ORIGINAL ARTICLE

Utility of the Free Deep Inferior Epigastric Perforator Flap in Chest Wall Reconstruction

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■ **Abstract:** Breast cancer chest wall recurrence is often treated with chemotherapy, radical surgery, and radiation. Extensive chest wall resection requires soft-tissue reconstruction with tissue that provides chest wall stability and durability for additional radiation. Local and regional muscle and musculocutaneous flaps are often used for reconstruction. Free flaps, such as the transverse rectus abdominis musculocutaneous flap, are used for large defects, although donor site morbidity can result. The free deep inferior epigastric perforator (DIEP) flap provides coverage for large defects and may have less donor site morbidity. We describe the use of the free DIEP flap to reconstruct large chest wall defects (mean, 501 cm^2 defects) after the resection of recurrent breast cancer in two patients. One patient had 2% flap loss. No donor site morbidity occurred. The free DIEP flap is a durable and reliable flap that provided immediate and complete coverage of these large chest wall defects with no donor site morbidity and did not delay the administration of adjuvant therapy. ■

Key Words: chest wall recurrence, free flap, recurrent breast cancer, soft-tissue coverage

The incidence of chest wall recurrence of stage I/II invasive breast cancer after mastectomy or breast-conserving surgery and radiation is 10–15% and, with aggressive therapy of isolated recurrences, may be associated with a 5-year survival of 60–90% (1). Chest wall recurrence is often initially treated systemically with chemotherapy, and if there is a good systemic and local response, locally with radical surgery and radiation (2,3). Surgical resection of the recurrence serves to gain local control and moderate the required dose of chest wall radiation (1).

The magnitude of the chest wall resection can be minimal to extensive, requiring rigid and soft-tissue reconstruction with the goals of providing chest wall stability and durable soft-tissue coverage that can undergo early postoperative radiation. Local and regional muscle and musculocutaneous flaps of the latissimus dorsi, pectoralis major, serratus anterior, rectus abdominis, and external oblique muscles are frequently used for soft-tissue coverage of most smaller chest wall defects (4). When the size of the wound is greater than that which can be covered with local and regional flaps, the omentum can be transposed (4). However, the omentum flap requires a laparotomy for harvest and then coverage with a skin graft, which is less durable than a musculocutaneous flap is to additional radiation. Skin grafts also have the added risks of infection, graft loss, and a second donor site, which can delay necessary radiation and chemotherapy.

When the magnitude of the defect exceeds the availability of local musculocutaneous flaps, free tissue transfer is the preferred method of reconstruction. Free flaps provide well-vascularized tissue with a reliable blood supply, which allows reconstruction of larger soft-tissue defects without the delay of additional local and systemic treatment (5). The most common free flap used for chest wall reconstruction is the rectus abdominis musculocutaneous flap (5–7), such as the transverse rectus abdominis musculocutaneous (TRAM) flap. Although the free TRAM has proved a workhorse for the reconstruction of extensive soft-tissue defects in the chest wall, the free TRAM may result in donor site morbidity. The unilateral TRAM flap, free or pedicled, leaves a defect in the rectus muscle and anterior rectus sheath. This defect can lead to abdominal discomfort (13–47%), bulge (10–42%), hernia (4–5%), and weakness (35%) (8,9).

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The free deep inferior epigastric perforator (DIEP) flap is a method of transfer of abdominal wall skin, subcutaneous fat, Scarpa's fascia, and the deep inferior epigastric pedicle vessels. Allen and Treece (10) popularized the use of the free DIEP flap for breast reconstruction. Retrospective reviews suggest less abdominal wall morbidity with the DIEP flap compared with the free TRAM because the DIEP preserves the rectus muscle and sheath (9,11–15). Depending on the caliber of the perforator(s), the free DIEP flap provides a large volume of durable soft tissue, has a robust blood supply, and has limited donor site morbidity, which may make the free DIEP flap ideal for chest wall reconstruction. The purpose of this report is to describe the utility of the free DIEP flap for soft-tissue chest wall reconstruction.

MATERIALS AND METHODS

In 2004, two patients who had previously undergone mastectomy for breast cancer subsequently developed chest wall recurrence and underwent radical resection followed by reconstruction with a free DIEP flap at the University of Washington Medical Center. Medical charts were retrospectively reviewed. Patient demographics and clinical variables were examined and included age, gender, prior therapy, time to chest wall recurrence, pathologic diagnosis, extent of resection, two-dimensional area of approximately circular defect (calculated using the formula πr^2 from the intraoperative measurements of defect sizes before the reconstruction), and timing and technique of reconstruction. The number of postoperative hospital days and complications were also recorded. This review was in accordance with and approved by the University of Washington Institutional Review Board.

Surgical Technique

Patients who require breast reconstruction or chest wall reconstruction undergo preoperative Doppler ultrasound to determine the size and location of abdominal wall perforating blood vessels. The surgical resection, guided by preoperative punch biopsies of the chest wall to determine the magnitude of the resection, was performed first. Once the size of the defect was determined, the suitability of the lower abdomen to reconstruct the chest wall was made. Intraoperatively, the largest periumbilical medial row perforators were identified to assure maximal perfusion of both zones III and IV (16). The anterior rectus sheath was incised at the fascial opening of the chosen perforator. Using loupe magnification, the rectus muscle was split in an orientation parallel to the fibers where the perforators course. Dissection extended inferiorly to the origin of the vessels to obtain a long pedicle, perforator vessels were traced within the rectus muscle, and hemoclips were applied to numerous small tributaries.

For both patients, the recipient vessels were the internal mammary artery and vein (IMA and IMV, respectively) at the level of the third intercostal cartilage. The IMA and IMV have a large caliber with excellent flow velocities and have not been in the field of prior surgical resection and possible injury, such as the thoracodorsal vessels. Routine microsurgical technique was used for the anastomoses and a Cook–Swartz Doppler Flow Probe (Cook Vascular, Leechburg, PA) was placed around the deep inferior epigastric vein just proximal to the anastomosis to provide continuous postoperative monitoring of flow.

RESULTS

Two patients underwent soft-tissue resection of the chest wall for recurrence of breast cancer followed by immediate reconstruction with a free DIEP flap (Table 1). The patients were 53 and 58 years of age. General health of both patients was relatively good. Both patients had a history of left breast cancer for which they had prior total mastectomy with axillary node dissection, radiation, and chemotherapy. Neither patient underwent previous breast reconstruction. Time from mastectomy to diagnosis of chest wall recurrence for these two patients was 63 and 6 months. Pathologic diagnosis in both patients was chest wall recurrence of breast carcinoma. In both patients, the resection included skin, subcutaneous,

Table 1. Patient Characteristics

Characteristics	Patient 1	Patient 2
Age (years)	53	58
Gender	Woman	Woman
Pathologic diagnosis	Recurrent breast carcinoma	Recurrent breast carcinoma
Adjuvant therapy	Radiation and chemotherapy	Radiation and chemotherapy
Time to recurrence (months)	63	6
Defect area (cm^2)	510	491
Complication	None	2% flap loss
Postoperative hospital stay (days)	4	5

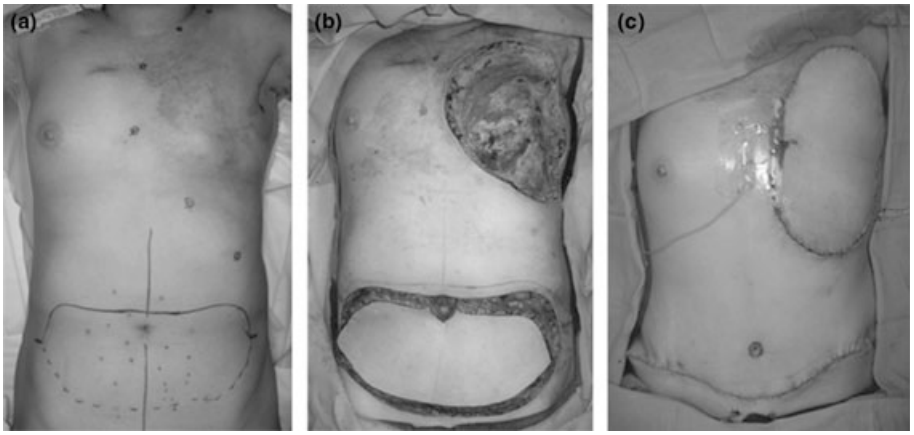

Figure 1. (a) Chest wall recurrence of breast cancer in a 53-year-old woman. Preoperative markings before the chest wall resection and immediate free DIEP flap reconstruction are shown. (b) After chest wall resection with a 510 cm^2 defect, DIEP flap elevation is started. (c) The DIEP flap is inset and fills the chest wall defect.

and pectoral muscle down to the ribs of the anterior central and lateral chest wall (Fig. 1a). No rib or skeletal resection for cancer was done. The sizes of the soft-tissue defects were 510 and 491 cm^2 (mean, 501 cm^2) (Fig. 1b). Free DIEP flaps were harvested in each patient using one medial row periumbilical perforator (Fig. 2). The IMA and IMV were the recipient vessels for microsurgical anastomosis in both patients. Chest wall defects were completely filled with the free DIEP flaps (Fig. 1c). The average postoperative length of hospital stay was 4.5 days; no days were spent on ventilatory support or in the intensive care unit. There

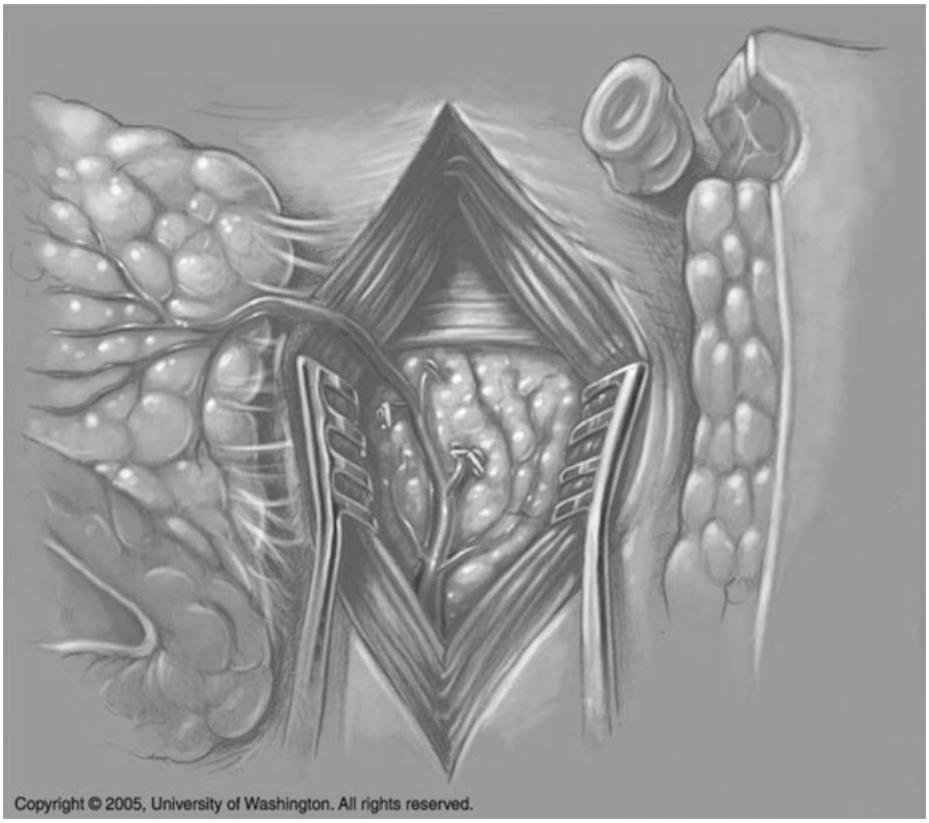

Figure 2. An incision is made through the anterior rectus abdominis sheath, the fibers of the rectus abdominis split, and a perforating branch from the deep inferior epigastric artery to the overlying skin and subcutaneous tissue of the abdominal wall is carefully dissected.

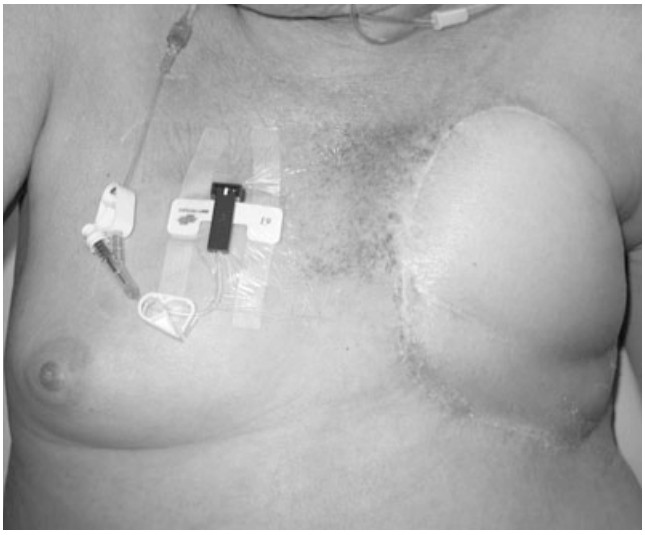

Figure 3. Sixteen-month follow-up after reconstruction and adjuvant therapy.

were no flap losses. The patient with the 491 cm^2 defect had a partial skin/subcutaneous tissue flap loss of approximately 2% on the distal tip of zone IV, which was excised and closed during an office follow-up 2 weeks postoperatively, without resulting in a delay in postoperative chemotherapy or radiation. Durable soft-tissue coverage by the DIEP flap is seen at 16 months after reconstruction and adjuvant therapy (Fig. 3). No donor site complications occurred.

DISCUSSION

The patients presented had extensive soft-tissue resection of the anterior central and lateral chest wall. Patients requiring chest wall resection and reconstruction are often in a tenuous medical status given the extent of disease and resection necessary to gain local control. Chest wall recurrence of breast cancer after conservative surgery and radiation often has a poor prognosis. Early chest wall recurrence within 2 years of initial treatment is associated with 5 year survival rates of 26–44% (17). Although radical surgery and chest wall reconstruction followed by radiation and chemotherapy are largely palliative for early chest wall recurrence, quality of life can be improved in some patients (18).

Reliable and durable coverage of soft-tissue chest wall defects is necessary and immediate and definitive coverage of chest wall defects with flaps can be accomplished in a single stage (19). Large defects require large flaps with robust vascular supply. Additionally, both patients received radiation to the chest and axilla prior to chest wall recurrence. Radiation produces ischemic fibrosis of the surrounding soft tissues and reasonable healing necessitates transfer of nonradiated and well-vascularized tissue after aggressive resection (18). The abdominal wall tissue of the DIEP lies outside the field of radiation and provides tissue with a fresh blood supply to the fibrotic chest wall tissue that has been compromised by radiation. Arnold and Pairolero (4) describe the pectoralis major muscles as the most frequently used for managing defects of the anterior central chest wall, although this flap was not an option for our patients as the large defects extended from the anterior central to the lateral chest wall and the ipsilateral pectoral muscle was removed in the oncologic resection. The most common muscle or musculocutaneous flaps used in reconstruction by Chang et al. (19) were the latissimus dorsi and the rectus abdominis flaps. Both of our patients underwent prior axillary dissection and radiation, which can compromise the thoracodorsal pedicle to the latissimus dorsi. With the large defects in our patients, skin grafts would have been needed to cover a latissimus dorsi muscle as the skin flap from the musculocutaneous latissimus dorsi flap would not have been large enough to fill the defects. Skin grafts are less durable against radiation and have the added potential complications of graft loss and infection, which can delay important postoperative radiation and chemotherapy. When compared with the latissimus dorsi, an advantage of the free DIEP flap is the large reliable paddle of vascularized skin that eliminates the need for skin grafts. The use of a free DIEP flap in our two patients did not delay the administration of adjuvant therapy.

The rectus abdominis flap is quite useful for anterior chest wall reconstruction because it provides both muscle and skin that can be oriented transversely as in the TRAM flap or vertically (4). The rectus abdominis can be transposed on the superior epigastric pedicle or as a free flap. As a pedicle flap, the superior blood supply of the rectus abdominis is not as robust as that of either the latissimus dorsi (4) or a free TRAM flap. Free flaps do provide a robust blood supply and can reduce the partial flap failure that can occur with pedicled rectus abdominis flaps (5). Chang et al. (19) used a free or multiple flap reconstruction for defects with an average size >305 cm^2, such as those described in our patients.

The only complication that occurred in one of our patients involved the distal-most tip of the flap in zone IV, which became compromised from venous

congestion postoperatively and approximately 2% of the skin and fat of the flap was excised and closed in clinic 2 weeks afterwards. Most of zone IV remained viable, however, and did not delay further treatment. We believe that when a DIEP free flap is used in a flat, two-dimensional plane without shaping into the third dimension as done in breast reconstruction, the DIEP flap has less venous congestion problems. This is why we believe that when the perforators are of suitable caliber (>1 mm) and the flap is not thick (>4 cm), the DIEP free flap can be as robust as a free TRAM flap.

The rectus abdominis flap also has the disadvantage of donor site morbidity, which includes discomfort, weakness, bulge, and hernia (8,11,20). Morbidity may be reduced with the DIEP flap by sparing the rectus muscle and sheath, and using only the overlying subcutaneous tissue and skin. When compared with the free TRAM, the DIEP may have a lower incidence of abdominal wall asymmetry, incisional bulge and hernia, less reduction in abdominal wall strength, and impairment of activities of daily living as found by retrospective studies (9,11–15,21). However, the DIEP flap requires a longer operative time and technical finesse in microsurgery due to the tedious dissection of the pedicle within the rectus muscle. The anastomosis of the DIEP to the IMA and IMV is also considerably more difficult in patients with prior radiation resulting in friable recipient vessels. Use of the DIEP for chest wall reconstruction in a radiated field should be reserved for surgeons with extensive microsurgical experience.

CONCLUSIONS

We found the free DIEP flap to provide an immediate and substantial volume of durable tissue with minimal donor or reconstruction site morbidity in our two patients with large soft-tissue defects of the chest wall. Provided the perforators are of suitable caliber, the free DIEP flap has a robust blood supply that can fill large central or lateral chest wall defects and allows radical chest wall resection, making it a flap of great utility in chest wall reconstruction. The free DIEP flap should be added to reconstructive algorithms of chest wall defects.

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