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### Paper:

Rozen, W., Whitaker, I., Chubb, D. & Ashton, M. (2010). Perforator Number Predicts Fat Necrosis in a Prospective Analysis of Breast Reconstruction with Free TRAM, DIEP, and SIEA Flaps. *Plastic and Reconstructive Surgery*, 126 (6), 2286-2288.

<http://dx.doi.org/10.1097/PRS.0b013e3181f61c04>

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(interperforator flow) occurs by means of direct and indirect linking vessels,<sup>1</sup> and is dictated by multiple factors such as perfusion pressure, perforator size, vascular resistance, and number and caliber of direct/indirect linking vessels. I agree with Drs. Hallock and Rozen that perfusion decreases with each additional perforasome recruited. Recruitment of two or more adjacent perforasomes is possible but carries a higher risk of venous congestion and arterial ischemia. This explains why there can be variations in perforator flap perfusion and why careful clinical assessment always remains important (Figs. 3 and 4).

#### DIEP Flap Zones of Perfusion

##### A. Medial row DIEP

II, I, II: very reliable

III\*, II, I: very reliable

III\*, II, I, II: reliable

III\*, II, I, II, III: variable

III\*, II, I, II, III, IV: variable

\*Third or half of zone III.

##### B. Lateral row DIEP

II, I, II: very reliable

II, I, II, III: variable

II, I, II, III, IV: less reliable

II, I, II, III, IV, V: much less reliable

DOI: 10.1097/PRS.0b013e3181fb7bad

**Michel Saint-Cyr, M.D.**

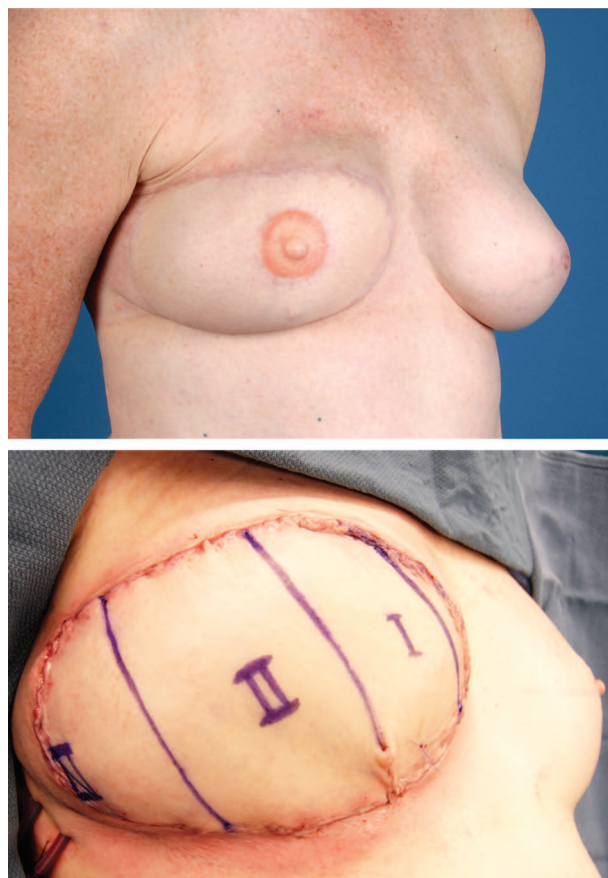
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#### DISCLOSURE

*The author has no financial conflict of interest to disclose.*

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**Fig. 4.** Intraoperative flap inset with use of all four zones, and postoperative results 4 months later after revision surgery. There was some minor epidermolysis of the flap skin edge in zone IV, which healed with conservative treatment.

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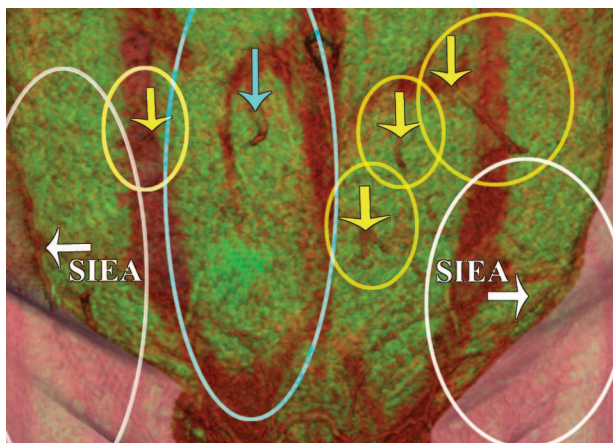
#### Perforator Number Predicts Fat Necrosis in a Prospective Analysis of Breast Reconstruction with Free TRAM, DIEP, and SIEA Flaps

**Sir:**

**W**e are writing regarding the interesting article by Baumann et al., “Perforator Number Predicts Fat Necrosis in a Prospective Analysis of Breast Reconstruction with Free TRAM, DIEP, and SIEA Flaps,” in which some exciting clinical observations have been made that may shed further light on the physiology of deep inferior epigastric artery (DIEA) perforator flaps.<sup>1</sup> However, we would like to clarify some important anatomical definitions made in the article that may have a substantial bearing on the ultimate interpretation of the findings.

In their assessment of perforator flaps, the authors include the superficial inferior epigastric artery (SIEA) flap, describing the flap as a perforator flap and stating that the SIEA flap comprises “a single fasciocutaneous perforator.” We would like to make note of our anatomical findings of the SIEA, in which we assessed 500 studies of the SIEA with imaging.<sup>2</sup> In our experience, the SIEA does not “uniformly” lie deep to the Scarpa fascia and in fact quite variably lies deep or superficial to the Scarpa fascia. Based on our studies, it would therefore not be appropriate to call the SIEA flap a perforator flap at all. As such, to include the SIEA in the same category as DIEA perforators is not appropriate, especially because even the SIEAs that are fasciocutaneous perforators may not be functionally equivalent to musculocutaneous perforators.

The authors also describe the SIEA territory, stating that “SIEA flaps were included in this study as they comprise the same anatomic territory of lower abdominal skin and subcutaneous fat as muscle-sparing TRAM and DIEP flaps.” This is certainly not true, with multiple cadaveric dissection and angiographic studies,<sup>3,4</sup> and clinical injection and immunofluorescence studies,<sup>2,5,6</sup> all showing that the anatomical studies of the DIEA and SIEA are absolutely distinct from one another (Fig. 1).<sup>7</sup> These studies have shown that the primary angiosome of the SIEA is the region between the linea semilunaris and the anterior axillary line, whereas that of the DIEA is between the linea alba and the linea semilunaris, although interindividual variability certainly occurs. This further emphasizes that for the scientific purposes of ad-



**Fig. 1.** Computed tomographic angiogram with volume-rendered technique reformat of the vasculature of the anterior abdominal wall, demonstrating the differences between angiosome territories of deep inferior epigastric artery perforators highlighted in blue (perforators >1 mm) and yellow (perforators <1 mm) and the SIEA highlighted in white. (Reproduced with permission from Rozen WM, Grinsell D, Koshima I, Ashton MW. Dominance between angiosome and perforator territories: A new anatomical model for the design of perforator flaps. *J Reconstr Microsurg.* 2010;26:539–545.

ressing the primary aims of the study by Baumann et al., it would be wise to exclude the data on the SIEA.

A last note on the methodology used by the authors in assessing perforator anatomy concerns the authors stating that they counted the number of perforators intraoperatively, even where transverse rectus abdominis myocutaneous (TRAM) flaps were used. Furthermore, perforator size was assessed based on external diameters, as observed intraoperatively. Both of these techniques seem difficult to achieve with substantial accuracy for interpretation of results. In terms of counting perforator number in TRAM flaps, there may be many perforators within the included muscle that are simply not seen intraoperatively and missed in counting. We would suggest that the use of preoperative imaging may substantially improve the accuracy of this assessment. In our studies of the use of computed tomographic angiography, we have found a near 100 percent positive predictive value for assessing perforator number with the use of computed tomographic angiography.<sup>8,9</sup> Of additional note, the use of the external diameter of perforators is a poor reflection of relative flow between perforators, as wall thickness varies substantially between individual perforators, as does relative flow between two perforators of the same external diameter. Again, the use of flow-dependent imaging may be useful as an objective measure of internal vessel diameter and relative flow, particularly with the use of color Doppler or duplex ultrasonography or contrast computed tomographic angiography or magnetic resonance angiography.  
DOI: 10.1097/PRS.0b013e3181f61c04

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## DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this communication.*

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## Reply

Sir:

We thank Drs. Rozen, Whitaker, Chubb, and Ashton for their letter<sup>1</sup> and interest in our article<sup>2</sup> showing the association of fat necrosis and the number of perforators in free flaps from the lower abdomen used for breast reconstruction, and their comments about perforator flap anatomy. We agree that the superficial inferior epigastric artery (SIEA) flap is a fasciocutaneous flap, not a perforator flap. We were very careful not to refer to the SIEA flap as a perforator flap in our article.<sup>2</sup> One must keep in mind that the purpose of our article was to present the association we discovered between the incidence of fat necrosis and the number of perforators (either musculocutaneous or fasciocutaneous) in free flaps from the lower abdomen when used for breast reconstruction (see the first paragraph of the Patients and Methods section of our article).<sup>2</sup> We wanted to study the incidence of fat necrosis in lower abdominal free flaps used for breast reconstruction, whether they are perforator (DIEP) flaps, musculocutaneous [muscle-sparing free transverse rectus abdominis musculocutaneous (TRAM)] flaps, or fasciocutaneous (SIEA) flaps. Our intent was not to study the territory of these flaps or the territory of the angiosomes of perforators.

We made a carefully considered decision to include SIEA flaps with DIEP and muscle-sparing free TRAM flaps in our study (see the third paragraph of the Discussion section of our article).<sup>2</sup> Neither SIEA flaps nor muscle-sparing TRAM flaps are perforator flaps, but both of these free flaps are used to reconstruct breasts with skin and subcutaneous tissue from the lower ab-

dominal donor site. We agree that the anatomical territory of the SIEA flap is distinct from the territory of the DIEP flap. However, their territories overlap to a great extent. Moreover, we do not use an SIEA flap unless the SIEA vessels are large enough, and medial enough, to allow transfer of the identical paddle of lower abdominal skin and subcutaneous tissue required for breast reconstruction as we would have harvested had we used a DIEP flap or muscle-sparing TRAM flap in the same patient.

Dr. Rozen et al. state that in their experience the SIEA does not uniformly lie deep to the Scarpa fascia. The SIEA originates from the femoral artery, or from a common trunk with the deep circumflex iliac artery off the femoral artery, and therefore is necessarily uniformly deep to the Scarpa fascia near its origin from the femoral artery. The SIEA runs superiorly from its origin within the anterior abdominal wall and, at some point, the SIEA or one of its branches pierces the Scarpa fascia from deep to superficial, but the SIEA always originates deep to the Scarpa fascia.

Dr. Rozen et al.<sup>1</sup> questioned our methodology of assessing perforators. Our flap selection algorithm is to attempt an SIEA flap first. If the SIEA vessels are inadequate to support the required flap volume, we identify and dissect all of the substantial perforators of the flap. If there are one or several dominant perforators, we usually use a DIEP flap. If the number and location of perforators required to support the desired DIEP flap volume would lead to division of a substantial amount of rectus abdominis muscle fibers, we harvest a muscle-sparing TRAM flap. Therefore, all of the perforators are identified and accounted for. We did not use full-muscle-width free TRAM flaps, and there was no undissected area of anterior rectus fascia of the flaps in which undetected perforators could have been present. We do not believe that preoperative imaging with computed tomographic angiography or other modalities would have improved the accuracy of counting perforators in the muscle-sparing TRAM flaps.

Finally, we agree that assessing the external diameter of perforators is difficult to achieve with substantial accuracy. For this reason, we based our major results and conclusions of our study on the number, and not size, of perforators.

DOI: 10.1097/PRS.0b013e3181f61c18

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