Bilateral Free Flap Breast Reconstruction Outcomes: Do Abdominal Scars Affect Bilateral Flaps?

The Harvard community has made this article openly available. Please share how this access benefits you. Your story matters.

Citation
Unukovych, Dmytro, Edward J. Caterson, Matthew J. Carty, Jessica Erdmann-Sager, Eric Halvorson, and Stephanie A. Caterson. 2017. "Bilateral Free Flap Breast Reconstruction Outcomes: Do Abdominal Scars Affect Bilateral Flaps?" Plastic and Reconstructive Surgery Global Open 5 (9): e1493. doi:10.1097/GOX.0000000000001493. http://dx.doi.org/10.1097/GOX.0000000000001493.

Published Version
doi:10.1097/GOX.0000000000001493

Citable link
http://nrs.harvard.edu/urn-3:HUL.InstRepos:34492141

Terms of Use
This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA
INTRODUCTION
The incidence of bilateral mastectomies for cancer and/or risk reduction is increasing along with the rates of breast reconstructions. Bilateral autologous free flap reconstructions are complex procedures associated with longer operating hours and technical challenges for plastic surgeons, as well as possible increased medical and surgical risks for the patients.

A substantial number of candidates for breast reconstruction will present with abdominal scars after Cesarean section, laparoscopy, laparotomy, and so on. The aim of this study was to evaluate the impact of prior abdominal scars on complication rates in abdominal bilateral free flap breast reconstruction.

Methods: All consecutive patients with autologous free flap breast reconstruction between 2007 and 2014 were eligible. The relevant demographic and clinical data were prospectively collected into a study-specific database. Complications and reoperations were prospectively registered after postoperative outpatient visits.

Results: Overall, 493 patients underwent abdominally based breast reconstruction during the study period: unilateral (n = 250; 50.7%) or bilateral (n = 243; 49.3%). In the bilateral group, the abdominal scar locations were Pfannenstiel (n = 73; 30.1%), midline (n = 16; 6.6%), lower oblique (n = 17; 7.0%), upper oblique (n = 5; 2.1%), and laparoscopic (n = 69; 28.4%). Four (1.7%) flap failures (including 1 converted to a pedicled transverse rectus abdominis flap) were registered, all occurring in patients from the scar group: 3 with Pfannenstiel incision and 1 patient with prior laparoscopy. Pfannenstiel scar was associated with higher risk of hematoma at the recipient site when compared with no scar group (13.7% versus 2.2%; \( P = 0.006 \)). Partial flap necrosis, infection, and seroma occurred in 14 (5.9%), 8 (3.4%), and 5 (2.1%) patients, respectively, and no differences between the scar groups were identified.

Conclusion: Surgical outcomes of bilateral reconstructions in patients with abdominal scars are generally comparable with ones in patients without prior surgery; however, some problems have been identified. These procedures might have some intraoperative considerations and often require increased operative times. Apart from the traditional preoperative computed tomography angiography, intraoperative imaging (e.g., fluorescence angiography) may be advocated in patients with abdominal scars.

Disclosure: The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.

Supplemental digital content is available for this article. Clickable URL citations appear in the text.
their reconstructive options. In abdominal flap reconstructions, previous abdominal and/or pelvic procedures have been shown to disturb perforator vessels, alter perfusion territories across the scar, and form fibrous scar tissue impeding flap dissection.7 Several studies have evaluated the effect of prior scars and found no difference in complication rates attributable to these prior incisions.7–11 These findings, however, typically rely on retrospective data analyses from mixed series of unilateral (predominantly) and bilateral flaps; therefore, the actual impact of the scars on bilateral reconstructions could be underestimated. Thus, in unilateral reconstructions, there is the advantage of choosing between the ipsilateral or contralateral hemi-abdomen, with the final decision being made intraoperatively depending on perforators caliber, flap perfusion, and tissue properties. In bilateral reconstructions, the impact of abdominal scars may be more significant, as both halves of the abdomen are used and may therefore potentially pose greater risks for the flaps and the donor site.

The aim of this study was to evaluate the impact of prior abdominal surgical scars on complication rates in abdominal flap breast reconstruction, with a special focus on bilateral flap procedures.

**PATIENTS AND METHODS**

All consecutive patients with abdominally based free flap breast reconstruction performed by the team of plastic surgeons at the Brigham and Women’s Hospital between 2007 and 2014 were eligible for the study; this included deep inferior epigastric (DIEP), superficial inferior epigastric artery (SIEA), and free TRAM flap reconstruction. The surgical techniques employed did not change during the study period and have been previously described elsewhere.7,12 In DIEP procedures, a standardized preoperative computed tomography angiography (CTA) assessment has been started in early 2008, and SPY intraoperative laser angiography has been intermittently used since 2012.

The data were prospectively collected into a study-specific database; all relevant characteristics as well as outcome variables were defined and categorized by the senior authors before study initiation. A dedicated physician assistant with expertise in breast reconstruction performed data entry and maintenance ensuring that the database was filled for each patient and flap.

Variables included baseline patient characteristics [age, body mass index (BMI), diabetes mellitus, hypertension, smoking status], oncologic history (mastectomy type, genetic predisposition, prior chemotherapy, or radiation therapy), and reconstructive characteristics (date of procedure, operating surgeon, reconstruction timing and laterality, flap type and weight, perforator characteristics, length of surgery, and length of stay). Data on abdominal scars and prior abdominal/pelvic procedures were also collected, and the scars were further grouped according to the incision/s on the abdominal wall: Pfannenstiel, midline, lower oblique, upper oblique, or laparoscopic.

Complications and reoperations were prospectively registered after postoperative outpatient visits and updated at the end of follow-up, if necessary. For the purpose of the outcome analysis, all complications were divided into flap-related (flap loss, fat necrosis, hematoma, seroma, infection) and donor-site (infection, seroma, hematoma, wound healing problems, hernia, bulging). Major complications requiring return to the operating room were further grouped as recipient-site reoperations and donor-site reoperations. Mastectomy flap revisions were registered separately and excluded from the current analyses. Medical complications (e.g., deep venous thrombosis, pulmonary embolism) were also listed for each patient.

**Statistical Analyses**

STATA/SE (Version 13.1) for MacOS (StataCorp, Tex) was used for all statistical analyses. Pearson’s chi-square or t test was utilized for assessment of differences in patients with and without scars, as well as differences between unilateral and bilateral reconstructions.

All unilateral breast reconstructions were excluded from the statistical analysis, and data on these procedures are provided for the descriptive purpose.

All reconstructed site complications in bilateral procedures were registered per flap, but analyzed and reported on a per patient basis.

In the assessment of flap variables (e.g., flap weight, perforator characteristics), the calculations were performed for all flaps within the subgroup (unilateral versus bilateral or scar group versus no scar group). A 2-tailed \( P < 0.05 \) was considered significant in all statistical tests. Fisher’s exact test was used in the analyses of complications due to lower number of outcome events.

**RESULTS**

Four hundred ninety-three consecutive patients underwent abdominally based breast reconstruction during the study period, with laterality split as follows: unilateral (\( n = 250; 50.7\% \)), bilateral (\( n = 243; 49.3\% \)). Overall, DIEP flaps were utilized in 654 (88.9%), fTRAM 45 (5.8%), SIEA 13 (1.8%), TRAM 8 (1.1%) breast reconstructions. Patients in the bilateral group were younger (47.0 versus 50.0 years; \( P = 0.0001 \)), had a greater BMI (29.1 versus 27.7 kg/m\(^2\); \( P = 0.0012 \)), and more often had comorbidities as obesity (39.9% versus 27.6%; \( P = 0.014 \)), diabetes (3.7% versus 0.8%; \( P = 0.028 \)), hypertension (21.9% versus 14.5%; \( P = 0.032 \)), see Table 1.

The bilateral reconstruction group more frequently had genetic predisposition to breast cancer (41% versus 3.6%; \( P < 0.001 \)) and significantly more often received immediate breast reconstruction (61.7% versus 47.6%; \( P = 0.0001 \)). There were also differences in selected flap type (\( P = 0.022 \)), operating plastic surgeon (\( P = 0.013 \)), and length of surgery (847.0 versus 460.4 minutes; \( P < 0.001 \)) between the bilateral and unilateral reconstructions, respectively (Table 1).

**Scars and Previous Abdominal/Pelvic Procedures**

In total, 148 of 243 (62.2%) patients with bilateral reconstruction had at least 1 prior abdominal (13.2%) or pelvic (31.7%) procedure, or a combination (14.8%; Table 2). Five other patients underwent bilateral prophylactic salpingo-oophorectomy concurrently with breast reconstruction.
Table 1. Demographic and Patients Characteristics Stratified for Uni- and Bilateral Reconstruction

| Characteristics                  | Total (n = 493) | Unilateral (n = 250) | Bilateral (n = 243) | P   |
|----------------------------------|----------------|----------------------|---------------------|-----|
| **Age** (y)                      | 48.5 (8.1)     | 50.0 (7.7)           | 47.0 (8.3)          | 0.001 |
| < mean                           | 220 (44.6)     | 93 (37.2)            | 127 (52.3)          |     |
| ≥ mean                           | 273 (55.4)     | 157 (62.8)           | 116 (47.7)          | 0.001 |
| **Calendar year surgery**        |                |                      |                     |     |
| 2007–2008                        | 61 (12.4)      | 35 (14.0)            | 26 (10.7)           |     |
| 2009–2010                        | 129 (26.1)     | 67 (26.8)            | 62 (25.5)           |     |
| 2011–2012                        | 139 (28.2)     | 76 (30.4)            | 63 (25.9)           |     |
| 2013–2014                        | 164 (33.3)     | 72 (28.8)            | 92 (37.9)           | 0.166 |
| **Breast reconstruction side**   |                |                      |                     |     |
| Left                             | 135 (54.0)     | —                    | —                   |     |
| Right                            | 115 (46.0)     | —                    | —                   |     |
| **Reconstruction timing**        |                |                      |                     |     |
| Immediate                        | 260 (53.6)     | 119 (47.6)           | 150 (61.7)          |     |
| Delayed                          | 200 (41.4)     | 131 (52.4)           | 78 (32.1)           |     |
| Immediate and delayed           | 15 (3.0)       | —                    | 15 (6.2)            | 0.001 |
| **Flap type**†                   |                |                      |                     |     |
| DIEP                             | 654 (88.9)     | 224 (89.6)           | 430 (88.5)          |     |
| TRAM                             | 43 (5.8)       | 12 (4.8)             | 31 (6.4)            |     |
| SIEA                             | 15 (1.8)       | 3 (1.2)              | 10 (2.0)            |     |
| TRAM                             | 8 (1.1)        | 0                    | 8 (1.7)             | 0.022 |
| Other (SGAP, PAP, TUG, TE)       | 18 (2.4)       | 11 (4.4)             | 7 (1.4)             |     |
| **Plastic surgeon**              |                |                      |                     |     |
| A                                | 243 (49.4)     | 139 (55.8)           | 104 (42.8)          |     |
| B                                | 137 (27.9)     | 63 (25.3)            | 74 (30.5)           |     |
| Other                            | 112 (22.7)     | 47 (18.9)            | 65 (26.8)           | 0.013 |
| **Length of surgery** (min)      | 655.5 (186)    | 460.6 (107)          | 847.0 (182)         | 0.038 |
| < mean                           | 342 (69.4)     | 220 (88.0)           | 122 (50.2)          |     |
| ≥ mean                           | 151 (30.6)     | 30 (12.0)            | 121 (49.8)          | 0.000 |
| **BMI** (kg/m²)                  | 28.4 (4.8)     | 27.7 (4.4)           | 29.1 (5.1)          | 0.0012|
| Normal (< 25)                    | 132 (26.8)     | 71 (28.4)            | 61 (25.1)           |     |
| Overweight (25–29.9)             | 195 (39.6)     | 110 (44.0)           | 85 (35.0)           |     |
| Obese (> 30)                     | 166 (33.6)     | 69 (27.6)            | 97 (39.9)           | 0.014 |
| **Genetic predisposition**       |                |                      |                     |     |
| BRCA1                            | 26 (11.6)      | 1 (0.4)              | 25 (18.0)           |     |
| BRCA2                            | 24 (10.7)      | 1 (0.4)              | 23 (16.5)           |     |
| Other mutation                   | 10 (4.4)       | 1 (0.4)              | 9 (6.3)             |     |
| No                               | 160 (73.3)     | 83 (34.4)            | 77 (30.9)           | 0.000 |
| Not tested/unknown               | 268 (54.5)     | 164 (66.4)           | 104 (42.8)          |     |
| **Physical activities‡**         |                |                      |                     |     |
| Yes                              | 239 (48.5)     | 125 (50.0)           | 114 (46.9)          |     |
| No                               | 105 (21.3)     | 49 (19.6)            | 56 (23.1)           | 0.351 |
| **Smoking§**                     |                |                      |                     |     |
| Yes                              | 28 (5.7)       | 15 (6.0)             | 13 (5.4)            |     |
| No                               | 463 (94.3)     | 234 (94.0)           | 229 (94.6)          | 0.755 |
| **Diabetes§**                    |                |                      |                     |     |
| Yes                              | 11 (2.2)       | 2 (0.8)              | 9 (3.7)             |     |
| No                               | 480 (97.8)     | 247 (99.2)           | 233 (96.3)          | 0.028 |
| **Hypertension§**                |                |                      |                     |     |
| Yes                              | 89 (18.1)      | 36 (14.5)            | 189 (78.1)          |     |
| No                               | 402 (81.9)     | 213 (85.5)           | 53 (21.9)           | 0.032 |
| **Preoperative radiation¶**      |                |                      |                     |     |
| Yes                              | 243 (49.4)     | 135 (54.2)           | 108 (44.4)          |     |
| No                               | 249 (50.6)     | 114 (45.8)           | 135 (55.6)          | 0.03 |
| **Preoperative chemotherapy‖**   |                |                      |                     |     |
| Yes                              | 234 (48.1)     | 126 (51.0)           | 108 (45.0)          |     |
| No                               | 253 (51.9)     | 121 (49.0)           | 132 (55.0)          | 0.184 |
| **Length of stay** (d)           | 5.7 (1.4)      | 5.5 (1.4)            | 6.0 (1.4)           | 0.0016|
| < mean                           | 342 (69.4)     | 220 (88.0)           | 122 (50.2)          |     |
| ≥ mean                           | 151 (30.6)     | 30 (12.0)            | 121 (49.8)          | 0.000 |
| **Prior abdominal/pelvic procedures** |            |                      |                     |     |
| Yes                              | 283 (58.5)     | 135 (54.9)           | 148 (62.2)          |     |
| No                               | 201 (41.5)     | 111 (45.1)           | 90 (37.8)           | 0.103 |

*Mean (SD).
†Number of flaps (percentage of total flaps).
‡Unknown for 149 patients.
§Unknown for 2 patients.
¶Unknown for 1 patient.
‖Unknown for 6 patients.
**Unknown for 9 patients.
PAP, profunda artery perforator; SGAP, superior gluteal artery perforator; TUG, transverse upper gracilis; TE, tissue expander.
Table 2. Abdominal Scars and Type of Abdominal or/and Pelvic Procedures before Breast Reconstruction Stratified for Reconstruction Laterality

| Characteristics                                       | Unilateral (n = 250) | Bilateral (n = 245) |
|-------------------------------------------------------|----------------------|---------------------|
| Prior abdominal/pelvic procedures                     |                      |                     |
| Yes                                                   | 135 (54.9)           | 148 (62.2)          |
| No                                                    | 111 (45.1)           | 90 (37.8)           |
| Unknown                                               | 4                    | 5                   |
| Incisions*                                            |                      |                     |
| Pfannenstiel                                          | 84 (33.6)            | 73 (30.1)           |
| Midline                                              | 18 (7.2)             | 16 (6.6)            |
| Lower oblique                                         | 17 (6.8)             | 17 (7.0)            |
| Upper oblique                                         | 7 (2.8)              | 5 (2.1)             |
| Laparoscopic                                          | 32 (12.8)            | 69 (28.4)           |
| Type of prior surgery†                                 |                      |                     |
| Abdominal procedures                                  | 23 (9.2)             | 32 (13.2)           |
| Pelvic procedures                                     | 85 (34.0)            | 77 (31.7)           |
| Mixed abdominal and pelvic                            | 24 (9.6)             | 36 (14.8)           |
| Unknown indications                                   | 3 (1.2)              | 3 (1.2)             |
| Number of prior procedures                            |                      |                     |
| 1                                                     | 81 (32.4)            | 80 (32.9)           |
| More than 1                                           | 54 (21.6)            | 68 (28.0)           |
| 2                                                     | 35 (14.0)            | 41 (16.9)           |
| 3                                                     | 14 (5.6)             | 19 (7.8)            |
| 4                                                     | 5 (2.0)              | 8 (3.3)             |
| Unknown                                               | 6 (2.4)              | 5 (2.1)             |

Some patients had a combination of scars and more than 1 procedure, see Fig. 1.†Five patient underwent prophylactic bilateral salpingoophorectomy concurrently with breast reconstruction.

The scar locations on the abdominal wall were as follows: Pfannenstiel (n = 73; 30.1%), midline (n = 16; 6.6%), lower oblique (n = 17; 7.0%), upper oblique (n = 5; 2.1%), and laparoscopic (n = 69; 28.4%). Some patients also had more than 1 scar each, most often having a combination of Pfannenstiel and another incision (Table 2; Fig. 1).

When compared with the unilateral group, the proportion of laparoscopic interventions among patients in bilateral group was significantly higher (28.4% versus 12.8%; P < 0.001).

Bilateral Reconstructions: Scar Group Versus No Scar Group

To further evaluate the role of scars in bilateral breast reconstruction procedures, we stratified our patient population into a no prior scar group and a prior scar group. Reconstruc-
tive timing in the groups was similar, but there were differences in flap design. In the scar group, TRAM flap was utilized more frequently when compared with the no prior scar group (Table 3).

The average flap weight was higher in the scar group (739.7 versus 635.6 g; P = 0.0036), although it was in line with the average mastectomy specimen weight within the groups (737.5 and 656.6 g, respectively). Other flap variables such as perforator characteristics, ischemic time, venous anastomoses, and mean vein coupler size did not differ between the groups (Table 3). Although not statistically significant, the mean length of surgery in scar group was higher (971.9 versus 655.8 minutes; P = 0.41).

Complications in Bilateral Reconstructions: Scar Group Versus No Scar Group

Recipient Site—Breasts

Overall, 4 of 238 (1.7%) flap failures (including 1 pedicled TRAM flap) were registered, all occurring in patients from the scar group: 3 with Pfannenstiel scar and 1 patient with prior laparoscopic intervention (Tables 4, 5).

Fat necrosis/partial flap necrosis, infection, and seroma occurred in 14 (5.9%), 8 (3.4%), and 5 (2.1%) patients, respectively, and no differences between the groups were identified (Table 4). The incidence of postoperative hematoma at the recipient site was 14 of 238 (5.9%) and found more frequently in patients with scars (8.1% versus 2.2%; P = 0.051).

Recipient-site reoperation rate (i.e., unplanned revisions) was 19 of 238 (7.9%) and patients with scars were affected more often (10.1% versus 4.4%; P = 0.090), although the difference did not reach statistical significance.

In the subgroup analysis, the presence of Pfannenstiel scar was associated with higher risk of hematoma at the recipient site when compared with no scar group (13.7% versus 2.2%; P = 0.006). No other differences were seen when comparing subgroups of patients with Pfannenstiel (n = 73) or laparoscopic incisions (n = 69) with the no scar group (n = 90), Table 4, right.

Mastectomy flap revisions were performed in 16 patients: 11 (7.4%) scar group and 5 (5.6%) no scar group, but were not included in the study analyses (data not shown).

Donor Site

Donor-site complications included delayed wound healing, infection, bulging, and seroma in 11 (4.6%), 1 (0.4%), 7 (2.9%), and 4 (1.7%) patients, respectively, and the donor-site reoperation rate was 5 of 238 (2.1%) with no significant differences between the groups (Table 4, below).

In the subgroup analysis of Pfannenstiel or laparoscopic incisions (Table 4; right), patients with prior laparoscopic procedures had problems with wound healing more often compared with no scar population (8.7% versus 2.2%; P = 0.069), although not statistically significant.

Systemic complications included 3 cases of deep venous thrombosis (1.2%) and 1 case of pulmonary embolism (0.4%).

DISCUSSION

This is the first study to assess the role of abdominal scars in a cohort of bilateral abdominal flap breast reconstructions. Our findings suggest that surgical outcomes of bilateral reconstructions in patients with abdominal scars are generally comparable with ones in patients without prior surgery; however, some problems have been identified.

Several previous articles have addressed the effects of prior abdominal surgery on the autologous breast reconstruction.7–11 The main limitation of these studies is that their data were analyzed on a per flap basis, where the variables for unilateral and bilateral procedures were col-
In the current study, we exclusively focused on bilateral reconstructions and report the outcomes on a per patient basis to adjust for intrinsic complexity of each bilateral procedure.

Parrett et al. were the first to evaluate abdominal scars in DIEP breast reconstructions in a cohort of patients with (n = 78) and without (n = 90) scars showing no increase in flap complications, but significantly higher donor-site morbidity in the scar group (24% versus 6.7%; \( P = 0.003 \)).

A recent article by Wes et al. evaluated abdominally based breast reconstructions in patients with (n = 417) and without (n = 395) scars and came to similar conclusions. In this large series of patients, no differences in flap-related outcomes or medical complications were identified, but patients with prior rectus sheath violation (both open and laparoscopic) had problems with donor-site wound healing more frequently (22.7% versus 16.5%, \( P = 0.03 \)).

Although both studies analyzed unilateral and bilateral flaps, their findings on the donor site were consistent with ours where delayed wound healing after laparoscopic procedures trended to be higher (8.7% versus 2.2%; \( P = 0.069 \)).

In addition, our results indicate that reconstruction site reoperation trended to occur more often in the scar group.
Table 3. Flap and Technical Characteristics of Bilateral Reconstructions Stratified for Scars

| Characteristics                        | No Scar Group (n = 180) | Scar Group (n = 296) | P   |
|----------------------------------------|-------------------------|----------------------|-----|
| Reconstruction timing                  |                         |                      |     |
| Immediate                              | 55 (61.1)               | 90 (60.8)            |     |
| Delayed                                | 26 (28.9)               | 52 (35.2)            |     |
| Immediate (L) and Delayed (R)          | 4 (4.4)                 | 3 (2.0)              |     |
| Immediate (L) and Delayed (R)          | 5 (5.6)                 | 3 (2.0)              | 0.278|
| Venous anastomoses‡                    |                         |                      |     |
| More than 1                            | 85 (47.2)               | 153 (51.7)           | 0.344|
| One                                    | 95 (52.8)               | 143 (48.3)           | 0.298|
| Ischemia time‡ (min)                   | 74.3 (18.1)             | 78.8 (21.8)          | 0.138|
| Length of surgery‡ (min)               | 655.8 (140.5)           | 971.9 (303.4)        | 0.41 |

SGAP, superior gluteal artery perforator; TUG, transverse upper gracilis; TE/ADM, tissue expander and acellular dermal matrix.

*All reconstructions a priori planned as DIEP and DIEP, but definitive flap design is presented.

†Including 3 DIEP and SIEA a analyzed in 1-vein flaps b excluded from analysis.

‡Mean (SD).

Conversely, some studies found that Pfannenstiel scar was associated with larger perforators and may potentially augment the perfusion of the lower abdomen by promoting the development of collateral pathways of circulation via delayed-phenomenon mechanisms,10,13 similar to those utilized in SIEA delay procedures.14 However, there was no reported difference between the presence or absence of usable SIEA vessels in patients with abdominal scars described in the operative reports. There is also a hypothesis that improved perfusion in multiparous women may be attributed to pregnancy per se rather than delivery via Caesarian section and subsequent scar.15 This could be explained by the gradual expansion of the abdominal wall by the pregnant uterus and consequent vascular rearrangements (e.g., extending axiality of the perforator vessels and/or collateral pathways), which could be beneficial in fasciocutaneous flap procedures.

In our cohort, the rates of fat necrosis/partial flap necrosis in subgroups of patients with and without Pfannenstiel incision were comparable. However, 3 flap failures in the study occurred in patients with Pfannenstiel scar after total abdominal hysterectomy (n = 2) or Caesarian section (n = 1), Table 5. Although not statistically significant, this finding has an important clinical relevance and should be considered in patients with Pfannenstiel scars.

Several studies have also discussed how to address and improve reconstructive outcomes in patients with Pfannenstiel,16 vertical midline,17 vertical infraumbilical,18 subcostal,19 and other scar types.9

Table 4. Complications following Bilateral Reconstructions Stratified for Abdominal Scars

| Complications                  | Total (n = 238) | No Scar Group (n = 90) | Scar Group (n = 148) | P*  | Pfannenstiel (n = 73) | P* a  | Laparoscopic (n = 69) | P* b  |
|--------------------------------|----------------|-----------------------|----------------------|-----|----------------------|-------|----------------------|-------|
| Reconstructed site (any side)  |                |                       |                      |     |                      |       |                      |       |
| Flap loss                      | 4 (1.7)        | 0                     | 4 (2.7)              | 0.147| 3 (4.1)              | 0.088 | 1 (1.5)              | 0.454 |
| Fat necrosis/partial flap necrosis | 14 (5.9)   | 6 (6.7)               | 8 (5.4)              | 0.446| 4 (5.5)              | 0.510 | 4 (5.8)              | 0.547 |
| Hematoma                       | 14 (5.9)       | 2 (2.2)               | 12 (8.1)             | 0.051| 10 (13.7)            | 0.006 | 2 (2.9)              | 0.584 |
| Seroma                         | 5 (2.1)        | 2 (2.2)               | 3 (2.0)              | 0.626| 1 (1.4)              | 0.578 | 3 (4.4)              | 0.376 |
| Infection                      | 8 (3.4)        | 2 (2.2)               | 6 (4.0)              | 0.360| 2 (2.7)              | 0.607 | 6 (8.7)              | 0.221 |
| Recipient-site reoperation      | 19 (7.9)       | 4 (4.4)               | 15 (10.1)            | 0.090| 8 (11.0)             | 0.100 | 6 (8.7)              | 0.221 |
| Donor site                     |                |                       |                      |     |                      |       |                      |       |
| Delayed wound healing           | 11 (4.6)       | 2 (2.2)               | 9 (6.1)              | 0.145| 3 (4.1)              | 0.402 | 6 (8.7)              | 0.069 |
| Infection                      | 1 (0.4)        | 0                     | 1 (0.7)              | 0.622| 0                    | 0     | 0                    | 0     |
| Bulging                        | 7 (2.9)        | 3 (3.3)               | 4 (2.7)              | 0.533| 2 (2.7)              | 0.598 | 2 (2.9)              | 0.624 |
| Seroma                         | 4 (1.7)        | 1 (1.1)               | 3 (2.0)              | 0.513| 1 (1.4)              | 0.697 | 1 (1.5)              | 0.681 |
| Donor-site reoperation          | 5 (2.1)        | 2 (2.2)               | 3 (2.0)              | 0.626| 2 (2.7)              | 0.607 | 1 (1.5)              | 0.599 |

*Fisher’s exact test.

a Pfannenstiel versus no scar.

b Laparoscopic versus no scar.
Our data showed that flap design and harvest were not different between the scar group versus no scar group. All patients included in this study had a preoperative plan for DIEP flaps. The tTRAM, pedicled TRAM, or SIEA decision was made intraoperatively if a DIEP was not viable (after clamping trials of exposed perforators). The presence of abdominal scars did not increase the need to convert to tTRAM (1 would expect that if the abdominal scar injured perforators, Table 3). The presence of scars also did not influence which row of perforators were used or increase the number of perforators required for adequate DIEP perfusion (Table 3). In this study on bilateral flaps, cases with scars seemed to be approached as they otherwise would, for example, a mid-line scar did not necessarily mean that medial row perforators are damaged.

Although not statistically significant, the mean length of surgery in patients with abdominal scars was on average 1.5 times longer, which could be explained by the presence of the scars as well as the complexity of the dissection in the scar tissue planes and altered vascularity.

Overall, patients undergoing bilateral breast reconstruction have certain demographic and perioperative differences, as well as some technical considerations when compared with unilateral reconstructions (see table, Supplement Digital Content 1, which displays rationale to separate unilateral and bilateral DIEP breast reconstructions in publications. An assessment of these differences is beyond the scope of this investigation, http://links.lww.com/PRSGO/A542).

One of the strengths of this study is its methodology where all variables for each patient and flap, including the postoperative follow-up course, were prospectively collected into a study-specific free flap database. A dedicated physician assistant updated the database after postoperative visits so that no patient was lost for the study follow-up.

To eliminate selection bias, all consecutive patients scheduled for abdominal flap reconstruction were included in the analyses according to the intention-to-treat principle. This approach allowed studying the actual reconstructive course even in scenarios when the reconstruction changed intraoperatively, for example, converting from a DIEP to a pedicled TRAM procedure.

In addition, we stratified the study population into unilateral and bilateral groups and focused exclusively on patients with bilateral scars where the effects of abdominal scars might be more consequential. Aiming for intrinsic randomness of each bilateral procedure, we analyzed reconstruction outcomes on a per patient basis, rather than counting as 2 separate unilateral reconstructions.

Conversely, the study may be underpowered because of the very low complications rate, when the differences between the study groups did not reach statistical significance. A clinically significant difference was however observed: the rate of flap failure in scar group versus no scar group was 4 and zero events, respectively. As in any other retrospective study in plastic surgery, a certain preselection bias could not be avoided. Thus, patients who are poor candidates (small donor sites, high risk for other reasons) and women with CTA showing no perforators (possi-
bly due to abdominal scarring) were not included, as they would have never been offered a DIEP.

The findings of this study could be used by plastic surgeons to facilitate preoperative planning in patients with prior abdominal procedures. In addition, the data will be helpful for gynecologists and general surgeons for planning their interventions and incisions, keeping in mind a possible need for flap reconstructions in future. The time interval from the abdominal procedures to flap harvest and number of previous procedures might also play a role, yet we have not included this information in the current study. Furthermore, data on the intraoperative assessment with fluorescence imaging were not collected prospectively and not included, although its routine use in this patient group is considered beneficial.

In conclusion, surgical outcomes of bilateral abdominal flap reconstructions in patients with abdominal scars are generally comparable with ones in patients without prior surgery. No greater risks for recipient- or donor site were demonstrated in general; however, some scar-specific problems have been identified. These procedures might have some intraoperative considerations and often require increased operative times. Apart from the traditional preoperative CTA, intraoperative imaging (e.g., fluorescence angiography) may be advocated in patients with abdominal scars. To further understand effects and vascular changes in patients with abdominal scars, more anatomical and imaging studies are needed.

Stephanie Caterson, MD
Division of Plastic Surgery
Brigham and Women’s Hospital
Harvard Medical School
75 Francis street
Boston, MA 02115
E-mail: scaterson@bwh.harvard.edu

REFERENCES
1. Arrington AK, Jarosek SL, Virnig BA, et al. Patient and surgeon characteristics associated with increased use of contralateral prophylactic mastectomy in patients with breast cancer. Ann Surg Oncol. 2009;16:2697–2704.
2. Tuttle TM, Habermann EB, Grund EH, et al. Increasing use of contralateral prophylactic mastectomy for breast cancer patients: a trend toward more aggressive surgical treatment. J Clin Oncol. 2007;25:5203–5209.
3. Mirzabeigi MN, Wilson AJ, Fischer JP, et al. Predicting and managing donor-site wound complications in abdominally based free flap breast reconstruction: improved outcomes with early reoperative closure. Plast Reconstr Surg. 2015;135:14–23.
4. Guerra AB, Metzinger SE, Bidros RS, et al. Bilateral breast reconstruction with the deep inferior epigastric perforator (DIEP) flap: an experience with 280 flaps. Ann Plast Surg. 2004;52:246–252.
5. Available at http://www.cdc.gov/nchs/fastats/delivery.htm. Accessed April 4, 2016.
6. Hunsinger V, Marchac AC, Deder M, et al. A new strategy for prophylactic surgery in BRCA women: combined mastectomy and laparoscopic salpingo-oophorectomy with immediate reconstruction by double DIEP flap. Ann Chir Plast Esthet. 2016;61:177–182.
7. Parrett BM, Caterson SA, Tobias AM, et al. DIEP flaps in women with abdominal scars: are complication rates affected? Plast Reconstr Surg. 2008;121:1527–1531.
8. Dayhim F, Wilkins EG. The impact of Pfannenstiel scars on TRAM flap complications. Ann Plast Surg. 2004;53:432–435.
9. Laporta R, Longo B, Sorotos M, et al. Tips and tricks for DIEP flap breast reconstruction in patients with previous abdominal scar. Microsurgery. 2015;37:282–292.
10. Mahajan AL, Zeltzer A, Claes KE, et al. Are Pfannenstiel scars a boon or a curse for DIEP flap breast reconstructions? Plast Reconstr Surg. 2012;129:797–805.
11. Wes AM, Cleveland E, Nelson JA, et al. Do prior abdominal surgeries increase complications in abdominally based breast reconstructions? Ann Plast Surg. 2015;75:526–533.
12. Caterson SA, Carty MJ, Helliswell LA, et al. Evolving options for breast reconstruction. Curr Prob Surg. 2015;52:192–224.
13. Niumsawatt V, Chow K, Shen XY, et al. The Pfannenstiel scar and its implications in DIEP flap harvest: a clinical anatomic study. Eur J Plast Surg. 2016;1–8.
14. Gregorič M, Flis V, Milotič F, et al. Delaying the superficial inferior epigastric artery flap: a solution to the problem of the small calibre of the donor artery. J Plast Reconstr Aesthet Surg. 2011;64:1181–1186.
15. Unukovych D, Gallego CH, Aineskog H, et al. Predictors of reoperations in deep inferior epigastric perforator flap breast reconstruction. Plast Reconstr Surg Glob Open. 2016:e1016.
16. Heller L, Feledy JA, Chang DW. Strategies and options for free TRAM flap breast reconstruction in patients with midline abdominal scars. Plast Reconstr Surg. 2005;116:753–759; discussion 760.
17. Hsieh F, Somia N, Lam TC. A new approach to preexisting vertical midline abdominal scars with crossover DIEP flap breast reconstruction. Microsurgery. 2010;30:151–155.
18. Schoeller T, Wechselberger G, Roger J, et al. Management of infraumbilical vertical scars in DIEP-flaps by crossover anastomosis. J Plast Reconstr Aesthet Surg. 2016;60:151–155.
19. Schoeller T, Huemer GM, Kolehmainen M, et al. Management of subcostal scars during DIEP-flap raising. Br J Plast Surg. 2004;57:511–514.