

Breast Reconstruction with Superficial Inferior Epigastric Artery Flaps: A Prospective Comparison with TRAM and DIEP Flaps

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Breast reconstruction using the lower abdominal free superficial inferior epigastric artery (SIEA) flap has the potential to virtually eliminate abdominal donor-site morbidity because the rectus abdominis fascia and muscle are not incised or excised. However, despite its advantages, the free SIEA flap for breast reconstruction is rarely used. A prospective study was conducted of the reliability and outcomes of the use of SIEA flaps for breast reconstruction compared with transverse rectus abdominis musculocutaneous (TRAM) and deep inferior epigastric perforator (DIEP) flaps. Breast reconstruction with an SIEA flap was attempted in 47 consecutive free autologous tissue breast reconstructions between August of 2001 and November of 2002. The average patient age was 49 years, and the average body mass index was 27 kg/m². The SIEA flap was used in 14 (30 percent) of these breast reconstructions in 12 patients. An SIEA flap was not used in the remaining 33 cases because the SIEA was absent or was deemed too small. The mean superficial inferior epigastric vessel pedicle length was approximately 7 cm. The internal mammary vessels were used as recipients in all SIEA flap cases so that the flap could be positioned sufficiently medially on the chest wall. The average hospital stay was significantly shorter for patients who underwent unilateral breast reconstruction with SIEA flaps than it was for those who underwent reconstruction with TRAM or DIEP flaps. Of the 47 free flaps, one SIEA flap was lost because of arterial thrombosis. Medium-size and large breasts were reconstructed with hemi-lower abdominal SIEA flaps, with aesthetic results similar to those obtained with TRAM and DIEP flaps. The free SIEA flap is an attractive option for autologous tissue breast reconstruction. Harvest of this flap does not injure the anterior rectus fascia or underlying rectus abdominis muscle. This can potentially eliminate abdominal donor-site complications such as bulge and hernia formation, and decrease weakness, discomfort, and hospital stay compared with TRAM and DIEP flaps. The disadvantages of an SIEA flap are a smaller pedicle diameter and shorter pedicle length than TRAM and DIEP flaps and the absence or inadequacy of an arterial pedicle in most patients. Nevertheless, in se-

lected patients, the SIEA flap offers advantages over the TRAM and DIEP flaps for breast reconstruction. (*Plast. Reconstr. Surg.* 114: 1077, 2004.)

The use of autologous tissue from the lower abdomen is a versatile and popular method of breast reconstruction. This technique was first reported by Holmstrom¹ in 1979 and was popularized by Hartrampf et al.² in 1982. The transverse paddle of skin and subcutaneous tissue from the lower abdomen remains unmatched in quality, texture, and quantity for breast reconstruction, and the lower abdominal donor site has the advantages of improved postoperative contour and an easily hidden scar. However, the lower abdominal donor site suffers from the risk of hernia, bulge formation, and motor weakness. In addition, the length of postoperative hospitalization and time to full recovery from surgery are often determined by healing at the abdominal donor site. Accordingly, breast reconstruction using the lower abdominal skin and subcutaneous tissue has evolved from use of pedicled to free transverse rectus abdominis myocutaneous (TRAM) flaps, muscle-sparing free TRAM flaps, and deep inferior epigastric artery perforator (DIEP)³ flaps. Each variation in this progression has involved the harvest of decreasing amounts of rectus abdominis muscle and anterior fascia with the aim of decreasing abdominal donor-site weakness, discomfort, complications, and hospital stay. The recovery of

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abdominal wall strength and function following TRAM and DIEP flap harvest correlates with decreased rectus abdominis muscle and fascia harvest.⁴⁻⁹

The superficial inferior epigastric artery (SIEA) flap can be used to transfer the lower abdominal skin and subcutaneous tissue for breast reconstruction without harvest or incision of the abdominal muscles or rectus fascia. This flap was well described as early as 1975 by Taylor and Daniel.¹⁰ In 100 cadaver dissections, they showed that the SIEA shared a common origin with the superficial circumflex iliac artery in 48 percent of specimens (with a mean diameter of 1.4 mm), had a separate origin from the femoral artery in 17 percent of specimens (with a mean diameter of 1.1 mm), but was absent in the remaining 35 percent of specimens. The use of the free SIEA flap for breast reconstruction was first described in a case report by Grotting¹¹ in 1991. In 1994, a series of eight SIEA flaps for breast reconstruction in six patients was reported.¹² A series of five SIEA flaps for breast reconstruction was reported in 1999.¹³ I present a series of 14 SIEA flap breast reconstructions demonstrating the reliability, advantages, and limitations of this technique including a significantly decreased hospital stay compared with TRAM and DIEP flaps.

PATIENTS AND METHODS

All patients in whom I performed breast reconstruction using autologous tissue from the lower abdomen during the 17-month period from August of 2001 through December of 2002 were included. During this time, 47 autologous tissue breast reconstructions were performed in 34 patients. In each case, reconstruction with an SIEA flap was attempted first. If the criteria for an SIEA flap were not met, reconstruction with a DIEP flap was attempted. If the criteria for a DIEP flap were not met, reconstruction was performed with a muscle-sparing free TRAM flap.

There were several anatomic criteria that had to be met for an SIEA flap reconstruction to be performed. First, an SIEA with palpable and visible arterial pulsation and a minimum external diameter of 1.0 mm at the level of the lower abdominal incision had to be present. Also, the SIEA had to be present on the side opposite the breast to be reconstructed. If these criteria were met, the superficial inferior epigastric vessels were dissected to their origins from the femoral vessels. The SIEA needed an

external diameter of at least 1.2 mm at its origin from the femoral artery. This requirement was increased to 1.5 mm later in the series.

If the criteria for an SIEA flap were not met, reconstruction with a DIEP flap was attempted. DIEP flaps required one large perforator or two substantial perforators in the lateral row. If reconstruction with a DIEP flap was not performed, a muscle-sparing free TRAM flap was used. This algorithm was used for all 47 consecutive breast reconstructions and is similar to one espoused by Arnez et al.¹⁴

Patients were told that the minimum amount of rectus abdominis muscle and fascia that their individual vascular anatomy allowed would be harvested but were blinded as to the type of flap reconstruction they had while they were inpatients. Patients were told that the average postoperative hospital stay was 4 to 6 days. Patients were discharged when they were sufficiently mobile to walk to and use a restroom alone and when their pain was controlled with oral medications.

Data on patient age, body mass index, length of surgery, hospital stay, smoking history within 2 weeks before surgery, and complications were collected. The lengths of hospital stay among patients who underwent unilateral reconstruction were compared by the log-rank test. The Wilcoxon rank sum test was used for comparing the continuous variables of body mass index, length of surgery, and age of patients who underwent unilateral breast reconstructions. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

Free SIEA flaps were used in 14 (30 percent) of the 47 consecutive autologous tissue breast reconstructions. DIEP flaps were used in eight (17 percent), and muscle-sparing free TRAM flaps were used in the remaining 25 reconstructions (53 percent). Twenty-one patients underwent unilateral breast reconstruction, and 13 patients underwent bilateral reconstruction. Twenty-nine breast reconstructions were immediate, and 18 were delayed. The mean patient age was 49 years, and the mean body mass index was 27 kg/m² (Table I).

The SIEA flap was used for immediate and delayed reconstruction of medium-size and large breasts. Figure 1 shows the right lower abdominal SIEA flap, its vascular pedicle, the resulting donor site without incision or exci-

TABLE I
 Characteristics of Patients Who Underwent Free Flap Breast Reconstruction

| | SIEA | DIEP | TRAM | Total |
|------------------------------------|----------|---------|----------|-----------|
| No. of patients* | 12 | 7 | 21 | 34 |
| No. of flaps | 14 (30%) | 8 (17%) | 25 (53%) | 47 (100%) |
| No. of immediate reconstructions | 8 | 6 | 15 | 29 |
| No. of delayed reconstructions | 6 | 2 | 10 | 18 |
| Mean age, years | 49 | 50 | 48 | 49 |
| Mean BMI, kg/m ² | 28 | 26 | 27 | 27 |
| No. smoking within 2 wk of surgery | 2 | 1 | 3 | 6 |
| Mean follow-up, days | 271 | 318 | 190 | 236 |

SIEA, superficial inferior epigastric artery flap; DIEP, deep inferior epigastric perforator flap; TRAM, transverse rectus abdominis myocutaneous flap; BMI, body mass index.

* The sum of the number of patients is greater than the total of 34 because patients who had bilateral breast reconstruction with two different flap types were included in two columns.

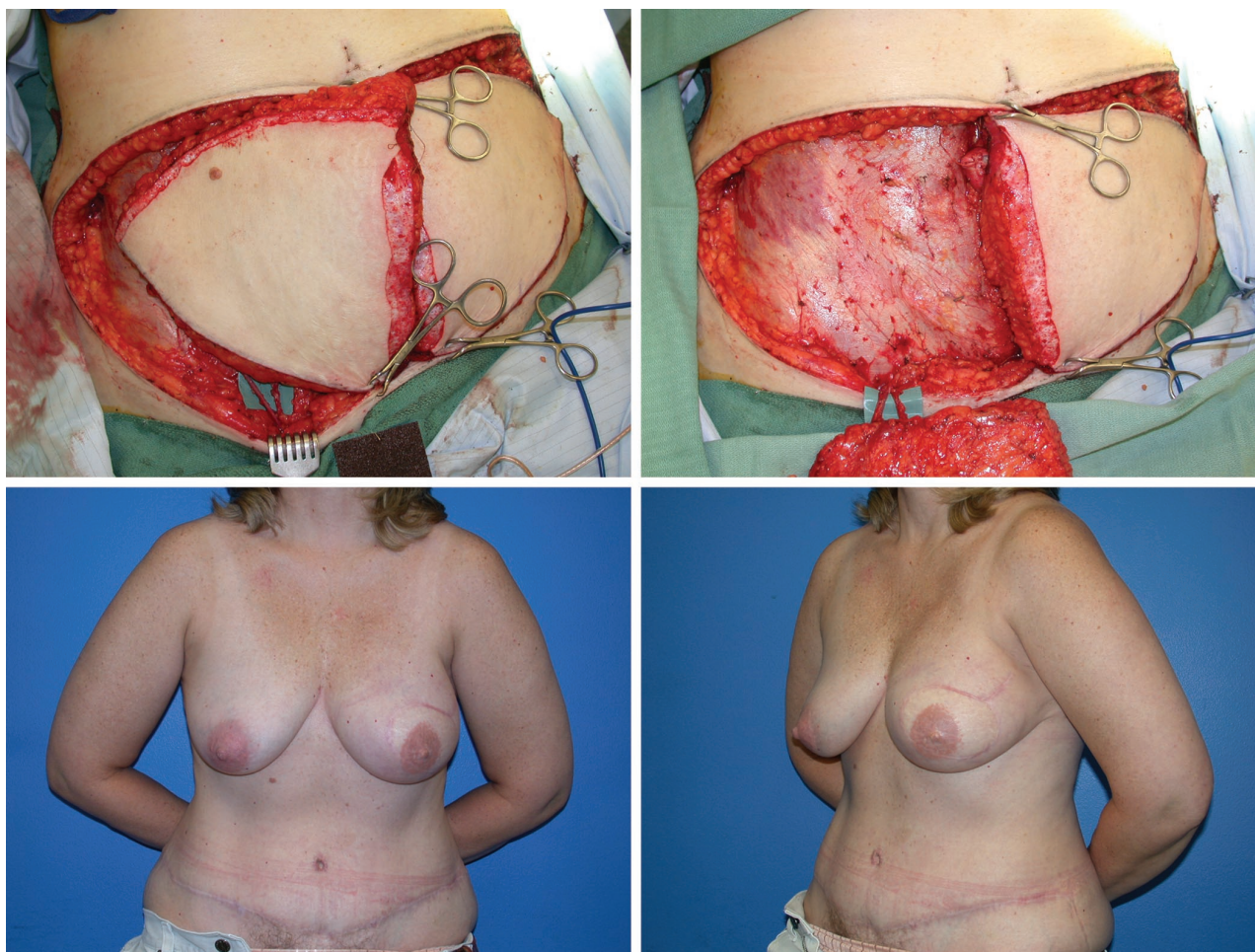


FIG. 1. Immediate reconstruction of a medium-size breast with an SIEA flap. (Above, left) Right SIEA flap showing medial superficial inferior epigastric vein and lateral SIEA pedicle vessels. (Above, right) Abdominal donor site with intact rectus abdominis fascia and muscle. (Below) Anterior and oblique views of completed left breast reconstruction 7 months after surgery. From Chevray, P. M. Update on breast reconstruction using free TRAM, DIEP, and SIEA flaps. *Semin. Plast. Surg.* 18: 97, 2004. Reprinted with permission.

sion of rectus abdominis muscle or fascia, and the postoperative result of immediate reconstruction of a medium-size left breast. Figure 2 shows the result of immediate reconstruction of a large right breast with a contralateral SIEA flap.

The SIEA flap could not be used in 33 (70 percent) of the 47 reconstructions. In 24 (51 percent) of these cases, there was no SIEA. In six cases (13 percent), there was an SIEA, but it was deemed too small to use reliably. In one



FIG. 2. Immediate reconstruction of a large breast with an SIEA flap. (Above, left) Left SIEA flap after revascularization to the right internal mammary vessels showing the pedicle emerging from the edge of the flap. (Above, right) Abdominal donor site just before closure showing intact rectus abdominis fascia and muscle. (Below) Anterior and oblique views of completed right breast reconstruction 19 months after surgery.

case each, there was inadequate drainage through the superficial veins, an appendectomy scar prevented perfusion of the flap, or the SIEA was accidentally divided.

One TRAM flap and two SIEA flaps required emergency reoperation for arterial insufficiency. Two of these three flaps were salvaged.

One SIEA flap was lost because of arterial insufficiency. This represents a 2 percent free flap loss rate (Table II).

One DIEP flap suffered a partial loss of 15 percent of the flap skin and subcutaneous tissue. Clinically detectable fat necrosis occurred in six (13 percent) of the flaps. This includes

TABLE II
Complications of SIEA, DIEP, and TRAM Flap Breast Reconstructions

| | SIEA | DIEP | TRAM | Total |
|--|----------|---------|----------|-----------|
| No. of flaps | 14 (30%) | 8 (17%) | 25 (53%) | 47 (100%) |
| Emergency reoperation | 2 | 0 | 1 | 3 (6%) |
| Flap loss | 1 | 0 | 0 | 1 (2%) |
| Partial flap loss | 0 | 1 | 0 | 1 (2%) |
| No. with fat necrosis | 2 | 1 | 3 | 6 (13%) |
| Mean % of flap volume with fat necrosis | 10 | 7 | 12 | 10 |
| Hematoma, seroma, or infection requiring reoperation | 0 | 0 | 0 | 0 |
| Postoperative abdominal bulge | 0 | 0 | 1 | 1 (2%) |
| Postoperative ventral hernia | 0 | 1 | 0 | 1 (2%) |

SIEA, superficial inferior epigastric artery flap; DIEP, deep inferior epigastric perforator flap; TRAM, transverse rectus abdominis myocutaneous flap.

the DIEP flap that suffered a 15 percent partial loss but does not include the SIEA flap that was completely lost. Fat necrosis affected a mean of 10 percent of the flap volume when it occurred and was treated nonsurgically. The incidence and extent of fat necrosis were similar among the three flap types (Table II).

There was a 2 percent incidence of abdominal bulge. There was one true ventral incisional hernia that occurred in a patient who had undergone bilateral breast reconstruction with one TRAM, and one DIEP flap. The hernia occurred at the medial end of a previous right subcostal cholecystectomy incision and was repaired with polypropylene mesh. The incidence of abdominal bulge or hernia was similar among the three flap types (Table II).

Statistical comparisons of patient characteristics and incidence of complications were not valid for the entire group because many patients underwent bilateral breast reconstruction with various combinations of the three flap types. Therefore, unilateral SIEA flap breast reconstructions were compared with unilateral DIEP and TRAM flap breast reconstructions (Table III). There were six unilateral SIEA flap breast reconstructions and 15 DIEP or TRAM flap unilateral reconstructions. There was no significant difference in the mean age, body mass index, or duration of surgery between these two groups. However, there was a statistically significant difference ($p = 0.04$) in the number of postoperative inpatient hospital days, with patients who had undergone reconstruction with an SIEA flap requiring an average of 1 day less in the hospital.

DISCUSSION

The free SIEA flap allows transfer of the malleable and often substantial lower abdominal skin and subcutaneous tissue for autologous tissue breast reconstruction. The rectus

TABLE III
SIEA Flaps Compared with DIEP and TRAM Flaps for
Unilateral Breast Reconstructions

| | SIEA | DIEP or TRAM | <i>p</i> |
|-----------------------------|------|-----------------|----------|
| No. of patients | 6 | 15 | — |
| Mean age, years | 50 | 49 | 0.61 |
| Mean BMI, kg/m ² | 31 | 29 | 0.31 |
| Mean surgery time, minutes | 516 | 537 | 0.67 |
| Mean hospital stay, days | 4.2 | 5.1 | 0.04 |

SIEA, superficial inferior epigastric artery flap; DIEP, deep inferior epigastric perforator flap; TRAM, transverse rectus abdominis myocutaneous flap; BMI, body mass index.

abdominis muscle and fascia are not incised or excised, leading to decreased abdominal donor-site morbidity compared with TRAM and DIEP flaps. In this study, there was a statistically significant decrease in the length of postoperative hospital stay in patients who underwent unilateral breast reconstruction with an SIEA flap compared with those who had TRAM or DIEP flaps. Moreover, my subjective evaluation was that patients who underwent reconstruction with an SIEA flap had decreased postoperative abdominal discomfort and pain. Because hospital stay following TRAM, DIEP, and SIEA flaps is largely determined by healing at the abdominal donor site, I concluded that the SIEA flap has less abdominal morbidity than do TRAM and DIEP flaps.

The SIEA flap is particularly advantageous in bilateral autologous tissue breast reconstructions. In these cases, if an SIEA flap can be used as one of the two lower abdominal flaps, the donor site is functionally converted into a unilateral TRAM or DIEP flap donor site. This avoids the need for a bilateral TRAM or DIEP flap donor site, which has significantly more morbidity in terms of effects on abdominal strength⁶ and contour^{7,15} compared with unilateral TRAM and DIEP flap donor sites.

The aesthetic results of breast reconstruction using the TRAM, DIEP, or SIEA flaps were found to be indistinguishable. Figures 1 and 2 show examples of SIEA flap reconstruction of medium-size and large breasts, with aesthetic results similar to those of TRAM and DIEP flaps. The incidence of fat necrosis among the three flap types was similar, ranging from 12 to 14 percent. When fat necrosis did occur, it was typically minor, averaging 10 percent of the flap volume.

The mean age, body mass index, and smoking history of patients in the three flap groups were similar. The incidences of complications such as fat necrosis, hematoma, seroma, abdominal bulge, and hernia were also similar. There were no abdominal wall complications in the patients who underwent reconstruction with SIEA flaps. However, emergency reoperation occurred more often in the SIEA flap group, and this difference is discussed further below. Statistical analysis for the entire group was confounded by patients who had undergone bilateral breast reconstruction using various combinations of the three flap types. Therefore, statistical analysis of these patient characteristics was valid only for patients who

underwent unilateral breast reconstructions (Table III).

The disadvantages of the SIEA flap are the inconsistent vascular pedicle anatomy and the shorter and smaller diameter arterial vascular pedicle. Taylor and Daniel¹⁰ reported that the SIEA is absent in 35 percent of cadavers, but I have found the artery to be absent in 51 percent of clinical cases and subjectively not suitable, mainly because of small diameter, in an additional 19 percent of cases. Therefore, I was able to use the SIEA flap in only 30 percent of the cases in this study. Similar findings were published by Arnez et al.¹³ in their series of five SIEA flap breast reconstructions. They reported that the SIEA was absent in 40 percent of cases and too small in an additional 30 percent of cases. Preoperative examination with duplex ultrasonography may be able to predict which patients have an adequate-size SIEA; however, I chose not to add this additional time, expense, and complexity to the breast reconstructions.

Despite the inconsistent arterial anatomy, I have found that there is a very consistent medial superficial inferior epigastric vein measuring 2 to 4 mm in external diameter located approximately one third of the distance from the pubic symphysis to the anterior superior iliac spine. The SIEA, when present, is only sometimes located alongside the medial superficial inferior epigastric vein. Commonly, the artery is located more laterally, between one third and two thirds of the distance from the pubic symphysis to the anterior superior iliac spine, and is accompanied by separate venae comitantes.

The SIEA flaps used in this study were all hemi-lower abdominal flaps. The SIEA often enters the hemi-lower abdominal flap further laterally than even the lateral row of rectus abdominis musculocutaneous perforators. For this reason, I was not confident of the perfusion or venous drainage of flap tissue on the contralateral side of the vertical midline and did not attempt to transfer this tissue. Despite reports that the unilateral SIEA flap territory can cross the midline,^{12,16} I wished to minimize the risk of fat necrosis and did not harvest tissue across the midline.

All SIEA flaps were anastomosed to internal mammary vessels and harvested from donor sites on the side opposite the reconstructed breast. The relatively short 7-cm

vascular pedicle of the flap required anastomosis to the internal mammary vessels so that the flap could be positioned sufficiently medially on the chest wall to achieve an aesthetic breast reconstruction. Previous reports have noted the requirement for vein grafts when using the thoracodorsal vessels with the SIEA flap for breast reconstruction.^{12,13} The vascular pedicle emerges from the middle of the inferior edge of the triangular flap. This geometry requires harvest of a flap contralateral to the breast to be reconstructed to allow anastomosis to internal mammary recipient vessels.

There was a higher rate of emergency reoperation for the SIEA flap compared with the TRAM and DIEP flaps. The two SIEA flaps that required emergency reoperation had lost arterial inflow. I believe this was attributable, at least in part, to the small diameter of the SIEA vessels and the resulting size mismatch with the recipient internal mammary artery. Both of these SIEA vessels were 1.5 mm in external diameter, which is the lower limit of vessel diameter that I will now accept. In both cases, there was a size mismatch with the internal mammary artery. In one of these two cases, the SIEA was spatulated to allow end-to-end anastomosis to the larger internal mammary artery. When a clinically significant size mismatch exists, I now anastomose the SIEA end-to-side to the internal mammary artery. I believe that the combination of not using SIEA vessels with a diameter smaller than 1.5 mm and using end-to-side arterial anastomosis when an arterial size mismatch exists has improved the reliability of the SIEA flap.

CONCLUSIONS

The SIEA flap can be used in selected patients to achieve breast reconstruction equal in aesthetic quality to that achieved with TRAM and DIEP flaps while decreasing abdominal donor-site morbidity and not increasing operative time.

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