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Perfusion-Related Complications are Similar for DIEP and MS FTRAM Flaps Harvested on Medial or Lateral Deep Inferior Epigastric Artery Branch Perforators for Breast Reconstruction

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Abstract

Background—Anatomic studies suggest the deep inferior epigastric artery (DIEA) medial branch perfuses more tissue across the midline than the lateral branch. We hypothesized that unilateral DIEP and MS FTRAM flaps based on medial branch perforators would have fewer perfusion-related complications.

Methods—We evaluated 2043 consecutive free flap breast reconstructions and included unilateral reconstructions where DIEP or MS FTRAM flaps were definitively harvested from a single DIEA branch. We grouped flaps by tissue volume, i.e., Hemiflaps, Cross-Midline Flaps, and Total Flaps. Primary outcome measures were fat necrosis and partial flap necrosis. Logistic regression was used to evaluate the association between patient and reconstruction characteristics and perfusion outcomes.

Results—We included 228 patients: 120 (52.6%) medial and 108 (47.4%) lateral branch flaps. Mean follow-up was 33.2 months. Cross-Midline Flaps (79.8%) were most common, followed by Hemiflaps (15.4%) and Total Flaps (4.8%). Overall fat necrosis and partial flap necrosis rates were 10.5% and 3.1%, respectively. Medial and lateral branch flaps had similar rates of fat necrosis (8.3% vs. 13.0%, respectively; p=0.26) and partial flap necrosis (3.3% vs. 2.8%, respectively; p=1.0). DIEP and MS FTRAM flaps had no difference in the incidence of fat necrosis (10.2% vs. 11.3%; p=0.81) or partial necrosis (3.2% vs. 2.8%; p=1.0). Medial and lateral branch flap perfusion-related complications were also similar among the flap volume classifications.

Conclusions—We suggest that surgeons base their decisions regarding DIEA branch harvest on the clinical assessment of perforator perfusion quality rather than relying on the theoretic benefit of medial branch perforator harvest.

Introduction

Abdominal-based free flaps perfused by the deep inferior epigastric artery (DIEA), such as the deep inferior epigastric perforator flap (DIEP) and the muscle-sparing transverse rectus

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abdominis musculocutaneous flap (MS FTRAM), remain a popular choice for autologous breast reconstruction.(1-24) Hartrampf defined perfusion zones of the anterior abdominal wall to facilitate decision-making when designing pedicled TRAM (PTRAM) flaps.(25) Fluorescence angiography by Holm demonstrated the Hartrampf zones to be appropriate for the superior epigastric artery (Figure 1a) but demonstrated a reversal of zones 2 and 3 when the perfusion was isolated to the DIEA (Figure 1b).(26, 27) Recent cadaveric anatomic studies using dynamic computed tomographic (CT) scanning have elegantly shown the medial and lateral DIEA branch perforasomes to differ in type II DIEA branching pattern flaps.(28, 29) Medial branch DIEA perforators appear to more often follow the perfusion pattern described by Hartrampf, while lateral branch DIEA perforators appear to resemble the Holm zones.(26, 28-33) On the basis of these findings, it has been suggested that DIEP and MS FTRAM flaps including tissue from the contralateral hemiabdomen should be perfused by medial DIEA branch perforators, and flaps based only on the ipsilateral hemiabdomen should be perfused by lateral DIEA branch perforators. Interestingly, attempts to replicate these cadaveric findings in living patients have not demonstrated significant differences in the medial vs. lateral branch perforasomes.(33) Despite the theoretic advantages of medial DIEA perforator harvest, it has not been determined whether perfusion-related complications such as fat necrosis and partial flap necrosis actually differ between flaps perfused by medial- or lateral-only branch perforators. We hypothesized that unilateral DIEP and MS FTRAM flaps based on medial DIEA branch perforators that include Holm zone 3 tissue across the midline will have a lower rate of perfusion-related complications such as fat necrosis and partial flap necrosis than those based on lateral branch perforators.

Patients and Methods

We evaluated all free-flap, abdominal-based autologous breast reconstructions performed at The University of Texas MD Anderson Cancer Center between January 1, 2000, and April 13, 2010 (2043 consecutive cases). Data collected from a prospectively entered departmental database and patients' medical records were retrospectively reviewed. We included only those cases of post-mastectomy, unilateral DIEP or MS FTRAM flap breast reconstruction in which the flap was perfused by either medial-only or lateral-only type II DIEA branch perforators. We excluded flaps harvested with both the medial and lateral DIEA branches, flaps harvested for one side of a bilateral breast reconstruction, bipedicled flaps for unilateral breast reconstruction, superficial inferior epigastric artery (SIEA) flaps, cases in which the operative report did not clearly communicate from which DIEA branch the flap was harvested, cases with type I or III DIEA branching patterns, and complete flap failures. MD Anderson Cancer Center's Institutional Review Board approved this study.

Patient, treatment, and surgical outcome data were analyzed. The primary outcome measure was the relationship between DIEA branch flap harvest and the occurrence of fat necrosis or partial flap necrosis. Secondary outcome measures included the effects of DIEP vs. MS FTRAM harvest, flap design, and perforator number on the occurrence of fat necrosis or partial flap necrosis.

Flap harvest patterns were classified into three groups--Hemiflaps, Cross-Midline Flaps, or Total Flaps--according to the Holm perfusion zones included with the flap (Fig. 2).(26) Fat necrosis was defined as a palpable firmness ≥1 cm in diameter that persisted beyond 3 months postoperatively. Partial flap necrosis was defined as necrosis of the flap skin island and underlying fat. For the purpose of this evaluation fat necrosis and partial flap necrosis were considered mutually exclusive complications. The presence of fat necrosis or partial flap necrosis was determined by clinical examination and radiographic and/or pathologic confirmation. The decision to image and/or biopsy a palpable firmness was made at the

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surgeons' and/or oncologists' clinical discretion. Patients were followed postoperatively at least monthly after discharge for 6 months, every 3-6 months until 1 year, and then at least yearly thereafter.

Surgical Technique

All DIEP and MS FTRAM flaps included in this patient series were harvested on either the medial or lateral DIEA branch through fascial incisions around the individual perforators using a fascia-sparing technique. DIEP flaps were raised by splitting the rectus abdominis muscle. MS FTRAM flaps were raised by harvesting a longitudinal section of muscle around the same-branch perforators.(14) Surgeons tended to harvest single perforators only when the combined arterial and venous perforator diameter was >3 mm.(34-36) Harvesting a flap on combined artery/vein perforators measuring <1.5 mm was typically avoided.

Statistical Analysis

Fisher's exact test or the Chi-square test was used to evaluate the association between categorical variables. Wilcoxon rank sum or Kruskal-Wallis testing was used to compare the distributions of continuous variables between patient groups. The multicovariate logistic regression model was used to determine the effects of patient and reconstructive characteristics on complication status.(37) Values for $p \leq 0.05$ were considered statistically significant. SAS statistical software (version 9.1.3, Cary, NC) was used for all the analyses. All statistical analyses were performed by a senior staff biostatistician (L.F.).

Results

We identified 228 patients meeting the strict criteria for study inclusion. There were 120 (52.6%) medial and 108 (47.4%) lateral DIEA branch cases. Reconstruction immediately followed mastectomy in 148 patients (64.9%) and was delayed in 80 patients (35.1%). DIEP flaps were used in 157 (68.9%) cases and MS FTRAM flaps in 71 (31.1%) cases. Of the MS FTRAM flaps, 64 (90.1%) were MS2 FTRAM flaps and 7 (9.9%) were MS1 FTRAM flaps. Flap designs were distributed as follows: Cross-Midline Flaps (79.8%), Hemiflaps (15.4%), and Total Flaps (4.8%). Patient follow-up was 33.2 ± 22.9 months (range 7.6 – 107.0 months).

Overall Flap Outcomes

Of the 228 cases, fat necrosis occurred in 24 (10.5%) and partial flap necrosis occurred in 7 (3.1%), for a total of 31 (13.6%) flaps that developed either fat necrosis or partial flap necrosis. Radiologic and/or pathologic confirmation was available for 61.3% of the cases of fat necrosis. Other flap complications included hematoma/seroma (5.7%), infection requiring antibiotics (2.6%), and anastomotic thrombosis (0.9%). Forty-five flaps (19.7%) developed at least one flap complication. Eight flaps (3.5%) developed two or more complications.

Medial vs. Lateral DIEA Branch Flap Outcomes

Patient clinical characteristics and co-morbidities for the cases stratified by DIEA branch are shown in Table 1. There were no significant differences in body mass index (BMI), smoking status, or adjuvant chemotherapy between the two groups. The lateral branch group had a higher incidence of diabetes mellitus (9.3%) compared to the medial branch group (2.5%; p=0.042).

Table 2 shows differences in breast reconstruction characteristics between the medial and lateral branch patients. DIEP and MS FTRAM flaps were similarly distributed (p=0.45), but flap designs differed significantly between the medial and lateral branch groups (p=0.012).

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The distribution of the number of perforators included with the flap harvest (1 vs. 2 vs. ≥3) differed significantly between the medial and lateral branch groups (p=0.03) (Figure 3). More of the overall medial branch flaps were harvested on 1 perforator (28.3% vs. 17.2%) and fewer on ≥3 perforators (30.1% vs. 46.5%) compared to the lateral branch flaps. The distribution of the number of perforators included with the flap harvest (1 vs. 2 vs. ≥3) was not statistically different for the Hemiflap and Total Flap groups (p=0.72 and p=0.27, respectively).

A comparison of outcomes for the combined, overall flap design classifications (i.e. Hemiflaps, Cross-Midline Flaps, and Total Flaps) demonstrated no differences in recipient site complications between the medial and lateral branch groups (Table 3). Unicovariate analysis demonstrated similar rates of fat necrosis in the medial (8.33%) and lateral (12.96%) DIEA branch flaps (p=0.26). There were also similar rates of partial flap necrosis between medial (3.3%) and lateral (2.78%) DIEA branch flaps (p=1.0). Multicovariate logistic regression analysis demonstrated no significant independent associations between 1) the presence of any patient co-morbidity or 2) lateral vs. medial perforator harvest and the development of fat necrosis. Unicovariate analysis showed no significant association between the numbers of perforators harvested and the development of fat necrosis in all flaps included in this study (p=0.92). We further attempted to control for the confounding affect of multiple perforators by performing direct comparisons between flaps perfused on the same number of perforators (e.g. one perforator medial branch DIEP flaps vs. 1 perforator lateral branch DIEP flaps). Direct comparison between 1, 2, or ≥3 perforator medial flaps to 1, 2, or ≥3 perforator lateral flaps and 1, 2, or ≥3 perforator DIEP flaps to 1, 2, or ≥3 perforator MS FTRAM flaps also demonstrated no differences in perfusion related complications between the comparison groups (data not shown).

Flap Characteristics and Outcomes by Perfusion Zones

Surgical outcomes based on flap design classification are shown in Table 4. Patient characteristics were similar among the three flap design classifications, with the exception of the Total Flap group having a lower age (p<0.0001), lower BMI (p=0.003), and fewer medical co-morbidities than the other two groups (p=0.032). Rates of fat necrosis and partial flap necrosis were not statistically different among the three groups (Table 4). Table 5 demonstrates the characteristics and outcomes for the Cross-Midline Flap, the most commonly used flap in the study. The distribution of the number of perforators included with the flap harvest (1 vs. 2 vs. ≥3) differed significantly between the Cross-Midline medial and lateral branch groups (p=0.017). More of the Cross-Midline medial branch flaps were harvested on 1 perforator (28.0% vs. 14.5%) and fewer on ≥3 perforators (28.0% vs. 47.4%) compared to the lateral branch flaps. The fat necrosis rates for the medial and lateral branch Cross-Midline Flap patients were similar (9.1% and 14.5%, respectively; p=0.26). The partial flap necrosis rates were also similar between medial (4.0%) and lateral (3.6%) branch Cross-Midline Flap patients (p=1.0).

In the Cross-Midline Flap group, multicovariate logistic regression analysis of lateral vs. medial harvest and the presence of any comorbidity showed a significant association between the presence of any comorbidity and the development of fat necrosis or partial flap necrosis (OR 2.63; 95% CI 1.16-5.98; p=0.021). No significant association was identified between medial vs. lateral perforator harvest and the development of fat necrosis, partial flap necrosis, fat necrosis/partial flap necrosis, or any individual complication. There was also no significant difference in fat necrosis rates or partial flap necrosis rates when medial and lateral branch groups were compared within the Hemiflap and Total Flap groups (data not shown).

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DIEP vs. MS FTRAM Patient Characteristics and Flap Outcomes

All patient characteristics and co-morbidities were similar between the DIEP and MS FTRAM patients, with the following exceptions: more of the DIEP patients received preoperative chemotherapy (p=0.0016) and more of the MS FTRAM patients received postoperative radiotherapy (p=0.045). Table 6 demonstrates that the number of perforators (1 vs. 2 vs. ≥3) differed between the MS FTRAM and DIEP flaps (p=0.0001). More of the MS FTRAM flaps had ≥3 perforators (61.8%) compared to the DIEP flaps (29.3%). There were no significant differences in fat necrosis (p=0.81) or partial flap necrosis (p=1.0) rates between the DIEP (10.2%, 3.2%) and MS FTRAM (11.3%, 2.8%) flaps, respectively.

Overall Predictors of Fat Necrosis and Partial Flap Necrosis

We assessed whether any patient or reconstructive characteristic was independently predictive of or protective for the development of fat necrosis or partial flap necrosis. Univariate logistic regression analysis did not demonstrate any individual comorbid medical condition to be predictive of complications but did identify that patients with at least one co-morbidity had a significantly greater risk of developing either fat necrosis or partial flap necrosis compared to those without any co-morbidities (20.7% vs. 9.2%; p=0.014). Multivariate logistic regression analysis that included 1) any comorbidity and 2) lateral vs. medial DIEA harvest demonstrated that the presence of at least one pre-existing co-morbid medical condition was the only independent risk factor predictive of fat necrosis/partial flap necrosis (OR 2.52; 95% CI 1.16 – 5.47; p=0.019).

Discussion

We found that DIEP and MS FTRAM flaps harvested on medial and lateral DIEA branch perforators had similar rates of the perfusion-related complications fat necrosis and partial flap necrosis. This was true for all flaps in the cohort combined and also when flaps were stratified on the basis of flap type and design classification. To our knowledge, this study is the first reported patient series comparing fat necrosis and partial flap necrosis rates between strict medial- or lateral-only DIEA branch harvest groups. The only characteristic that consistently predicted the development of postoperative perfusion-related complications in this meticulously controlled group of patients was the presence of any co-morbid medical condition.

This is the first clinical study to quantify the clinical relevance of the perforasome variances of the medial and lateral DIEA branches with respect to actual patient outcomes. We anticipated significantly higher rates of fat necrosis and partial flap necrosis in flaps perfused by lateral DIEA branch perforators in comparison to medial DIEA branch perforators, particularly for flaps that included tissue across the midline. However, our results were contrary to our hypothesis.

We did find a difference in the numbers of perforators included with the medial and lateral DIEA branch flaps, a finding that could explain the similarities in perfusion-related complication rates between these two groups. A recent study by Baumann and co-workers demonstrated the importance of perforator number in the development of fat necrosis.(22) The study did not specify from which DIEA branch the perforators were harvested but was specifically designed to test the effects of perforator number by dividing the flaps into 4 groups: 1) SIEA flaps, 2) one to two perforators, 3) three to five perforators, and 4) greater than five perforators. Although we saw a difference in our study between the distribution of 1, 2, or ≥3 perforators, few of the flaps in our study, irrespective of branch harvest classification, were harvested on more than 3 perforators (Figure 3). This observation is likely owing to our exclusion of flaps that included perforators from both the medial and

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lateral branches of the DIEA, as a single branch of the DIEA rarely has >3 perforators.(36) Irrespective of the differences in perforator distribution between flap classifications, we saw no differences in perfusion-related complications both with regression analysis and with direct comparison of 1, 2, or ≥3 perforator medial flaps vs. 1, 2, or ≥3 perforator lateral flaps and 1, 2, or ≥3 perforator DIEP flaps vs. 1, 2, or ≥3 perforator MS FTRAM flaps.

It is unclear why the surgeons in our study chose to include more perforators with the lateral branch flaps. One possibility is that this was a strategy to potentially increase perfusion across the midline. However, the more likely possibility is that our surgeons tended to harvest multiple perforators in a longitudinal row. The differences in lateral and medial flap perforator number likely reflect an inherent anatomic difference between the medial and lateral DIEA branches. Although DIEA perforators originate from the lateral branch only 34% of the time, the lateral DIEA branch takes a vertical course through the rectus abdominis complex 79.2% of the time.(36) This vertical orientation allows the rectus abdominis muscle to be split longitudinally so that more same-branch perforators may be included with a lateral branch flap, with minimal muscle damage. In contradistinction, the medial DIEA branch takes an oblique course through more than one intermuscular septum 81.8% of the time.

The longitudinal vs. oblique course of the DIEA branch likely explains why more perforators were included in the MS FTRAM patients. When inclusion of more perforators was felt appropriate in an obliquely oriented, medial DIEA branch, our surgeons may have been more likely to harvest the intervening muscle between perforators as an MS FTRAM flap rather than dissect the muscle from the perforators to create a DIEP flap. Although the observed differences in perforator numbers between the medial vs. lateral DIEA branch groups may explain the observed similarities in perfusion-related complications in our patients, we were not able to demonstrate an association between perforator number and perfusion-related complications among the specific comparative groups in our study.

Another important finding in this study is the effect of DIEP vs. MS FTRAM technique. Prior studies have questioned the durability of perfusion with the DIEP technique in comparison to TRAM.(7, 18, 23, 35, 38) We found the rates of perfusion-related flap morbidity between the DIEP and MS FTRAM flaps to be almost identical in this series of flaps harvested exclusively on perforators from a single DIEA branch. The inclusion or exclusion of rectus abdominis muscle in this highly selected, homogenous group of patients appeared to have had no effect on the development of fat necrosis or partial flap necrosis.

The strengths of this study include the large experience with free flap breast reconstruction by multiple surgeons using similar techniques at a single center, careful study design to isolate and compare perfusion-related flap morbidity between strict medial- or lateral-only branch harvest groups, data obtained from a prospectively entered patient database, and unicovariate and multicovariate regression analyses. Limitations of this study include its retrospective design, imprecise nature of evaluations of fat necrosis and partial flap necrosis, potential variability in the amount of contralateral tissue or Zone 3 sub-Scarpal fat transferred, and potential surgeon bias to harvest a greater number of perforators for larger flaps, lateral DIEA branch flaps, or MS FTRAM flaps.

On the basis of the results of this study we suggest that medial row perforators not be specifically selected on the basis of anticipated reduced flap morbidity. To control for surgeon bias, it is reasonable to hypothesize that a prospective study arbitrarily assigning patients into medial or lateral perforator groups irrespective of the intraoperative findings might demonstrate greater perfusion-related complications among the lateral branch groups. However, unless such a study clearly demonstrates fewer perfusion-related complications

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among medial branch flaps, we suggest that surgeons not overestimate the clinical relevance of the anatomic variances in medial versus lateral DIEA branch perforasomes when harvesting abdominally based flaps. The selection of perforators should take into account the perforator size, perfusion quality, and DIEA branch orientation. Knowledge of the similar rates of perfusion-related complications for flaps raised on medial or lateral DIEA branch perforators should enable surgeons to make more informed intraoperative decisions when harvesting DIEP and MS FTRAM flaps for breast reconstruction.

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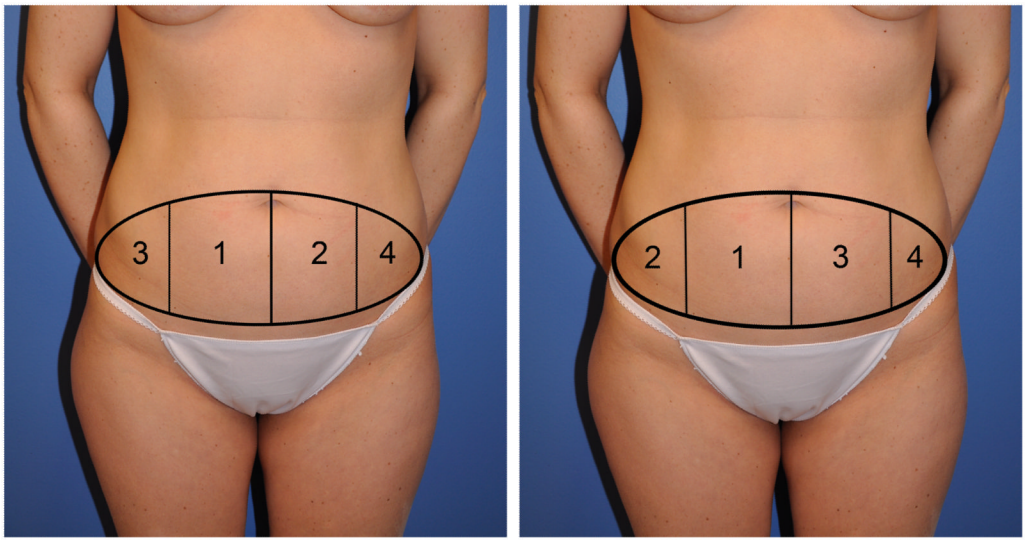

Figure 1.
a) Holm's perfusion zones of the abdomen appear to more reflect the perfusion of lateral DIEA branch perforators. b) Hartrampf's perfusion zones of the abdomen appear to more reflect the perfusion of medial DIEA branch perforators.

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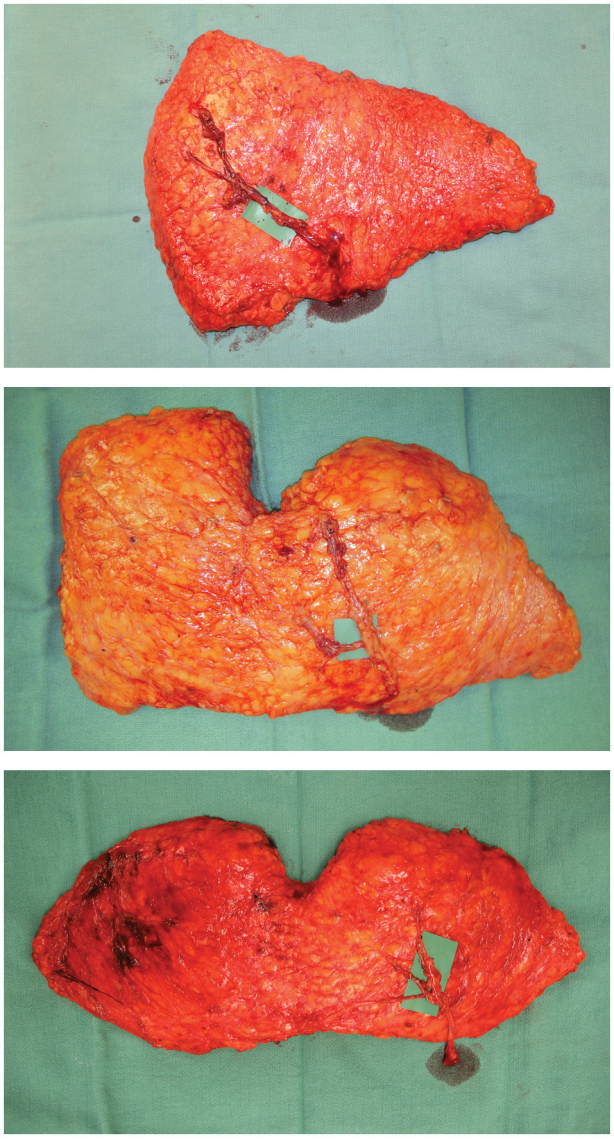

Figure 2.
Flap harvest patterns were classified into three groups according to the Holm perfusion zones included with the flap: a) Example of a Hemiflap, which includes Holm zones 1 and 2; b) Example of a Cross-Midline Flap, which includes Holm zones 1, 2, and 3; and c) Example of a Total Flap, which includes Holm zones 1, 2, 3, and 4.

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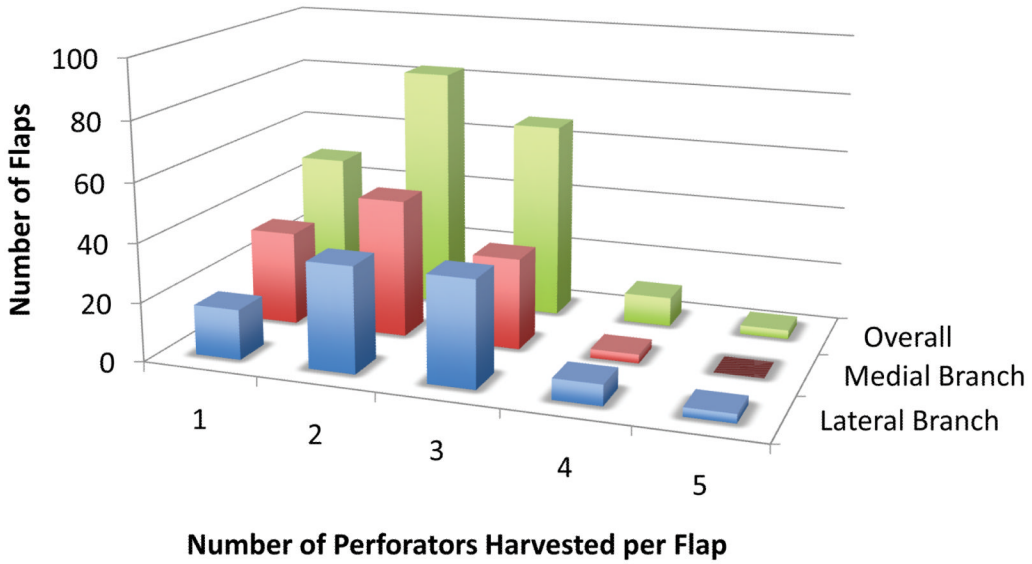

Figure 3.
A comparison of the number of perforators included per lateral branch flap and medial branch flap and overall.

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Table 1
Patient Clinical Characteristics and Co-Morbidities

	Medial Branch N=120	Lateral Branch N=108	P-value
Body Mass Index, mean (mg/kg^2)	26.9 ± 5.2	27.3 ± 6.2	0.95
Age, mean (years)	50.8 ± 9.1	50.8 ± 9.2	0.86
Bra Cup Size, mean			
• A or B	53 (46.5%)	34 (37%)	0.17
• ≥ C	61 (53.5%)	58 (63%)	
Active Smoker	9 (7.5%)	5 (4.6%)	0.42
Alcohol Consumption	54 (45%)	45 (41.7%)	0.61
Preoperative Chemotherapy	47 (39.2%)	49 (45.4%)	0.34
Preoperative Radiation Therapy	35 (29.2%)	32 (29.6%)	0.94
Postoperative Radiation Therapy	11 (9.2%)	11 (10.2%)	0.79
Any Medical Co-morbidity	42 (35%)	45 (41.7%)	0.30
• Adrenal Disease	1 (0.8%)	0 (0%)	1.0
• Arrhythmias	6 (5%)	3 (2.8%)	0.50
• Cerebrovascular Disease	2 (1.7%)	0 (0%)	0.50
• Coronary Artery Disease	1 (0.8%)	0 (0%)	1.0
• Diabetes Mellitus	3 (2.5%)	10 (9.3%)	**0.04**
• Gastrointestinal Disease	14 (11.7%)	9 (8.3%)	0.40
• Hypertension	28 (23.3%)	28 (25.9%)	0.65
• Liver Disease	1 (0.8%)	0 (0%)	1.0
• Morbid Obesity	1 (0.8%)	3 (2.8%)	0.35

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Table 2

Reconstruction Characteristics

	Medial Branch N=120	Lateral Branch N=108	P-value
Immediate Reconstruction	80 (66.7%)	68 (63%)	0.56
Number of Perforators Harvested			
• 1	32 (28.3%)	17 (17.2%)	**0.03**
• 2	47 (41.6%)	36 (36.4%)	
• ≥ 3	34 (30.1%)	46 (46.5%)	
Flap Type			
• DIEP	80 (66.7%)	77 (71.3%)	0.45
• MS FTRAM	40 (33.3%)	31 (28.7%)	
Recipient Vessels			
• Internal Mammary	114 (95%)	98 (90.7%)	0.21
• Thoracodorsal	6 (5%)	10 (9.3%)	
Flap Design			
• Hemiflap	12 (10%)	23 (21.3%)	**0.012**
• Cross-Midline Flap	99 (82.5%)	83 (76.9%)	
• Total Flap	9 (7.5%)	2 (1.9%)	

DIEP, Deep Inferior Epigastric Perforator Flap; MS FTRAM, Muscle-Sparing Free Transverse Rectus Abdominis Musculocutaneous Flap.

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Table 3

Postoperative Outcomes

	Medial Branch N=120	Lateral Branch N=108	p-value
Fat Necrosis	10 (8.33%)	14 (12.96%)	0.26
Partial Flap Necrosis	4 (3.3%)	3 (2.78%)	1.0
Fat Necrosis / Partial Flap Necrosis	14 (11.7%)	17 (15.7%)	0.37
Inpatient Hospital Days, mean	4.7 ± 1.0	4.9 ± 1.4	0.37
Follow-Up, mean (Months)	28.2 ± 24.2	33.2 ± 26.1	0.09

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Table 4

Postoperative Outcomes by Flap Design

	Hemiflaps N=35	Cross-Midline Flaps N=182	Total Flaps N=11	p-value
Fat Necrosis	3 (8.6%)	21 (11.5%)	0 (0%)	0.70
Partial Flap Necrosis	0 (0%)	7 (3.8%)	0 (0%)	0.72
Fat Necrosis / Partial Flap Necrosis	3 (8.6%)	28 (15.4%)	0 (0%)	0.32
Inpatient Hospital Days, mean	4.8 ± 1.3	4.8 ± 1.2	5.0 ± 0.8	0.36
Follow-Up, mean (Months)	28.9 ± 25.7	31.0 ± 24.9	29.4 ± 30.8	0.66

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Table 5
Cross-Midline Flap Patient and Reconstruction Characteristics and Surgical Outcomes

	Medial Branch N=99	Lateral Branch N=83	p-value
Body Mass Index, mean (mg/kg^2)	26.5 ± 4.9	27.1 ± 6.6	0.97
Age, mean (years)	50.7 ± 9.0	49.7 ± 8.5	0.54
Any Medical Co-morbidity	37 (37.4%)	31 (37.3%)	1.0
Number of Perforators			
• 1	26 (28.0%)	11 (14.5%)	**0.017**
• 2	41 (44.1%)	29 (38.2%)	
• ≥3	26 (28.0%)	36 (47.4%)	
Flap Type			
• DIEP	69 (69.7%)	58 (69.9%)	0.98
• MS FTRAM	30 (30.3%)	25 (30.1%)	
Complications			
• Fat Necrosis	9 (9.1%)	12 (14.5%)	0.26
• Partial Flap Necrosis	4 (4.0%)	3 (3.6%)	1.0
• Fat Necrosis / Partial Flap Necrosis	13 (13.1%)	15 (18.1%)	0.36
• Infection	4 (4%)	2 (2.4%)	0.69
• Hematoma/Seroma	4 (4%)	7 (8.4%)	0.23
• Anastomotic Thrombosis	2 (2%)	0 (0%)	0.50
• Any Complication	21 (21.2%)	19 (22.9%)	0.79

DIEP, Deep Inferior Epigastric Perforator Flap; MS FTRAM, Muscle-Sparing Free Transverse Rectus Abdominis Musculocutaneous Flap.

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Table 6
DIEP vs. MS FTRAM Patient and Reconstruction Characteristics and Surgical Outcomes

	DIEP N=157	MS FTRAM N=71	p-value
Body Mass Index, mean (mg/kg^2)	26.9 ± 5.5	27.5 ± 6.2	0.55
Age, mean (years)	50.9 ± 9.3	50.4 ± 8.8	0.59
Any Medical Co-morbidity	62 (39.5%)	25 (35.2%)	0.54
Number of Perforators			
• 1	44 (28.0%)	5 (9.1%)	**0.0001**
• 2	67 (42.7%)	16 (29.1%)	
• ≥3	46 (29.3%)	34 (61.8%)	
Harvest Type			
• Medial DIEA Branch	80 (51.0%)	40 (56.3%)	0.45
• Lateral DIEA Branch	77 (49.0%)	31 (43.7%)	
Complications			
• Fat Necrosis	16 (10.2%)	8 (11.3%)	0.81
• Partial Flap Necrosis	5 (3.2%)	2 (2.8%)	1.0
• Fat Necrosis / Partial Flap Necrosis	21 (13.4%)	10 (14.1%)	0.89
• Any Complication	31 (19.7%)	14 (19.7%)	1.0

DIEP, Deep Inferior Epigastric Perforator Flap; MS FTRAM, Muscle-Sparing Free Transverse Rectus Abdominis Musculocutaneous Flap; DIEA, Deep Inferior Epigastric Artery.