American College of Radiology
ACR Appropriateness Criteria®
Imaging of Deep Inferior Epigastric Arteries for Surgical Planning (Breast Reconstruction Surgery)

<u>Variant 1:</u> **Imaging of deep inferior epigastric arteries for surgical planning (breast reconstruction surgery). Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRA abdomen and pelvis without and with IV contrast	Usually Appropriate	O
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
MRA abdomen and pelvis without IV contrast	May Be Appropriate	O
US color Doppler abdomen and pelvis	Usually Not Appropriate	O
Arteriography abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

IMAGING OF DEEP INFERIOR EPIGASTRIC ARTERIES FOR SURGICAL PLANNING (BREAST RECONSTRUCTION SURGERY)

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Summary of Literature Review

Introduction/Background

Breast cancer is the most common malignancy in women in the United States, with surgical options including lumpectomy and mastectomy. Breast reconstruction options following mastectomy range from saline or silicone implants to autologous breast reconstruction. The latter procedure uses skin, fat, blood vessels, and/or muscle from the upper back, abdomen, buttocks, or hips. Transverse rectus abdominis muscle flap procedure is a traditional method of breast reconstruction that harvests underlying muscle. This can result in increased donor site morbidity. The deep inferior epigastric perforator (DIEP) flap is a muscle-sparing perforator free flap breast reconstruction technique, which uses the deep inferior epigastric artery (DIEA) perforators to create a vascular pedicle [1].

Compared with transversus rectus abdominus muscle flaps, DIEP flaps result in less fat necrosis and loss of function at the donor site. The DIEP tissue harvesting procedure involves dissecting the anterior abdominal wall subcutaneous tissues to locate and visually identify the most suitable vessel to serve as the vascular pedicle. Although the DIEA is reliably identified because of its consistent take off from the external iliac artery, the anatomy of the perforators used in DIEP flap is variable. Lack of preoperative imaging can lead to increased operative times given the time-consuming nature of identifying the variable vascular anatomy. The efficiency of the vascular pedicle selection process can be significantly improved with preoperative imaging [2].

Multiple perforators are identified by imaging, which are typically ranked based on size, location, and intramuscular course. The ideal perforator is the largest caliber [1,3] and is medially located within the flap with an extended vascular territory beyond the midline to provide optimal perfusion. Dissection of the selected perforator should preserve muscle innervation and avoid fat necrosis [1,3,4]. A short intramuscular course allows for successful dissection [3,14,15]. Perforators are reported by the location where they pierce the anterior rectus sheath in relation to the umbilicus. This is important because, although the perforator can move within the subcutaneous tissues with applied pressure, its position at the rectus sheath is fixed relative to the umbilicus [5].

Special Imaging Considerations

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [6]:

> *"CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings."*

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

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Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Imaging of deep inferior epigastric arteries for surgical planning (breast reconstruction surgery). Initial imaging.

The goal of preoperative imaging is to aid the surgical team in preoperative planning given the variability of the DIEA perforator branches anatomy between patients, and even between the left and right hemiabdomen of the same patient. Improved clinical outcomes with preoperative imaging have been shown to include decreased length of surgery, decreased flap loss rate, decreased hernia rate, decreased intraoperative blood loss, shorter mean inpatient stay, reduced learning curve when compared with hand-held Doppler, and increased surgeon confidence [7-15].

Arteriography Abdomen and Pelvis

Although catheter directed arteriography can aid in delineation of variant anatomy of the DIEA to guide surgical planning for breast reconstruction, it is an invasive procedure with risks that outweigh benefits compared to current alternative noninvasive imaging methods. Additionally, given the small caliber of the vessels and potentially tortuous course, this would likely lead to prolonged procedure times and potentially unreliable assessment of vessel caliber given variable source and detector distances. Furthermore, the course of perforator arteries in the abdominal wall musculature and subcutaneous tissues is not easily assessed with catheter directed arteriography. There is no relevant literature supporting the use of arteriography in evaluation of imaging of deep inferior epigastric arteries for surgical planning.

CT Abdomen and Pelvis With IV Contrast

To date, there is no relevant literature supporting the use of CT abdomen and pelvis with intravenous (IV) contrast in the evaluation of imaging of deep inferior epigastric arteries for surgical planning.

CT Abdomen and Pelvis Without and With IV Contrast

There is no relevant literature supporting the use of CT abdomen and pelvis without and with IV contrast in the evaluation of imaging of deep inferior epigastric arteries for surgical planning.

CT Abdomen and Pelvis Without IV Contrast

There is no relevant literature supporting the use of CT abdomen and pelvis without IV contrast in the evaluation of imaging of deep inferior epigastric arteries for surgical planning.

CTA Abdomen and Pelvis With IV Contrast

CTA is currently beneficial in evaluating the perforator anatomy for preoperative planning before DIEP flap breast reconstruction. Perforator size, perforator location relative to abdominal landmarks, branching pattern of DIEA, presence of superficial inferior epigastric vessels, subcutaneous course, and intramuscular course all affect operative techniques, operative time, and outcomes. CTA is a fast, efficient, and highly reproducible modality, capable of yielding excellent opacification of the small caliber perforator arteries with optimal contrast bolus timing. CTA evaluation performed with the use of specific postprocessing and display techniques may yield more accurate assessment of the optimal vessel for selection for breast reconstruction when compared to color Doppler ultrasound (CDU) [2,8,16]. Some studies have demonstrated superiority of CTA over CDU utilization [17,18], suggesting a routine use of preoperative CTA. A virtual 3-D plan based on CTA can be preoperatively projected onto the abdomen intraoperatively, which can aid in identifying perforator locations and thus decreasing operative time [19].

CTA is also helpful in predicting which DIEA perforators are the most clinically useful in patients with scarred abdomens [20]. Therefore, preoperative imaging is essential for DIEP flap surgery [17,21-28]. Preoperative CTA evaluation can also reliably estimate the volume of abdominal tissue for DIEP flap breast reconstruction [19,29].

Preoperative mapping allows calculation of a flap viability index, which predicts the amount of tissue which will survive based on perforator diameter as well as flap weights [30]. CTA evaluation also allows for the assessment of factors, which may lead to venous congestion of the flap and, therefore, flap failure [31]. A superficial inferior epigastric vein larger than the deep inferior epigastric vein as well as axial nonarborizing superficial venous system are highly predictive of subsequent venous congestion. Knowledge of these findings can aid in preoperative discussion with patients, which may alter management [32]. Preoperative use of CTA allows estimation of contralateral abdominal perfusion and therefore allows for efficient breast reconstruction and decreased complications [33].

Use of preoperative CTA has been shown to result in the increased use of single perforators, increased use of medial-row perforators, significantly reduced operative time, decreased intraoperative blood loss, decreased inpatient hospital stay, and decreased complications such as hernias [9,11,12,14,34]. CTA evaluation allows for faster selection of laterality of dissection, as well as reduced flap loss rates [15].

MRA Abdomen and Pelvis Without and With IV Contrast

Donor site preoperative imaging for mapping the perforator artery anatomy results in improvement in perforator selection, reduces operative time, and reduces donor site morbidity. Although CTA is considered most helpful, emerging literature supports MR angiography (MRA) as an alternative imaging tool with accurate assessment of DIEA perforator anatomy [35-44]. A recent meta-analysis demonstrates that CT and MRI appear to have similar accuracy in preoperative DIEP mapping [44]. MRA evaluation is limited by increased scanning times relative to CTA evaluation. Continued research is needed to evaluate the accuracy of the new emerging MRA techniques and their role in preoperative perforator branch imaging.

MRA Abdomen and Pelvis Without IV Contrast

The literature review yields one study that used noncontrast MRA for preoperative planning in 56 women who underwent DIEP flap with preoperative planning using MRA without IV contrast. The perforator chosen intraoperatively corresponded to the dominant perforator selected on the MRA in all the patients, yielding 100% predictive value with no false-positive or false-negative results [41]. MRA evaluation is limited by increased scanning times relative to CTA evaluation. To date, there is no other relevant literature supporting the use of MRA abdomen and pelvis without IV contrast in evaluation of imaging of deep inferior epigastric arteries for surgical planning. Continued research is needed to evaluate the accuracy of the new emerging MRA techniques and their role in preoperative perforator branch imaging.

MRI Abdomen and Pelvis Without and With IV Contrast

There is no relevant literature supporting the use of MRI abdomen and pelvis without and with IV contrast in the evaluation of imaging of deep inferior epigastric arteries for surgical planning.

MRI Abdomen and Pelvis Without IV Contrast

There is no relevant literature supporting the use of MRI abdomen and pelvis without IV contrast in the evaluation of imaging of deep inferior epigastric arteries for surgical planning.

US Color Doppler Abdomen and Pelvis

CDU allows for identification of the dominant perforator, evaluation of perforator caliber, and delineation of intramuscular course of the perforator vessel [45,46]. Few studies have demonstrated the reliability of CDU relative to CTA in identifying perforators or determining their number, size, and location [47]. Overall, there is limited literature to support the use of CDU over CTA. Many studies demonstrate superiority of CTA over CDU as a preoperative planning tool of perforator-based breast reconstruction [17].

Summary of Recommendation

- **Variant 1**: CTA of the abdomen and pelvis with IV contrast is usually appropriate for the initial imaging of deep inferior epigastric arteries for surgical planning (breast reconstruction surgery). MRA of the abdomen and pelvis without and with IV contrast is an alternative modality, which can be used if there is contraindication to obtaining CTA evaluation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [48].

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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