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Salvage of Intraoperative Deep Inferior Epigastric Perforator Flap Venous Congestion with Augmentation of Venous Outflow: Flap Morbidity and Review of the Literature

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Background: Breast reconstruction with deep inferior epigastric perforator (DIEP) flaps has gained considerable popularity due to reduced donor-site morbidity. Previous studies have identified the superficial venous system as the dominant outflow to DIEP flaps. DIEP flap venous congestion occurs if superficial venous outflow via the deep venous system is insufficient for effective flap drainage. Although augmentation of venous outflow through a second venous anastomosis may relieve venous congestion, effects on flap morbidity remain ill defined.

Methods: A retrospective analysis of 1616 patients who underwent 2618 DIEP flap breast reconstructions between March 2005 and January 2012 was performed. Patients with intraoperative venous congestion underwent a second venous anastomosis. Preoperative demographic data and methods used to relieve venous congestion were recorded. Incidence of flap morbidity was calculated and compared with a group of 418 controls having 639 DIEP flap breast reconstructions with no venous congestion.

Results: Venous augmentation was required to relieve venous congestion in 87 (3.3%) DIEP flaps on 81 patients. The superficial inferior epigastric vein or accompanying deep inferior epigastric venae comitantes was used to augment venous outflow. Preoperative comorbidities were similar between both groups. Patients requiring a second venous anastomosis had a longer operative time and length of hospital stay. Overall, flap morbidity, delayed wound healing, fat necrosis, and flap loss were similar to controls.

Conclusions: Arterial and venous anatomies play unique roles in flap reliability. DIEP flap venous congestion must be treated expeditiously with venous augmentation to relieve venous congestion and mitigate flap morbidity. *(Plast Reconstr Surg Glob Open 2013;1:e52; doi:10.1097/GOX.0b013e3182aa8736; Published online 18 October 2013.)*

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Abdominal-based reconstruction is considered by many the standard of care in autologous breast reconstruction due to natural-appearing and long-lasting results. The deep inferior epigastric perforator (DIEP) flap has gained considerable popularity due to reduced abdominal morbidity.[1–5] While limiting the number of vascular

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perforators used for DIEP flap elevation has enabled rectus muscle and fascial sparing, it has also generated concerns regarding flap reliability.[2,6,7]

Arterial perfusion of the infraumbilical abdomen has been studied extensively[8–13] since first described by Hartrampf et al.[14] Alternatively, venous anatomy has received less attention but remains a critical component of flap viability. While arterial perfusion to the infraumbilical abdomen is primarily dependent on the deep inferior epigastric system, venous outflow is preferentially channeled through the *superficial* venous system.[15–17] During flap dissection, venous outflow is redirected from the (dominant) superficial venous system to venous perforators of the deep inferior epigastric system through a network of linking veins.[17–19] Because of suboptimal venous outflow through the deep venous system, venous congestion may occur at various stages of flap dissection or after flap transfer. If venous insufficiency is not recognized and addressed expeditiously, venous congestion will lead to increased flap complications and potential flap failure.

The reported incidence of venous congestion in DIEP flaps is 2–8%.[7,18–22] To minimize the incidence of DIEP flap venous congestion, previous investigators have recommended utilization of multiple perforators[23] or inclusion of rectus muscle during flap elevation.[7,19] Once present, DIEP flap venous congestion may be relieved with augmentation of venous outflow through additional venous anastomoses. The purpose of this study is to determine the incidence of flap morbidity following augmentation of venous outflow among intraoperatively congested DIEP flaps and suggest potential alleviating interventions.

METHODS

A retrospective review was conducted after institutional review board approval among 1616 consecutive patients who underwent 2618 DIEP flap breast reconstructions from March 2005 to January 2012 by a single group practice. Flap elevation was conducted in a consistent stepwise manner in all patients. The ipsilateral superficial inferior epigastric vein (SIEV) was preserved and dissected when present, regardless of size, at the caudal edge of the abdominal flap. Identification and skeletonization of perforators was performed under high-powered magnification to prevent inadvertent injury. Focal areas of flap venous congestion were debrided in situ before flap transfer. A single, hand-sewn, arterial and venous anastomosis was routinely performed between the deep inferior epigastric and internal mammary vessels after flap transfer.

Patients with clinically diffuse intraoperative flap venous congestion in situ, or after transfer without primary venous anastomotic complications, underwent an additional venous anastomosis (double vein group). Data regarding patient demographics, medical comorbidities, abdominal surgical history, body mass index (BMI), active tobacco use (≤6 wk before reconstruction), and neoadjuvant therapies were collected preoperatively. Methods used for venous augmentation, flap perforator number, ischemia time, time for reconstruction, and length of hospital stay were recorded. Primary outcomes defined as postoperative flap complications were recorded. A group of consecutive patients undergoing DIEP flap breast reconstruction without venous congestion from January 2006 to March 2008 were selected as controls for comparison.

Associations involving categorical variables were assessed using Pearson's chi-square test or Fisher's exact test, as appropriate. The Kruskal-Wallis test was used to assess associations involving continuously distributed variables. Associations involving flap complications and reconstruction timing were assessed using a logistic model with binary response adjusted for correlations introduced by bilateral reconstructions. Logistic regression was used to identify independent risk factors associated with double vein procedures. A propensity score was derived using a logistic regression model of demonstrated intraoperative venous congestion requiring a second venous anastomosis in terms of medical comorbidities, patient characteristics, flap characteristics, and adjuvant therapy. All flap complication results were adjusted for the propensity score. All statistical analyses were performed using a significance level of 5% and SAS Version 9.3 (SAS Institute, Cary, N.C.).

RESULTS

During the study period, 81 (5.0%) patients undergoing 87 (3.3%) DIEP flaps demonstrated intraoperative venous congestion requiring a second venous anastomosis. Based on the availability of data, 418 consecutive patients undergoing 639 DIEP flaps were designated as controls for comparison. There were no selection biases or exclusions and no decisions to include or exclude patients based on good or bad outcomes, ultimately resulting in 499 patients and 726 flaps for statistical analysis.

The SIEV was used as the source of additional venous outflow in 67.8% of cases. The most frequently used recipient vessel was a second internal mammary vein (57.5%) or a second/third intercostal perforating vein (27.6%) (Table 1). Interposition vein grafts were required in 15 (17.2%) cases.

Table 1. Double Vein Group Procedures

Variable	*N*	%
Double vein group	87	3.3
Second vein donor		
SIEV	59	67.8
DIEVC	28	32.2
Second vein recipient		
IMV	50	57.5
IC	24	27.6
DIEVC	6	6.9
LSTV	5	5.7
TD	2	2.3
Vein graft	15	17.2

DIEVC, deep inferior epigastric venae comitantes; IC, intercostal perforating vein; IMV, internal mammary vein; LSTV, lateral superficial thoracic vein; TD, thoracodorsal vein.

The mean age of patients requiring a second venous anastomosis was 51.5 years (range, 32–72 y). The mean age of the control group was similar (P = 0.37) at 50.4 years (range, 24–74 y). Average BMI was 29.1 in the double vein group compared with 28.3 in the control group (P = 0.32). A trend toward a lower mean number of abdominal surgeries was seen in the double vein group (1.0) compared with controls (1.3) (P = 0.09) (Table 2). Individual medical comorbidities were similar between both groups (Table 3).

Distribution of patients in relation to BMI was similar (P = 0.27) for both study groups. The most prevalent subset of patients in both the double vein and control groups was classified as overweight (BMI, 25–29.9). The majority of remaining patients in both study groups had a BMI ≥ 30, with normal weight (BMI ≤ 24.9) patients representing less than one quarter of the total population of each study group (Table 4).

Administration of neoadjuvant chemotherapy or radiation was equivalent in both study groups. Patients in the double vein group underwent a higher proportion of delayed reconstructions (35.6%) compared with control group patients (22.5%) (P = 0.05). The proportion of unilateral versus bilateral reconstructions (47.1 vs 52.9%) was nearly equal in the control group population. By contrast, patients requiring a second venous anastomosis underwent a significantly (P = 0.004) higher rate of bilateral (70.4%) versus unilateral (29.6%) reconstructions compared with controls (Table 5).

Flap ischemia time was nearly identical for both groups. Number of perforators dissected during flap elevation was greater for both left-sided (P = 0.07) and right-sided (P < 0.05) flaps in the double vein group compared with controls (Table 6).

Operative times were longer for patients requiring a second venous anastomosis compared with control patients overall (P < 0.01) and when unilateral (314 vs 253 min) and bilateral (434 vs 413 min) reconstructions were considered separately (Table 7). When patients in the double vein group were further subdivided into those with or without vein grafts, a similar correlation was maintained compared with controls (Fig. 1). Mean length of stay was significantly (P < 0.01) different between all groups. For control patients, mean length of stay was 4.0 days. Double vein patients without vein grafts had a mean length of stay of 4.7 days, whereas the longest length of hospital stay (6.6 d) was reported in patients requiring vein grafts (Fig. 2).

Comparison of flap morbidity between the double vein and control groups demonstrated similar (21.8 vs 23.8%, P = 0.37) overall flap complications. Soft-tissue infection was more commonly reported in the control group (5.4%) compared with patients requiring a second venous anastomosis (1.2%). All other individual flap complications, including fat

Table 2. Mean Preoperative Characteristics of 499 DIEP Patients

Variable, Mean (SD)	Double Vein (*N* = 81)	Control (*N* = 418)	*P*
Age	51.5 (9.3)	50.4 (9.1)	0.37
BMI	29.1 (5.8)	28.3 (4.9)	0.32
Abdominal surgery			
Laparoscopic	0.4 (0.6)	0.5 (0.6)	0.3
Open	0.7 (0.9)	0.9 (1.1)	0.28
Total	1 (1.1)	1.3 (1.3)	0.09

Table 3. Prevalence of Medical Comorbidities in 499 DIEP Patients

Variable	Double Vein (%) (*N* = 81)	Control (%) (*N* = 418)	*P*
Hypertension	25.9	25.8	1
Diabetes mellitus	9.9	5.0	0.11
Cardiac disease	2.5	6.7	0.2
Pulmonary disease	2.5	4.5	0.55
Peripheral vascular disease	0.0	0.2	1
Autoimmune disease	2.5	5.5	0.4
Coagulopathy	3.7	2.6	0.48
Tobacco	4.9	8.1	0.49

Table 4. Distribution of Body Mass Index in 499 DIEP Patients

Variable	Double Vein (%) (*N* = 81)	Control (%) (*N* = 418)	*P*
Body mass index			0.27
Normal (≤24.9)	23.5	23.9	
Overweight (25–29.9)	34.6	36.6	
Obese (30–34.9)	21	27	
Severely obese (35–39.9)	17.3	10.8	
Morbidly obese (≥40)	3.7	1.7	

Table 5. Laterality, Timing, and Adjuvant Therapy

Variable	Double Vein (%)	Control (%)	*P*
Reconstruction*			0.004
Unilateral	29.6	47.1	
Bilateral	70.4	52.9	
Timing of reconstruction†			0.05
Immediate	64.4	77.5	
Delayed	35.6	22.5	
Neoadjuvant therapy*			
Radiation	27.2	28.4	0.82
Chemotherapy	38.3	41.6	0.57

*In 499 DIEP patients (81 double vein and 418 control).
†In 726 DIEP flaps (87 double vein and 639 control).

Table 6. Mean Flap Ischemia Time and Perforator Number in 499 DIEP Patients

Variable, Mean (SD)	Double Vein (*N* = 81)	Control (*N* = 418)	*P*
Flap ischemia, min			
Right	24 (5.3)	23.6 (5.2)	0.48
Left	22.7 (4.5)	22.7 (5.4)	0.58
No. perforators			
Right	2.3 (0.9)	2 (0.8)	0.02
Left	2.2 (1)	1.9 (0.8)	0.07

Table 7. Mean Reconstruction Time in Minutes in 499 DIEP Patients

Variable, Mean	Double Vein (*N* = 81)	Control (*N* = 418)	*P*
Reconstruction, min			
Unilateral	314	253	<0.01
Bilateral	434	413	<0.01
Total	413	339	<0.01

necrosis and flap failure, were similar between both groups (Table 8).

In a multivariate logistic regression model, flaps based on a greater number of perforators were significantly ($P < 0.01$) associated with an *increased* risk of venous congestion requiring a second venous anastomosis. On the other hand, previous abdominal surgery was significantly ($P = 0.03$) associated with a *decreased* risk of requiring a second venous anastomosis. No other recorded variables were found to be independent risk factors for DIEP flap venous congestion including BMI (Table 9).

DISCUSSION

Background

Promoted by landmark studies by Hartrampft et al[14] and Holm et al,[9] perfusion to the infraumbilical abdomen has received considerable interest in an attempt to improve abdominal flap reliability. A more thorough understanding of the abdominal wall microcirculation has facilitated the evolution of abdominal-based reconstruction from myocutaneous (ie, transverse rectus abdominis myocutaneous) to perforator (ie, DIEP) flaps. With elimination of muscle harvest, DIEP flaps rely solely on a limited number of vascular perforators for perfusion and venous outflow. Recent studies have further delineated unique flap perfusion characteristics based on perforators from the medial or lateral branches of the deep inferior epigastric vessels.[11,12] In addition to perforator location, perforator caliber may also represent a significant determinant of flap perfusion and secondarily venous outflow.[13] Although perfusion via small (<5 mm) perforators is limited to the subscarpal adipose layer, large arterial perforators (>5 mm) have a direct course into the subdermal plexus optimizing flap perfusion. Moreover, some large perforators (>5 mm) are associated with venae comitantes draining the subdermal plexus,[13] making selection of perforators critical not only for flap perfusion but also for venous outflow.

The venous anatomy of the infraumbilical abdominal wall contains unique characteristics of critical importance for successful DIEP flap elevation. For instance, while the dominant arterial source of the infraumbilical abdominal wall is the *deep* inferior epigastric artery, venous drainage is preferentially channeled through the *superficial* venous system.[15–17] The superficial and deep venous systems are, in turn, joined by a variable number[16] of valve-less linking veins that allow redirection of venous outflow into the deep venous system if superficial channels are disrupted such as during flap dissection. Communication between the superficial and deep venous systems via linking veins thus becomes a critical component of adequate venous drainage and contributes to a full spectrum of venous outflow ranging in varying degrees from superficial to deep venous dominance.[24]

Venous Congestion and Outflow Augmentation

Diffuse flap venous congestion is ultimately a result of insufficient superficial venous outflow via the deep venous system (Fig. 3). It may arise subtly in the form of brisk capillary refill, cutaneous discoloration that improves promptly with release of venous blood through the SIEV, or predominant venous bleeding with peripheral flap incisions. The specific etiology may include an intrinsic underdevelopment of veins linking the superficial and deep venous systems, inadequate perforator selection, or suboptimal deep venous drainage through a single venous anastomosis. In our clinical experience, the temporal relationship between venous congestion occurrence and stage of flap dissection and transfer may suggest an etiology and guide treatment options. An algorithm

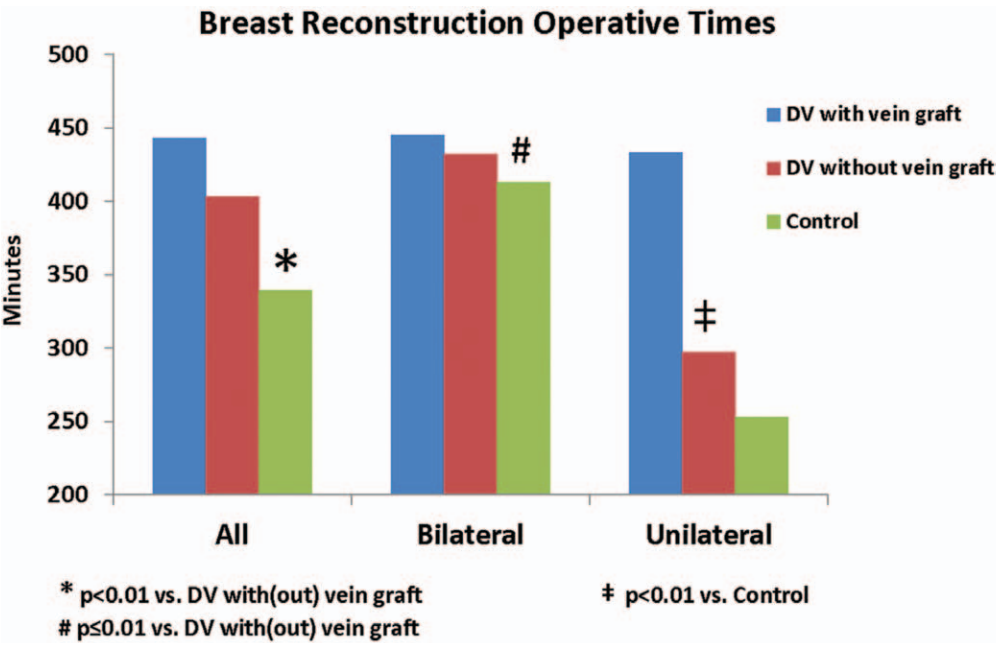

Fig. 1. Reconstruction time among patients undergoing a second venous anastomosis with and without the use of vein grafts compared with control patients. Patients in the control group had significantly (P < 0.01) shorter operative times for all and bilateral and reconstructions compared with double vein patients with or without vein grafts. Patients requiring a second venous anastomosis without a vein graft undergoing unilateral reconstruction had significantly (P < 0.01) longer operative times compared with controls.

is proposed outlining a stepwise approach for flap dissection facilitating diagnosis of flap congestion and suggested treatment options (Fig. 4).

In our experience, proper perforator selection is a crucial component of prevention of venous congestion. Perforators should be selected based on the

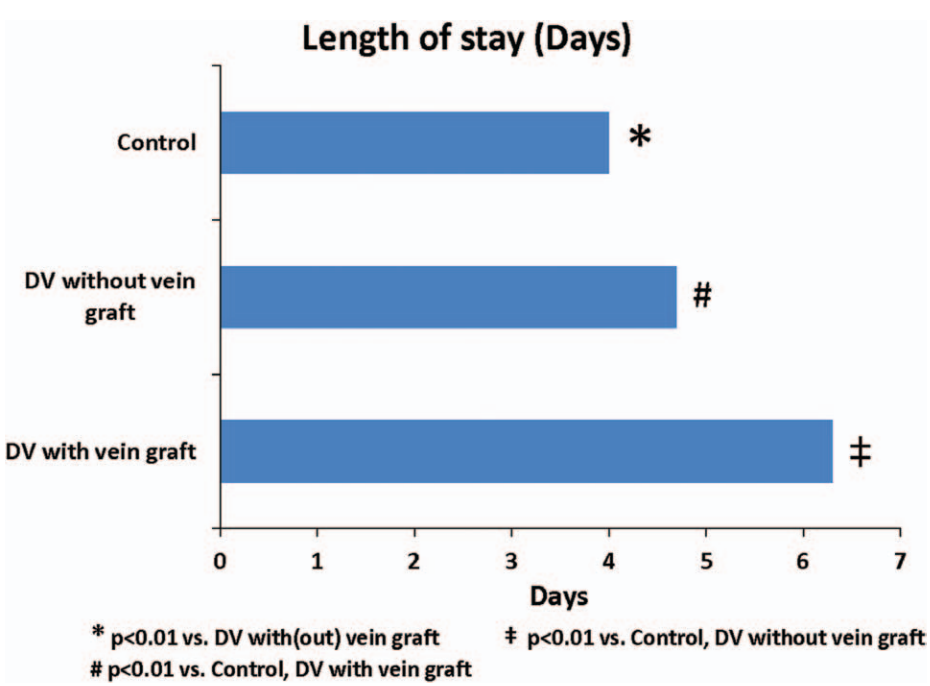

Fig. 2. Mean length of hospital stay among patients undergoing a double vein (DV) procedure with and without the use of vein grafts compared with control patients. Mean length of stay significantly differed (P < 0.01) between all groups.

Table 8. Incidence of Flap Morbidity in 729 DIEP Flaps

Variable	Double Vein (%) (*N* = 87)	Control (%) (*N* = 639)	*P* *
Infection	1.2	5.4	0.02
Hematoma	1.2	1.9	0.6
Seroma	0	0.8	NA
Fat necrosis	12.8	10.4	0.53
Delayed wound healing	10.5	6.3	0.62
Vessel thrombosis	0	0.6	NA
Flap failure	0	1	NA
Total	21.8	23.8	0.37

*Adjusted for propensity score.
NA, not available.

Table 9. Independent Risk Factors for Requiring a Second Venous Anastomosis among 726 DIEP Flaps

Variable	Odds Ratio	95% CI	*P*
Number of perforators	1.46	1.17–1.83	0.004
Previous abdominal surgery	0.8	0.66–0.99	0.03
Body mass index	1.04	0.99–1.10	0.14

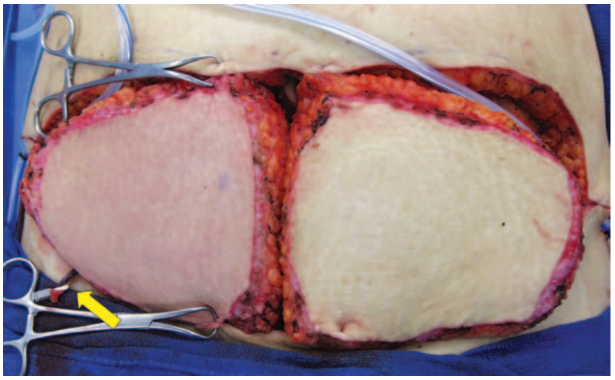

Fig. 3. Intraoperative appearance of congested right hemiabdominal DIEP flap with deep inferior epigastric pedicle in continuity. Right SIEV dissected and temporarily occluded with temporary vascular clamp (yellow arrow).

quality (caliber, palpable pulse, and venous component) as opposed to the absolute number. Schaverien et al[20] demonstrated the critical relationship between linking vein anatomy and venous congestion. In a retrospective study of 54 DIEP flaps with preoperative MRI, 7 flaps developed diffuse venous congestion. None of the congested DIEP flaps demonstrated direct connections between the perforator used for flap elevation and the superficial venous system, while 46 out of the 47 noncongested flaps demonstrated direct connections between the deep and superficial venous system by MRI. To optimize drainage of the superficial venous system through deep perforators, some authors[19] have recommended increasing the number of perforators or conversion of a DIEP to a free TRAM flap if venous perforators are of small caliber or inadequate for flap drainage. By including a greater number of perforators when diameter is less than 1.5 mm, similar rates of venous congestion, fat necrosis, and flap loss have been reported among DIEP and muscle-sparing TRAM flaps.[23]

If congestion is recognized, prompt intervention with augmentation of venous outflow is required. Various effective techniques to augment venous outflow have previously been described (Table 10). In the current study, patients underwent venous augmentation through anastomosis of the ipsilateral SIEV or second deep inferior epigastric venae comitantes to increase venous outflow (Fig. 5). As outlined in the proposed algorithm (Fig. 4), use of the second deep inferior epigastric venae comitantes for venous augmentation is effective only in a subset of flaps that exhibit persistent venous congestion only after primary anastomosis. In these flaps, the deep venous system is sufficient for venous drainage based on the cumulative cross-sectional area[38] of both patent deep venae comitantes in situ before flap transfer. After flap transfer and anastomosis, the cross-sectional area of a single deep venous anastomosis is insufficient for adequate flap drainage. Cutaneous venous congestion in these flaps is a result of transduced venous hypertension from the deep to superficial system through valve-less linking veins within a flap. Through a second deep venous anastomosis, venous outflow is significantly increased[27] effectively off-loading both deep and superficial systems alleviating venous congestion.

Patient Characteristics

Age, BMI, preoperative medical comorbidities, tobacco history, surgical history, and neoadjuvant therapies were similar between both groups. Patients in the double vein group underwent a higher proportion of bilateral reconstructions negating the possible effect of extended unilateral flaps on venous congestion.[19] Not surprisingly, patients requiring additional venous outflow procedures had a longer operative time than control patients even when those who required vein grafts were separated. A longer operative time associated with double vein patients was not only due to additional time required for identification and isolation of a recipient vein and time for an additional venous anastomosis but also due to dissection of a greater number of perforators during flap elevation. Compared with the control group, double vein patients had DIEP flaps based on a greater number of perforators. A higher perforator number was, therefore, not preventative of venous congestion in this study. Similar findings have been reported pre-

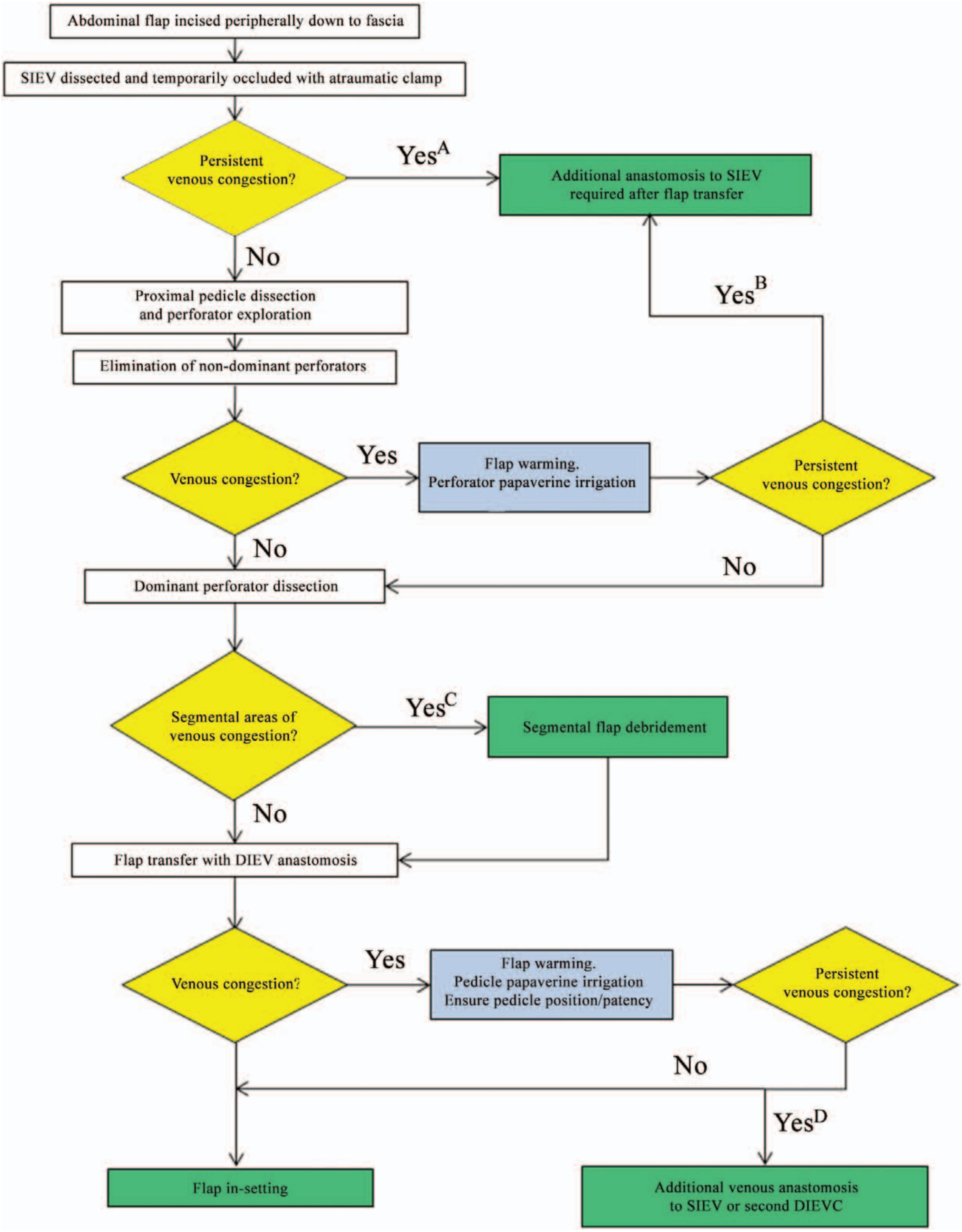

Fig. 4. Stepwise approach for DIEP flap elevation. Venous congestion may occur at various points during dissection suggesting a likely etiology and effective interventions. (A) Type 1 venous congestion—Intrinsic malformation of linking vein network where superficial and deep venous systems are discontinuous. (B) Type 2 venous congestion—Improper perforator selection. (C) Type 3 venous congestion—Focal areas of flap venous congestion. (D) Type 4 venous congestion—Incomplete venous outflow through a patent single deep venous anastomosis.

Table 10. Techniques for Venous Drainage of Abdominal-based Flaps

Author	Technique	Journal
Barnett et al[25]	SIEV to cephalic vein as outflow channel	*PRS*, 1996
Blondeel et al[19]	Interposition vein grafts between SIEV and IMV	*PRS*, 2000
Wechselberger et al[18]	SIEV to thoracodorsal, lateral thoracic vein, IC	*PRS*, 2001
Niranjan et al[26]	Contralateral SIEV to cephalic vein (using vein graft)	*BJPS*, 2001
Tutor et al[27]	DIEV comitantes to IC	*J Reconstr Microsurg*, 2002
Mehrara et al[28]	DIEV to external jugular or cephalic vein	*PRS*, 2003
Rohde and Keller[29]	SIEV to proximal cut end of second DIEV venae comitantes	*Ann Plast Surg*, 2005
Cohn and Walton[30]	SIEV to thoracodorsal vein as outflow	*J Reconstr Microsurg*, 2006
Liu et al[31]	SIEV to DIEV venae comitantes	*Ann Plast Surg*, 2007
Guzzetti and Thione[32]	SIEV to basilic vein as outflow	*Microsurgery*, 2008
Shamsian et al[33]	SIEV to DIEV end-to-end anastomosis (reverse flow)	*PRS*, 2008
Stasch et al[34]	Venesection of superficial epigastric vein	*Ann Plast Surg*, 2009
Kerr-Valentic et al[35]	Use of retrograde IMV for outflow	*PRS*, 2009
Enajat et al[21]	SIEV to cephalic vein for outflow	*Microsurgery*, 2010
Cheng and Nguyen[24]	SIEV to DIEV comitantes in end-to-end or end-to-side anastomosis	*Microsurgery*, 2010
Sojitra et al[36]	Contralateral SIEV to proximal DIEV or SIEV to branch from DIEV	*PRS*, 2010
Eom et al[22]	SIEV to lateral thoracic, thoracoacromial, IC	*Ann Plast Surg*, 2011
Sbitany et al[37]	SIEV to proximal cut end of second DIEV venae comitantes	*PRS*, 2012

IC, intercostal perforating vein; IMV, internal mammary vein.

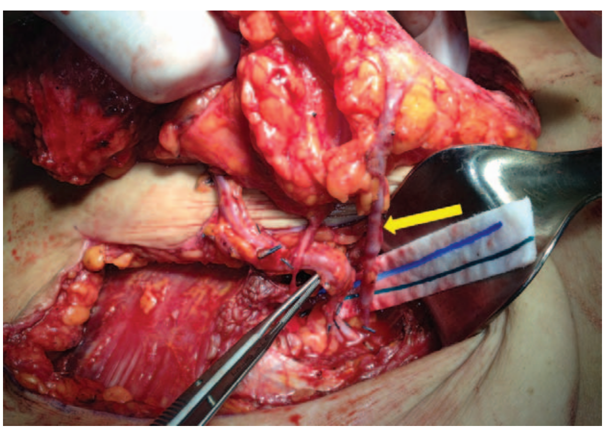

Fig. 5. Deep inferior epigastric perforator flap anastomosis. Primary DIEP flap anastomosis to the internal mammary artery and lateral IMV (elevated by Gerald forceps). Second venous anastomosis from the SIEV to the medial IMV (yellow arrow).

viously,[7,20] where the number of perforators was unrelated to the development of venous congestion. Moreover, logistic regression analysis identified a positive correlation between a greater number of perforators and development of intraoperative venous congestion requiring a second venous anastomosis. The explanation behind this correlation is that flaps without a dominant perforator(s) required a greater number of lesser quality perforators included with the dissection. Although the cumulative effect of a greater number of lesser quality perforators was able to provide sufficient inflow, venous outflow was suboptimal due to the small venous component within those perforators. Longer hospital stays among patients in the double vein group is attributed to an extended course of postoperative anticoagulation routinely used in this patient population.

An inverse correlation was identified between previous abdominal surgery and venous congestion requiring an additional venous anastomosis. The etiology behind this finding is unclear. However, based on the principle of superficial to deep venous system shunting through linking veins, we speculate that patients who have undergone previous abdominal surgery are more likely to have disturbed the natural venous drainage of the superficial venous system through incisions on the abdominal wall promoting gradual conditioning of venous outflow through the deep venous system. In the current study, no other variables were correlated with the development of DIEP flap venous congestion requiring an additional venous anastomosis including patient BMI.

Flap Morbidity

Intraoperative DIEP flap venous congestion was identified in 87 (3.3%) flaps performed in the current study. Incidence of venous congestion in DIEP flaps reported in the literature range between 2% and 8%,[7,18–22] with one study reporting rates as high as 15%.[39] Augmentation of venous outflow was necessary to relieve venous congestion to minimize flap morbidity and almost assured flap loss.

Expansion of venous stasis caused by venous congestion increases interstitial edema reducing the caliber of oscillating linking veins.[18] This, in turn, exacerbates the disconnection between the superficial and deep venous systems causing a disturbance in local microcirculation and tissue ischemia, which may proceed to complete flap loss. In a study by Ali et al,[40] congested DIEP flaps that underwent no additional surgical intervention (observation) and those treated with additional venous outflow procedures at take-back (postoperative salvage) had rates of total flap loss of 9.1% and 14.3%, respectively. By contrast, no flap losses were reported in noncongested (normal) flaps or flaps that underwent additional venous outflow procedures initially (intraoperative salvage). Similarly, no flap losses or vessel thromboses requiring reoperation were reported in the current study among patients undergoing venous outflow augmentation.

The results of the current study suggest that early recognition of venous congestion and intervention is crucial in minimizing flap morbidity. Initially, compromised DIEP flaps were restored or salvaged to normal conditions with augmentation of venous outflow; overall flap morbidity was similar compared with our control group and previous studies.[41–43] Regarding rates of individual flap complications, reported rates of fat necrosis following DIEP flap reconstruction have ranged between 1.8% and 29%.[2,6,17,41–47] Moreover, impaired venous outflow has been associated with increased rates of fat necrosis in DIEP flaps.[2] In the current study, clinical fat necrosis was mitigated to 12.8% by using a second venous anastomosis. If salvage venous outflow procedures are delayed, a 4-fold increase in fat necrosis has been reported compared with intraoperative salvage.[40] With the exception of soft-tissue infection, all remaining individual flap complications were reduced by venous outflow augmentation to rates equivalent to controls.

CONCLUSIONS

DIEP flaps have proven to be a valuable option for autologous breast reconstruction with limited donor-site morbidity. The arterial and venous anatomies of the anterior abdominal wall play unique roles in flap reliability. Successful DIEP flap elevation is based not only on adequate arterial inflow but also on sufficient venous outflow. Venous outflow insufficiency may result from multiple etiologies along the venous outflow pathway. Once recognized, effective treatment of venous congestion is based on the inciting etiology. Venous outflow augmentation with an additional venous anastomosis is effective in salvaging compromised DIEP flaps.

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