# An Intraoperative Algorithm for Use of the SIEA Flap for Breast Reconstruction

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**Background:** The deep inferior epigastric perforator (DIEP) flap has been shown to be a reliable option for breast reconstruction. A further refinement in the transfer of lower abdominal tissue for breast reconstruction is the superficial inferior epigastric artery (SIEA) flap. A retrospective study was conducted to assess the reliability and examine the outcomes of SIEA flaps for breast reconstruction while considering an intraoperative algorithm established in this study.

**Methods:** Ninety-nine SIEA flap reconstructions were performed in 82 patients in a 3½-year period. Patients were divided into two groups (before and after algorithm implementation), and their medical records were evaluated with respect to demographic information, tumor type, tobacco use, ischemic time, flap weight, and complications. Potential risk factors for complications were also assessed.

**Results:** Of the first 72 SIEA flaps, five were lost because of arterial thrombosis. All failed flaps had an SIEA diameter of less than 1.5 mm at the level of the lower abdominal incision. In February of 2004 (point T), the senior author (A.J.S.) implemented an intraoperative algorithm for flap selection that allowed use of the SIEA flap only when the SIEA diameter was 1.5 mm or greater than. In the remaining cases, a DIEP flap was used for breast reconstruction. After point T, 27 SIEA flap procedures were performed without any flap losses. Overall fat necrosis and partial flap loss rates were 1.0 and 5.1 percent, respectively. No abdominal bulges/hernias were observed. Only smoking at the time of surgery was associated with increased donor-site complications ($p = 0.016$).

**Conclusion:** The intraoperative algorithm helped decrease flap and abdominal complication rates for the SIEA flap. (*Plast. Reconstr. Surg.* 120: 1450, 2007.)

Few would deny that lower abdominal tissue continues to be the standard for autologous breast reconstruction. First popularized by Hartrampf and colleagues[1] in 1982, it remains unsurpassed in its quality and quantity. The added benefit to patients of having a vastly improved abdominal contour postoperatively and an easily hidden bikini-line scar makes it the ideal donor site. Unfortunately, the incidence of abdominal wall complications associated with sacrifice of the rectus abdominis muscle varies considerably, from 1 to 82 percent.[2–4] These complications, which are usually more severe in patients undergoing bilateral reconstruction, include chronic discomfort, motor weakness, and a predisposition to hernia and/or bulge formation. Use of synthetic materials to repair the abdominal wall defect has not eliminated the occurrence of such problems and, as a result, attention has shifted from the use of pedicled and free transverse rectus abdominis musculocutaneous (TRAM) flaps to muscle-sparing free flaps from the same donor region.

The deep inferior epigastric perforator (DIEP) flap, which was popularized by Allen and Treece[5] in 1994, has been shown to be a reliable option for breast reconstruction. Although the DIEP flap offers decreased donor-site morbidity because it does not require excision of the rectus abdominis muscle and fascia, the superficial inferior epigastric artery (SIEA) flap is even more

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advantageous because it requires neither the incision nor the excision of these two structures.

Since its introduction in 1971 by Antia and Buch[6] as a free-tissue transfer for facial reconstruction, the SIEA flap has often been described for facial and limb reconstructions. This may be attributed to the favorable orientation of its pedicle, with the vessels emerging from the border of the flap rather than from its deep surface. In 1999, Arnez and colleagues[7] reported their experience with the SIEA flap for breast reconstruction in a series of 20 patients. The SIEA flap was used in only five of the 20 cases, however, because the protocol specified that the SIEA diameter had to be equal to or larger than 1.5 mm at the origin. More recently, Chevray[8] described a series of 14 subjects in whom the SIEA flap was used for breast reconstruction. For it to be used, several anatomical criteria, including an SIEA with a palpable and visible pulsation and a minimum diameter of 1.0 mm at the level of the lower abdominal incision, had to be met. In this article, we present our experience with an intraoperative algorithm for use of the SIEA free flap in 99 breast reconstructions.

## PATIENTS AND METHODS

### Patient Population

This study included 82 patients who underwent breast reconstruction with the SIEA flap over a 3½-year period. During that time, 199 autologous tissue breast reconstructions were performed in 145 patients. Flaps and patients were divided into two groups: before and after algorithm implementation. The medical records for all 82 patients who underwent a total of 99 SIEA flap breast reconstructions were evaluated with respect to demographic information, tumor type, tobacco use, ischemic time, flap weight, and complications. Complications included flap-specific or donor-site adverse events, fat necrosis, venous congestion, partial flap loss, and total flap loss. Wound dehiscence was strictly defined as separation of the closure with evidence of epidermolysis. The diagnosis of fat necrosis was based strictly on the results of physical examination findings persisting for more than 6 months postoperatively. No minimum percentage was defined for partial flap loss. Potential risk factors for complications included age older than 60 years, a body mass index equal to or greater than 30 kg/m$^2$, duration of ischemic time, current history of smoking, significant abdominal scarring from Pfannenstiel incisions, timing of reconstruction (immediate versus delayed), use of prereconstruction radiotherapy, and a flap weight greater than 1000 g.

### Intraoperative Algorithm

In all cases, reconstruction with the SIEA flap was attempted first. If the SIEA was not present or was too small, reconstruction with the DIEP flap was performed. Later in our series (a point in time that will be referred to as point T), we implemented an algorithm that allowed us to determine when to use the SIEA flap (Fig. 1). The algorithm is as follows: When performing a unilateral breast reconstruction, we first preserve the contralateral superficial inferior epigastric vein (SIEV) and then explore the contralateral SIEA. Using a vessel sizer provided with the venous coupler, we measure the SIEA's external diameter at the site of the lower abdominal incision. If its external diameter is larger than 1.5 mm and there is a visible and palpable pulse, we dissect it to the origin and use the SIEA flap. If the external diameter is smaller than 1.5 mm or the pulse is weak, we explore the ipsilateral SIEA. If the ipsilateral SIEA is adequate, we preserve it and use the ipsilateral SIEA flap. If, however, it is too small or displays a weak pulse at the level of the lower abdominal incision, we explore the contralateral lateral and medial row deep inferior epigastric perforators. If these are unacceptable, we use the ipsilateral DIEP flap. For this series, all arterial anastomoses were performed between the SIEA and the internal mammary artery.

### Statistical Analyses

Demographic information, patient characteristics, and reconstruction-related variables are summarized as means ± SD and medians for continuous variables and as proportions for categorical variables based on the number of flaps. When two flaps were used in the same patient, each flap was considered independently for all statistical tests. Overall flap complication was defined as flaps with one or more complication(s). The incidence of overall and specific flap complications was calculated based on a total of 99 flaps. Overall donor-site complication was defined as patients experiencing one or more donor-site complication(s). The incidence of overall and specific donor-site complications was calculated based on a total of 82 patients. Chi-square and Fisher's exact tests were used to determine whether flap and donor-site complications differed when stratified before and after implementation of the intraoperative algorithm. Univariate analyses were carried out to determine potential risk factors for flap and

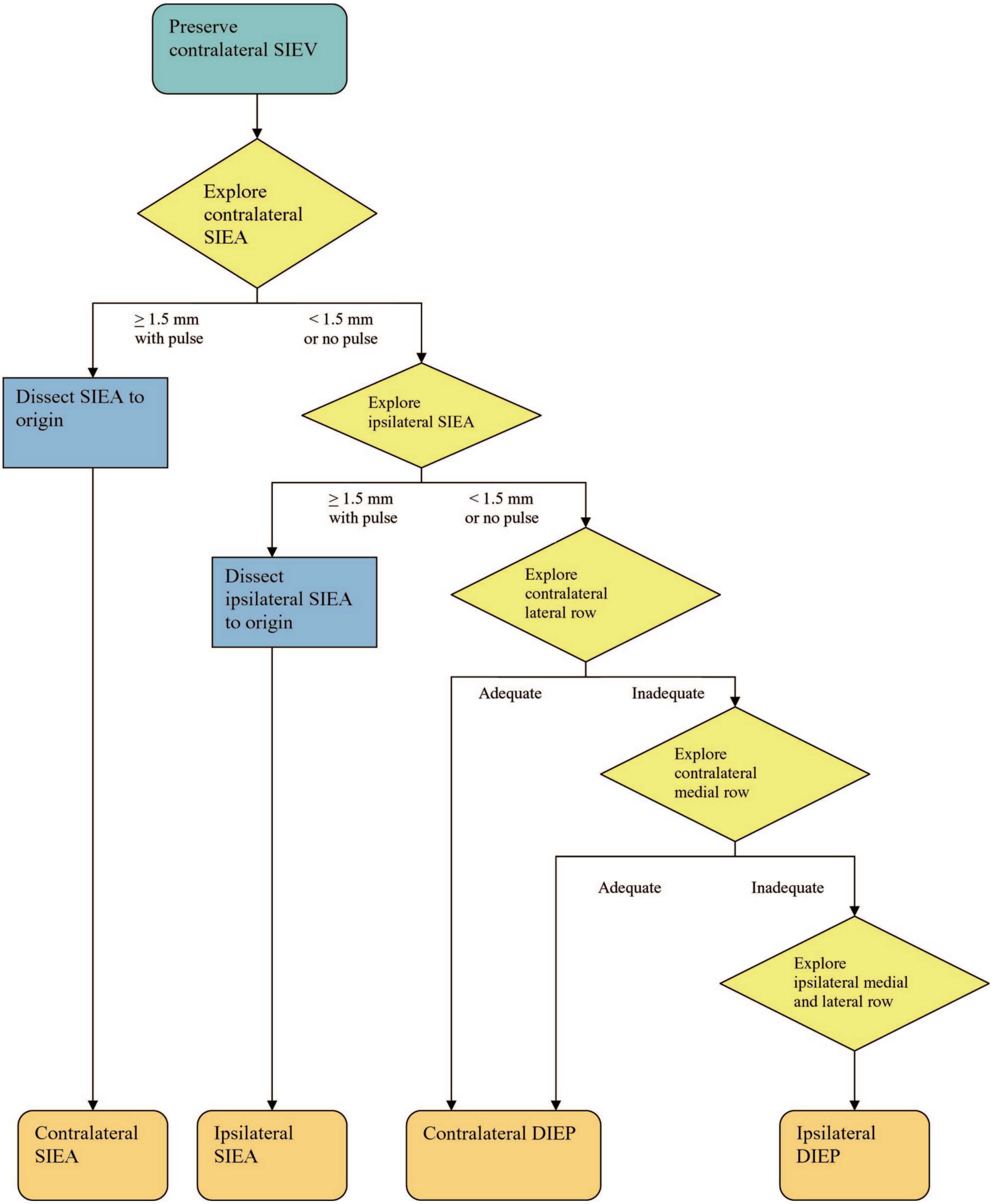


**Fig. 1.** Intraoperative algorithm. SIEA, superficial inferior epigastric artery; DIEP, deep inferior epigastric perforator.

donor-site complications. Odds ratios and 95 percent confidence intervals were derived using a logistic regression model. Whenever appropriate, an exact logistic regression model was used to model sparse data for specific complications. A value of $p < 0.05$ was considered statistically significant. Statistical analyses were performed using SAS 9.1 (SAS Institute, Inc., Cary, N.C.).

## RESULTS

### Overall

The overall patient descriptive statistics are listed in Table 1 and are based on the number of flaps (99 free SIEA flaps used in 82 patients). Of those 99, 77.8 percent were performed after cancer resection, 21.2 percent were performed for prophylaxis, and 1.0 percent were performed after failed implants. Seventy-two SIEA flaps were completed before implementation of the intraoperative algorithm, whereas 26 were performed afterward. The average patient age at the time of reconstruction was 49.6 years (range, 33 to 68 years). Fifty-six reconstructions (57.2 percent) were performed immediately and 42 (42.8 per-

**Table 1. Comparisons of Descriptive Statistics for SIEA Flap Breast Reconstructions Overall and before and after Algorithm Implementation**

| Patient Characteristics | Overall ($n$ = 99) (%) | Before Algorithm ($n$ = 72) (%) | After Algorithm ($n$ = 27) (%) |
|---|---|---|---|
| No. of patients | 82 | 60 | 22 |
| Age, years | | | |
| Mean ± SD | 49.6 ± 7.7 | 50.1 ± 7.1 | 48.1 ± 9.1 |
| Range | 33–68 | 33–68 | 33–67 |
| Median | 50 | 50 | 46.5 |
| BMI, kg/m² | | | |
| Mean ± SD | 27.5 ± 4.7 | 27.2 ± 4.2 | 28.6 ± 6.0 |
| Range | 18.7–38 | 20.6–38 | 18.7–37 |
| Median | 26.6 | 26.6 | 27.3 |
| Ischemic time, minutes* | | | |
| Mean ± SD | 95.7 ± 23.8 | 101.1 ± 23.3 | 81.5 ± 19.2 |
| Range | 52–165 | 62–165 | 52–132 |
| Median | 92 | 100 | 80 |
| Flap weight, g | | | |
| Mean ± SD | 655.7 ± 294.0 | 649.7 ± 260.9 | 672.3 ± 379.3 |
| Range | 109–1416 | 161–1150 | 109–1416 |
| Median | 615.5 | 615 | 616 |
| Follow-up, months | | | |
| Mean | 28.4 ± 9.8 | 31.8 ± 8.1 | 16.9 ± 10.3 |
| Range | 6–47 | 25–47 | 6–24 |
| Median | 29 | 33 | 19 |
| Smoking at date of operation | | | |
| Yes | 8 (8.1) | 7 (9.7) | 1 (3.7) |
| No | 91 (91.9) | 65 (90.3) | 26 (96.3) |
| Prereconstruction irradiation | | | |
| Yes | 22 (22.3) | 16 (22.2) | 6 (22.2) |
| No | 77 (77.7) | 56 (77.8) | 21 (77.8) |
| Reason for mastectomy | | | |
| Cancer | | | |
| DCIS plus invasive ductal | 1 (1.0) | 0 (0.0) | 1 (3.7) |
| DCIS | 27 (27.3) | 22 (30.6) | 5 (18.5) |
| LCIS | 4 (4.0) | 4 (5.6) | 0 (0.0) |
| Inflammatory | 1 (1.0) | 0 (0.0) | 1 (3.7) |
| Invasive ductal | 36 (36.4) | 29 (40.3) | 7 (25.9) |
| Invasive lobular | 3 (3.0) | 2 (2.8) | 1 (3.7) |
| Unknown | 5 (5.1) | 4 (5.6) | 1 (3.7) |
| Prophylactic | 21 (21.2) | 11 (15.3) | 10 (37.0) |
| S/p failed implants | 1 (1.0) | 0 (0.0) | 1 (3.7) |
| Timing for breast reconstructions | | | |
| Immediate | 56 (57.2) | 38 (53.5) | 18 (66.6) |
| Delayed | 42 (42.8) | 33 (46.5) | 9 (33.3) |
| Flap technique | | | |
| Unilateral | 51 (51.5) | 39 (54.2) | 12 (44.4) |
| Bilateral | 48 (48.5) | 33 (45.8) | 15 (55.5) |
| Scars | | | |
| Appendectomy | 3 (3.0) | 3 (4.2) | 0 (0.0) |
| Cesarean section | 24 (24.2) | 17 (23.9) | 7 (25.9) |
| Cholecystectomy/laparotomy cholecystectomy | 4 (4.0) | 1 (1.4) | 3 (11.1) |
| Laparotomy/exploratory laparotomy | 1 (1.0) | 0 (0.0) | 1 (3.7) |
| Liposectomy | 1 (1.0) | 1 (1.4) | 0 (0.0) |
| No scars | 61 (61.6) | 48 (67.6) | 13 (48.1) |
| Others | 4 (4.0) | 1 (1.4) | 3 (11.1) |

BMI, body mass index; DCIS, ductal carcinoma in situ; LCIS, lobular carcinoma in situ; S/p, status post.
*Statistically significant reduction in ischemic time after implementation of algorithm was attributed to experience.

cent) were delayed. A total of 51 women underwent unilateral SIEA breast reconstruction, whereas 31 underwent bilateral reconstruction. Of those 31, 14 underwent reconstruction with both a DIEP and an SIEA flap (data not shown). When flap-specific characteristics were compared between before and after implementation of the intraoperative algorithm (Table 1), ischemic time was significantly reduced for the latter group (mean, 101.1 minutes versus 81.5 minutes; $p = 0.0004$).

### Flap Complications

Table 2 lists the overall and specific flap complications before and after algorithm implementation. Flap complications assessed include fat necrosis, partial flap loss, venous congestion, arterial thrombosis, acute ischemia, total flap loss, breast dehiscence, breast hematoma, breast seroma, and breast infection. Before point T, the overall flap complication rate was 25.0 percent compared with 18.5 percent after point T. More importantly, no total flap losses were observed after point T compared with five total flap losses (6.9 percent) before point T. Likewise, no arterial thrombosis was observed after compared with before [$n = 6$ (8.3 percent)] implementation of the intraoperative algorithm. None of these comparisons achieved statistical significance because of the small sample study numbers after point T. A comparison of the mean vessel size for thrombotic and nonthrombotic vessels, however, revealed a statistically significant difference (1.4 mm versus 1.8 mm; $p = 0.002$).

### Donor-Site Complications

Table 3 lists the overall and specific donor-site complications before and after algorithm implementation. The specific donor-site complications include abdominal wound dehiscence, abdominal hematoma, abdominal seroma, and bulge/hernia formation. Before point T, the overall donor-site complication rate was 11.7 percent. After implementation of the algorithm, the overall donor-site complication rate dropped to 0.0 percent. Again, although the $p$ value was not statistically significant ($p = 0.187$) because of small sample size, there is a trend toward decreased donor-site complications after algorithm implementation. This will be

**Table 2. Flap Complications Overall and before and after Algorithm Implementation**

| Flap Complications | Overall (%) | Before Algorithm (%) | After Algorithm (%) | $p$, before versus after Algorithm‡ |
|---|---|---|---|---|
| Overall* | 23 (23.2) | 18 (25.0) | 5 (18.5) | 0.679§ |
| Specific† | | | | |
| Arterial thrombosis | 6 (6.1) | 6 (8.3) | 0 (0) | 0.332 |
| Acute ischemia | 1 (1.0) | 0 (0) | 1 (3.7) | 0.250 |
| Breast dehiscence | 5 (5.1) | 4 (5.6) | 1 (3.7) | 1.000 |
| Breast hematoma | 4 (4.0) | 4 (5.6) | 0 (0) | 0.569 |
| Breast infection | 3 (3.0) | 3 (4.2) | 0 (0) | 0.571 |
| Breast seroma | 0 (0) | 0 (0) | 0 (0) | — |
| Fat necrosis | 1 (1.0) | 0 (0) | 1 (3.7) | 0.250 |
| Total flap loss | 5 (5.1) | 5 (6.9) | 0 (0) | 0.327 |
| Partial flap loss | 5 (5.1) | 4 (5.6) | 1 (3.7) | 1.000 |
| Venous congestion | 2 (2.0) | 1 (1.4) | 1 (3.7) | 0.440 |

*Overall flap complication was defined as presence of any listed flap-specific complications.
†The incidence was based on number of flaps (72 flaps before algorithm and 27 flaps after algorithm).
‡Based on Fisher's exact test.
§Based on the chi-square test.

**Table 3. Donor-Site Complications Overall and before and after Algorithm**

| Donor-Site Complications | Overall (%) | Before Algorithm (%) | After Algorithm (%) | $p$, before versus after Algorithm‡ |
|---|---|---|---|---|
| Overall* | 7 (8.5) | 7 (11.7) | 0 (0) | 0.187 |
| Specific† | | | | |
| Abdominal hematoma | 0 (0) | 0 (0) | 0 (0) | — |
| Abdominal seroma | 2 (2.4) | 2 (3.3) | 0 (0) | 1.000 |
| Abdominal wound dehiscence | 5 (6.1) | 5 (8.3) | 0 (0) | 0.329 |
| Bulge/hernia | 0 (0) | 0 (0) | 0 (0) | — |

*Overall donor-site complication was defined as the presence of any listed donor-site specific complications.
†The incidence was based on number of patients (60 patients before algorithm and 22 patients after algorithm implementation).
‡Based on Fisher's exact test.

further explained in relation to flap design changes that occurred before algorithm implementation.

### Risk Factor Analysis

Risk factors were evaluated for their association with overall flap and overall donor-site complications. Based on univariate analyses, no risk factors demonstrated significant association with overall flap complications. Higher incidences of donor-site complications, however, were associated with patients who were current smokers at the time of surgery (odds ratio, 15.8; 95 percent confidence interval, 1.62 to 164.40; $p = 0.016$). The imprecise odds ratio estimate for smoking was attributable to the small number of patients in our study population who reported being current smokers at the time of surgery.

## DISCUSSION

Since implementing our algorithm, the SIEA flap has become our first choice for breast reconstruction. Although case series reporting the use of the SIEA flap for breast reconstruction have been presented in the literature, large published reports with strong statistical power are lacking. To our knowledge, despite the fact that Rizzuto and Allen[9] have mentioned performing over 200 successful total breast reconstructions with the SIEA flap in a case report, this is the first published report of a substantial number of SIEA flaps for breast reconstruction performed at a single institution.

The major advantage of using the SIEA flap is that it virtually eliminates donor-site morbidity related to the incision and/or excision of the rectus abdominis muscle and fascia that is commonly seen with free transverse rectus abdominis musculocutaneous (TRAM) flaps and, to a lesser extent, with the DIEP flap (Figs. 2 and 3). However, concerns have been raised regarding the adequacy of the vessel size and pedicle length. Because these two parameters can directly influence flap survival, it would be counterintuitive to use the SIEA flap if there is an increased risk of flap complications.

With our first 72 SIEA flaps, we based our flaps on the SIEA, provided that its diameter at the origin was greater than or equal to 1.3 mm. Unfortunately, using this protocol, we had six cases of arterial thrombosis that required emergent reexploration. Only one flap was salvaged. After reviewing our data at point T, we noticed that all five flap failures had been based on superficial inferior epigastric arteries with a diameter of less than 1.5 mm at the lower abdominal incision. Furthermore, at the time of reexploration, it was noted that the thrombus was always located at the turn in the artery as it entered the flap. Unlike the DIEP flap, the superficial inferior epigastric vessels enter the flap at its subcutaneous border instead of its inferior surface. To accommodate this, the vessels have to make an upward turn. We realized, therefore,

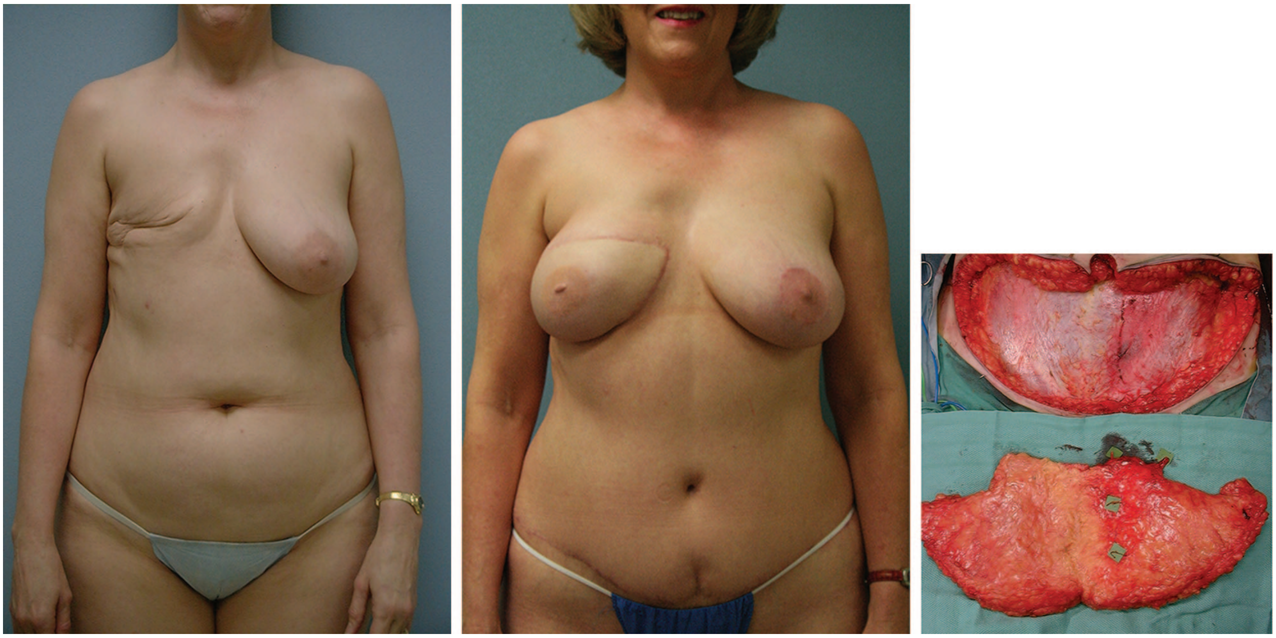

**Fig. 2.** (*Left*) Fifty-year-old woman approximately 3 years after right modified radical mastectomy. (*Center*) Three-year postoperative view after nipple-areola reconstruction. (*Right*) Intraoperative view of SIEA flap. No violation of fascia has occurred.

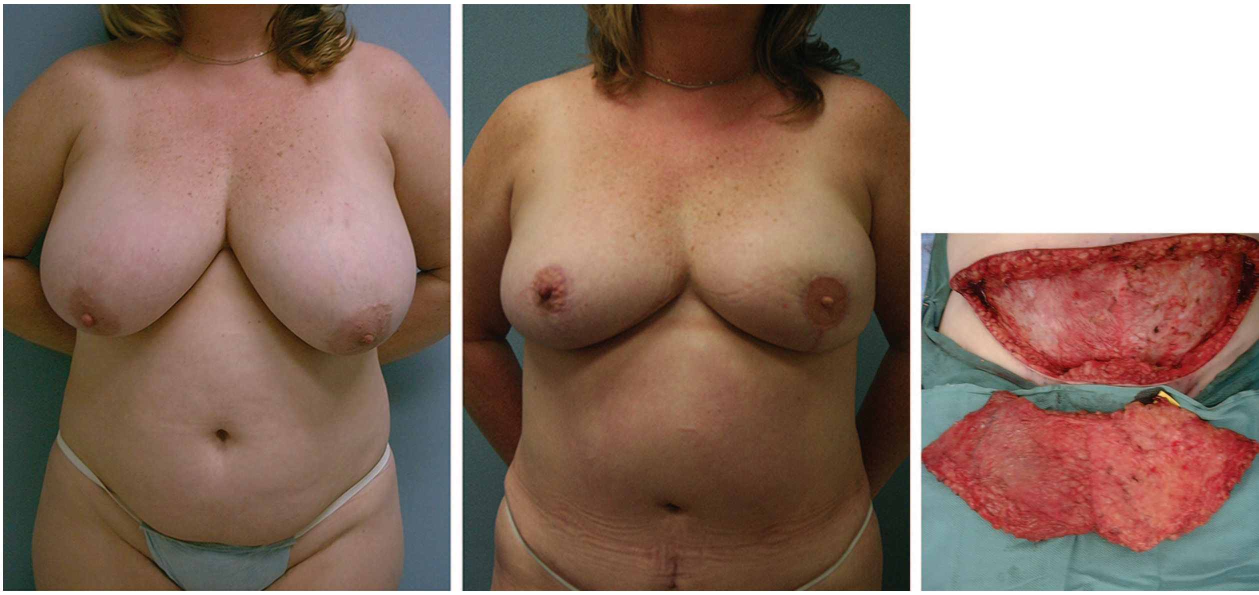

**Fig. 3.** (*Left*) A 44-year-old woman diagnosed with left-sided breast cancer. Notice the bilateral grade II ptosis preoperatively. (*Center*) Two-year postoperative view after contralateral reduction and left nipple-areola reconstruction. (*Right*) Intraoperative view of SIEA flap. No violation of fascia has occurred.

that even though the diameter of the SIEA at the origin may be more than adequate, what really mattered was its diameter as it entered the flap. If the diameter was smaller than 1.5 mm as the SIEA entered the flap, there was an increased chance of vascular compromise. This was further strengthened by the fact that a statistically significant difference was found when the mean vessel sizes for thrombotic and nonthrombotic vessels were compared (1.4 mm versus 1.8 mm, respectively; $p = 0.002$).

Ideally, vascular imaging using duplex ultrasonography preoperatively would allow us to determine whether or not the diameter of the SIEA is adequate. Unfortunately, we do not have access to such routine imaging at our institution. Therefore, we instituted an intraoperative algorithm (Fig. 1) that allows us to determine when to use the SIEA flap. Reconstruction with the SIEA flap was only attempted if the SIEA had a palpable and visible arterial pulsation and a minimum external diameter of 1.5 mm at the level of the lower abdominal incision. If these criteria were met, dissection to the origin of the superficial inferior epigastric vessels from the femoral vessels was performed. If these criteria were not met, dissection for the deep inferior epigastric perforators was performed instead. It is of the utmost importance that the SIEA and/or perforators should display a visible and palpable pulse at the level of the lower abdominal incision throughout the exploration and dissection. Often, an initially "adequate" SIEA or perforator will diminish in size and strength as the dissection progresses. In addition, we recommend preserving the SIEV because it can serve as a lifeboat for venous drainage in cases of venous congestion. Although we almost always use the two deep venae comitantes for our primary venous anastomosis, the SIEV can be used for a secondary, or even primary, anastomosis with the internal mammary vein.

Before implementing the above-mentioned algorithm, our total flap loss rate was 6.9 percent. After point T, however, this rate dropped to 0.0 percent. This rate compares favorably to those that have been reported in the literature for free TRAM and DIEP flap breast reconstructions.[10,11] Interestingly enough, we found no association between a flap weight greater than 1000 g and the development of overall flap complications. This parallels Allen's experience with the DIEP flap.[11]

Although the superficial vessels are more lateral than the lateral row of rectus abdominis perforators, we have been able to successfully harvest tissue across the midline. It is our observation that as long as zone IV and any poorly perfused tissue are excised after the completion of the anastomosis, we do not have to define the limit of the flap at the midline or in terms of its weight. In 40 of our patients who underwent unilateral SIEA breast reconstruction, we recorded the total flap weight

**Table 4. Literature Review**

| Flap | Study | No. of Flaps | Fat Necrosis (%) | Partial Flap Loss (%) | Total Flap Loss (%) | Hernia/ Abdominal Bulge (%) |
|---|---|---|---|---|---|---|
| Free TRAM | Kroll[10] | 279 | 12.9 | 2.2 | 0.4 | NR |
| Free TRAM | Nahabedian et al.[12] | 113 | 7.1 | NR | 1.8 | 9.0 |
| DIEP | Nahabedian et al.[12] | 110 | 6.4 | NR | 2.7 | 2.3 |
| DIEP | Blondeel[13] | 100 | 6.0 | 7.0 | 2.0 | 2.0 |
| DIEP | Gill et al.[11] | 758 | 12.9 | 2.5 | 0.5 | 0.6 |
| SIEA | Chevray[8] | 14 | 14.3 | 0 | 7.1 | 0 |
| SIEA | This study (overall) | 99 | 1.0 | 5.1 | 5.1 | 0 |
| SIEA | This study (before algorithm) | 72 | 0 | 5.6 | 6.9 | 0 |
| SIEA | This study (after algorithm) | 27 | 3.7 | 3.7 | 0 | 0 |

NR, not reported.

and the weight of the flap after excision of zone IV. We found that the average percentage of total flap used was 66.5 percent. Furthermore, in 17 of those 40 patients, more than 70 percent of the total flap was used. Compared with complication rates that have been reported with the free TRAM and DIEP flaps, our rates of 1.0 percent and 5.1 percent for overall fat necrosis and partial flap loss are quite encouraging (Table 4).[5,7,8,12,13] Therefore, we believe that harvesting tissue across the midline is acceptable, provided that zone IV and any ischemic tissue are carefully excised.

No association was found between prereconstruction irradiation, obesity, or abdominal scarring caused by Pfannenstiel incisions and the development of overall flap complication. Although preoperative irradiation can induce scar formation, we have rarely observed it to make the internal mammary vessels unacceptable for microvascular anastomosis. It is our policy, however, to delay reconstruction for at least 6 months in patients who have undergone irradiation to allow for some of the soft-tissue changes to resolve. We believe that better cosmesis is obtained after allowing the initial inflammatory phase to pass.

Our overall donor-site complication rate for the entire series was 8.5 percent. Perhaps most importantly, no abdominal bulges or hernias were observed. A significant association was observed between smoking at the time of reconstruction and the development of abdominal complications (odds ratio, 15.8; 95 percent confidence interval, 1.62 to 164.40; $p = 0.0032$). Supporting Allen's suggestion,[11] we now require all of our patients to quit smoking for at least 2 months before surgery.

It is interesting to note that after implementation of our algorithm, the overall donor-site complication rate dropped from 11.7 percent to 0.0 percent. The 11.7 percent donor-site complication rate included five cases of abdominal wound dehiscence (8.3 percent) and two cases of abdominal seroma (3.3 percent). We believe the high incidence of abdominal wound dehiscence may be attributable to the fact that we changed our flap design midway through our series. Although the details of this will be presented in a subsequent article, we started with a high lower abdominal incision, approximately 1 to 1.5 cm above the pubic hairline. To facilitate dissection for the superficial vessels, we changed the design to a lower abdominal incision before implementation of the algorithm. This caused the low abdominal incision to be at the level of the pubic hairline and the upper abdominal incision to be approximately 3 cm below the umbilicus. With this design, we noticed more cases of abdominal wound dehiscence, particularly in the central midline region. This prompted us to revert to the high lower abdominal incision at point T and, since then, we have not observed any major cases of abdominal wound dehiscence.

We also carefully clip any major lymphatic vessels while dissecting the superficial vessels to their origin. We believe this has reduced our rate of seroma formation at the donor site.

The disadvantages often cited for the SIEA flap stem from the classic study of the anatomy of the SIEA in 100 cadaveric dissections by Taylor and Daniel.[14] In 35 dissections, the SIEA was absent. In 48 dissections, the SIEA arose as a common trunk with the superficial circumflex iliac artery (SCIA), having an average external diameter of 1.4 mm. In the remaining 17 dissections, the artery arose as an independent vessel with an average diameter of 1.1 mm. More recent anatomical studies have shown more consistent results, with Reardon et al.[15] describing the SIEA in 20 of 22 cadaveric dissections. The mean external diameter was 1.9 mm at the origin from the femoral artery, and the mean pedicle length from the origin to the inguinal ligament was 5.2 cm. Over 3 years, we performed 278 clinical dissections for the superficial vessels. The SIEA was absent or inconsequential in 118, or 42 percent of the total dissections. In the remaining 160, or 58 percent of the total dissections, 87 SIEAs had an external diameter greater than or equal to 1.5 mm at the level of the lower abdominal incision. With our algorithm in mind, this suggests that the SIEA is adequate for use in approximately 31 percent of cases. Our series had a greater number of SIEA flaps because, before implementing the algorithm, we often used SIEAs with an external diameter of less than 1.5 mm.

Although we did not measure the pedicle length in our dissections, we did not have a problem anastomosing the superficial vessels to the internal mammary vessels. No vein grafts were needed, suggesting sufficient length. Furthermore, provided that the SIEA is larger than or equal to 1.5 mm, size mismatch is minimal because our average internal mammary artery diameter at the level of the third intercostal space was 2.14 mm. Of the 51 unilateral SIEA flaps used, 17 were ipsilateral. We prefer to use the internal mammaries as the recipient vessels for both ipsilateral and contralateral flaps because they allow for more medial positioning of the flap. For both ipsilateral and contralateral flaps, the triangular SIEA flap needs to be rotated approximately 180 degrees to allow for the anastomosis. Once the anastomosis is complete, zone IV and any excess tissue are removed to allow for adequate shaping of the flap before inset.

Use of the internal mammary vessels also allows us to keep the thoracodorsal vessels intact should the latissimus dorsi flap be needed in the future. If the sentinel lymph nodes are found to be positive after an immediate reconstruction, avoidance of the thoracodorsal vessels allows the general surgeon to confidently perform an axillary lymph node dissection.

Critics will argue that because the SIEA flap can only be used in 30 percent of cases, we should not include it in our algorithm. Because the preoperative markings, and thus the lower and upper abdominal incisions, are the same for both the SIEA and DIEP flaps, we find it convenient to first look for the superficial vessels. If the SIEA is inadequate or missing, we simply continue our dissection for the deep inferior epigastric perforators. Given the comparable flap complication rates and favorable donor-site complication rates cited above, we believe taking the extra time to explore for the SIEA is justified.

## CONCLUSIONS

The SIEA flap is an excellent choice for breast reconstruction in selected patients. Having decreased abdominal complication rates and flap complication rates comparable to those of the DIEP flap, the SIEA should be the flap of choice when attempting autologous abdominal tissue reconstruction. Perhaps most importantly, however, our intraoperative algorithm allows physicians to more confidently choose the most reliable flap for breast reconstruction.

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### DISCLOSURE

*Neither of the authors has a financial interest in any of the products, devices, or drugs mentioned in this article.*

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