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Outcomes of Take-Back Operations in Breast Reconstruction with Free Lower Abdominal Flaps

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Background Microvascular complications after free-flap breast reconstructions are potentially devastating problems that can increase patient morbidity and lead to flap loss. To date, no comprehensive study has examined the rates of salvage and the methods of microvascular revision in breast reconstruction. We reviewed the treatment of microvascular complications of free-flap breast reconstruction procedures over a seven-year period.

Methods A retrospective review of all patients who underwent microvascular breast reconstruction at our institution between April 2006 and December 2013 was conducted. Based on their surgical records, all patients who required emergency re-exploration were identified, the rate of flap salvage was determined, the factors associated with flap salvage were evaluated, and the causes and methods of revision were reviewed.

Results During the review period, 605 breast reconstruction procedures with a free lower abdominal flap were performed. Seventeen of these flaps were compromised by microvascular complications, and three flaps were lost. The overall salvage rate was 82.35%. No significant differences between the salvaged group and the failed group were observed with regard to age, BMI, axillary dissection, number of anastomotic arteries and veins, recipient vessel types, or use of the superficial inferior epigastric vein in the revision operation. Successful salvage of the flap was associated with a shorter time period between recognizing the signs of flap compromise and the take-back operation.

Conclusions The salvage rate of compromised lower abdominal flaps was high enough to warrant attempting re-exploration. Immediate intervention after the onset of flap compromise signs is as important as vigilant postoperative monitoring.

Keywords Perforator flap / Surgical flaps / Free tissue flaps / Salvage therapy / Breast

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INTRODUCTION

The free flap has undergone important technical improvements and is now a reliable method of reconstructing surgical defects, with a success rate of over 91% [1,2]. Free flaps made of lower abdominal tissue are being increasingly used in breast reconstruction, and have become the most commonly adopted method among the options for breast reconstruction using autologous tissue. However, lower abdominal free flaps may experience microvascular complications that can potentially lead to flap loss. As the purpose of breast reconstruction is not merely to provide coverage of the defect, but also to restore the symmetric shape and volume of the breast, a compromised flap in a breast reconstruction procedure may be more emotionally traumatic to the patient than in other operations.

Many reports have evaluated free-flap salvage in reconstruction of the head and neck region or the lower extremity [1-3]. To date, no comprehensive analysis of the factors associated with flap salvage or loss in free-flap breast reconstruction has been published. We therefore reviewed cases of free lower abdominal flap breast reconstructions and investigated the factors that were associated with success in take-back operations performed to save the flaps with microvascular complications. In our study, the term "take-back operation" is used to refer to a revision operation to salvage a flap that was compromised by a vascular insult.

METHODS

A retrospective chart review was performed of 605 cases of free lower abdominal flap breast reconstruction carried out between April 2006 and December 2013. Immediate reconstruction was performed in 566 cases and delayed reconstruction was performed in 39 cases. In this cohort, a deep inferior epigastric perforator (DIEP) flap was used in 304 cases, while a muscle-sparing free transverse rectus abdominis musculocutaneous (TRAM) flap was used in 301 cases. Of the 605 cases that we initially screened, 17 required a take-back operation due to circulatory compromise and were subjected to further analysis. We divided the 17 cases of take-back operations into two groups, depending on whether the flap was successfully salvaged or the take-back operation failed. We then considered age, body mass index (BMI), smoking, axillary node dissection, the type of recipient vessels, and use of the superficial inferior epigastric vein (SIEV) as factors that could potentially affect the outcomes of salvage surgery. In order to evaluate the time interval between the initial operation and the take-back operation, we measured and compared the interval from the completion of the primary operation to the first recognition of the signs of microvascular compromise (time A), and the interval from the first recognition of the signs of microvascular compromise to the commencement of the revision operation (time B). For statistical analysis, Fisher's exact test was used for categorical variables, the two-sample t-test was used for continuous variables, and the Wilcoxon rank-sum test was used for comparing time A and time B. P-values < 0.05 were considered to indicate statistical significance.

RESULTS

Three cases of flap loss occurred in the 17 take-back operations. In the other 14 cases, the flaps were successfully salvaged either by reanastomosis of the main pedicle or establishing an alternative drainage with the SIEV. The success rate of the take-back operations was 82.4%. Detailed information about the flaps and revision operations are presented in Table 1, in which the numbering of the patients reflects the chronological order of operation. The SIEV was used with the supercharging technique in the primary operation in two patients. The initial cause of flap compromise was venous thrombosis in 12 cases, venous insufficiency without thrombosis in four cases, and arterial thrombosis in one case. The procedures that were performed to save the congested flap all attempted to re-establish venous outflow. Thrombectomy and reanastomosis of the deep inferior epigastric vein (DIEV) was performed in 11 cases. SIEV anastomosis was performed in eight cases. In four cases, the SIEV was used as additional venous augmentation, while in the other four cases, the SIEV was used for main venous outflow after abandoning the DIEV. Arterial thrombectomy and reanastomosis were performed in five cases. During a follow-up period of six months or more, fat necrosis with a size of 1 cm or more was observed in five of the 14 patients in the salvaged group.

No significant differences were found between the salvaged group and the failed group with regard to age, BMI, axillary dissection, the extent of muscle sparing, the number of arteries and veins, and type of recipient vessel. No statistically significant differences were observed between the outcomes of cases in which SIEV was used or not used, but all eight cases in which the SIEV was used in the re-exploration were successfully salvaged (Table 2). All 17 patients were non-smokers, and smoking was therefore not analyzed as a factor.

The average time A was 16.57 hours in the salvaged group and three hours in the failed group, which was a statistically significant difference ($P = 0.023$). The average time B was 4.82 hours in the salvaged group and 29 hours in the failed group, which was likewise a statistically significant difference ($P = 0.032$) (Table 3).

DISCUSSION

Microsurgical free tissue transfer is currently considered to be a reliable option for breast reconstruction [4-6]. However, even when this procedure is performed by the most experienced surgeons, microvascular compromise of the flap can still occur. Our flap success rate was 99.5%, but it must not be forgotten that experiencing microsurgical complications can be extremely stressful and traumatic for the patients. Hence, every precaution should be taken to avoid vascular compromise and to ensure a maximally high success rate. Information about fat necrosis and partial necrosis in the salvaged flaps is also valuable and worthy

Table 1. Individual characteristics of the 17 cases who required a revision operation

Case no.	Age (yr)	BMI (kg/m²)	Type of mastectomy	Type of muscle sparing	Final flap weight (g)	Use of the SIEV in primary operation	Recipient artery/vein in primary operation	Cause of flap compromise	Use of SIEV in revision operation	Revision procedure	Final outcome
1	31	22.35	SSM	I	446	No	TDA/TDV	Venous thrombosis	No	Change of recipient vein to LTV	Salvaged
2	37	22.68	SSM	III (DIEP)	458	No	TDA/TDV	Venous thrombosis	No	Vein reanastomosis	Salvaged
3	38	20.12	SSM	III (DIEP)	339	No	TDA/TDV	Venous insufficiency	Yes (to LTV)	Supercharge with SIEV	Salvaged
4	35	23.15	NSM	III (DIEP)	445	No	LTA/TDV	Arterial thrombosis	No	Artery reanastomosis	Failed
5	51	23.45	NSM	III (DIEP)	460	Yes (to LTV)	TDA/TDV	Venous thrombosis	Reanastomosis	SIEV reanastomosis with vessel graft	Salvaged
6	44	21.91	NSM	III (DIEP)	225	No	IMA/IMV	Venous thrombosis	Yes (to TDV)	Arterial and vein reanastomosis Supercharge with SIEV	Salvaged
7	34	21.22	SSM	II	222	No	IMA/IMV	Venous thrombosis	Yes (to TDV)	Vein reanastomosis Supercharge with SIEV	Salvaged
8	41	22.10	SSM	III (DIEP)	197	No	IMA/IMV	Venous insufficiency	Yes (to IMV perforator)	Supercharge with SIEV	Salvaged
9	40	18.96	NSM	III (DIEP)	417	No	IMA/IMV	Venous insufficiency	No (unavailable)	Vein reanastomosis	Failed
10	41	26.03	SSM	III (DIEP)	588	No	IMA/IMV	Venous thrombosis	Yes (to IMV)	Artery reanastomosis SIEV anastomosed to IMV	Salvaged
11	42	29.60	NSM	III (DIEP)	279	No	IMA/IMV	Venous thrombosis	No (unavailable)	Artery and Vein reanastomosis	Salvaged
12	41	29.34	SSM	II	360	No	IMA/IMV	Venous thrombosis	Yes (to IMV)	Vein reanastomosis Supercharge with SIEV	Salvaged
13	48	20.0	NSM	II	400	No	IMA/IMV	Venous thrombosis	Yes (to IMV)	Change of Recipient vein to LTV Supercharge with SIEV	Salvaged
14	36	22.14	NSM	III (DIEP)	292	Yes (to IMV)	IMA/IMV	Venous insufficiency	No	Hematoma evacuation	Salvaged
15	44	24.01	NSM	I	627	No	IMA/IMV	Venous thrombosis	No	Artery and vein reanastomosis	Salvaged
16	35	24.01	NSM	I	473	No	TDA/TDV	Venous thrombosis	No	Vein reanastomosis	Salvaged
17	43	22.06	NSM	I	323	No	LTA/LTV	Venous thrombosis	No (unavailable)	Artery and vein reanastomosis	Failed

BMI, body mass index; SIEV, superficial inferior epigastric vein; SSM, skin sparing mastectomy; TDA, thoracodorsal artery; TDV, thoracodorsal vein; LTV, lateral thoracic vein; DIEP, deep inferior epigastric artery perforator flap; NSM, nipple sparing mastectomy; LTA, lateral thoracic artery; IMA, internal mammary artery; IMV, internal mammary vein.

of further study. The incidence of fat necrosis in our study (36%) was higher than in previous reports (9.78%–23.4%) [7,8]. However, partial loss of the flaps in the salvaged group was not observed, possibly because all of the cases involved immediate reconstruction, in which most of the skin flap was buried.

The causes of free flap failure have been reported to be related to anastomotic failure due to technical errors, vasospasm, or thrombogenesis [9]. Muscle-sparing TRAM flaps and DIEP flaps were developed to minimize donor site morbidity in comparison with earlier techniques [10,11]. However, the inclusion of only a few large perforators along with the sacrifice of many perforators can interrupt the connection to the superficial venous system, resulting in insufficient venous drainage. Venous congestion has been identified as a major disadvantage of the DIEP flap [12-14]. The majority of the 17 cases of take-back operations in our study involved venous problems, except for one case of arterial insufficiency. This may have been because venous anastomosis is more technically demanding, and veins are more prone to vasospasm and thrombosis. However, the fact that muscle-sparing TRAM flaps and DIEP flaps have the inherent drawback of venous insufficiency is another critical factor. Signs of venous congestion can be recognized during the operation, such as immediately after flap elevation or vessel anastomosis. Rapid refill, dark blood oozing at the flap margin, and an engorged SIEV are clear indicators that venous augmentation with SIEV anastomosis is necessary. However, some cases involve ambiguous signs of venous congestion that can lead surgeons to overlook the seriousness of the state of the flap. The congestion can accumulate and develop into serious flap compromise after completion of the operation. Whatever the cause

Table 2. Comparison of basic and microsurgical factors between the salvaged group and the failed group

Characteristic	Salvaged group (n = 14)	Failed group (n = 3)	P-value[a)]
Age (yr)	40.2	39.3	0.799
BMI (kg/m^2)	23.3	21.3	0.313
Axillary dissection			0.676
No	10 (71.4)	2 (66.7)	
Yes	4 (28.6)	1 (33.3)	
Muscle sparing			0.999
I	3 (21.4)	1 (33.3)	
II	3 (21.4)	0	
III (DIEP)	8 (57.1)	2 (66.7)	
No. of anastomosed vein			0.535
1	11 (78.6)	3 (100.0)	
2	3 (21.4)	0	
Recipient artery			0.222
IMA	8 (57.1)	1 (33.3)	
LTA	0	2 (66.7)	
TDA	6 (42.9)	0	
Recipient vein			0.228
IMV	8 (57.1)	1 (33.3)	
LTV	0	1 (33.3)	
TDV	6 (42.9)	1 (33.3)	
SIEV used in revision procedure			0.124
No	6 (42.9)	3 (100.0)	
Yes	8 (57.1)	0	

BMI, body mass index; DIEP, deep inferior epigastric artery perforator flap; IMA, internal mammary artery; LTA, lateral thoracic artery; TDA, thoracodorsal artery; IMV, internal mammary vein; LTV, lateral thoracic vein; TDV, thoracodorsal vein; SIEV, superficial inferior epigastric vein.
[a)]Fisher's exact test for categorical variables, two-sample t-test for continuous variables.

of the venous congestion, the solution should attempt to re-establish venous outflow. We performed thrombectomy and re-anastomosis of the DIEV in 11 cases and SIEV anastomosis in eight cases. In the other seven cases of venous congestion, we did not use the SIEV because it was unavailable or already irreversibly thrombosed. As the superficial venous system can be the dominant path of venous drainage in abdominal perforator flaps [7,15], the SIEV may play a more important role in the revision operation, and it would be preferable to connect the SIEV independently to alternative recipients. Targets may include the thoracodorsal, external jugular, lateral thoracic, intercostal, cephalic, and thoracoacromial veins, or even the contralateral internal mammary vein [16,17]. In our cases, we used SIEV turbocharging to a branch of the DIEV or supercharging to the thoracodorsal vein, internal mammary vein, or lateral thoracic vein. Preparing the SIEV over the greatest length possible during the primary operation is the best way to cope with the unpredictable occurrence of venous congestion. It is notable that in patients with a Pfannenstiel incision scar, the SIEV is less

Table 3. Comparison of the time intervals for the recognition of signs of flap compromise and the initiation of the revision operation

Time value	Average time (hr)	Standard deviation	Standard error of mean	P-value[a)]
Time from primary operation to signs of compromise (A)				0.023
Salvaged group	16.57	12.09	3.23	
Failed group	3.00	1.00	0.57	
Time from signs of compromise to revision operation (B)				0.032
Salvaged group	4.82	3.46	0.92	
Failed group	29.00	24.06	13.89	

[a)]Wilcoxon rank-sum test.

likely to be the dominant venous drainage, and is often absent [18]. In the current study, while all eight cases with SIEV use were successfully salvaged, we did not prove that the use of the SIEV in the revision operation increased the flap salvage rate. Due to the low incidence of failure and revision in the breast reconstruction patients included in our study, we were only able to review a small number of flap failure cases, which reduced the statistical power of our analysis.

In the present study, we observed that most of the microvascular complications occurred within 24 hours after the first operation, and that the early detection of any signs indicative of microvascular compromise was essential for successfully salvaging a flap. However, in three of the cases of failed flaps, while the microvascular compromise signs were noticed earlier than the salvaged group, the surgical interventions were delayed for much longer. As the signs were not apparent at first, the flap compromise was mistaken for temporary vasospasm, and the decision to perform the take-back operation was not made in a timely manner. The unexpectedly early onset of the signs of vascular compromise might confuse the surgeons and impede the performance of a revision operation, because vasospasm could be one of the causes of early signs of compromise. Based on our observations, we argue that a prompt decision to perform flap revision after detecting the signs of microvascular complications and performing the re-exploration immediately are critical to a successful salvage outcome. Rapid and proper intervention to correct microvascular compromise is as important as the early detection of the signs of a compromised flap.

The re-exploration of microvascular complications in free lower abdominal flap breast reconstruction procedures resulted in a salvage rate of 82% in the current case series. Once the signs of flap compromise are detected, prompt decision-making regarding the take-back operation is likely to increase the success rate of the salvage procedures.

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