INTRODUCTION

Breast cancer is the most common malignancy in women worldwide. More than 60% of women who undergo mastectomy desire breast reconstruction to improve body image, quality of life, and patient satisfaction. Although many techniques are available for breast reconstruction, autologous techniques demonstrate superior quality-of-life outcomes compared with alloplastic reconstruction. Different modalities of autologous reconstruction are available; however, abdominal-based flaps remain the most common type of autologous breast reconstruction. The deep inferior epigastric perforator (DIEP) flap can provide an adequate volume of soft, malleable tissue to replace the surgically absent breast, and is associated with superior long-term aesthetic results, a low hernia/bulge rate, and typically with improved abdominal contour. In some cases, however, patients may have inadequate abdominal tissue to achieve their reconstructive goals. For instance, thin patients often do not have adequate abdominal adiposity and/or redundancy to obtain enough volume and projection of the reconstructed breast, especially in bilateral cases. In addition, previous abdominal surgeries may limit the amount of tissue that can be transferred safely. The use of multiple free flaps, beyond a single flap reconstruction, may be necessary. However, the use of multiple free flaps can lead to increased operative time, increased flap and implant loss, and increased complications.

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Received for publication July 17, 2020; accepted August 20, 2020.

Presented at the 88th Annual Plastic Surgery Meeting, September 20–23, 2019, San Diego, California.

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DOI: 10.1097/GOX.0000000000003180

Disclosure: The authors have no financial interest to declare in relation to the content of this article.
DIEP flap, has been described; however, as this option adds complexity and operative time to a procedure that already requires a high level of skill, it has not been widely adopted.20

Combining a latissimus dorsi flap with an implant is the most common form of “hybrid reconstruction” (the combination of autologous and alloplastic reconstruction techniques).10,11 However, some surgeons have used an implant in addition to free tissue transfer to provide the desired breast volume for their patient.12-16 In this type of hybrid reconstruction, authors have described either placing an implant at the time of free flap reconstruction17 or in a delayed fashion at a secondary procedure.12,13,16,18,19

In these studies, authors have reported clinical outcomes and postoperative complications associated with single-stage and secondary implant placement under abdominally based musculocutaneous free flaps and perforator flaps.

Due to the added complexity of hybrid reconstruction (free flap and implant) in a single stage, most authors recommend secondary placement of the implant below the flap. However, at the second stage, dissection deep to the flap raises concerns of inadvertent injury to the perforator or flap pedicle. While the delay associated with a 2-stage approach allows for flap neovascularization, inadvertent division of the pedicle may result in subsequent fat necrosis and volume loss. Furthermore, a case of breast reconstruction flap loss after pedicle division has been reported as late as 3 years postoperatively.20

In this study, we evaluate the outcomes of secondary subpectoral implant augmentation of abdominally based perforator flaps for breast reconstruction over a 11-year period at our institution. Our primary outcome of interest was the development of any complication related to the flap or implant requiring surgical intervention. We present our technique and experience to address asymmetries and inadequate breast volume after autologous breast reconstruction.

METHODS

In reporting our case series, we followed the recommendation provided by the SCARE statement.21 We retrospectively reviewed all patients who underwent secondary implant augmentation following abdominal-based free flap breast reconstruction at our institution over a 11-year period (January 2008 to December 2018). Our center is an Academic Institution, with a catchment area of 2.3 million people. All procedures were performed by the senior author (R.A.). Patients with at least 1-year follow-up were included. Data regarding patient characteristics, surgical procedures, peri- and postoperative complications were collected from the electronic health record for each patient by a single reviewer. Demographic information included age, body mass index, smoking status, medical comorbidities, and previous radiotherapy. Surgical information included (1) timing of index flap reconstruction (immediate versus delayed); (2) reconstruction laterality (unilateral or bilateral); (3) type of flap used; (4) recipient vessels; (5) indication for secondary augmentation; and (6) implant characteristics (type and volume of implant used). Postsurgical data included perioperative and postoperative flap or implant complications. Objective definitions of postoperative events were established before review. Recorded flap-related complications included flap loss, partial flap loss, fat necrosis, and mastectomy skin necrosis. Implant-related complications included periprosthetic infection, implant exposure, hematoma, implant malposition, capsular contracture, rippling, and implant rupture.

Surgical Technique

The standard anatomical landmarks are marked in the preoperative holding area. These include the midline, inframammary fold, anterior axillary line, and the borders of the flap. Intraoperatively, an access incision is made along an existing scar line at the inferior border of the flap. Dissection is then carried out through subcutaneous tissue down to the level of chest wall fascia. For patients who had immediate breast reconstruction at their first surgery, dissection proceeds between the native chest wall skin and underlying flap to the inferior border of the reconstructed breast and then down to chest wall fascia. The pectoralis muscle and fascia are then incised and elevated to create a submuscular pocket, similar to a standard submuscular breast augmentation. Every effort is made to avoid separation of the free flap from the underlying pectoralis muscle.

Controlled dissection of the superomedial area is performed with a lighted retractor to avoid pedicle injury. However, if the pedicle is deemed to interfere with the implant position, the pedicle is ligated and divided. A multilevel intercostal nerve block is then performed with bupivacaine. After hemostasis is confirmed, a temporary implant sizer is used to determine the ideal breast volume and shape to achieve adequate projection and symmetry. The temporary sizer is removed, and the pocket irrigated with a triple antibiotic solution. The wound edges are painted with an iodine-based solution. The permanent implant is inserted into the pocket. Closure is performed in a layered fashion with a running absorbable suture for the deeper layer and both interrupted and running absorbable, monofilament suture material for the dermis and epidermal layers.

RESULTS

Over the 11-year study period, 24 consecutive patients underwent 40 perforator flap breast reconstructions. A total of 36 breast flaps had their volume augmented using an implant. Mean follow-up time was 15 months (range, 12–28 months). The mean age for our cohort was 51 years (range, 39–66 years), and 6 patients (25%) suffered from one or more comorbidities. Most patients (n = 16, 67%) had a bilateral reconstruction. Thirty-one breasts (78%) were reconstructed with a DIEP flap and 9 (22%) with a superficial inferior epigastric artery (SIEA) perforator flap. Of the 36 breasts that had secondary implant augmentation, 8 received radiation therapy before flap reconstruction (22%) (Table 1).
As per our center’s protocol, immediate breast reconstruction is offered if neoadjuvant radiation therapy is not planned. If radiation is known to be required preoperatively, reconstructive procedures are performed in a delayed fashion. In our cohort, 34 flaps (85%) were performed for immediate breast reconstruction and 6 flaps for delayed reconstruction (Table 1).

As per the senior author’s (R.A.) technique, all implants were placed in the subpectoral pocket, with the access incision placed along the inferior border of the flap. Three pedicles were ligated and divided in 2 patients (1 patient had bilateral augmentation). The mean time between secondary augmentation and index procedure was 22 months (range, 6–60 months). saline and silicone implants were used according to patients’ preference. However, saline implants were used more frequently than silicone implants (Table 1). The mean implant volume was 270 mL (range, 175–495).

We did not observe any flap-related complications. Specifically, no flap loss, partial flap loss, or fat necrosis were observed (Table 2). However, of the 36 breasts that received secondary implant augmentation, 6 (17%) breasts from 4 patients had a surgical site infection requiring intervention. One patient’s infection resolved with intravenous antibiotics; however, 5 patients had severe infections requiring implant explantation (a total of 4 implants) (Table 3). Among these patients, 2 had previous radiation. Three patients had DIEP flap reconstruction, while 1 had SIEA flap reconstruction. The SIEA patients had partial flap necrosis after their initial breast reconstruction surgery, which required a revision procedure.

DISCUSSION

Our series demonstrates that secondary implant augmentation of free flap breast reconstruction can achieve improved volume and asymmetry, without causing any deleterious effects on the existing free flap. However, the postoperative rate of infection was higher than expected. We used a consecutive sample from a tertiary care center and objective definitions of postoperative events. Analyses included comorbidities, adjuvant therapy, flap techniques, and postoperative management.

The combination of implant and flap reconstruction for breast reconstruction has been described previously.15-18,22 However, these studies evaluated outcomes of “hybrid” breast reconstruction using both musculocutaneous and perforator flaps. In addition, studies have included prepectoral and subpectoral implant placement. In our study, we focused on evaluating outcomes of secondary subpectoral implant augmentation following a primary perforator flap breast reconstruction. While we had 3 events of pedicle division, we did not experience any immediate flap-related complications. Interestingly, we observed a higher rate of periprosthetic infection (17%) during the early postoperative period compared with existing studies.

Secondary revisions following autologous breast reconstruction have been described previously.23 The primary goal of these procedures is to adjust the shape, contour, and volume of the reconstructed breast.23 Typically, surgeons use either a permanent implant12,15,13,16,21 or fat grafting techniques25-27 to achieve their goal. Autologous fat grafting is a powerful tool to improve contour irregularities and possibly to increase the volume if used in a large quantity.26 However, around 20% of transferred fat is subject to resorption.28 Therefore, multiple fat grafting procedures is often required to obtain a desired volume. On the other hand, implant augmentation offers more predictable and stable augmentation in a single stage.

Roehl et al16 evaluated timing of implant placement relative to autologous reconstruction in 110 patients (59 concurrent versus 51 secondary). In this study, various types of flaps were used, including free transverse rectus abdominis musculocutaneous (TRAM) (n = 32), muscle sparing TRAM (n = 51), DIEP (n = 37), and SIEA (n = 7). Although total early implant-related complications were 5%, they did not observe any infections in the staged reconstruction group. In addition, Spear and Wolfe41 reported their experience on 18 patients who underwent TRAM flap breast reconstruction with concurrent (n = 14) and secondary (n = 4) implant placement. Similarly, a higher rate of complications was observed in the concurrent placement group. In the concurrent group, 3 patients (18%) developed periprosthetic infection compared with no patients in the secondary augmentation group.15

Momeni and Kanchwala17 advocate for the combination of free tissue transfer with simultaneous implant placement. They argue that the use of abdominal flap transfer will allow smaller implants to be placed and thus decrease implant-related complications.17 They place the implant in the prepectoral plane and posit that the abdominal flap minimizes implant visibility and rippling. While this approach has been criticized as combining the disadvantages of both autologous and alloplastic reconstruction methods,24 Momeni and Kanchwala17 believe that in the appropriate patient, it can provide a single-stage reconstruction option for patients who have abdominal skin laxity in the absence of adequate volume, yet still desire autologous reconstruction. However, they acknowledge that performing microsurgical anastomosis after the implant has been inserted can be challenging at times.29

Most studies suggest that abdominal flap reconstruction with implant augmentation is safer in the long term when performed in a staged fashion.19 The higher rate of infection that occurs with single-stage implant placement is likely due to unrecognized implant contamination at the time of the index procedure.16 However, in our series of secondary (staged) implant placement, 6 implants (17%) developed periprosthetic infection and 4 required implant explantation. The cause of higher infection rate in our study is unclear; the difference in quality and vascularity of the soft-tissue coverage over the implant likely contributes to this higher infection rate.30-31 The surgical site infection rate in implant-based breast reconstruction ranges from 6% to 28% compared with a rate of 5% associated with autologous breast reconstruction.32-36 This is significantly higher.
Table 1. Patient Characteristics

| Patient | Age | Comorbidities | BMI | Previous Radiation Therapy | Flap Type | Unilateral versus Bilateral | Immediate versus Delayed | Augmentation Side | Time Since Index Surgery | Implant Type | Implant Size |
|---------|-----|---------------|-----|-----------------------------|-----------|-----------------------------|--------------------------|-----------------|-------------------------|--------------|------------|
| 1       | 49  | Healthy       | 27.4| Required                    | DIEP      | Bilateral                   | Immediate                | Bilateral       | 6 mo                    | Silicone     | Left, 495; Right, 445 |
| 2       | 41  | Healthy       | 33  | Required                    | DIEP      | Bilateral                   | Immediate                | Left            | 8 mo                    | Saline       | Left, 180    |
| 3       | 66  | Hypothyroidism, asthma | NA | Not required | DIEP      | Bilateral                   | Left immediate            | Right           | 20 mo                   | Silicone     | Right, 100   |
| 4       | 51  | Healthy       | 27  | Not required                | SIEA      | Bilateral                   | Left immediate right delayed | Right           | 15 mo                   | Silicone     | Left, 225; Right, 300 |
| 5       | 46  | Healthy       | 21  | Not required                | SIEA      | Bilateral                   | Immediate                | Bilateral       | 15 mo                   | Silicone     | Left, 250; Right, 250 |
| 6       | 55  | HTN, DM, smoker | 28 | Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 19 mo                   | Saline       | Left, 240    |
| 7       | 65  | Healthy       | 22  | Required                    | DIEP      | Bilateral                   | Left delayed, right immediate | Right           | 15 mo                   | Saline       | Right, 160   |
| 8       | 49  | Healthy       | 24  | Not required                | SIEA      | Bilateral/right             | Immediate                | Right           | 27 mo                   | Saline       | Right, 210   |
| 9       | 39  | Hypothyroidism | 34  | Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 15 mo                   | Saline       | Left, 350; Right, 480 |
| 10      | 57  | Healthy       | 35.5| Not required                | SIEA      | Bilateral                   | Immediate                | Bilateral       | 25 mo                   | Saline       | Left, 250; Right, 420 |
| 11      | 41  | Healthy       | 32  | Not required                | SIEA      | Bilateral                   | Immediate                | Bilateral       | 20 mo                   | Saline       | Left, 200; Right, 400 |
| 12      | 60  | HTN           | 25.3| Not required                | DIEP      | Bilateral                   | Immediate                | Right           | 22 mo                   | Saline       | Right, 190   |
| 13      | 52  | Healthy       | 35  | Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 15 mo                   | Saline       | Left, 350; Right, 325 |
| 14      | 39  | Healthy       | 32  | Not required                | DIEP      | Bilateral                   | Immediate                | Right           | 11 mo                   | Saline       | Right, 250   |
| 15      | 45  | Healthy       | 24.9| Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 12 mo                   | Silicone     | Left, 275; Right, 275 |
| 16      | 43  | Healthy       | 24.7| Not required                | DIEP      | Unilateral/left             | Immediate                | Left            | 13 mo                   | Saline       | Left, 240    |
| 17      | 56  | Healthy       | 25.5| Required                    | DIEP      | Unilateral/right            | Immediate                | Right           | 39 mo                   | Saline       | Right, 145   |
| 18      | 52  | Healthy       | 27.6| Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 13 mo                   | Saline       | Left, 300; Right, 205 |
| 19      | 46  | Healthy       | 29.4| Required                    | DIEP      | Bilateral                   | Delayed                  | Left            | 20 mo                   | Saline       | Left, 175    |
| 20      | 54  | Healthy       | 22.7| Required                    | DIEP      | Unilateral/left             | Delayed                  | Left            | 50 mo                   | Saline       | Left, 175    |
| 21      | 54  | Healthy       | 28.2| Required                    | DIEP      | Bilateral                   | Immediate                | Bilateral       | 48 mo                   | Silicone     | Left, 350; Right, 225 |
| 22      | 54  | Healthy       | 30  | Not required                | DIEP      | Unilateral/right            | Immediate                | Right           | 22 mo                   | Silicone     | Right, 350   |
| 23      | 39  | HTN, DM, smoker | 45.6| Not required                | DIEP      | Bilateral                   | Immediate                | Bilateral       | 20 mo                   | Saline       | Left, 225; Right, 225 |
| 24      | 60  | HTN           | 22.6| Not required                | SIEA = 9, DIEP = 31 | Bilateral                   | Immediate                | Bilateral       | 12 mo                   | Silicone     | Left, 215; Right, 215 |
| Mean, 50.5 | 6 out of 24 | 28.4 | | SIEA = 8, \text{bilateral} = 16, \text{delayed} = 6, \text{immediate} = 34 | Bilateral                   | \text{Unilateral} = 12, \text{bilateral} = 24 | Mean = 22 | \text{Silicone} = 13, \text{Saline} = 25 | Right, 215; Mean, 270 g (range, 495–160) |

BMI, body mass index; DM, Diabetes Mellitus; HTN, hypertension.
dependent on maintaining arterial inflow and venous outflow through a patent arterial and venous anastomosis. Several articles have described complete flap survival despite injury to the vascular pedicle; however, these examples are from the head and neck reconstruction literature, where the size of free flaps are typically significantly smaller than abdominally based flaps. The survival of these small flaps is believed to be due to neovascularization process from the wound bed that allows flap autonomy.44,45 Mücke et al.45 prospectively evaluated vascularization process from the wound bed that allows flap survival despite injury to the vascular pedicle; 17 flaps showed evidence of flap neovascularization; 17 flaps showed evidence of neovascularization at 4 weeks and 41 flaps at 3 months postoperatively. Authors indicated that location, flap type, and previous radiation were important factors affecting flap neovascularization rate.45

Given the significantly larger size of abdominally based flaps for breast reconstruction, it is hypothesized that while a flap may survive after inadvertent division of the pedicle, it can still result in subsequent fat necrosis and volume loss.52 We were surprised to find a higher infection rate (17%) than anticipated in our patient cohort, especially since we had few incidences of pedicle injury during secondary procedures. Nevertheless, it is possible that the dissection during pocket development resulted in a loss of vascular supply from the wound bed, thus increasing the risk of infection of a newly placed implant. This study is limited by a relatively small sample size and a lack of a control group. However, all of the patients underwent abdominally based free flap surgery and then subsequently (at least 6 months later, and up to 5 years later) expressed a desire for a larger breast volume. Over the past few years, our breast reconstruction team has expanded; therefore, we anticipate the ability to revisit this topic in the future with more data.

This study adds to a growing body of evidence confirming the efficacy of combining an implant with autologous breast reconstruction to improve volume and asymmetry and to enhance aesthetic outcome. However, in our study, we observed a higher rate of peri-prosthetic infection despite implant placement at a secondary procedure. Although previous studies indicated that the risk of infection is greater with a combined flap and implant placement, it seems that the risk of infection is still high, compared with elective nonreconstructive augmentation, during staged placement.

Table 2. Prospective Complications

| Complications                        | No. (%) |
|--------------------------------------|---------|
| Secondary flap augmentation          | 36      |
| Postoperative complications          |         |
| Flap loss                            | 0 (0)   |
| Partial flap loss                    | 0 (0)   |
| Fat necrosis                         | 0 (0)   |
| Pedicle injury                       | 3 (8.3) |
| Mastectomy skin necrosis             | 0 (0)   |
| Hematoma                             | 0 (0)   |
| Implant infection                    | 4 (11.1)|
| Cellulitis                           | 2 (5.5) |

Table 3. Implant Infection Cases Variables

| Patient | 1 | 11 | 15 | 17 |
|---------|---|----|----|----|
| Age     | 49 | 41 | 45 | 56 |
| Comorbidities | Healthy | Healthy | Healthy | Healthy |
| Smoking status | Nonsmoker | Nonsmoker | Nonsmoker | Nonsmoker |
| BMI     | 27.4 | 32.0 | 24.9 | 25.5 |
| Previous radiation therapy | Required (left) | Not required | Not required | Required (right) |
| Flap type | DIEP | SIEA | DIEP | DIEP |
| Unilateral versus bilateral | Bilateral | Bilateral | Bilateral | Bilateral |
| Immediate versus delayed | Immediate | Immediate | Immediate | Immediate |
| Indication for augmentation | Asymmetry | Asymmetry—previous right partial flap necrosis | Fuller appearance | Asymmetry |
| Augmentation side | Bilateral | Bilateral | Bilateral | Bilateral—Right |
| Implant type | Silicone | Saline | Silicone | Saline |
| Implant size | Left, 495; Right, 445 | Left, 200; Right, 400 | Left, 275; Right, 275 | Left, NA; Right, 145 |
| Pedicle injury | No | No | Yes (bilateral) | No |
| Outcome | Bilateral implant infection/explanation | Bilateral cellulitis | Right side implant infection/explanation | Right side implant infection/explanation |

BMI, body mass index.

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