THE IMPORTANCE OF THE SUPERFICIAL VENOUS ANATOMY OF THE ABDOMINAL WALL IN PLANNING A SUPERFICIAL INFERIOR EPIGASTRIC ARTERY (SIEA) FLAP: CASE REPORT AND CLINICAL STUDY

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The importance of the venous drainage of the anterior abdominal wall to free tissue transfer in deep inferior epigastric artery perforator flap surgery has been highlighted in several recent publications in this journal, however the same attention has not been given to superficial inferior epigastric artery (SIEA) flaps, in which the flap necessarily relies on the superficial venous drainage. We describe a unique case, in which the presence of two superficial inferior epigastric veins (SIEVs) draining into separate venous trunks was identified. The use of only one trunk led to a well-demarcated zone of venous congestion. A clinical study was also conducted, assessing 200 hemiabdominal walls with preoperative computed tomographic angiography imaging. The presence of more than a single major SIEV trunk was present in 80 hemiabdominal walls (40% of overall sides). There was considerable variability in the source of drainage of the SIEV, draining variably into the deep inferior epigastric vein, the great saphenous vein, the saphenous bulb, a common trunk with the superficial circumflex iliac vein or a common trunk with a second branch of the SIEV. These findings highlight the considerable variation in the number of SIEV trunks as well as their source of regional drainage, and show the importance of consideration of such variation. © 2011 Wiley-Liss, Inc. Microsurgery 31:454–457, 2011.

The importance of the venous drainage of the anterior abdominal wall to free tissue transfer in deep inferior epigastric artery perforator (DIEP) flap surgery has been highlighted in several recent publications in this journal.[1–3] This has mirrored previous clinical, imaging and anatomical studies that have also highlighted this anatomy as paramount to success in DIEP flap surgery, with venous problems the more frequently encountered vascular complications seen.[4–9] To this end, many authors have sought to augment or supercharge the venous drainage of congested or compromised DIEP flaps through the use of additional venae comitantes of the ipsilateral deep inferior epigastric artery (DIEA),[10,11] the venae comitantes of the contralateral DIEA,[12] through the ipsilateral superficial inferior epigastric vein (SIEV)[5,13,14] and the contralateral SIEV.[15] Although the DIEA is the predominant arterial supply to the anterior abdominal wall, the frequency of venous problems highlights the preferential superficial venous drainage of the same tissue through the SIEV, which has been confirmed in several anatomical studies.[4,6–8]

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Although the importance of assessing the venous anatomy in planning DIEP flap harvest has been highlighted, the same attention has not been given to superficial inferior epigastric artery (SIEA) flaps, in which the flap necessarily relies on the superficial venous drainage. Although the flap is ‘optimally’ drained through the SIEV, venous problems may still occur and we describe a unique case to highlight this fact, in which the presence of two SIEVs draining into separate venous trunks was identified. Although venous anatomy is known to be variable, this variant of normal anatomy has not been described previously, with clinical implications clearly warranting a review. We thus conducted a clinical study reviewing 200 hemiabdominal walls using angiographic imaging.

CASE REPORT

A 40-year-old woman with left breast cancer was planned for an immediate breast reconstruction with an abdominal wall free flap. She was previously well, with no previous surgical or medical history, was a non-smoker and had a body mass index (BMI) of 27. She underwent a preoperative computed tomographic angiogram (CTA) to assess the vasculature of the anterior abdominal wall for flap planning. As shown in Figure 1, there was found to be a paucity of DIEA perforators, and rather dominant SIEAs bilaterally were identified. Large SIEVs were also seen adjacent to the SIEAs, which were considered suitable for donor venous drainage. The differentiation between the superficial arterial and venous systems was based upon careful three-dimensional, multiplanar analysis of the CTA, rather than a single image (as seen in Fig. 1),

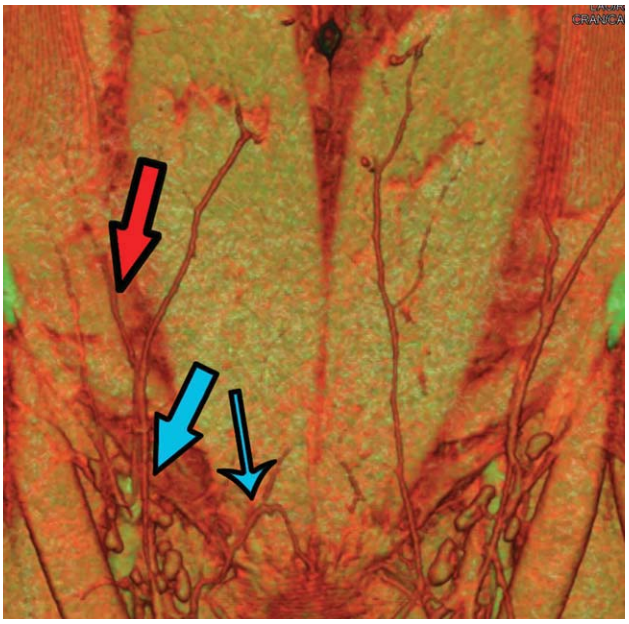

Figure 1. Computed tomographic angiogram of the anterior abdominal wall, with a dominant superficial inferior epigastric artery (SIEA; red arrow) highlighted, and the presence of both a medial superficial inferior epigastric vein (SIEV; thin blue arrow) and a lateral SIEV (thick blue arrow). The differentiation between the superficial arterial and venous systems was based upon careful three-dimensional, multiplanar analysis of the CTA, rather than a single image, tracing the vessels to their origins and destinations. This anatomical variant in which there are two separate SIEVs is present in 40% of hemiabdominal walls. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

tracing the vessels to their origins and destinations. As was our routine practise (and as described in the broader literature to date), the scan was carefully analysed in terms of arterial vasculature, whereas the venous anatomy was analysed only in terms of its presence and location. The branching pattern of the SIEV was not primarily considered in the process of flap planning.

As such, the patient underwent an abdominal wall flap based on the right SIEA. The right hemiabdominal flap (to the midline) was raised on the right SIEA and SIEV. The SIEA (2.2 mm at its origin) and SIEV (2.5 mm) were anastomosed to the internal mammary artery and vein, with relatively good size match (2.9 mm and 3.0 mm, respectively). The anastomoses were both sutured with interrupted nylon sutures, and there was good pedicle flow upon removal of the clamps.

Although perfusion was good throughout the length of the operation, relative venous congestion to half the flap was noted progressively throughout the early postoperative period. Of particular note was the clear demarcation of the congestion to half the flap only (see Fig. 2). The lack of global venous congestion highlighted that this was not a pedicle problem, but rather a territorial issue related to relative venous congestion. Rather than warranting immediate exploration, this suggested an expectant approach. Although consideration of re-exploration was certainly given, we reviewed the patient's preoperative CTA to explore any potential reasons for the area of venous compromise. Retrospective review of her CTA highlighted an interesting feature of her SIEV—there were two separate SIEV trunks on the right side, with only one (the lateral trunk) used to drain the flap (see Fig. 1). Although clear that an additional venous anastomosis of the medial trunk is what would have been required in this case, this trunk was not prophylactically dissected for any substantial length, and thus was not a clinical option. This understanding of the cause of the congestion contributed to the decision for expectant management. Over the course of the postoperative period, the congestion gradually improved and ultimately a small area of fat necrosis was treated conservatively, with no reoperation performed.

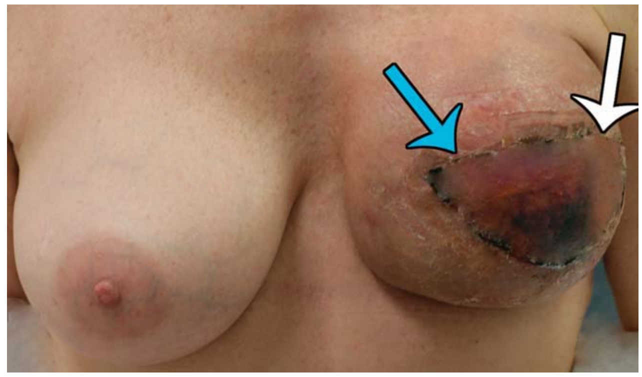

Figure 2. Postoperative photograph following left breast reconstruction with a superficial inferior epigastric artery (SIEA) flap and the lateral superficial inferior epigastric vein (SIEV) shown in Figure 1. The medial half of the reconstructed breast (that drained by the medial SIEV) showed venous congestion postoperatively (blue arrow), whereas the lateral half of the flap did not (white arrow). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

CLINICAL STUDY

Patients and Methods

A retrospective review of 100 computed tomographic angiograms (CTAs) perforator for preoperative vascular mapping of the abdominal wall vasculature (200 hemiabdominal walls) was undertaken. Patients were recruited at a single institution, with institutional ethics approval, and no patients were excluded from the study. Patients were all female, were of a range of body habitus types (mean BMI 28, range 23–32), were between 35 and 68 years of age and had no comorbidities to affect their suitability for free flap surgery or autologous tissue transfer. None of the patients were current smokers, with 25 having ceased smoking greater than 6 months preoperatively. All patients were planned for SIEA or DIEP flap surgery. All imaging was performed at a single institution, using a 64 slice multidetector row CT scanner (Siemens Medical Solutions, Erlangen, Germany), with 100 ml of intravenous contrast (Omnipaque 350; Amersham Health, Princeton,). CTA images were reformatted into maximum intensity projection (MIP) and three-dimensional volume rendered technique images using commercially available software (Siemens Syngo InSpace; Version: InSpace2004A_PRE_19, Pennsylvania). The number of SIEV trunks, their course and drainage route were all recorded.

Results

The superficial veins of the anterolateral abdominal wall were clearly evident and visualized with diagnostic accuracy in all 100 cases. Of the 200 hemiabdominal walls, the presence of a medial trunk of the SIEV was a frequent occurrence, present in 88% of cases (see Table 1). Of these cases, the medial trunk was variably present as a separate SIEV trunk with no common trunk (80 hemiabdominal walls, 40% of overall cases), or joined the lateral SIEV trunk to form a common SIEV (96 cases, 48% of overall cases).

There was considerable variability in the source of drainage of the SIEV (see Table 1), with the majority of SIEV trunks draining directly into the superficial femoral vein (42%), and other routes including a common trunk with the superficial circumflex iliac vein (SCIV) (21%), the long saphenous vein (7%), the saphenous bulb (23%), the deep inferior epigastric vein (DIEV) (6%), and the superficial external pudendal vein (1%). As mentioned, an SIEV trunk was found to drain into (or join a common trunk with) a second branch of the SIEV in 88% of cases.

DISCUSSION

This study has identified several important features of the anatomy of the SIEV that can have profound implications for the raising of an SIEA flap, which relies on the SIEV for venous drainage. First, there is frequently considerable variation in the number of SIEV trunks, with the importance of utilizing both SIEVs for cases in which superficial venous drainage alone is relied upon highlighted in the case report. Furthermore, there is substantial variation in their source of regional drainage, with implications in planning the harvest of one or more SIEV trunks.

Although this particular information has not been explored sufficiently in previous anatomical studies, other important factors in assessing the venous anatomy of the anterior abdominal wall have been identified and explored, largely with a particular focus on implications for DIEP flap harvest. These have included the size of arterial perforators (and their concomitant veins), communication with veins of each side of the abdominal wall is also essential, the presence of midline crossover of the SIEV, and the presence and size of "communicating (oscillating) veins" between the deep and superficial venous systems.[5,7,8] One of the larger studies of the SIEV, that by Schaverien et al. (2008),[8] focused on the interplay between the SIEV and DIEV perforators, and showed that it was infrequent that direct midline crossover between hemi-abdominal SIEVs occurred. Although the presence or incidence of SIEV branches was not explored in that study, it is interesting to note the lack of true communication between SIEV trunks of contralateral hemiabdominal walls as well as separate trunks within the same hemi-abdominal wall, as investigated in the current study. We have shown, for the first time, that separate SIEV trunks have distinct radiological and clinical territories, and that all separate trunks should be utilized to maximize venous drainage.

Each of these features plays an important role in the physiology of flap drainage. In terms of perforator size, the lack of adequate perforating veins have been postulated in clinical studies,[6] and shown in experimental,[16,17] and clinical studies,[13] to be true. The degree of midline crossover by the SIEV has been shown to contribute to venous compromise, with communication of veins across sides of the abdominal wall essential: Blondeel et al. (2000) found a lack of midline crossover by the SIEV in 36% of specimens, whereas Schaverien et al. (2008) identified a case without midline crossover.[5,8] A further anatomical feature contributing to venous problems has been postulated as the communications between perforating veins and the SIEV, known as oscillating veins between the adjacent venous territories.[18] In our previous clinical and anatomical studies assessing the venous anatomy of the abdominal wall, we identified that an SIEV greater than 1.5 mm in diameter suggests dominance of the superficial system, a perforating vein greater than 1 mm in diameter suggests dominance of the deep venous system,

Table 1. Branching and Drainage Route of the Superficial Inferior Epigastric Vein as Recorded From Preoperative Imaging with Computed Tomographic Angiography

	Percentage of cases (%)
Medial SIEV trunk present	88
Arising from common SIEV trunk	48 overall
Arising as a separate SIEV trunk	40 overall
Destination of SIEV drainage	
Superficial femoral vein (SFV)	42
Long saphenous vein	7
Saphenous bulb	23
Deep inferior epigastric vein	6
Superficial circumflex iliac vein	21
Superficial external pudendal vein	1

and a communicating (oscillating) vein of greater than 0.5 mm suggests adequate drainage across these systems.[19] This is further compounded in the setting of anatomical variations in the abdominal wall vasculature, with the anatomical variant of a "perforating" SIEV described in 3.4% of cases, in which the SIEV perforates the rectus abdominis muscle as a very large (>3mm) musculocutaneous perforator to drain into the DIEV.[20]

We have shown, through both our case example and clinical study, that prophylactic dissection of both SIEV trunks, where such anatomy exists, is essential to maximize venous drainage of the flap. We suggest several key approaches to SIEV harvest: first, the use of preoperative imaging can identify the number of SIEV trunks as well as the SCIV trunks (which also drain the lower abdominal integument); second, we suggest intraoperative dissection of each venous pedicle to a sufficient length for anastomosis if required; third, we suggest that where two SIEV branches arise from different trunks altogether (as occurred in 40% of cases in our anatomical study), both trunks be used for venous drainage (i.e., two sources of venous drainage). The role of the SIEV in venous drainage for the DIEP flap (and the selection between an SIEA or a DIEP flap), has been extensively explored elsewhere, and is outside the scope of the current study.[1,21]

Although most cases of substantial venous congestion, such as was seen in our case example, warrant immediate re-exploration, an understanding of the venous anatomy of a particular flap through preoperative imaging can achieve several things: it can help to select cases for expectant management in the case of venous congestion, it can preface the dominance of a particular vein or venous system, and it can offer means for venous augmentation. It should of course be noted, that where an expectant approach is taken, close observation and diligence for any progression in venous congestion need be given, with a view to "diagnostic" exploration.

CONCLUSIONS

There is considerable variation in the superficial venous anatomy of the anterior abdominal wall, with several anatomical features that can have profound implications for success in SIEA flap transfer. The number of SIEV trunks as well as their source of regional drainage is highly variable, and adequate preoperative awareness of this variability may aid operative decision making.

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