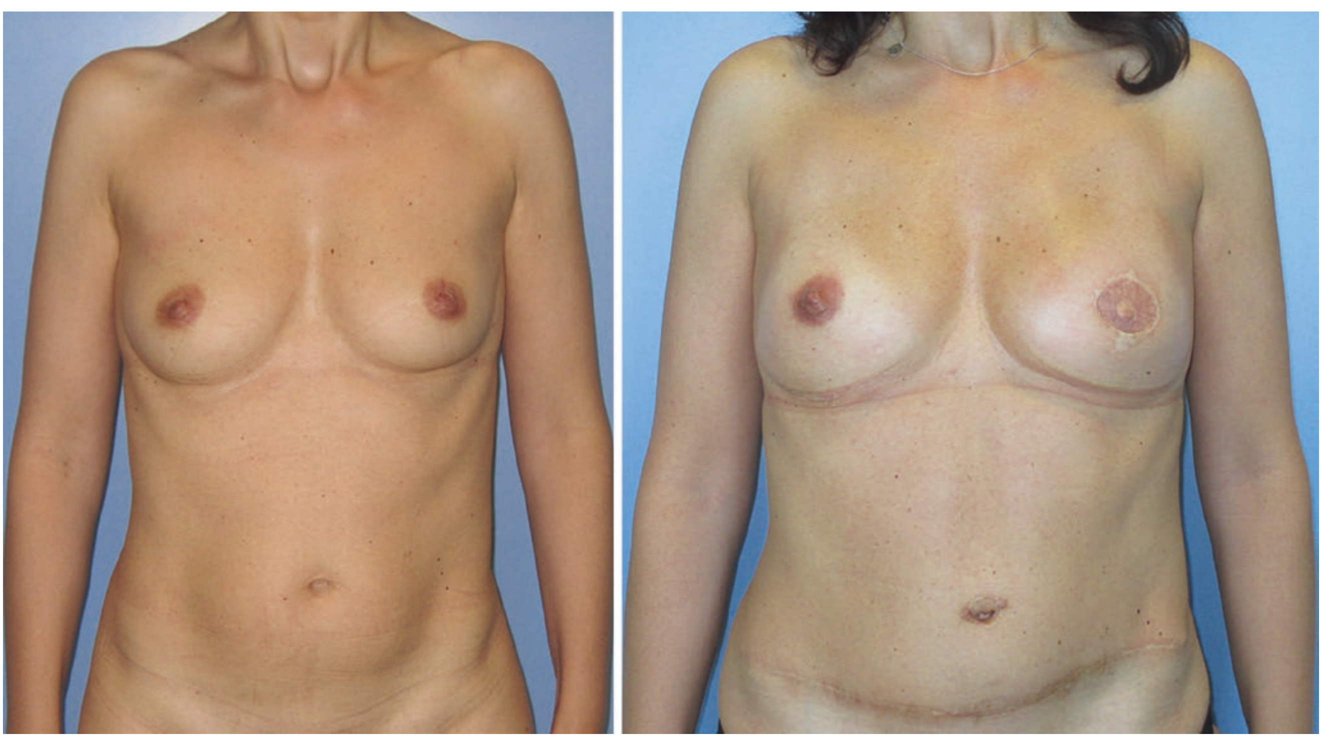

Fig. 37.4 A woman underwent immediate bilateral one-stage DIEP flap reconstruction following right nipple-sparing mastectomy and left skin-sparing mastectomy. Preoperative (*left*) and postoperative (*right*) frontal view

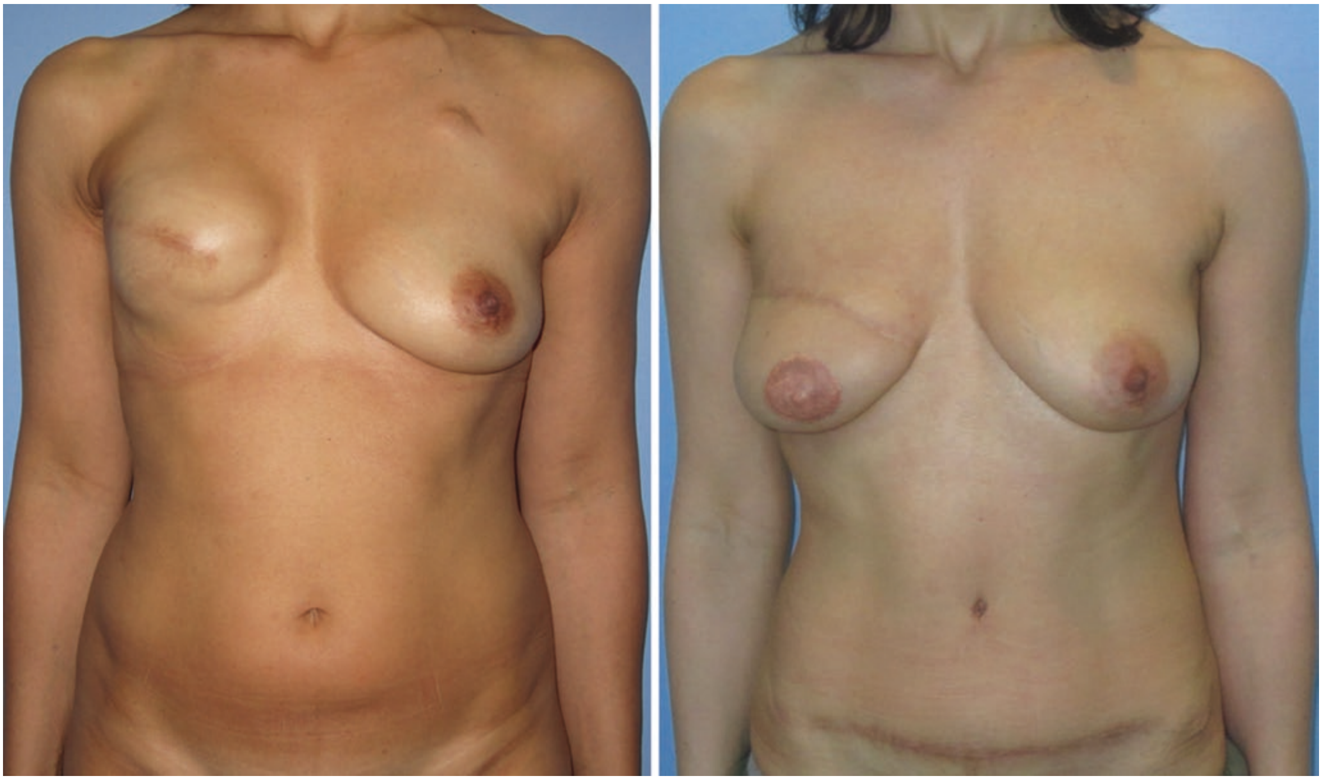

Fig. 37.5 A woman underwent secondary DIEP flap breast reconstruction after right modified radical mastectomy and failed reconstruction with breast expander. Preoperative (*left*) and postoperative (*right*) frontal view

correlated to its venous drainage [26, 27]. Adding veins in parallel and choosing veins with larger diameter can increase drainage from the flap and reduce risk of venous congestion. Both axillary and IMV have adequate negative vein pressure and drainage, but using IMV the main drawback is the difficulty to have two veins of adequate size and length compared to TDV and CSV [27, 28].

The perforators arising from the internal mammary vessels have also been used as recipient vessels avoiding many of the complications related to the use of IMV, but unfortunately their presence depends on anatomical variability and preservation by the general surgeon [29]. The absence of a proper and careful preoperative planning may cause an increased operative time and/or surgical errors.

We prefer the use of the CSV as a recipient pedicle [28]. Majority of our cases involve immediate breast reconstruction where the axillary vessels are already exposed during lymph node dissection. From our experience, vascular anastomosis, re-exploration, and revision are technically easier in the axilla. Complications such hematoma can be quickly identified and managed easily in the axilla. Moreover the use of CSV saves TDV pedicle to assure the viability of a myocutaneous latissimus dorsi flap, useful for salvage procedure in case of previous reconstruction failure. Furthermore, despite the possibility of accidental TDV injury by the general surgeon during lymph node dissection or radiotherapy damage in delayed reconstructions, the anatomical location of the CSV make it unlike for CSV [23, 30] as they are located in the omotricipital space and not embedded in scar tissue neither their lumen is never reduced nor weakened.

37.2.3 SIEA Flap

The procedure is similar to the DIEP flap, but the SIEA flap is harvested on the superficial inferior epigastric vessels just below the skin surface avoiding injury to the anterior rectus abdominis fascia or the muscle. Grotting first described it for breast reconstruction in 1991 [31]. The SIEA artery is a direct cutaneous vessel that arises from the medial side of the common femoral artery as a common trunk with superficial circumflex iliac artery or, independently, approximately 2 cm below the inguinal ligament. It travels up and pierces the cribriform fascia supplying the subcutaneous tissue and skin of the lower abdomen. The artery is accompanied by venae comitantes, and an additional prominent vein runs 3–4 cm medially to the artery. As previously described, this vessel is very useful as a second vein anastomosis in DIEP flap reconstruction.

By the use of the SIEA flap, there is no risk of abdominal hernia or bulge. Indeed, there is the significant saving of operating time because the vessels run above the rectus sheath avoiding any tedious intramuscular vessel dissection. Nevertheless, its major drawbacks are the inconsistent vascular pedicle anatomy, the shorter (6–15 cm) and smaller diameter (1.4 mm) vascular pedicle, and limited flap territory. The skin area supplied by the artery is 140 ± 100 cm^2 running in a curvilinear way, 5 cm above the iliac crest. The flap spreads from the anterior superior iliac spine to the lateral border of the rectus abdominis muscle and below the umbilicus to the pubic hairline [32, 33]. A well-vascularized flap includes the zones I and II (ipsilateral hemiabdomen), while zones III and IV (contralateral hemiabdomen) are not considered reliable. Blondeel observed the inverse relationship between superficial and deep inferior epigastric veins [34]. The superficial inferior epigastric vessels may be dissected and preserved if more than 1.5 mm in diameter as previously suggested, irrespective of DIEP, SIEA, or MS-1 TRAM [35, 36].

37.2.4 Abdominal Free Flaps and Prior Abdominal Surgery

Despite the relative contraindications due to the supposed extensive vascular interruption [5, 37, 38], free TRAM, DIEP, and SIEA flaps can be harvested safely by tailoring the flaps previous abdominal surgery such as appendicectomy, hysterectomy, low cesarean section, subcostal cholecystectomy, midline laparotomy, laparoscopy, and other laparoscopic scars. Hamdi et al. proposed their clinical approach to maximize the perfusion to the upper abdominal flap by either widening/lengthening or "augmenting" the supply of the upper flap (with perforator preservation). A bipedicled free flap is also suggested in order to obtain an adequate amount of tissue when the anatomical condition does not allow harvesting ample tissue using standard flap markings [39]. Depending on the location and type of the scars, available vascular pedicle, perforator locations, and required flap tissue for breast reconstruction, Laporta et al. also suggested three clinical approaches by the use of standard abdominoplasty markings to ensure well-vascularized flap and to minimize abdominal donor-site complication [40]. If the Pfannenstiel or laparoscopic (hysterectomy or other gynecological operations) scars damage or interrupt the deep inferior epigastric vessels, the length of the pedicle is too short to reach CSV; they suggest the use of the serratus anterior pedicle (SAP) as recipient vessels. In patients with midline laparotomy scars, a simple but effective strategy is to vertically split the infraumbilical tissue into two hemi-DIEPs. To overcome the relative lack of volume, they propose a delayed fat graft session within 6 months after primary surgery. In all patients with a chevron or subcostal scars, the skin area caudal to the previous incisions is left attached to the periumbilical perforators.

In doubtful cases, a CT angiogram may be useful and can be arranged preoperatively to assess the status of perforators and the main vessels.

37.3 Free Flaps from Other Sites

In cases where abdominal tissue is not available for reconstruction, focus shifts on the gluteal or upper thigh region as donor sites. The SGAP, IGAP, TUG, and profunda artery perforator (PAP) flaps are usually considered flaps of second choice when abdominal tissue is not available. In a review of 31 cases of GAP by Granzow et al., 20 (65%) were performed due to inadequate abdominal tissue, 6 (19%) due to patients' donor-site choice, and 2 (8%) due to failed DIEP flaps [41].

37.3.1 SGAP Flap

The superior gluteal myocutaneous free flap for breast reconstruction was first described by Fujino in 1975 [42] and popularized by Shaw [43]. The main limitation of this flap is the short vascular pedicle, which frequently requires vein grafting, increasing the difficulty, complications, and the time required for this procedure. The SGAP flap for breast reconstruction was described by Allen et al. in 1993 [44]. Advantages of the gluteal artery perforator flaps versus the previous myocutaneous gluteal flaps include the preservation of the gluteus maximus muscle and additional length of the pedicle without the use of vein grafts for anastomosis.

The superior gluteal artery (SGA) is a continuation of the posterior division of the internal iliac vessel. It is a relatively short artery (6–8 cm) and emanates from the pelvis above the upper border of the piriformis muscle, where it immediately divides into both superficial and deep branches. The deep branch travels between the gluteus medius muscle and the iliac bone, while the superficial branch supplies the upper portion of the gluteus muscle and overlying fat and skin.

With the hip slightly flexed and rotated inward, a line is drawn from the posterior superior iliac spine to the posterior superior angle of the greater trochanter. The point of emergence of the superior gluteal corresponds to the junction of the upper and middle thirds of this line. An average of four perforators is usually found from the superior branch of the SGA to supply the skin.

The skin paddle can be designed as an oblique ellipse or horizontally producing a more favorable scar keeping the marked perforator in the center. The average flap height and length are 8 cm (range 5–12 cm) and 22 cm (range up to 30 cm). It should be noted that perforators located laterally would produce longer pedicles. The whole flap can be raised on single perforator and the donor site is closed primarily.

In unilateral cases, the patient is positioned in the lateral decubitus in order to perform mastectomy, recipient vessel dissection, and the flap harvest simultaneously. If a bilateral procedure is scheduled in the primary setting, the patient is placed first supine during the mastectomy and exposure of the recipient vessels. Then, prone positioning, flap harvesting, and closure of both buttocks follow this dissection. The patient is returned in supine position and redraped in order to complete the anastomosis in this setting. The flap is elevated from the muscle in the subfascial plane, and the perforator's dissection starts from lateral to medial. It is preferred to use a single large perforator, if present, but two perforators in the same plane and direction of the gluteus maximus muscle fibers can be taken together as well. The muscle is then spread in the direction of the muscle fibers, and the perforators are followed through the muscle. The dissection continues until both the artery and the vein are of sufficient size to be anastomosed to the recipient vessels in the chest wall.

37.3.2 IGAP Flap

Higgins et al. subsequently introduced the IGAP flap for ischial pressure sore reconstruction in 2002 [45], while Guerra et al. introduced it for breast reconstruction in 2004 [46]. This flap uses the excess lower buttock tissue and preserves the muscle leaving the scar in the natural depression of the inferior gluteal crease. Its use is not widespread, and in literature, there are few articles encouraging this procedure for breast reconstruction [47, 48].

Inferior gluteal artery is the terminal branch of the anterior division of internal iliac artery and emerges through greater sciatic foramen below the piriformis muscle, with sciatic nerve and posterior cutaneous nerve of the thigh. The course of the vessel is more oblique providing a longer pedicle than the SGAP flap.

The gluteal crease is marked with the patient in the standing position. The flap is drawn as a horizontal ellipse with the major axis centered above the gluteal crease and the inferior incision located 2 cm inferior to it. The orientation of the skin paddle is usually parallel to the gluteal fold.

A second line is drawn from the posterior superior iliac spine to the outer part of the ischial tuberosity; the junction of the lower and middle third marks the point of emergence of the inferior gluteal arteries.

The dimensions of the flap usually are typically 8 cm (maximum 12 cm) in length and 18 cm (maximum 30 cm) in width. Flap dissection and patient positioning on operating table is similar to SGAP flap planning. Care must be taken to avoid injury to the posterior femoral cutaneous nerve of the thigh that travels with the inferior gluteal vessels. The sciatic nerve is never visualized because of the subfascial dissection. In small-breasted patients and large buttocks, the IGAP flap can give an excellent result, particularly with secondary liposuction of the lateral thighs. Nevertheless, if a unilateral small IGAP flap is harvested in a thin patient, buttock projection and the inferior gluteal fold may be distorted with unattractive outcomes. Painful donor-site scar and discomfort particularly in the sitting position are more common with the IGAP harvest than the SGAP.

37.3.3 TUG Flap

In 1992, Yousif et al. described the use of the transverse gracilis musculocutaneous flap for breast reconstruction with a transverse orientation of the cutaneous paddle in the proximal third of the muscle [49]. Arnez and Wechselberger popularized simultaneously the flap presenting their case series in 2004 [50, 51]. Compared to the common free flaps from the abdomen (TRAM, DIEP) and the buttocks (SGAP, IGAP), the size of the free TUG flap (25 cm × 10 cm) is smaller and the fat pad is usually thinner [51]. Because of the aforementioned, the flap provides inadequate tissue bulk to reconstruct large and ptotic breasts. Moreover, it is also considered less appropriate for secondary reconstructions where additional skin may be required for the excision of tissues in between the postmastectomy scar and the new inframammary fold.

With the patient in the supine position and the knee and hip flexed, the lower extremity is abducted. The flap is harvested from the ipsilateral side. This enables the reconstructive and general surgery teams to work simultaneously. The skin paddle is oriented transversely on the upper part of gracilis muscle just below the groin crease. The average pedicle length is 5–6 cm, with the vessel diameter around 1.6 mm. A line is drawn on the medial thigh from the pubic symphysis to the medial tibial condyle.

On this line, 8–12 cm distal to the symphysis, perforators from the main (proximal) vascular pedicle are identified by the use of a Doppler probe and marked. Around this marking, the width (vertical diameter) of the flap usually depends on the excess of skin/fat that allows primary skin closure avoiding the risk of wound dehiscence.

The flap is then outlined as a crescent shape with one tip in the lateral anterior groin and the other tip in the middle of the proximal posterior thigh. The superior incision of the crescent is parallel to the groin-gluteal crease (4 cm distal to it), while the inferior incision is drawn 10–12 cm distally.

The incisions are made along the preoperative markings, and the flap is dissected from an anterior to posterior direction in a subfascial plane until the intermuscular septum between the adductor longus and the gracilis muscle is visualized.

The greater saphenous vein can be included in the flap harvest allowing an extra-venous drainage. The fascia is incised anteriorly at the posterior border of the adductor longus muscle, which is then retracted. The dominant vascular pedicle is exposed traveling under the adductor longus and medially the undersurface of the gracilis muscle. The vascular pedicle dissection proceeds until its origin from the profunda femoris artery. The fascia is then incised at the posterior border of the gracilis muscle, and at the knee-joint level, the tendon of the gracilis muscle is divided and mobilized proximally. After checking vascular flap perfusion, the pedicle is divided and then ligated and the TUG flap is transferred to the chest wall. Both the artery and vein from the dominant gracilis pedicle are usually anastomosed end to end to the IMV or TDV. The donor-site closure is similar to the tight lift.

37.3.4 PAP Flap

An interesting recent advance of the TUG flap has been the description by Allen et al. of the profunda artery perforator (PAP) flap [52].

The ideal patient has a breast of small-medium size and excess tissue in the posterior thigh with contraindication for DIEP flap reconstruction. Preoperative imaging such as magnetic resonance or computed tomographic angiography of the pelvis and thigh with contrast can be useful to identify suitable posterior thigh profunda artery perforators. The posterior thigh tissue is bordered horizontally by the iliotibial tract and adductor muscles and vertically by the gluteal fold and popliteal fossa. The profunda femoris artery enters the posterior compartment of the thigh proximally to the knee giving three main perforators. The first perforator supplies the adductor magnus and gracilis, and the second and third perforators supply the semimembranosus, biceps femoris, and vastus lateralis. By the use of the imaging and a handheld Doppler, the perforators are identified and marked on the skin. Between medial and lateral perforators, the medial perforators are preferred because of the easier harvesting in the supine position and the perforator size. The skin paddle is drawn as an ellipse avoiding visible scar in the lateral or medial portion of the thigh outside of the gluteal fold. The superior marking is 1 cm inferior to the gluteal crease, while the inferior marking is approximately 7 cm below it.

Flap harvest can be performed in the prone or supine position. The supine frog-leg position offers the advantage of rapid dissection from a medial approach. Moreover, it is not necessary to reposition the patient to decrease the operative time. The prone position uses a lateral approach and gives the possibility to convert the PAP in TUG flap if no adequate perforators are identified. The elliptical incision is made and dissection proceeds in a suprafascial plane that helps with perforator identification. Once the key perforator is found, standard perforator dissection proceeds to harvest the desired pedicle length and vessels diameter. The donor-site closure is carried out in a multilayer fashion over a drain. After recipient-site preparation, the flap is transferred to the chest wall and the anastomoses are performed. The advantages on the use of PAP flap compared to TUG flap include the pedicle length as long as 13 cm (average, 9.9 cm) that provides versatility at the recipient site (IMV or TDV or CSV), the elliptical design that provides an ideal shape for coning to create a natural breast without the gracilis muscle harvest, and lower risk of lymphedema and seroma compared to the TUG because of the dissection near the lymphatic system that is not damaged. Moreover, the posterior femoral cutaneous nerve can be used to transfer a sensitized flap with branches from this nerve.

37.4 Complications

Vascular complications in free tissue transfer cannot be completely prevented; however a careful preoperative evaluation, prophylactic strategies, meticulous surgical technique, and meticulous postoperative monitoring may be significantly reduced the incidence [53]. Rapid exploration with revision is possible if an adequate flap monitoring is performed in the early postoperative period. Venous complications are more common than arterial likely due to the venous low-flow system being more prone to stasis or the easy vein kinking or compressing [53–56].

Kroll et al. reported that all microvascular complications occurred within the first 48 h and recommended that 3–4 days was the optimal length of time required for intensive postoperative microvascular monitoring [57].

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