

# Initial Experience with Unidirectional Barbed Suture for Abdominal Donor Site Closure in Deep Inferior Epigastric Perforator Flap Breast Reconstruction

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**Background:** The deep inferior epigastric perforator (DIEP) flap is a predominant technique for autologous breast reconstruction. However, the best method of abdominal fascial closure in this technique is not well defined. This study details our initial experience with unidirectional barbed suture-only repair of abdominal donor site fascia.

**Methods:** Patients who underwent DIEP flap breast reconstruction and abdominal fascial closure with Stratafix Symmetric Polydioxanone PDS Plus were retrospectively reviewed. Information regarding pertinent patient history, medical comorbidities, risk factors, and surgical technique was extracted, along with the incidence of eight separate postoperative abdominal surgical site occurrences.

**Results:** Retrospective review identified 43 patients who underwent 19 unilateral and 24 bilateral DIEP flap breast reconstruction procedures (n = 67). Average patient follow-up was 791 days (range 153–1769). Six patients (14%) had a complication of the donor site. Seroma was most frequent (n = 3, 7%), followed by surgical site infection (n = 2, 5%). One patient had incisional dehiscence (2%) and another patient developed bulging (2%). No patients had chronic pain, weakness, hematoma, or hernia postoperatively. Patients with donor site complications had a history of abdominal/pelvic surgery significantly more often than the patients without donor site complications (100% versus 49%;  $P = 0.032$ ).

**Conclusions:** Abdominal fascial repair with Stratafix Symmetric suture alone led to low rates of abdominal donor site morbidity, including no hernia and rare bulging, following DIEP flap breast reconstruction. Additional advantages of this technique may be reduced operative times and lower operative costs compared with alternative methods of fascial repair, although prospective and randomized studies are warranted. (*Plast Reconstr Surg Glob Open* 2024; 12:e5681; doi: 10.1097/GOX.0000000000005681; Published online 25 March 2024.)

## INTRODUCTION

Breast cancer is the most common noncutaneous cancer affecting women in the United States, with an estimated 288,000 cases diagnosed in the year 2022.<sup>1</sup> Approximately one in five of these women will undergo

mastectomy and subsequent autologous breast reconstruction. Over the years, significant advancements in abdominally based autologous breast reconstruction have been aimed at preserving the anatomy of the abdomen as a donor site.<sup>2</sup> This progression has resulted in a shift in practice from the transverse rectus abdominis myocutaneous (TRAM) flap to the free TRAM flap; muscle-sparing free TRAM flap; and ultimately, the deep inferior epigastric perforator (DIEP) flap in the late 1980s.<sup>2–5</sup>

The DIEP flap, being adipocutaneous in nature, preserves the bulk of the rectus muscle and most, if not all, of the associated fascia. This tissue preservation technique allows for the retention of rectus muscle innervation,

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which contributes to reduced donor site morbidity from hernia and bulging.<sup>5,6</sup> Several studies have provided evidence to support this theory, demonstrating a lower incidence of postoperative donor site complications in DIEP flap reconstruction compared with more traditional methods of autologous tissue transfer, such as TRAM flap variations.<sup>7-11</sup> Despite this lower incidence, the development of hernia and bulge following DIEP flap reconstruction is still a common occurrence, reported in more than 7% and 33% of patients who undergo this procedure.<sup>12</sup>

Optimal techniques for abdominal fascial closure that minimize the incidence of local complications are a subject of controversy and practice variation in the plastic surgery community. Beyond a commitment to preserve the greatest amount of donor site muscle, fascia, and nerves as possible, mechanical techniques for abdominal fascial repair can consist of barbed or nonbarbed sutures, either with or without reinforcing surgical mesh.<sup>9,13-15</sup> Since their introduction in the 1990s, barbed suture variations may offer numerous advantages over nonbarbed sutures such as the ability to bypass surgical knot tying, decrease the operative time for fascial and subcuticular closure, reduce tension, eliminate cheese wiring, and promote wound healing by evenly distributing tension parallel to the defect edges.<sup>16-19</sup> Nonetheless, regular use of barbed sutures in plastic surgery has been somewhat limited to body contouring and abdominoplasty procedures.<sup>17</sup> This multicenter, retrospective series details our early initial experience using unidirectional barbed sutures specifically designed for fascial closure to perform the donor site repair in DIEP flap breast reconstruction.

## METHODS

### Data Collection

This study was granted institutional review board exemption status at both participating institutions; Luminis Health Anne Arundel Medical Center (Annapolis, Md.) and University of Miami Health System (Miami, Fla.). Medical electronic records were filtered by patients

### Takeaways

**Question:** Does abdominal fascial repair with unidirectional barbed suture alone lead to low rates of donor site complications in DIEP flap breast reconstruction?

**Findings:** Retrospective review yielded a low rate of donor site complications including bulging, incisional dehiscence, and surgical site infection. No patients developed chronic pain, weakness, hematoma, or hernia postoperatively.

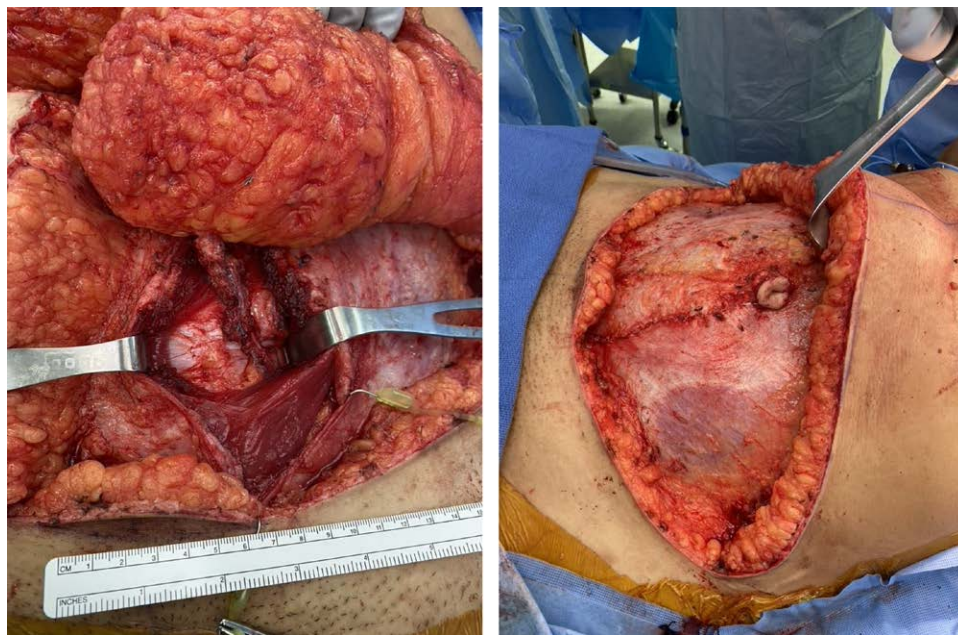
**Meaning:** Unidirectional barbed suture may be a safe and effective alternative to existing techniques for abdominal fascial closure.

18 years of age or older who underwent DIEP flap autologous breast(s) reconstruction with one of the four plastic surgeons between October 2017 and May 2020 at Luminis Health Anne Arundel Medical Center (LHAAMC) (n = 18) and between July 2020 and October 2022 at University of Miami Health System (n = 25). Only patients who underwent abdominal donor site fascial repair with Stratafix Symmetric barbed suture alone after DIEP flap harvest were included for further evaluation. Stratafix Symmetric Polydioxanone PDS Plus (Ethicon, LLC, Somerville, N.J.) is a commercially available, unidirectional barbed suture, referred to in this article as Stratafix Symmetric (Fig. 1). Patients who had simultaneous surgical mesh placement, interrupted nonbarbed suture repair of the fascia without the use of Stratafix Symmetric, harvest of a superficial inferior epigastric or TRAM flap, or less than 6 months of postoperative follow-up were excluded.

Information regarding each patient's age; body mass index (BMI); medical comorbidities (diabetes mellitus, hypertension; hyperlipidemia; chronic obstructive pulmonary disease); smoking status; and history of abdominal surgery, pregnancy, chemotherapy, or postmastectomy radiation therapy was collected from retrospective chart review. Additional information including details of the operative procedure (perforator choice, use of incisional negative pressure dressing along the waistline incision) was retrieved from operative



Fig. 1. Stratafix Symmetric PDS suture.



**Fig. 2.** Abdominal donor site before (A) and after (B) the use of Stratafix Symmetric suture to repair the abdominal fascia following DIEP flap harvest and transfer.

procedure notes. All clinic notes from the first preoperative visit throughout the last recorded postoperative visit were reviewed for the incidence of eight separate postoperative abdominal donor site complications: surgical site infection, seroma, hematoma, incisional dehiscence, chronic pain, weakness, bulge, and abdominal hernia. To qualify as having chronic pain or weakness of the donor site, the patient must have had documented complaints for at least three consecutive postoperative visits (the equivalent of approximately three postoperative months).<sup>20</sup> Bulge was another subjective factor determined by postoperative documentation and defined as a patient's subjective perception and description of a localized protrusion. To be classified as a hernia, the defect must have been detected and specifically documented by the provider during a physical examination and/or diagnosed by postoperative computed tomography imaging.

#### Data Analysis

Statistical analyses were performed with IBM SPSS. Data variables were reported as frequencies, percentages, and/or mean  $\pm$  SD as appropriate. Although a Fisher exact or chi-squared test was used for comparisons between categorical variables, a one-tailed *t* test was conducted to determine statistical significance between continuous variables. Significance was determined based on a 95% confidence interval and a *P* value of less than 0.050.

#### Technique

All plastic surgeons used the same abdominal donor site closure technique for all patients over the 5-year period. Fascial closure was commonly performed simultaneously with breast microsurgery because it does not disrupt the flow of the case and can be completed by a

surgical extender or trainee with minimal supervision. Starting with identification of the posterior fascial leaflet, the paramedian fascial opening was closed primarily using Stratafix Symmetric #0 PDS barbed suture (Fig. 2). Running of the suture began superiorly, advancing approximately 8-10mm with each bite in the inferior direction. [See Video (online) which shows an intraoperative demonstration of abdominal fascial site closure technique with running Stratafix Symmetric suture.] The abdominal wound was then copiously irrigated and inspected meticulously for hemostasis before placement of a 15- or 19-French round fluted Blake drain (Medline) in each hemiabdomen, brought out of the abdomen through a separate incision. Upper abdominal skin was advanced over the umbilicus, and the waistline incision was closed carefully in layers, starting with interrupted 0-Vicryl suture (Ethicon, Somerville, N.J.) to reapproximate the Scarpa layer. Next, interrupted 2-0 buried dermal Vicryl sutures (Ethicon) and the Insoorb stapler (Incisive Surgical, Plymouth, Minn.) were used to reapproximate the dermis. Finally, a running Stratafix Spiral (a barbed variation specifically designed for subcuticular closure) Monocryl suture 3-0 was used to reapproximate the final layer of skin. The umbilicus was delivered and inset along the proper position in the midline, taking great care to ensure it was not torse or placed on undue tension.

## RESULTS

Forty-three patients underwent 67 DIEP flap autologous breast reconstruction procedures with abdominal fascial repair using only Stratafix Symmetric sutures at one of the two participating institutions. Nineteen patients (44%) underwent unilateral reconstruction, and 24 patients (56%) underwent bilateral reconstruction.

Our study population was almost evenly split between immediate (n = 20, 47%) and delayed (n = 23, 53%) autologous breast reconstruction. Of the patients with delayed reconstruction, the mean duration of delay was 595 days (range 10–1809 d). Average patient age on the date of reconstruction was 49 years (range 28–69 y) and the average BMI was 29.5 kg/m<sup>2</sup> (range 18.2–35.8 kg/m<sup>2</sup>). The most common medical comorbidity among patients was hypertension (n = 17, 40%) (Table 1). Fifty-six percent of patients (n = 24) had a history of abdominal/pelvic surgery. Specific information regarding each patient’s surgical procedure can be found in Table 2.

**Donor Site Outcomes**

The average postoperative follow-up duration between both institutions was 791 days (range 153–1769 d). Of the 43 patients included in this retrospective review, six (14%) developed one or more complications of the abdominal donor site (Table 3). No patient demographic factor or existing comorbidity was found to significantly increase the rate of complications in our study population, including age (50 versus 48.5 y; P = 0.379) and BMI (29.7 versus 29.5; P = 0.438). Nonetheless, six patients with postoperative complications had a history of abdominal or pelvic

surgery significantly more often than patients who did not develop complications of the donor site (100% versus 49%; P = 0.032). The most frequently encountered complication was seroma, which was identified in three patients (7%). This required operative aspiration in two of the patients (67%) and outpatient office intervention in the one remaining patient (33%). Although two patients had uncomplicated surgical site infections postoperatively (5%), one patient (2%) developed incisional dehiscence that necessitated operative intervention. Bulging was a complication in one patient (2%) who underwent unilateral DIEP flap breast reconstruction. This patient had a preoperative BMI of 25 and a history of hypertension, chemotherapy, chest radiation, and prior pelvic surgery. The plan for this patient is computed tomography imaging and eventual operative evaluation with repair of the bulge at the time of breast reconstruction revision. No patients developed a hernia during the follow-up period.

**DISCUSSION**

This multicenter retrospective study shares our initial experience with Stratafix Symmetric suture to repair the abdominal donor site fascia in DIEP flap breast

**Table 1. Patient Comorbidities and Risk Factors for Abdominal Donor Site Complications**

	No. Patients (n = 43)	No. Complications (n = 6)
<b>Comorbidities</b>		
Diabetes mellitus	8 (19%)	1 (13%)
Hypertension	17 (40%)	4 (24%)
Hyperlipidemia	14 (33%)	3 (21%)
Active smoker	0 (0%)	0 (0%)
COPD	4 (9%)	0 (0%)
<b>Risk factors</b>		
Chemotherapy before	19 (44%)	4 (44%)
Chemotherapy after	10 (23%)	1 (11%)
Radiation before	17 (40%)	3 (18%)
Radiation after	7 (16%)	0 (0%)
Prior abdominal surgery	23 (53%)	6 (26%)
Prior pregnancy	28 (65%)	3 (11%)

COPD, chronic obstructive pulmonary disease.

**Table 2. Patient Surgical Information**

	No. Patients (n = 43)	No. Complications (n = 6)
<b>Laterality</b>		
Unilateral	19 (44%)	2 (33%)
Bilateral	24 (56%)	4 (67%)
<b>Donor site dressing</b>		
Incisional NPT	35 (81%)	5 (83%)
Dermabond	8 (19%)	1 (17%)
<b>Perforators</b>		
One medial	13 (19%)	1 (8%)
One lateral	7 (11%)	1 (8%)
Two medial	11 (16%)	1 (8%)
Two lateral	10 (15%)	3 (25%)
Medial and lateral	7 (11%)	0 (0%)
Unknown	19 (28%)	6 (50%)

NPT, negative pressure therapy.

**Table 3. Patient Abdominal Donor Site Complications**

Complication	No. Total Affected Patients	No. Requiring Office Intervention	No. Requiring OR Intervention
Hematoma	0	0	0
Seroma	3	1	2
Incisional dehiscence	1	0	1
Surgical site infection	2	0	0
Bulge	1	0	1
Hernia	0	0	0
Chronic pain	0	0	0
Weakness	0	0	0

OR, operating room.

reconstruction. Of the 43 patients who had donor site fascial repair with Stratafix Symmetric suture alone, no patients developed a hernia, and only one patient developed a subjective bulge postoperatively. The rate of most remaining complications including hematoma, incisional dehiscence, chronic pain, weakness, and surgical site infection were on the low end of what is reported in the literature or absent. The use of unidirectional barbed sutures may therefore be considered a safe and effective technique for abdominal fascial repair in this patient population.

Yasuda et al<sup>21</sup> were the first to describe their experience with Stratafix Symmetric sutures alone for abdominal fascial repair in 18 patients who underwent reconstruction with either a VRAM or DIEP flap. Complications were not a focus of their technique-focused article, apart from the discussion of one male patient who underwent a VRAM flap and developed a postoperative hernia. Kitano et al<sup>22</sup> recently published a retrospective comparison of abdominal donor site closure with absorbable barbed continuous and nonabsorbable, nonbarbed interrupted suture following rectus abdominis myocutaneous flaps to the head and neck.<sup>22</sup> However, it is important to note that polypropylene mesh was simultaneously placed in all abdominal fascial repairs. Despite the study yielding no significant differences in the incidence of postoperative bulge and hernia according to suture type, there was a tendency for shorter wound closure times with the barbed continuous suture.<sup>22</sup>

No patients in the current study developed a hernia, whereas only one patient developed a bulge postoperatively. This rate compares favorably to the incidence of hernia and bulge following DIEP flap breast reconstruction reported in the literature, which ranges from upwards of 7% for hernia to 33% for bulge.<sup>12</sup> Stratafix Symmetric suture has outward-facing, evenly spaced anchors that grip the tissue with each stitch, making it ideal for closures under high tension such as the abdominal fascia.<sup>21,22</sup> This is in contrast to the sliding motion of traditional smooth monofilament suture, which can place tears (cheese wiring) in the fascia that ultimately leads to suture-line failure.<sup>23</sup> Improved approximation of the tissue and a reduced incidence of suture cheese wiring may collectively result in a more integral repair with less fascial laxity and thus, decrease the incidence of clinically significant postoperative hernia or bulge.<sup>21</sup> Anecdotally, Stratafix Symmetric is used by the authors for midline rectus plication during

cosmetic abdominoplasty. Although some surgeons opt to incorporate fascial midline plication during the closure of the DIEP flap donor site, our practice holds a different perspective. We abstain from this technique as we believe it potentially elevates tension within the fascia donor site. Consequently, the authors do not perform fascial midline plication during DIEP flap closure.

This study additionally showcased minimal occurrences of donor site incisional dehiscence and surgical site infection among patients who underwent abdominal fascial repair with Stratafix Symmetric suture. This is compared with the documented rates of dehiscence and surgical site infection in the literature for DIEP flap reconstruction, reported to be as high as 39% and 11% in this patient population.<sup>12</sup> Previous studies have demonstrated that barbed suture exhibits significantly greater incisional strength compared with the nonbarbed continuous variations, retaining this strength for up to 6 weeks following surgery.<sup>24,25</sup> Exerting an even tension across the suture line, the combination of Stratafix Symmetric and Stratafix Spiral suture may have an additive impact on dehiscence by reducing the tension placed on both the fascial and incisional closures.<sup>16,18</sup> Moreover, the knotless and absorbable property of this barbed suture can protect against chronic fistula formation and eliminate wounds that may result from knot breakage, slippage, splitting, or irritation of the tissue overlying a bulky knot.<sup>17</sup> This might have further implications for patients, as incisional dehiscence has been found to increase the risk of developing other complications including hernia, bulge, and infection.<sup>6,26</sup> Although lower surgical site infection rates have been reported when the fascial repair is completed with Stratafix Symmetric suture compared with nonbarbed PDS suture (Ethicon), this has not been comprehensively studied in the current literature.<sup>27</sup> Nonetheless, surgical site infection should be of particular concern in repair techniques employing mesh, as the mesh can serve as a nidus for infection or seroma, necessitating operative removal.

Although not a routine practice in DIEP flap breast reconstruction, prophylactic placement of surgical mesh has been shown to reduce the likelihood of developing hernia and bulge following abdominally based autologous breast reconstruction.<sup>9,28</sup> Decisions to prophylactically place surgical mesh are largely based on surgeon preference and require choosing from synthetic, biological, and biosynthetic mesh variations, each accompanied by specific

benefits, risks, and cost profiles.<sup>29</sup> The plane of mesh placement is a factor thought to influence the risk of specific donor site complications. For instance, positioning of mesh in a deeper abdominal plane may require greater dissections that lead to inadvertent nerve avulsion and denervation of the rectus muscle, a known risk factor for postoperative weakness, bulge, and hernia development.<sup>6</sup> Another undeniable disadvantage to the use of mesh in DIEP flap reconstruction is the cost.<sup>30</sup> This can be in the form of upfront costs, which will vary depending on the type and size of the mesh material, or downstream costs from complications such as reoperation for removal of infected mesh. However, it is possible that the combination of Stratafix Symmetric suture with prophylactic placement of mesh could be beneficial in patients with a history of previous abdominal or pelvic surgery, as this was a factor associated with increased donor site complications in this study.

It is estimated that up to 80% of healthcare-related costs may be related to patient care decisions by physicians.<sup>31</sup> Despite Stratafix Symmetric suture having a higher upfront cost than alternative nonbarbed suture variations, barbed suture has been shown to significantly reduce operative times for abdominal closure and, therefore, the patient's anesthesia exposure and associated morbidity.<sup>32–34</sup> With an approximated cost per minute in the operating room ranging from \$29 to \$80, shortened operative times could also have substantial financial implications for the patient and the healthcare system at large.<sup>35</sup> Although more studies are necessary, reduction of donor site hernia and bulge could further decrease healthcare costs related to reoperation or associated complications.

Limitations of this study include its retrospective nature and small sample size. A large, prospective, randomized controlled trial comparing donor site repair with Stratafix Symmetric suture to other methods of repair including prophylactic surgical mesh and nonbarbed interrupted suture would provide more definitive evidence of safety and efficacy. The authors aim to execute subsequent studies comparing unidirectional barbed suture to alternative methods of abdominal fascial repair, such as the prophylactic placement of mesh. Although the retrospective data collection limited our ability to record specific factors such as operative time for fascial site closure, the small sample size made us unable to determine the true effect of confounding variables that may have influenced patient outcomes such as the laterality, number of harvested flap perforators, or differences in unilateral versus bilateral fascial repair. Moreover, the presence of a complication was solely based on the information recorded from prior operative reports or clinic notes. Therefore, the rates of bulge, weakness, and chronic pain may be slightly underestimated due to these variables being subjective topics that were not measured numerically with a questionnaire or scoring system. Finally, heterogeneous follow-up is considered a limitation of the present study, which ranges from 153 to 1769 days in our patient population. Nonetheless, this study adds value to the limited existing literature on the topic of Stratafix Symmetric suture abdominal wall fascial repair in DIEP flap breast reconstruction by highlighting

our early initial experience with this technique. Future studies should focus on differences in upfront costs of materials and downstream costs of managing postoperative complications between methods of fascial repair. Operative time among the various techniques can also be evaluated.

## CONCLUSIONS

Repair of donor site abdominal fascia with Stratafix Symmetric suture led to no patients developing hernia and only one patient developing a bulge in the postoperative follow-up period. The rates of hematoma, surgical site infection, seroma, incisional dehiscence, chronic pain, and weakness were also low compared with reported rates in the literature. The use of unidirectional barbed suture may therefore be a safe and effective technique for abdominal fascial repair in DIEP flap breast reconstruction. Combined use of Stratafix Symmetric suture and mesh could be considered for patients with multiple risk factors for donor site hernia and bulge.

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## DISCLOSURES

*D.S. is a consultant for 3M/Acelity. T.H. is a consultant for 3M/Acelity, Stryker, and RTI Surgical. The other authors have no financial interest to declare.*

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