Patient Body Mass Index and Perforator Quality in Abdomen-Based Free-Tissue Transfer for Breast Reconstruction

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ABSTRACT

Body mass index (BMI) must be considered when selecting patients suitable for abdomen-based microsurgical breast reconstruction. It is unknown whether BMI or age affects quality or quantity of abdominal wall perforating blood vessels. The purpose of this study was to identify differences in abdominal wall perforating blood vessels among patients with different BMI and age. A retrospective review was conducted of 66 patients undergoing abdomen-based microsurgical breast reconstruction tissue transfer from 2000 to 2006. Median age was 48.6 years ($\pm$ 8.2). Patients were divided into BMI < 25 (28 patients), BMI 25 to 30 (26 patients), or BMI > 30 (12 patients). Perforator size and location was determined by ultrasound data. There was a greater number of perforators in horizontal zone II compared with the remaining zones ($p < 0.05$, Bonferroni corrected). There were no differences between age or BMI and the number of perforators or average perforator size per patient. A significant positive linear association was found between the average perforator diameter and total number of abdominal wall perforators. We concluded there is no anatomical difference in perforator quality among patients with varying BMIs ≤ 35. Zone II remains the most likely region for quality perforators. Abdomen-based microsurgical breast reconstruction is reasonable and safe for women with a BMI < 35.

KEYWORDS: Perforator, body mass index, abdomen

Microvascular tissue transfer, used for many years in breast reconstruction, has been a welcome advance in the field of plastic surgery. Many perforator flaps have been described and shown to be useful, most recently focusing on perforator flaps from the abdomen[1,2] and perforators at the gluteal musculature,[3] gracilis, and latissimus dorsi, among other sources. Much has been written about preoperative planning of free flaps for breast reconstruction using imaging such as ultrasound,[4,5] as well as computed tomography angiography (CTA).[6,7]

Despite the high-quality imaging now at the surgeon's disposal, it is unclear how patient factors such as body habitus and age relate to perforator quality and quantity. Patients with varying body mass index (BMI) potentially present unique challenges in microsurgical

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abdominal tissue transfer for breast reconstruction. In the preoperative setting, it is important to have information specific to the patient regarding candidacy for abdomen-based microvascular tissue transfer for breast reconstruction. It has been noted in the literature that patients with an elevated BMI have higher rates of complications in abdomen-based microsurgical breast reconstruction.[8] Further, there is some published evidence that use of perforator techniques in abdomen-based microsurgical breast reconstruction eliminates any differences in donor-site complication rates between patients with normal versus elevated BMI.[9] However these findings are unexplained by patient anatomical differences because to date, no studies have examined the relationship between BMI and age with regard to perforator quality, quantity, and location.

Our aim was to identify consecutive patients with both BMI and ultrasound data to determine whether overweight or obese patients have less suitable anatomy for abdomen-based microvascular breast reconstruction.

MATERIALS AND METHODS

We performed a retrospective review of all 66 women who underwent abdominal wall duplex evaluation in preparation for autologous tissue breast reconstruction at the University of Washington Medical Center between 2000 and 2006 after receiving approval from the Human Subjects Internal Review Board. Patients underwent either superficial inferior epigastric artery (1 patient), free transverse rectus abdominis myocutaneous (TRAM; 9 patients), or deep inferior epigastric perforator (DIEP; 56 patients) breast reconstruction. Twenty-six patients underwent bilateral and 40 patients underwent unilateral reconstruction. Data collected from the medical records included patient age, BMI, surgery type, and results of duplex studies, including perforator diameter in millimeters, number of perforators in each zone, and average perforator diameter in each zone. All perforators with a diameter ≥ 1 mm were included in the study.

At our institution during the study period, preoperative color duplex ultrasound is routinely performed before free microvascular tissue transfer for breast reconstruction. All patients in the study had bilateral abdominal wall duplex performed prior to surgery, including routine placement of abdominal markings for perforator location in addition to a written report detailing location of the perforator.

In brief, the patient is asked to lay supine for the duplex ultrasound examination. First, a grid is placed over the abdomen to identify precise perforator location. The abdomen is separated into four horizontal zones consisting of 4 cm vertical height each. Horizontal zone 1 includes the region from superior to the umbilicus up to 4 cm, zone 2 is the immediate infraumbilical zone extending 4 cm inferiorly, followed by zone 3 and zone 4 inferiorly (Fig. 1). A 5- to 10-MHz transducer is used with settings suitable for peripheral arteries. The external iliac and internal iliac are identified, followed by the origin of the deep inferior epigastric arteries. The settings are then adjusted for low-flow arterial vessels and

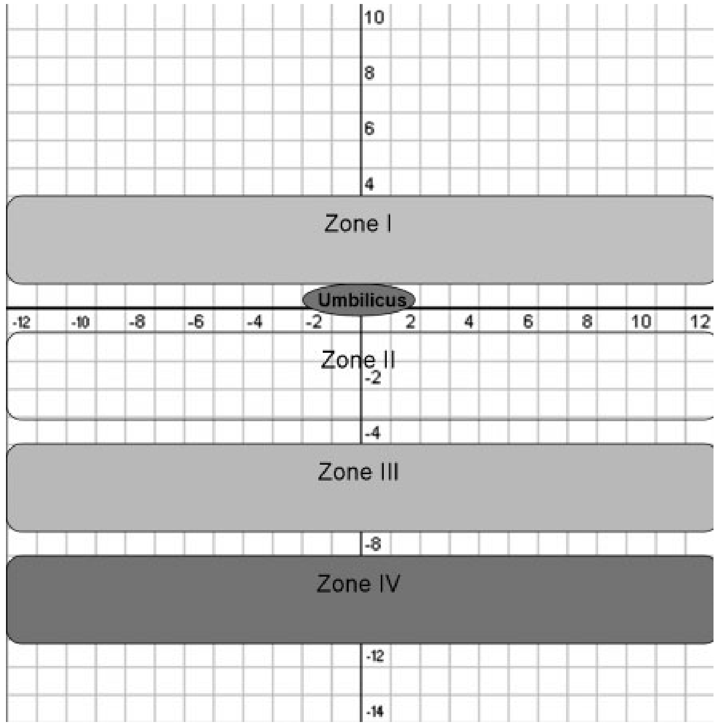

Figure 1 The horizontal zones I through IV are designed as 4-cm areas beginning 4 cm superior to the umbilicus.

the zones are examined from inferior to superior, starting with horizontal zone 4. Distance from the umbilicus is measured in the vertical and horizontal axis.

Statistical Analysis

We used linear regression analysis to test for an association between our outcomes of interest (total perforator number and average perforator diameter) and continuous patient variables (age, BMI). Results are reported as mean ± standard deviation. We used one-way analysis of variance to test for potential differences in total perforator number or average perforator diameter and on abdominal wall quadrant. If a significant association was found among abdominal wall quadrant and total perforator number or average perforator diameter, multiple comparisons between quadrants were performed and adjusted using Bonferroni's method. All statistical analyses were performed using Stata version 8 (Stata, College Station, TX).

RESULTS

Table 1 summarizes the demographic, clinical characteristics, and descriptive statistics of 66 consecutive women who had mastectomy for breast cancer and abdominal wall duplex ultrasound in preparation for abdomen-based microsurgical breast reconstruction. Median age was 48.6 years (± 8.2). Patients were divided into BMI < 25 (28 patients), BMI 25 to 30 (26 patients), or BMI > 30 (12 patients). A significant positive linear association was found between the average perforator diameter and total number of abdominal wall perforators (Table 2). Each increase in the total number of abdominal wall perforators by 5 was associated with an average increase in perforator diameter of 0.2 mm (95% confidence interval, 0.014 to 0.03; $p < 0.001$).

Total abdominal wall perforators varied significantly among abdominal wall quadrants ($p < 0.002$). Abdominal wall horizontal zone II had was found to have a significantly greater number of abdominal wall perforators compared with horizontal zones I, III, and IV ($p < 0.05$, Bonferroni corrected). No differences in total number of perforators were found among other horizontal zones. No differences in average perforator diameter were found among abdominal wall quadrants ($p = 0.98$).

There was no correlation between BMI and perforator diameter or total number of perforators. There was no correlation between patient age and perforator diameter or total number of perforators. A scatterplot was designed showing the location of all perforators included in the study from all patients, as well as specific scatterplots for patients of varying BMI categories (Fig. 2).

Table 1 Clinical Characteristics Compared with Perforator Number Total and Average Perforator Diameter (mm)

Characteristic		Perforator No. Total (p)	Perforator Diameter (p)
Age (y)	48.6 ± 8.2	0.56	0.09
Body mass index	26.1 ± 3.6	0.47	0.28

DISCUSSION

In this study, we have discovered no differences in deep inferior epigastric artery perforator quality and quantity between women of varying BMI and age. We have shown anatomical differences in quantity of perforator by horizontal zone, with the immediate infraumbilical region carrying the best number of perforators among all women in the study. Our finding of high perforator density in the immediate inferior periumbilical region is consistent with prior reports.[4,7,10] In addition to published reports, this is anecdotally consistent with our experience. This verifies the importance of focusing on this region in planning perforator-based breast reconstruction.

Another interesting finding relates to the correlation between the number of perforators available for reconstruction and perforator diameter. We have found the presence of higher numbers of perforators was predictive of larger diameter perforators by ultrasound. This may imply that patients who have both few perforators and thus smaller diameter perforators are actually patients with a more dominant superficial inferior epigastric artery-based system, or that these patients simply rely on a greater number of very small perforating vessels, which are not clinically useful for anastomosis and are difficult to detect. Further study of patients with pre-

Table 2 Perforator Number and Diameter by Zones of the Abdomen*

	Perforator No.	
Total	6.9 ± 3.6	***p***
Zone I	2.0 ± 1.6	
Zone II	2.4 ± 1.6	< 0.05
Zone III	1.9 ± 1.4	
Zone IV	0.7 ± 1.0	
	Perforator Diameter	
Total	0.13 ± 0.02 mm	
Zone I	0.13 ± 0.03 mm	
Zone II	0.13 ± 0.03 mm	
Zone III	0.13 ± 0.03 mm	
Zone IV	0.13 ± 0.03 mm	
Perforator Diameter and Perforator Number	Each increase by 5 perforators = 0.2-mm increase in average diameter	< 0.001

*A significantly greater number of perforators were found in horizontal zone II.

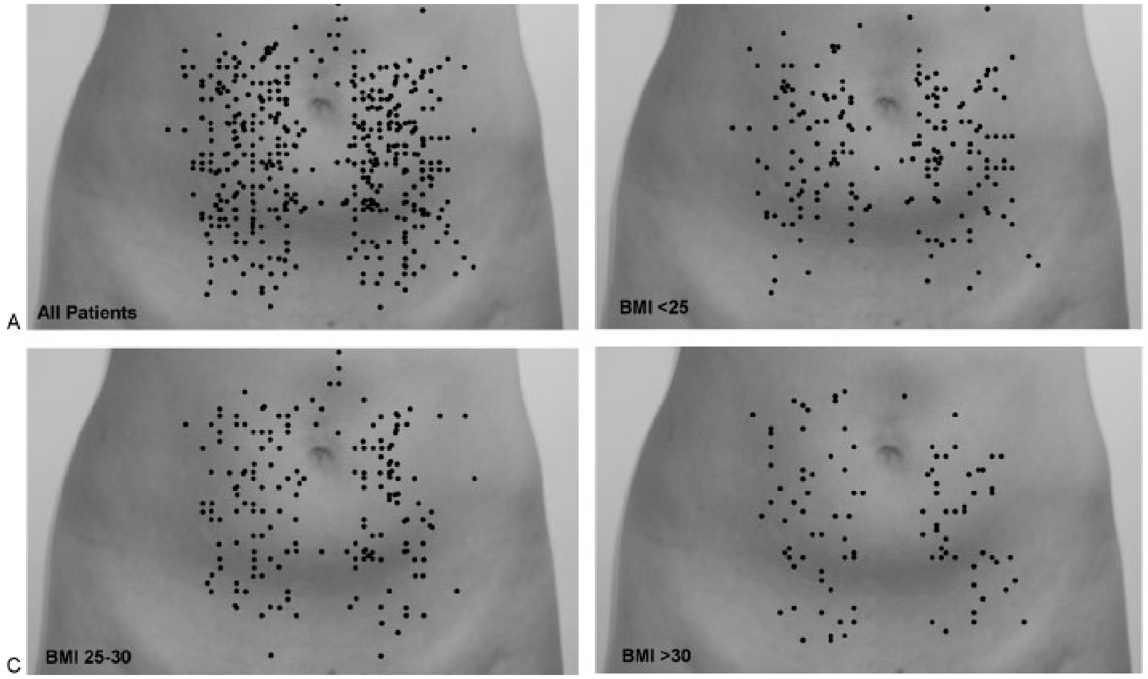

Figure 2 Scatterplots superimposed over the female abdomen showing the location of perforating vessels. (A) All perforators in all patients. (B) Perforators in patients with body mass index (BMI) <25. (C) Perforators in patients with BMI 25 to 30. (D) Perforators in patients with BMI >30.

operative findings suggestive of a robust superficial inferior epigastric system confirming both intraoperative findings and operative outcomes would be useful.

We used duplex ultrasound scanning in this particular study and found it to be generally accurate when compared with clinical findings. Other studies have verified this, including Giunta et al, who only 11% of the time found a perforating vessel intraoperatively that was not already known on preoperative Doppler ultrasound.[5] Blondeel et al found that color duplex scanning in planning perforator yielded a nearly 100% true-positive rate and positive predictive value.[4] Of note, this study also examined patient weight and age to uncover any differences in perforator quality or quantity, finding a significant correlation between patient weight and perforator quality. However, no report was given on patient BMI, nor was there an examination of perforator number and BMI or patient age. It is unknown whether greater patient height or weight is actually responsible for perforator quality. However, we have shown that there is no difference between patients with a higher BMI (up to 35) and patients with a lower BMI with regard to perforator number and diameter. This is potentially useful information in preoperative planning of abdominal perforator flaps for breast reconstruction, and it may prevent discrimination (up to a BMI of 35) against women seeking abdomen-based microsurgical breast reconstruction.

The limitations of this study include the fact that no reconstructions were performed on patients with a BMI >35. It is unclear whether there is a significant change in perforator quantity or quality in those patients with a BMI >35. However, in a study by Chang et al, complications such as total flap loss were elevated in those patients undergoing free TRAM reconstruction in both the obese (BMI >30) as well as the overweight (BMI 25 to 30).[8] We did not find a significant difference in perforator anatomy to account for this increased rate of complications. Another group published their results with DIEP-based breast reconstruction in the obese and did not find an increase in the incidence such as flap failure.[9] Another limitation is anecdotally noted by the authors who have found that duplex ultrasound of perforators that travel obliquely from fascia to skin can often falsely increase the perforator's diameter measured, and increasing distance from fascia to skin in obese patients may affect accuracy and can add time and difficulty to sonographic study. We aim to examine this finding more carefully in future studies.

CTA is useful in planning perforator flaps and thought to be more accurate compared with ultrasound, resulting in decreased operating time,[7] despite radiation exposure and higher cost. A recent study attempted to compare high-quality duplex imaging and CTA; however, the authors failed to identify any perforators with ultrasound, limiting the feasibility of the comparison.[6] Further work is needed to determine the role of magnetic resonance imaging angiography in abdominal free tissue transfer because it may prove to be a high-quality alternative as well, as early reports with microsurgical planning suggest.[11]

CONCLUSION

Perforator quality and quantity in abdominal-based free tissue transfer are not related to patient BMI or age. Patients with a greater number of deep inferior epigastric artery perforators found on duplex are likely to have a larger perforator diameter. This may indicate that patients preferentially depend on either the DIEP system or the superficial epigastric system for abdominal wall perfusion. Perforator-based reconstruction is a reasonable and safe approach to breast reconstruction for women with a BMI < 35.

REFERENCES

1. Allen RJ, Treece P. Deep inferior epigastric perforator flap for breast reconstruction. Ann Plast Surg 1994;32(1):32–38
2. Blondeel PN, Boeckx WD. Refinements in free flap breast reconstruction: the free bilateral deep inferior epigastric perforator flap anastomosed to the internal mammary artery. Br J Plast Surg 1994;47(7):495–501
3. Allen RJ, Tucker CJ. Superior gluteal artery perforator free flap for breast reconstruction. Plast Reconstr Surg 1995; 95(7):1207–1212
4. Blondeel PN, Beyens G, Verhaeghe R, et al. Doppler flowmetry in the planning of perforator flaps. Br J Plast Surg 1998;51(3):202–209
5. Giunta RE, Geisweid A, Feller AM. The value of preoperative Doppler sonography for planning free perforator flaps. Plast Reconstr Surg 2000;105(7):2381–2386
6. Rozen WM, Phillips TJ, Ashton MW, et al. Preoperative imaging for DIEA perforator flaps: a comparative study of computed tomographic angiography and Doppler ultrasound. Plast Reconstr Surg 2008;121(1 Suppl):1–8
7. Masia J, Clavero J, Larrañaga J, et al. Multidetector-row computed tomography in the planning of abdominal perforator flaps. J Plast Reconstr Aesthet Surg 2006;59(6): 594–599
8. Chang DW, Wang B, Robb G, et al. Effect of obesity on flap and donor-site complications in free transverse rectus abdominis myocutaneous flap breast reconstruction. Plast Reconstr Surg 2000;105(5):1640–1648
9. Garvey PB, Buchel EW, Pockaj BA, Gray RJ, Samson TD. The deep inferior epigastric perforator flap for breast reconstruction in overweight and obese patients. Plast Reconstr Surg 2005;115(2):447–457
10. Rand RP, Cramer MM, Strandness DE. Color-flow duplex scanning in the preoperative assessment of TRAM flap perforators: a report of 32 consecutive patients. Plast Reconstr Surg 1994;93(3):453–459
11. Fukaya E, Grossman R, Saloner D, et al. Magnetic resonance angiography for free fibula flap transfer. J Reconstr Microsurg 2007;23(4):205–211