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Secondary Implant Augmentation in the Subpectoral Plane following Abdominal-based Perforator Flaps for Breast Reconstruction

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Background: Abdominal-based perforator flaps are the gold standard for autologous breast reconstruction. However, among patients with a small-to-medium amount of redundant abdominal tissue, this may result in an inadequate breast mound. Secondary implant augmentation has been reported as one method to augment volume, address breast mound asymmetry, and enhance overall aesthetic outcome. We aim to analyze postoperative complications associated with the secondary implant augmentation following a primary breast reconstruction with abdominal perforator flaps.

Methods: This retrospective study included patients who underwent secondary implant augmentation following abdominal-based perforator flap breast reconstruction. Patient characteristics, immediate versus delayed reconstruction, type of flap used, indication for secondary augmentation as well as perioperative and postoperative complication including flap or implant loss were reviewed and analyzed.

Results: Twenty-four patients met inclusion criteria. Forty flaps were performed (16 bilateral and 8 unilateral). A total of 36 implants were placed in subpectoral plane in a secondary revision procedure. The mean time between secondary augmentation and index procedure was 22 months. Average implant volume was 270 g. No intraoperative complication or flap loss was recorded. Postoperative surgical site infection occurred in a total of 4 patients (17%) with 3 patients requiring explantation of a total of 4 implants.

Conclusions: Secondary augmentation of abdominal-based perforator flap using a permanent implant is an effective method to address volume and asymmetry and to enhance aesthetic outcome. In our study, however, we observed a higher than expected rate of postoperative infection. *(Plast Reconstr Surg Glob Open 2020;8:e3180; doi: 10.1097/GOX.0000000000003180; Published online 4 November 2020.)*

INTRODUCTION

Breast cancer is the most common malignancy in women worldwide.[1] More than 60% of women who undergo mastectomy desire breast reconstruction to improve body image, quality of life, and patient satisfaction.[2,3] Although many techniques are available for breast reconstruction, autologous techniques demonstrate superior quality-of-life outcomes compared with alloplastic reconstruction.[2,4] Different modalities of autologous reconstruction are available; however, abdominal-based flaps remain the most common type of autologous breast reconstruction.[5] 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.[5,6]

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.[7] The use of multiple free flaps, beyond a single

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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.[8,9]

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 reconstruction[17] 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 though 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 bupivicaine. 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, 3 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.[12–18,22] 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 implant[12,13,15,16,24] or fat grafting techniques[25–27] 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 al[16] 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 Wolfe[15] 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 Kanchwala[17] 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 Kanchwala[17] 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 (left breast)	DIEP	Bilateral	Immediate	Bilateral	6 mo	Silicone	Left, 495; Right, 445
2	41	Healthy	33	Required (left breast)	DIEP	Unilateral/left	Delayed	Left	8 mo	Saline	Left, 180
3	66	Hypothyroidism, asthma	NA	Not required	DIEP	Unilateral/left	Immediate	Left	24 mo	Saline	Left, 120
4	51	Healthy	27	Not required	SIEA	Bilateral	Left immediate right delayed	Right	20 mo	Silicone	Right, 100
5	46	Healthy	21	Not required	SIEA	Bilateral	Immediate	Bilateral	15 mo	Silicone	Left, 225; Right, 300
6	55	HTN, DM, smoker	28	Not required	DIEP	Bilateral	Immediate	Bilateral	19 mo	Saline	Left, 250; Right, 250
7	65	Healthy	22	Required (left breast)	DIEP	Bilateral	Left delayed, right immediate	Right	15 mo	Saline	Right, 160
8	49	Healthy	24	Not required	SIEA	Unilateral/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	23 mo	Saline	Left, 350; Right, 420
11	41	Healthy	32	Not required	SIEA	Bilateral	Immediate	Bilateral	60 mo	Saline	Left, 200; Right, 400
12	60	HTN	25.3	Not required	DIEP	Unilateral/right	Immediate	Right	22 mo	Saline	Right, 190
13	52	Healthy	35	Not required	DIEP	Bilateral	Immediate	Bilateral	15 mo	Saline	Left, 390; Right, 325
14	39	Healthy	32	Not required	DIEP	Bilateral	Immediate	Right	11 mo	Saline	Right, 290
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 (right breast)	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 (right breast)	DIEP	Bilateral	Delayed	Left	20 mo	Saline	Left, 175
20	54	Healthy	22.7	Required (left breast)	DIEP	Unilateral/left	Delayed	Left	50 mo	Saline	Left, 175
21	54	Healthy	28.2	Required (right breast)	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	43.6	Required (right breast)	DIEP	Bilateral	Immediate	Bilateral	20 mo	Saline	Left,225; Right, 225
24	60	HTN	22.6	Not required	DIEP	Bilateral	Immediate	Bilateral	12 mo	Silicone	Left, 215; Right, 215
	Mean, 50.5 (range, 39–66)	6 out of 24	28.4		SIEA = 9, DIEP = 31	Unilateral = 8; bilateral = 16	Delayed = 6; immediate = 34	Unilateral = 12; bilateral = 24	Mean = 22 (range, 6–60 mo)	Silicone = 13; Saline = 23	Mean, 270 g (range, 495–160)

BMI, body mass index; DM, Diabetes Mellitus; HTN, hypertension.

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)

than the published infection rate following elective, nonreconstructive breast augmentation (0.1%–1.5%).[37] The different surgical site infection rates of implant-based reconstruction and elective, nonreconstructive breast augmentation highlights the importance of healthy soft-tissue coverage to minimize infection and implant exposure. Other risk factors for infection includes radiation, obesity, smoking, large breast size, chemotherapy, prolonged drain duration, and advanced age, which are typically more frequent in breast reconstruction patients.[34,38–40] Free tissue transfer survival is

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	Unilateral (right)
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	Unilateral—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.

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[41–43]; 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 50 flaps for head and neck reconstruction for 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.[12] 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 periprosthetic 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.

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