Bipedicled TRAM Flap

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29.1 Introduction

Described by Hartrampf et al. [1] in 1982 and popularized by many authors during the last 30 years, the use of the transverse skin and fat harvested from the lower abdominal region, the so-called transverse rectus abdominis myocutaneous (TRAM) flap, is still considered by many to be the gold standard for breast reconstruction. It gives the surgeon the possibility to recreate a breast of a desirable size with controlled shape.

The pioneer publication suggested that use of the flap could be delayed to improve vascular perfusion (and the authors did this in their first three cases). In four cases the authors used preoperatively selective angiography in order to confirm the anatomic continuity between the internal thoracic and the deep epigastric system. Therefore, they recognized the potential incapacity for efficient blood perfusion of the total abdominal flap through a single pedicle.

This deficiency was demonstrated later by Moon and Taylor [2] in their radiographic studies of the deep superior epigastric artery. Their publication is considered to be a landmark in the breast reconstruction literature and created the basis for the understanding of the complex circulation of the TRAM flap.

It was shown that blood perfusion can be unpredictable beyond the midline. This potential difficulty was experienced by many surgeons. Fat and skin necrosis are frequently seen in different degrees when the flap is harvested in its total length.

Many suggestions were made to support a reliable blood supply to the entire flap. Delaying, supercharging, free flap transfer, and the bipedicled version of the TRAM flap are techniques that could effectively bring about better perfusion and therefore the possibility to enhance considerably the length of the abdominal flap [3–7].

The use of two pedicles for unilateral reconstructions has been demonstrated to be a simple way of improving the blood supply to the classic monopedicled TRAM flap. With this approach, theoretically, one could harvest the flap totally, beyond the safe zone [8] (Fig. 29.1).

Although currently I use the procedure only in very select cases, it is able to provide the surgeon with an excellent amount of well-perfused abdominal tissue comparable only to techniques using free flap transfer.

29.2 Indications

Its principal indication is to increase the circulation to the abdominal flap; therefore, the blood supply can be doubled and complications such as fat or cutaneous necrosis can be essentially minimized.

Maneuvers to improve the flap perfusion are used for patients with risk factors that can impair the perfect blood supply to the abdomen.

The most relevant risk factors are smoking, obesity, previous abdominal surgery, radiotherapy, and existence of systemic disease (diabetes, hypertension) [9] (Fig. 29.2).

29.3 Free Flap or Bipedicled TRAM Flap?

The apologists for the use of microsurgical technique to transfer the abdominal tissue for breast reconstruction (free TRAM flap, mastectomy flap, deep inferior epigastric perforator, DIEP, flap) are extremely emphatic when describing its many advantages.

The main one is the unquestionable better blood supply, once the flap nutrition is provided by the inferior epigastric system (it is the primary blood supply to the lower abdominal skin and subcutaneous fat). The second one

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Fig. 29.1 The transverse rectus abdominis myocutaneous (TRAM) flap with its two pedicles

relates to the significant abdominal wall injury caused by the bilateral flap harvesting [10].

However, the free flap transfer demands especial skills of trained surgeons and nurses. The full control of the technique also depends on specialized staff to closely evaluate the patient during the postoperative period. Operating in a center where the patient can be safely taken to the operating room anytime for an urgent revision is also mandatory.

29.4 The Abdominal Wall Issue

It has been widely recognized that a unilateral or bilateral pedicled TRAM flap can lead to a considerable reduction of the abdominal strength (Fig. 29.3). Many publications on this subject witness the discomfort of authors with this topic.

An early study published by Hartrampf and Bennet [11] showed that the postoperative assessment of 300 women after bilateral harvesting resulted in a remarkable decrease of the abdominal strength, represented by an incapacity to perform sit-ups.

Also Petit et al. [12] in evaluating unilateral and bilateral pedicled TRAM flaps in 38 patients showed that 50 % of the single-pedicle transfers caused important impairment of the upper portion of the rectus and oblique muscles opposed to 60 % of the double-pedicle series.

The muscle-sparing technique (transferring only the central portion of the muscle, which contains the vessels) based on the work of Mizgala et al. [13] has not proved the expected efficiency in reducing the morbidity to the abdominal wall of the classic pedicled TRAM flap, unilateral or bilateral. On the other hand, splitting the muscle in pedicled flaps remains controversial and some surgeons [14] emphatically avoid doing this because of the vascular pattern of the epigastric system (choke vessels connect the superior and the inferior systems), where superficial to the rectus muscle an important net of arteries and veins can be injured during muscular division.

Finally, a recent study by Chun et al. [15] suggests there is no significant difference in donor site morbidity, functional outcomes and patient satisfaction when bipedicled TRAM or DIEP flaps are use din breast reconstruction, concluding that the technique remains a good choice for many patients who will undergo postmastectomy breast reconstruction with autologous tissue.

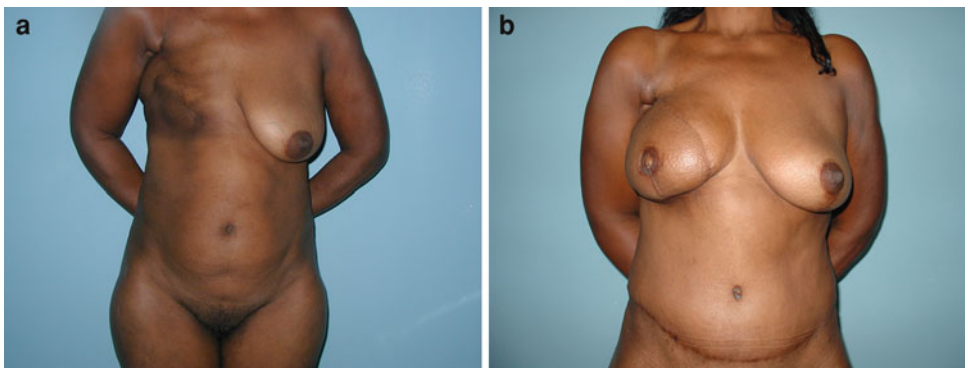

Fig. 29.2 Preoperative (**a**) and postoperative (**b**) delayed reconstruction on a patient with visible damage after radiotherapy. The bipedicled TRAM flap was a suitable option a with good outcome

Fig. 29.3 Bulges and true hernias are more frequent with the bipedicled TRAM flap technique

29.5 Patient Selection

The success of the reconstruction employing the transfer of the lower abdominal tissue will ultimately depend on two factors: patient selection and the selection of the right procedure.

The patient is assessed for risk factors. Increased complication rates after TRAM breast reconstruction s are associated with the following risk factors: age (over 60 years), obesity (more than 25 % over ideal body weight), abdominal scars (primarily, Kocher, paramedian, or multiple abdominal surgical scars), diabetes mellitus, hypertension, previous radiotherapy applied to the chest wall, and smoking history.

I also consider it as indicated for patients who perform competitive high-impact sports or those who depend on intensive muscular dynamics at work (maids).

Anatomical assessment is also of paramount relevance, including abdominal contour and fat deposits (potbelly habitus patients are formally contraindicated for TRAM flaps).

The slender patient and those patients with poor abdominal strength or abdominal muscular laxity will not be considered for bipedicled TRAM flap reconstruction.

Preoperative testing by sit-ups is an easy and effective method to evaluate the abdominal strength. Patients who are not able to perform these movements are considered poor candidates too.

To select the right procedure, one simple question is mandatory: What are the patient's needs?

The primary indication for the bipedicled TRAM flap is the need for a large amount of abdominal tissue to replace a large breast (Fig. 29.4). The second is a need for increased vascularity. Patients who have risk factors will benefit from the technique. When we take as an example fat necrosis, a typical complication with its origin in poor vascular supply, for monopedicled flaps, patients with two or more risk factors have three times the incidence of those with no or one risk factor. Patients with two or more risk factors who had bipedicled TRAM flaps had no associated increased incidence of fat necrosis. For flap loss complications, similar findings have been noted.

29.6 Patient Education and Preoperative Care

The patient is clearly informed about the procedure. Postoperative pain and 4–5 days of hospitalization is emphasized. The presence of drains that can remain for 1 week and the need for a synthetic mesh to reinforce the abdominal wall are also pointed out.

The recovery time is roughly 6 weeks, and the patient is made aware of a long resting period of not less than 2 months. The patient is also informed of weakness of the abdominal wall, mainly patients who undergo bilateral TRAM flap reconstructions.

Finally, potential complications are discussed and it is important that the patient is confident in the capacity of her surgeon to solve every problem related to an incidental failed reconstruction.

I rarely do immediate bilateral or free TRAM flap reconstructions. The extension of the operation added to the mastectomy procedure is not appealing. Perhaps on an institutional basis with a very well trained team it could be beneficial to the patient.

I frequently use a two-stage operation, performing the permanent phase after a primary expansion simultaneously with the mastectomy; therefore, blood transfusion and clinical complications have been rare in my practice.

Fig. 29.4 Patients with large breasts benefit from double-pedicle harvesting. The whole abdominal flap can be safely raised

29.7 The Importance of an Image Profile for Safe Harvesting

Since my interest in the perforator-based TRAM flap began, I have found the necessity of imaging evidence, which can give me not only the dimensions but also flow measurements of the upper and lower epigastric vessels, both breasts, and the positions of the perforators. Initially, I found the color Doppler scan very illustrative. The evolution toward angiotomography was able to detail and locate very clearly the whole system and its perforators to the lower abdominal skin-fat paddle (Fig. 29.5).

Probably this is not so important for the evaluation of pedicled flaps but it can sharply define the circulation from the breast to the lower epigastric vessels, which can be useful in irradiated patients.

29.8 Surgical Technique

After a judicious selection of the technique and indication of the bipedicled TRAM flap, the flap is outlined on the abdominal wall. Two teams work simultaneously. One preparing the recipient site and other undermining the abdominal flap.

The concept of "breast footprint" popularized by Blondeel et al. [16] is applied here to create a pocket of the right size to receive the abdominal flap and match the remaining breast in shape and volume (Fig. 29.6).

All scar tissue must be removed. In irradiated patients, extra care is required with the mastectomy flaps in order to keep them well vascularized, avoiding any damaging maneuver. Attention has to be paid to the submammary fold, which must be kept at the same level as that of the opposite side.

The tunnel that connects both spaces should be large enough to permit the large flap to pass through. At this point gentle maneuvers are expected and compression or constriction must be strongly avoided.

The abdominal flap is marked previously with the patient in the standing and seated position. The possibility of flap donation is rechecked and confirmed. The incision is placed in the most cosmetic position according to the principles of safety for an ideal closure (Fig. 29.7).

During the abdominal detachment, the surgeon should avoid dissecting too far laterally in order to preserve the intercostal perforators responsible for the vascular nutrition of the flap.

After the upper abdominal flap elevation the rectus abdominis muscles are partially degloved from their sheath. A strip of fascia is kept attached to each muscle. I prefer to elevate the whole muscular unit. A better vascular supply is expected with this technique and the damage to the abdominal wall is apparently equivalent to that with the muscle-sparing technique.

The umbilicus is then outlined and released from the lower abdominal flap, making possible its future ascent to the thoracic wall.

Next, the identification and ligation of the lower deep epigastric artery and veins is performed. Next, the lower abdominal flap is entirely separated from the abdominal wall. This dissection is done with magnification (×2.5) and a sharp scalpel so many tiny subcutaneous vessels can be identified and preserved. The epigastric pedicle is observed and the point it enters the muscle is used as a landmark for

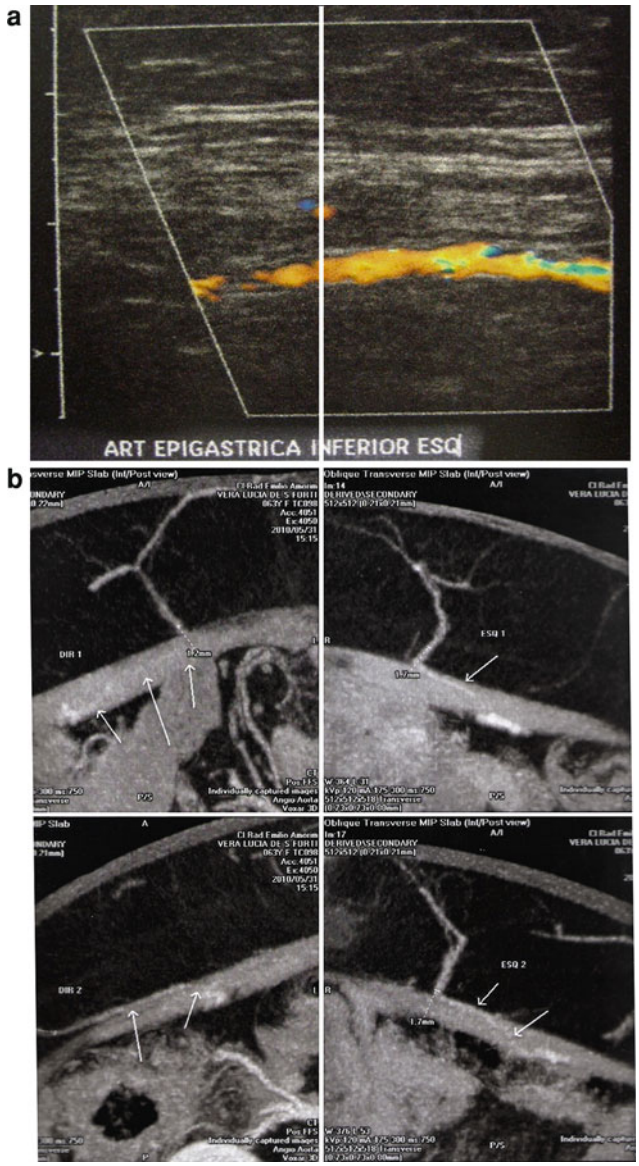

Fig. 29.5 Color Doppler scan (**a**) and angiotomography (**b**) allow the surgeon to locate very clearly the whole epigastric system and its perforators

its section. Usually this point is located above the arcuate ligament.

Both rectus abdominis muscles are sectioned and the whole flap is raised to its new location very carefully with gentle maneuvers.

Next, the upper abdominal flap is inset and stapled in the new site with the patient in the seated position. Now, the new breast is shaped. I have no rules for this exciting time. The skin and fat flap must fit the subcutaneous pocket in the most appropriate position according to the remaining breast "footprint", shape, and volume.

Once the surgeon feels the breast can be considered done, the patient returns to her normal decubitus position and the abdominal wall is repaired simultaneously to the breast suture.

I always use a Prolene mesh to repair the abdominal muscular deficit. The mesh is sutured to the remaining oblique muscles with polydioxanone 2-0 in two planes.

A vacuum drain is always used and kept in place for at least 5 days for the new breast and abdominal areas. The abdomen is finally sutured following a normal abdominoplasty pattern.

A surgical brassiere is used for the breast and a moderate compressive dressing for the abdomen is employed for 2 days.

29.9 Complications

Specific complications of the bipedicled TRAM flap are:

Fat necrosis is a late complication. It can appear after 12 months and is associated with an ischemic mechanism. Clinically, it presents as a subcutaneous firmness that can be confused with malignancy (recurrence or a new tumor). A biopsy is mandatory to clarify the diagnosis. A more extensive fat necrosis area can definitely compromise the cosmetic outcome.

Bipedicled TRAM flap and free flap transfer have significantly reduced the incidence of fat necrosis.

Partial flap loss is a complication that occurs in more than 10 % of all pedicled TRAM flaps. It can happen to different degrees. Light marginal necrosis due to venous deficiency can be revised later and does not compromise cosmetically the result. A remarkable reduction of this complication is observed when the bipedicled TRAM flap or free flap transfer is employed (Fig. 29.8).

Total flap loss can happen when free flap transfer is used, probably owing to arterial or venous thrombosis when salvage methods have failed. It is infrequent for pedicled flaps and is extremely rare when bipedicled flaps are used. In general, total flap loss corresponds to an important technical mistake.

These ischemic complications are often present in patients with more than two risk factors.

Hernias and abdominal laxity (bulges) are donor-site complications resulting from the bipedicle technique. From the mere incapacity to do sit-ups to real hernias and back pains, these are frequent complaints that afflict patients who underwent the technique.

In my personal series I have had less than 2 % of cases with abdominal laxity. I ascribe this low rate to respect for the arcuate line limits and closure in every case with only Prolene mesh.

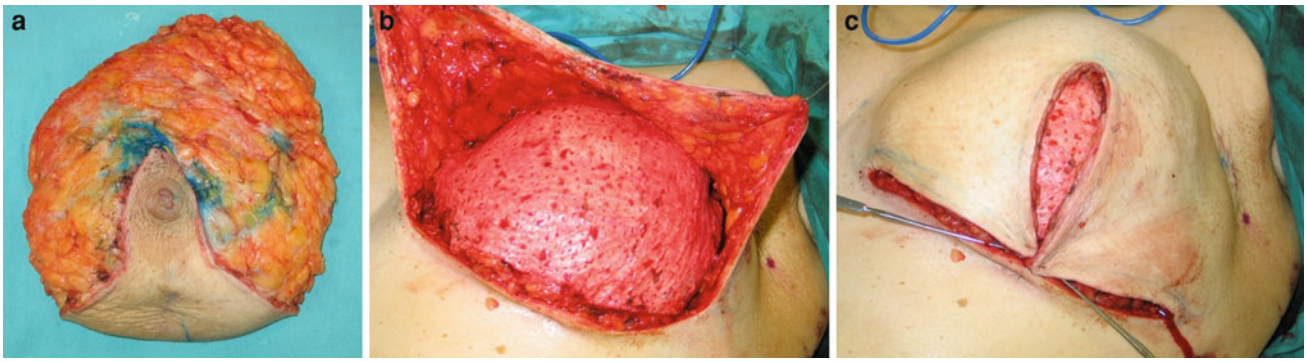

Fig. 29.6 The concept of breast "footprint" is clearly shown here: an inverted-T pattern mastoplasty is drawn over one dermal fat paddle of a TRAM flap

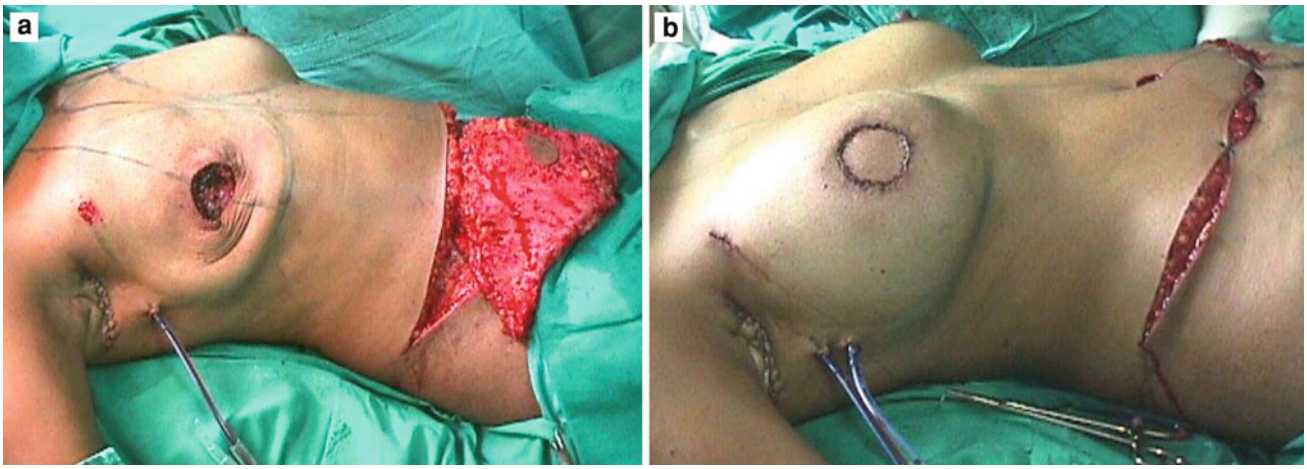

Fig. 29.7 The abdominal flap of a bipedicled TRAM flap ready to be transposed

Hematoma is minor complication. The rates of postoperative bleeding and subsequent hematoma have been lowered to practically zero thanks to the long-term drainage and changing of chemoprophylaxis for venous thromboembolism for intermittent leg compression perioperatively and postoperatively.

Seroma of the abdominal flap has also dramatically improved by regular tacking of the abdominal flap to the fascia, enhancing the contact and avoiding the sliding movements associated with the seroma.

Abdominal slough and necrosis are expected complications when extensive abdominal undermining is done. Limited dissection preserving the intercostal perforators is essential to avoid such complications.

For infections, prophylactic antibiotics are always used (according to the hospital protocol).

29.10 Discussion

Since its first description in 1982 by Hartrampf et al., the TRAM flap has been considered by many as the gold standard for breast reconstruction after mastectomy.

Technically it has evolved. Two issues propelled that evolution.

First, the blood supply. The classic pattern, monopedicled TRAM flap, has been demonstrated to be unreliable or at least unsteady when harvested beyond the midline.

Moon and Taylor [2] have elegantly and definitely demonstrated that the rectus abdominis's arterial and venous territories both present the same pattern. Blood has to traverse a multiple venous valvular system before reaching the deep superior epigastric territory. These valves frequently impair the venous drainage owing to obstructions, resulting in fat and skin necrosis. Several modifications, including a more cephalad flap, primary delays, and the free TRAM flap transfer, have minimized this problem.

The bipedicled TRAM flap also increased flap perfusion because of a dual artery inflow and similar venous outflow. Basically it is indicated when a large amount of tissue is required.

Partial flap loss and fat necrosis rates have been consistently reduced by the method.

Fig. 29.8 Partial flap loss: marginal necrosis follows generally progressive venous impairment

The recognition of risk patients made the technique appealing and for patients with more than two factors, for many surgeons, mandatory.

The other important and controversial issue is the injury that the pedicled TRAM flap causes to the abdominal wall. Hernias and bulges have been shown, mainly when the two rectus abdominis muscles are used. To minimize the anatomic deficit provided by TRAM flap harvesting, muscle-sparing free TRAM flap and no muscle transfer, like perforator flaps (DIEP flap and superficial inferior epigastric artery flap), have been described and popularized worldwide especially in centers where highly trained microsurgeons master the technique and perform it in a conveniently short time.

Unfortunately this is not the general rule for many services where mastectomy is responsible for severe damage that needs to be fixed fast and safely.

Nonetheless, a study has been published comparing in a large series with a long follow-up patients who have undergone reconstructions with bilateral TRAM flaps with bilateral DIEP flaps. The results showed no significant differences in donor-site morbidity, functional outcome and patient satisfaction between bilateral TRAM flap and DIEP flap breast reconstruction.

The author's conclusion is although the perforator flap is technically an evolution, bilateral TRAM flap reconstruction is still a good option for autologous breast reconstruction

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