

Imaging of Deep Inferior Epigastric Arteries for Surgical Planning (Breast Reconstruction Surgery)
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Rozen WM, Ashton MW. Improving outcomes in autologous breast reconstruction. <i>Aesthetic Plast Surg.</i> 2009;33(3):327-335.	Review/Other-Dx	N/A	To review ways to maximize operative success and minimize the risk of complications.	DIEP flaps, the current mainstay in choice of autologous reconstruction, provide generally good outcomes. However, improvements in outcomes can still be achieved with a better understanding of individual anatomy. Perforator size, location, intramuscular and subcutaneous course, and association with motor nerves are all factors that can significantly affect operative technique, length of operation, and operative outcomes. With significant variation between individuals, preoperative imaging has become an essential element of DIEP flap surgery. CTA is currently the gold standard but evolving techniques such as MRA and image-guided stereotaxic are rapidly contributing to improved outcomes.	4
2. Rozen WM, Ashton MW, Grinsell D. The branching pattern of the deep inferior epigastric artery revisited in-vivo: a new classification based on CT angiography. <i>Clin Anat.</i> 2010;23(1):87-92.	Observational-Dx	250 patients	To re-evaluate the classification system.	The branching pattern of the DIEA and correlation to the contralateral hemiabdominal wall were assessed. The branching patterns of the DIEA were found to be different in vivo compared with cadaveric studies, with a higher than previously reported incidence of Type 1 patterns and lower than reported incidence of Type 3 patterns, and that some patterns exist which were not included within the previous nomenclature (namely, Type 0 or absent DIEA and Type 4 or four-trunk DIEA). There was also shown to be no overall concordance in the branching patterns of the DIEA between contralateral sides of the same abdominal wall; however, there was shown to be a statistically significant concordance in cases of a Type 1 DIEA (51% concordance, $P=0.04$). As such, a new modification to the classification system for the branching pattern of the DIEA is presented based on imaging findings.	3

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3. Cina A, Salgarello M, Barone-Adesi L, Rinaldi P, Bonomo L. Planning breast reconstruction with deep inferior epigastric artery perforating vessels: multidetector CT angiography versus color Doppler US. <i>Radiology</i> . 2010;255(3):979-987.	Observational-Dx	45 patients	To evaluate the accuracy of multidetector CTA vs color Doppler US for perforating artery identification, intramuscular course of perforator vessel assessment, and superficial venous communication detection before a DIEP procedure for breast reconstruction.	The accuracy for identifying dominant perforator arteries was 97% for color Doppler US and 91% for CTA. Perforator arteries suitable for surgery were identified in 90% of cases with color Doppler US and in 95% of cases with CTA. For measurement of perforator calibers, surgical findings were similar to color Doppler US measurements ($P=.33$) but were significantly different than CT measurements ($P<.0001$). The accuracies for intramuscular course of perforator vessel assessment and superficial venous communication detection were 95% and 97% for CT and 84% and 80% for color Doppler US, respectively. In our population, the absence of superficial venous communication was associated with a risk for flap morbidity ($P=.009$).	2
4. Karunanithy N, Rose V, Lim AK, Mitchell A. CT angiography of inferior epigastric and gluteal perforating arteries before free flap breast reconstruction. <i>Radiographics</i> . 2011;31(5):1307-1319.	Review/Other-Dx	N/A	To familiarize readers with the acquisition and interpretation of CTAs so that they can relay to the surgical team information that is relevant for preoperative planning.	CTA is a valuable tool that can enhance the precision of preoperative planning for perforator free flap breast reconstruction. Knowledge of the relevant anatomy, surgical technique, and protocols for acquiring and interpreting CTAs can help reduce procedure time and lead to better outcomes.	4

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5. Casey WJ, 3rd, Chew RT, Rebecca AM, Smith AA, Collins JM, Pockaj BA. Advantages of preoperative computed tomography in deep inferior epigastric artery perforator flap breast reconstruction. <i>Plast Reconstr Surg.</i> 2009;123(4):1148-1155.	Observational-Dx	213 cases	To compare the outcomes of DIEAP and superficial inferior epigastric artery breast reconstruction both before and after the routine use of preoperative CT to determine the advantages that this imaging technique can provide.	287 flaps were performed on 213 patients. There were 139 unilateral and 74 bilateral reconstructions, with 168 flaps performed immediately after mastectomy and 119 flaps performed in a delayed setting. 101 flaps were performed with CT, whereas 186 flaps followed hand-held Doppler interrogation alone. Mean follow-up was 24 months. The use of CT had a beneficial impact on operative times (unilateral, 370 vs 459 minutes; bilateral, 515 vs 657 minutes; $P<0.05$), number of perforators included (1.5 vs 1.9; $P<0.05$), and abdominal bulges (1% vs 9.1%; $P<0.05$). Anastomotic complications (6.9% vs 8.1%), failure rates (2% vs 3.8%), fat necrosis (10.9% vs 13.4%), and abdominal wounds (11.8% vs 16.6%) were not found to be significantly different. CT did identify 3 cases of deep inferior epigastric vessel ligation from previous operations, which compromised these as suitable source vessels.	2
6. Gacto-Sanchez P, Sicilia-Castro D, Gomez-Cia T, et al. Computed tomographic angiography with VirSSPA three-dimensional software for perforator navigation improves perioperative outcomes in DIEP flap breast reconstruction. <i>Plast Reconstr Surg.</i> 2010;125(1):24-31.	Observational-Tx	70 patients	To reduce surgery time and the number of complications.	The use of VirSSPA preoperative planning correlated with operative times reduced by a mean of 2 hours 8 minutes. In addition, a statistically significant reduction (>45%) in the incidence of any flap-related complications was observed in patients undergoing preoperative CTA-guided VirSSPA reconstruction and a decrease above 50% in overall donor-site morbidity. The use of CTA-guided VirSSPA 3D reconstruction was found to be a protective factor against developing any kind of complication after DIEP flap surgery (odds ratio, 0.03; 95% CI, 0.006 to 0.15).	1

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
7. Ghattaura A, Henton J, Jallali N, et al. One hundred cases of abdominal-based free flaps in breast reconstruction. The impact of preoperative computed tomographic angiography. <i>J Plast Reconstr Aesthet Surg.</i> 2010;63(10):1597-1601.	Observational-Dx	100 cases	To examine the impact of CTA imaging on our practice and also to discuss the process of image acquisition.	Following use of CTA, fewer superficial inferior epigastric artery flaps were performed (18% vs 0%), although the number of DIEP and muscle-sparing transverse rectus abdominis myocutaneous flaps remained similar. There was an increased use of single perforators in the CTA group than in the non-CTA group (48% vs 18%) as well as increased numbers of medial-row perforators (65% vs 32%). Unilateral reconstructions were performed 1h faster in the CTA group (489 min vs 566 min). Finally, hernia rates decreased from 6% in the non-CTA group to 0% in the CTA group.	3
8. Keys KA, Louie O, Said HK, Neligan PC, Mathes DW. Clinical utility of CT angiography in DIEP breast reconstruction. <i>J Plast Reconstr Aesthet Surg.</i> 2013;66(3):e61-65.	Observational-Dx	52 sequential DIEP free flaps in 37 patients	To specifically evaluate the clinical utility of CTA in DIEP free flaps.	A total of 62/76 planned perforators were ultimately used (82%). Of those not used, 71% were abandoned due to inadequacy of preoperative CT. An additional 38 perforators were used that were not part of the initial preoperative plan, 60% of which were added due to inadequacy of the preoperative CT for planning. In total 23/52 flaps (44%) involved intraoperative changes due to features not appreciated on preoperative CT.	3
9. Malhotra A, Chhaya N, Nsiah-Sarbeng P, Mosahebi A. CT-guided deep inferior epigastric perforator (DIEP) flap localization -- better for the patient, the surgeon, and the hospital. <i>Clin Radiol.</i> 2013;68(2):131-138.	Observational-Dx	100 CTA patients and 100 US patients	To define the clinical benefits to the patient of preoperative imaging planning for DIEP flap reconstruction.	There were statistically significant improvements in mean operative duration ($P<0.05$), intraoperative blood loss ($P<0.05$), shorter mean inpatient stay ($P<0.05$) for the CTA planning vs the US planning of DIEP flap reconstruction.	2
10. Masia J, Kosutic D, Clavero JA, Larranaga J, Vives L, Pons G. Preoperative computed tomographic angiogram for deep inferior epigastric artery perforator flap breast reconstruction. <i>J Reconstr Microsurg.</i> 2010;26(1):21-28.	Observational-Dx	357 patients	To review our 5-year experience with the technique we developed based on our previous research confirming accuracy of a MDCT in preoperative planning of abdominal perforator flap surgery.	Exact correlation between surgical and radiological results was found in the first 36 cases. A significant reduction in average operating time and postoperative complications was noted in the following 321 patients.	2

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11. Masia J, Larranaga J, Clavero JA, Vives L, Pons G, Pons JM. The value of the multidetector row computed tomography for the preoperative planning of deep inferior epigastric artery perforator flap: our experience in 162 cases. <i>Ann Plast Surg.</i> 2008;60(1):29-36.	Observational-Dx	162 patients	To describe the working method, establish an actuation algorithm, and reach new conclusions which may be of considerable use for breast reconstruction surgery using autologous tissue.	In the first 36 cases, an absolute correlation was observed between the radiologic information and intraoperative findings. In the following 126 cases, surgery time and the rate of postoperative complications decreased significantly. The multidetector scanner provides valuable preoperative information enabling identification of the most suitable perforator in view of its caliber, location, course, and anatomic relationships.	3
12. Minqiang X, Lanhua M, Jie L, Dali M, Jinguo L. The value of multidetector-row CT angiography for pre-operative planning of breast reconstruction with deep inferior epigastric arterial perforator flaps. <i>Br J Radiol.</i> 2010;83(985):40-43.	Observational-Tx	44 patients	To describe the benefits of this method for preoperative planning before breast reconstruction with DIEP flaps.	The preoperative redesign ratio was 22.7% in the test group and 0% in the control group. The intraoperative method change ratio was 0% in the test group and 13.6% in the control group. The mean time spent on flap harvest was 2.8 +/- 0.2 h in the test group and 4.4 +/- 0.2 h in the control group ($P<0.05$). The flap complication rate was 1/22 in the test group and 3/22 in the control group ($P=0.04$).	4
13. Molina AR, Jones ME, Hazari A, Francis I, Nduka C. Correlating the deep inferior epigastric artery branching pattern with type of abdominal free flap performed in a series of 145 breast reconstruction patients. <i>Ann R Coll Surg Engl.</i> 2012;94(7):493-495.	Review/Other-Dx	145 patients	To evaluate the distribution of the different DIEA branching patterns in abdominal free flap breast reconstruction patients who had undergone preoperative CTA.	Some 150 breast reconstructions were performed in 145 patients. There were 67 DIEP flaps, 69 MS-2 transverse rectus abdominis myocutaneous flaps and 14 MS-1 transverse rectus abdominis myocutaneous flaps (where MS-1 spares the lateral muscle and MS-2 spares both lateral and medial segments). Proportionally more DIEP flaps were performed in patients with a type 2 branching pattern. There was 1 flap loss (0.67%).	4
14. Aubry S, Pauchot J, Kastler A, Laurent O, Tropet Y, Runge M. Preoperative imaging in the planning of deep inferior epigastric artery perforator flap surgery. <i>Skeletal Radiol.</i> 2013;42(3):319-327.	Review/Other-Dx	N/A	To discuss advantages and drawbacks of current imaging modalities for mapping the course of perforating vessels in the planning of DIEP flap surgery, and to present state-of-the-art imaging techniques.	No results stated in abstract.	4

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15. Chernyak V, Rozenblit AM, Greenspun DT, et al. Breast reconstruction with deep inferior epigastric artery perforator flap: 3.0-T gadolinium-enhanced MR imaging for preoperative localization of abdominal wall perforators. <i>Radiology</i> . 2009;250(2):417-424.	Observational-Dx	19 patients	To prospectively evaluate 3.0-T gadolinium-enhanced MRI for localization of inferior epigastric artery perforators before reconstructive breast surgery involving a DIEP flap.	There were 30 surgical flaps, and 11 (58%) of the 19 patients underwent bilateral flap dissection. At surgery, 122 perforators were localized, and 118 (97%) of these perforators—with a mean diameter of 1.1 mm (range, 0.8–1.6 mm)—had been identified at preoperative MRI. 30 perforators with a mean diameter of 1.4 mm (range, 1.0–1.6 mm) were labeled as the best at MRI. 33 perforators were harvested intraoperatively, and all of these had been localized preoperatively. 28 (85%) of these 33 perforators were labeled as the best at MRI.	3
16. Tseng CY, Lipa JE. Perforator flaps in breast reconstruction. <i>Clin Plast Surg</i> . 2010;37(4):641-654, vi-ii.	Review/Other-Dx	N/A	To review pertinent surgical anatomy, preoperative planning, intraoperative decision making in flap elevation, and reported outcomes.	No results stated in abstract.	4
17. Hijjawi JB, Blondeel PN. Advancing deep inferior epigastric artery perforator flap breast reconstruction through multidetector row computed tomography: an evolution in preoperative imaging. <i>J Reconstr Microsurg</i> . 2010;26(1):11-20.	Review/Other-Dx	N/A	To describe the advantages of MDCT over color duplex imaging in perforator flap breast reconstruction.	No results stated in abstract.	4
18. Imai R, Matsumura H, Tanaka K, Uchida R, Watanabe K. Comparison of Doppler sonography and multidetector-row computed tomography in the imaging findings of the deep inferior epigastric perforator artery. <i>Ann Plast Surg</i> . 2008;61(1):94-98.	Review/Other-Dx	5 patients	To compare MDCT with Doppler US and assess the usefulness of the MDCT for the preoperative planning.	We could detect 83 perforators on 5 cases, while could detect 35 perforators by the Doppler US. We measured the distance from the fascia perforating points to rubber markings points. It ranged from 0 to 22.47 mm (7.62 mm on average).	4
19. Ohkuma R, Mohan R, Baltodano PA, et al. Abdominally based free flap planning in breast reconstruction with computed tomographic angiography: systematic review and meta-analysis. <i>Plast Reconstr Surg</i> . 2014;133(3):483-494.	Meta-analysis	13 studies	To systematically assess breast reconstruction outcomes after abdominally based free flaps planned with preoperative CTA vs Doppler US.	A total of 13 studies met inclusion criteria. Preoperative CTA was associated with significantly fewer flap-related complications (relative risk, 0.87; 95% CI, 0.78 to 0.97), reduced donor-site morbidity (relative risk, 0.84; 95% CI, 0.76 to 0.94), and shorter reconstruction operative time by 87.7 minutes (mean difference, 87.7 minutes; 95% CI, 78.3 to 97.1 minutes).	M

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20. Rozen WM, Phillips TJ, Ashton MW, Stella DL, Gibson RN, Taylor GI. Preoperative imaging for DIEA perforator flaps: a comparative study of computed tomographic angiography and Doppler ultrasound. <i>Plast Reconstr Surg.</i> 2008;121(1):9-16.	Observational-Dx	8 patients	To compare preoperative Doppler US with CTA for imaging the DIEA.	CTA was superior to Doppler US at identifying the course of the DIEA and its branching pattern, and in visualizing its perforators. Preoperative CTA was highly specific (100%) and more sensitive in mapping and visualizing perforators ($P=0.0078$). It was also proficient at identifying the superficial epigastric arterial system and for effectively displaying the results intraoperatively. It was substantially quicker and removed the interobserver error associated with Doppler US. The study was ceased after 8 patients because of the overwhelming benefit of CTA over Doppler US.	2
21. Scott JR, Liu D, Said H, Neligan PC, Mathes DW. Computed tomographic angiography in planning abdomen-based microsurgical breast reconstruction: a comparison with color duplex ultrasound. <i>Plast Reconstr Surg.</i> 2010;125(2):446-453.	Review/Other-Dx	22 patients	To compare the accuracy of CTA in locating clinically useful abdominal wall perforators with that of duplex US.	CTA preoperatively identified 83 of the largest perforators, while only 55 of these large perforators (66.3%) were preoperatively identified on US. No superficial inferior epigastric arteries were identified by US. However, in all 8 breast reconstructions performed with the superficial inferior epigastric system, the superficial inferior epigastric arteries were identified preoperatively as adequate size for microsurgical transfers, with an average diameter of 1.6 mm.	4
22. Teunis T, Heerma van Voss MR, Kon M, van Maurik JF. CT-angiography prior to DIEP flap breast reconstruction: a systematic review and meta-analysis. <i>Microsurgery.</i> 2013;33(6):496-502.	Meta-analysis	8 studies	To evaluate flap loss after preoperative CTA and Doppler US in DIEP-flap breast reconstruction.	From 678 studies, 8 were selected for appraisal. 6 case control studies were included in the final analysis. Pooled analysis showed CTA resulted in a significant reduction in partial necrosis (odds ratio 0.15; 95% CI, 0.07–0.32, $P<0.0001$) and decreased flap loss (OR 0.28; 95% CI, 0.10–0.79, $P=0.02$).	M
23. Rozen WM, Stella DL, Bowden J, Taylor GI, Ashton MW. Advances in the pre-operative planning of deep inferior epigastric artery perforator flaps: magnetic resonance angiography. <i>Microsurgery.</i> 2009;29(2):119-123.	Observational-Dx	6 patients	To investigate the role of preoperative MRA as an alternative to CTA for DIEA perforator imaging prior to DIEP flap breast reconstruction.	Pre-operative renal function was normal for all patients, and there were no contraindications to CTA, MRA, or surgery. There was a 100% operative success rate, with no partial or total flap losses, and no known operative complications. Similarly, there were no immediate complications arising from the use of MRA or CTA.	3

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24. Lam DL, Mitsumori LM, Neligan PC, Warren BH, Shuman WP, Dubinsky TJ. Pre-operative CT angiography and three-dimensional image post processing for deep inferior epigastric perforator flap breast reconstructive surgery. <i>Br J Radiol.</i> 2012;85(1020):e1293-1297.	Review/Other-Dx	N/A	To review the arterial anatomy of the anterior abdominal wall, describe the features used to select a perforator artery for DIEP flap surgery and present a CT scanning and image post-processing protocol.	No results stated in abstract.	4
25. Nanidis TG, Ridha H, Jallali N. The use of computed tomography for the estimation of DIEP flap weights in breast reconstruction: a simple mathematical formula. <i>J Plast Reconstr Aesthet Surg.</i> 2014;67(10):1352-1356.	Observational-Dx	17 patients	To develop a simple, yet reliable method of calculating the DIEP flap weight using the routine preoperative CTA scan.	In the retrospective group 17 DIEP flaps in 17 patients were analyzed. Average predicted flap weight was 667 g (range 293-1254). The average actual flap weight was 657 g (range 300-1290) giving an average percentage error of 6.8% (for weight difference $P=0.53$). In the prospective group 15 DIEP flaps in 15 patients were analyzed. Average predicted flap weight was 618 g (range 320-925). The average actual flap weight was 624 g (range 356-970) giving an average percentage error of 6.38% (for weight difference $P=0.57$).	3
26. Pennington DG, Rome P, Kitchener P. Predicting results of DIEP flap reconstruction: the flap viability index. <i>J Plast Reconstr Aesthet Surg.</i> 2012;65(11):1490-1495.	Observational-Dx	45 patients	To develop a mathematical tool to predict the risks of partial flap necrosis utilizing preoperative measurements and to discover the maximum survival weight of flaps based on internal diameters of perforators.	At operation, perforator positions correlated well with CTA measurements. 7 flaps (14%) sustained some partial fat or skin necrosis. There was no significant difference in mean perforator internal diameter between 59 chosen medial perforators (mean 1.66 mm) and lateral perforators (mean 1.61 mm $P=0.284$). Mean weight for 50 flaps was 618 gm. There was no significant difference between the weights of flaps with no necrosis and those with some. Comparing 43 flaps with no necrosis and 7 with some partial skin or fat necrosis, there were no significant differences for perforator numbers per flap ($P=0.45$) nor for mean vertical distance of perforators from flap equator ($P=0.26$). There was a marginal advantage for perforators closer to the midline ($P=0.048$) and a significant advantage for larger perforators as predicted by the FVI ($P=0.037$).	3

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27. Gacto-Sanchez P, Sicilia-Castro D, Gomez-Cia T, et al. Use of a three-dimensional virtual reality model for preoperative imaging in DIEP flap breast reconstruction. <i>J Surg Res.</i> 2010;162(1):140-147.	Observational-Dx	12 patients	To evaluate the role of this application in the preoperative evaluation of the vascular supply to the abdominal wall compared with operative findings, considered the standard for the purposes of this analysis.	In all cases, the major perforators were accurately localized using both methods. 3D reconstruction of the abdominal wall with VirSSPA demonstrated a significant good correlation with perforator location compared with operative findings, showing an average error rate of 0.23cm (95% CI, 0.17–0.30).	2
28. Gomez-Cia T, Gacto-Sanchez P, Sicilia D, et al. The virtual reality tool VirSSPA in planning DIEP microsurgical breast reconstruction. <i>Int J Comput Assist Radiol Surg.</i> 2009;4(4):375-382.	Observational-Dx	12 patients	To present a study about VirSSPA tool for virtual reality navigation in DIEP flap surgery and compare findings with operative measurements.	3D reconstruction of the abdominal wall with VirSSPA demonstrated a significant good correlation with perforator location compared to operative findings, showing an average error rate of 0.228 cm (95% CI, 0.17–0.30). The Pearson product–moment correlation coefficient was found to be 0.99 ($P=0.01$), reflecting an almost linear relationship between the 22 distances, intraoperative and the 1 measured in the 3D reconstruction.	2
29. Pacifico MD, See MS, Cavale N, et al. Preoperative planning for DIEP breast reconstruction: early experience of the use of computerised tomography angiography with VoNavix 3D software for perforator navigation. <i>J Plast Reconstr Aesthet Surg.</i> 2009;62(11):1464-1469.	Review/Other-Dx	3 patients	To discuss the apparent benefits of VoNavix, a software that creates 3D images from CTA data, by describing the learning-curve, the effect on our operative planning and the actual surgery.	No results stated in abstract.	4
30. Rozen WM, Ashton MW, Stella DL, Phillips TJ, Taylor GI. The accuracy of computed tomographic angiography for mapping the perforators of the DIEA: a cadaveric study. <i>Plast Reconstr Surg.</i> 2008;122(2):363-369.	Observational-Dx	5 cadavers	To evaluate the role of CTA in the preoperative imaging of the vasculature of the anterior abdominal wall.	Cadaveric CTA identified 154 perforators in 10 hemiabdominal walls. CTA was highly accurate, with 8 false-positives and 6 false-negatives on cadaveric CTA, establishing an overall sensitivity of 96% and a positive predictive value of 95% for mapping perforators. For perforators >1 mm in diameter, the sensitivity was 100% and the positive predictive value was 100%.	3
31. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: http://www.acr.org/~media/ACR/Documents/PCTS/guidelines/Body_CTA.pdf .	Review/Other-Dx	N/A	Guidance document to promote the safe and effective use of diagnostic and therapeutic radiology by describing specific training, skills and techniques.	N/A	4

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32. Alonso-Burgos A, Garcia-Tutor E, Bastarrika G, Benito A, Dominguez PD, Zubieta JL. Preoperative planning of DIEP and SGAP flaps: preliminary experience with magnetic resonance angiography using 3-tesla equipment and blood-pool contrast medium. <i>J Plast Reconstr Aesthet Surg.</i> 2010;63(2):298-304.	Review/Other-Dx	10 patients	To show the usefulness of MRA, using a 3-T equipment and blood-pool contrast medium, for preoperative planning for DIEP and superior gluteal artery perforator flaps.	MRA showed all the main perforator vessels later observed during the surgical procedure with a very good location concordance, but missed 1 main perforator vessels in each of 2 patients. In all patients undergoing superior gluteal artery perforator flaps, an accurate identification of the main perforator vessels was achieved. MRA clearly showed the intramuscular course of the perforator vessels for DIEP and superior gluteal artery perforator flaps. Exact correlation between MRA and surgical findings was observed.	4
33. Cina A, Barone-Adesi L, Rinaldi P, et al. Planning deep inferior epigastric perforator flaps for breast reconstruction: a comparison between multidetector computed tomography and magnetic resonance angiography. <i>Eur Radiol.</i> 2013;23(8):2333-2343.	Observational-Dx	23 patients	To prospectively evaluate the accuracy of both techniques in identifying perforator vessels, measuring their caliber and intramuscular course, assessing direct venous connections between perforators and the superficial venous network, superficial venous communications between the right and left hemiabdomen and DIEA branching type, in patients undergoing DIEP flap breast reconstruction.	Accuracy in identifying dominant perforators was 91.3% for both techniques and mean error in caliber measurement 1.18 +/- 0.35 mm for CTA and 1.63 +/- 0.39 mm for MRA. Accuracy in assessing perforator intramuscular courses was 97.1% for CTA and 88.4% for MRA, direct venous connections 94.4% for both techniques, superficial venous communications 91.3% as well, and DIEA branching type 100% for CTA and 91.3% for MRA. Image acquisition and interpretation time was 21 +/- 3 min for CTA (35 +/- 5 min for MRA).	2
34. Greenspun D, Vasile J, Levine JL, et al. Anatomic imaging of abdominal perforator flaps without ionizing radiation: seeing is believing with magnetic resonance imaging angiography. <i>J Reconstr Microsurg.</i> 2010;26(1):37-44.	Observational-Dx	31 patients	To detail our initial experience with MRA for preoperative imaging of abdominal perforator vessels used for breast reconstruction.	50 abdominal flaps were successfully transferred in 31 patients. All perforators visualized on MRA were found at surgery (0% false-positive). In 2 flaps, preoperative MRA failed to demonstrate significantly sized lateral row perforators vessels that were used for tissue transfer (4% false-negative rate). In both of these flaps, the signal from the patient's buttock fat was inadequately suppressed and obscured the signal from the lateral portion of the abdomen.	3

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35. Masia J, Kosutic D, Cervelli D, Clavero JA, Monill JM, Pons G. In search of the ideal method in perforator mapping: noncontrast magnetic resonance imaging. <i>J Reconstr Microsurg.</i> 2010;26(1):29-35.	Observational-Dx	162 patients	To evaluate our results after 3 years of using the multidetector scanner and to characterize the anatomic findings.	In the first 36 cases, an absolute correlation was observed between the radiologic information and intraoperative findings. In the following 126 cases, surgery time and the rate of postoperative complications decreased significantly. During the evaluation of the radiologic image for each of the 162 patients studied, at least 1 appropriate perforator was identified as suitable for surgery. An average of 2.3 perforators on each hemiabdomen was found useful for surgery. In 4.9% of cases, only 1 perforator vessel was found to meet selection criteria because abdominal tissue was scarce; supraumbilical perforators could not be chosen since abdominal wall closure might be compromised. Only 1 suitable infraumbilical perforator was found in these patients. Its location and study by means of radiologic imaging contributed significantly to the success of the surgical procedure.	3
36. Neil-Dwyer JG, Ludman CN, Schaverien M, McCulley SJ, Perks AG. Magnetic resonance angiography in preoperative planning of deep inferior epigastric artery perforator flaps. <i>J Plast Reconstr Aesthet Surg.</i> 2009;62(12):1661-1665.	Observational-Dx	10 patients	To report our initial experience and show that contrast-enhanced MRA is able to identify perforator vessels, measure their size and describe their course and describe the impact these scans have had on our practice.	An average of 2.8 perforators per study (range 1-5) was identified. Mean perforator luminal diameter was 2.6 mm (1.4-4.0 mm) with a mean intramuscular course length of 22.3 mm (6.4-51.9 mm). Perforator course length was classified as 17% long intramuscular course (>4 cm), 80% short intramuscular course (<4 cm) and 3% paramedian. In all 10 patients, DIEP flaps were successfully elevated. In all cases the flaps were elevated on vessels identified in preoperative review of the contrast-enhanced MRA. There was a significant difference in the rates of conversion from DIEP to transverse rectus abdominis myocutaneous flaps in the group who underwent contrast-enhanced MRA in comparison to historical controls from the previous year ($P=0.025$).	3

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Versluis B, Tuinder S, Boetes C, et al. Equilibrium-phase high spatial resolution contrast-enhanced MR angiography at 1.5T in preoperative imaging for perforator flap breast reconstruction. <i>PLoS One</i> . 2013;8(8):e71286.	Observational-Dx	23 patients	To evaluate the accuracy of equilibrium-phase high spatial resolution contrast-enhanced MRA at 1.5T using a blood pool contrast agent for the preoperative evaluation of DIEP, and to compare image quality with conventional first-pass contrast-enhanced MRA.	There was 100% agreement between equilibrium-phase contrast-enhanced MRA and surgical findings in identifying the single best perforator branch. All equilibrium-phase acquisitions were of diagnostic quality, whereas in 10 patients the quality of the first-pass acquisition was qualified as non-diagnostic. Both signal- and contrast-to-noise ratios were significantly higher for equilibrium-phase imaging in comparison with first-pass acquisitions ($P=0.01$).	2
38. Mathes DW, Neligan PC. Preoperative imaging techniques for perforator selection in abdomen-based microsurgical breast reconstruction. <i>Clin Plast Surg</i> . 2010;37(4):581-591, xi.	Review/Other-Dx	N/A	To review the available techniques for preoperative planning with the currently available imaging modalities: hand-held Doppler, color Doppler (duplex) US, CTA, and MRA.	No results stated in abstract.	4
39. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: http://www.acr.org/~media/ACR/Documents/AppCriteria/RadiationDoseAssessmentIntro.pdf	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	N/A	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
 - *Category 2* The study is moderately well-designed and accounts for most common biases.
 - *Category 3* There are important study design limitations.
 - *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
 - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
 - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
 - c) the study is an expert opinion or consensus document.
 - M = Meta-analysis
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Dx = Diagnostic

Tx = Treatment