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Integrating Imaging Techniques in Deep Inferior Epigastric Perforator Breast Reconstruction

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Abstract: **Deep inferior Epigastric perforated (DIEP) flaps is reconstructing the breast for female who have previous operation which was diagnosed from any serious diseased. Its usually autologous breast reconstructions to minimize the scar of the breast at the site of operation.**
Method: We used the significant technique to evaluate the flaps to been successfully done with radiological multidetector Doppler ultra sound, CT Angiography (MDCTA). All of them used to evaluate and demarcate the flaps tissue to reduce the risk of rejecting the falp. Our goal was to let the patients feel normal as anyone can enjoy in this life.
Conclusion: The efficiency of DIEP flap in breast reconstruction are to a great extend technology-driven and attributed to integrated imaging technologies and it helps in improving the treatment.

Keywords: **Doppler ultrasound, MDCTA, MRI, flap implant.**

1. INTRODUCTION

The deep inferior epigastric perforator (DIEP) flap has become the gold standard for autologous breast reconstruction owing to the reduced donor site morbidity and inconspicuous scar, abundance and reliability of transferred tissue as well as texture and contour emulation to the female breast.[1,2] The vascular anatomy of the DIEP and its perforators greatly varies not only among patients but also from one hemi-abdomen to the other in the same individual. Because of numerous congenital and acquired anatomical variations of the DIEP branching pattern, thorough knowledge of the perforators topography and perforator dominance is essential for accurate preoperative planning.[3-8]

The evolution of imaging technology has significantly contributed to the enhancement of predictability and reproducibility of DIEP breast reconstruction outcomes. Meticulous pre-operative imaging of the perforator flap and mapping of the vessels facilitates precise flap design and harvest, reduces operative time and intraoperative complications while it improves outcomes and efficiency.[4,9-11]

The selected dominant perforator is usually medially located, bares a short intramuscular course and a diameter >1 mm, with an extended vascular distribution within the flap adipose tissue to match the flap and to allow preservation of muscle innervation. [2,12]

The pre-operative vascular mapping includes imaging modalities ranging from Color Doppler [13] to sophisticated stereotactic vascular representation systems.[11,14] The ideal imaging technique should have no risk to the patient, attain exceptional quality and highly informative images, and be fast and comfortable to the patient.[11,12] Pre-requirement for the reliability of each of the imaging techniques is a standardized protocol for accurate identification of DIEA perforators.[13]

This review presents current imaging methods integrated in DIEP mapping for breast reconstruction, emphasizing on ultrasonography and computed tomographic angiography.

2. DOPPLER ULTRASONOGRAPHY

Doppler flowmetry for planning the DIEP flap was first described by Blondeel et al in 1998 and can access the flow velocity, patency, location, and caliber of the perforator arteries and venus tributaries.[15]

Color Doppler Ultrasonography (CDU) exhibits 96% sensitivity nearly 100% positive predictive value.[16,17] It can identify perforators > 0. 5mm in diameter and can be used in pre-operative planning, intraoperative decision-making, and post-operative follow-up.[16-18]

CDU is performed the day before or the morning before the operation with the patient in supine position, as in surgery, and allows for direct visualization of the perforator as it emerges from the deep fascia of the rectus abdominis.

Following the course of the DIEA from its origin to the umbilicus, CDU scans the entire flap at a radius of approximately 10 cm above and laterally to the umbilicus. The penetration point of the superficial fascia of the rectus abdominis to the flap skin is exactly located and marked accurately on the skin.

CDU is a low-cost, non –ionizing, bedside examination. Although a reliable method in estimating the vessel caliber, specificity and sensitivity of CDU may vary. Expertise is required while there is interobserver variability. [11,12] Subcutaneous vessels that are not perforators may be visualized resulting in false positives, while in overweight patients sensitivity further decreases. Moreover, the duration of the examination is 45-60 minutes, rendering the technique uncomfortable for the patient, who has to remain in the same position during the procedure.[11,12]

It is noteworthy that CDU does not provide information on the anatomic relationship between the deep inferior epigastric system and other structures, such as the superior inferior epigastric (SIE) system. In addition, as CDU is a real-time technique, further post examination analysis of data is not possible.[11]

3. CT ANGIOGRAPHY (CTA)

The introduction of CTA in preoperative vascular mapping has significantly improved DIEP flap dissection and survival, as it provides highly accurate information concerning the arterial as well as the venous anatomy of the DIEP flap and can display DIEA's course, branching patterns, number, size, intramuscular trajectory and location of perforators.[19-23] CTA has a sensitivity of 96%, a positive predictive value of 95% and may identify perforators as small as 0.3 mm. Moreover, CTA may reveal the structure and competence of the abdominal wall fascial layers. [11,12,23]

The rate and timing of the injection and the patient's cardiac output and body habitus determine the degree of enhancement. Careful optimization of single phase CTA prevents low opacification due to early scan as well as venous contamination due to late arterial phase. In multiphase CTA examination on the other hand, each phase should be independently validated and the radiation dose is multiple compared to single phase CTA. [24,]

Kim et al.[25] reported the use of CTA to evaluate flap and recipient vessels, scanning the area from the clavicle to the pubic symphysis. They assessed the intercostal space, the internal mammary artery and vein, and the internal mammary artery perforator to determine which intercostal space was most appropriate. The authors also used CTA for volumetric estimation of the contralateral breast and the abdominal flap.

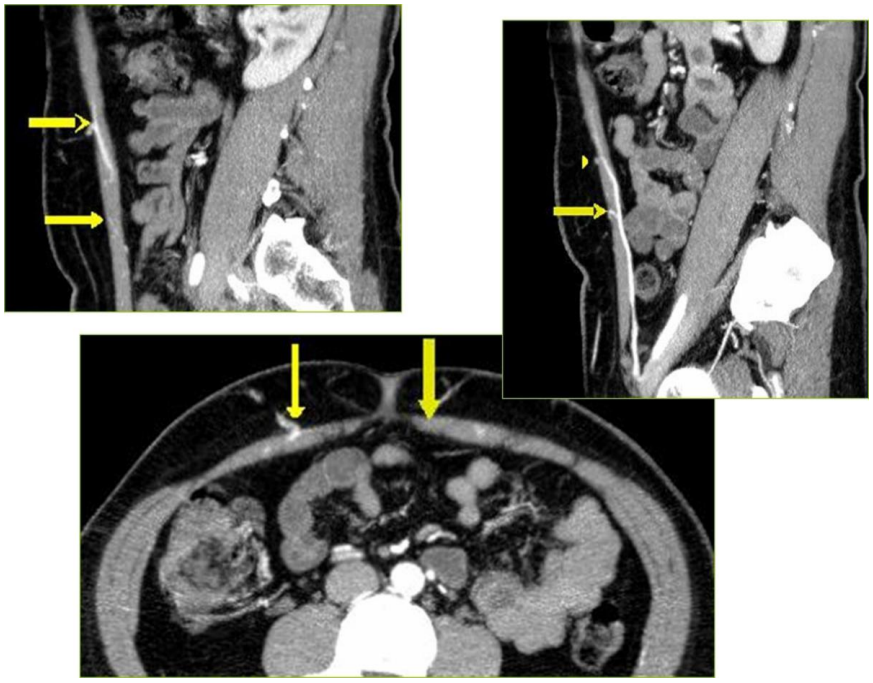
The use of multidetector CT increases accuracy and may provide further data on the number of perforators, their distribution and axiality to the flap subcutaneous tissue.[12,16,17] This information is highly beneficial in patients with lower abdominal scars, as it facilitates selection of the best perfused region of abdominal tissue supplied by the dominant perforator. [12,26,27]

CTA is a three-dimensional, non-invasive, operator- independent method, highly reproducible, requiring a short scanning time of 5 minutes[11,12]. Apart from the high spatial resolution, [28-30] there is availability of free software for post processing 3D digital reconstruction for detailed mapping of the vascular anatomy.[11,31] Also 4D reconstruction adds temporal resolution enabling dynamic analysis of perforator anatomy and may be used to delineate the perforasomes in lower abdomen.[6,11,,17,32]

Among drawbacks, is the high cost of the investigation, which may be counterbalanced by the reduction in operative time and intraoperative complications, resulting from thorough and accurate preoperative mapping.[11,12,32] Another limitation is the exposure of the patient to ionizing radiation and the use of intravenous contrast medium, that is nephrotoxic and allergenic.

Compared to CDU, both methods provide reliable information about the size, localization, and course of DIE perforators. CTA is a more accurate method in detecting the course and location of perforators compared to CDU [11,16] but CDU is superior to a standalone CTA examination for measuring perforator diameters.[33-35] and for hemodynamic evaluation of both arterial and venous conduits of the perforator-complex. [36]

In order to increase the accuracy of preoperative mapping, CDU may be used in addition to CTA.



In this CTA showing the inferior epigastric artery which showing the perforator to determine for seorgone the mark line for the patient before the operation 14.

For this patient pre-operative once we compare for the left pic. Showing the scar and deformity of the breast. All this depend on the reconstruction of the breast and the prognosis.

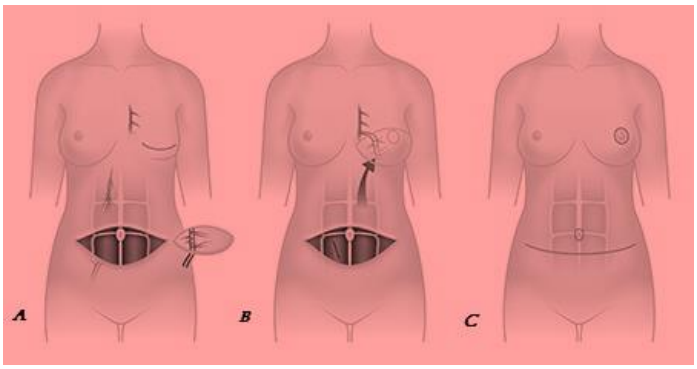
4. PERFORATOR ARTERY OR PERFORATOR COMPLEX?

Despite the fact that the majority of DIEP flaps are compromised due to venous congestion and rarely arterial insufficiency,[37] all techniques were until recently spotlighting on the dominant arterial-perforator, downsizing the importance of the accompanying venous – tributaries.[36,38]

It is well-perceived that, although any medially located arterial perforator>1 mm in diameter can perfuse any flap, not every associated vein can drain every flap.[36] Lately the concept of the perforator complex, which includes the triad of an arterial perforator, venous tributaries and nerve in any combination, has been brought in, suggesting that selection of the dominant perforator-complex based on dominant veins ensures optimal flap microcirculation, while diminishing intraoperative incidents and postoperative healing complications.

Figus et al.[38] demonstrated that if a dominant vein is identified first, the probability of detecting a suitable perforator-complex increases to 93.5%, while significantly decreases to 69.8% when a dominant artery is identified first. [38]

Our team introduced the perforator- complex imaging protocol termed as "CTA-guided CDU examination", [36] which combines the use of CTA and CDU in the decision-making process of choosing the best suitable perforator-complex. The CTA results are used as a guide to conduct a CDU examination to investigate the size and patency of the accompanying venous tributaries. Selection of the suitable perforator complex based on the size and patency of the dominant vein resulted in better flap revascularization ($p<0.05$) and decreased postoperative complications ($p<0.05$) compared to dominant artery based selected complexes. Our preliminary results indicated that this protocol may identify more optimal perforator-complexes based on venous mapping and thus, further improve the pre-operative microsurgical planning.[36]



This figure. A. showing the vascular arteries and vein is determine, B. tissue is transfer from right side and anastomosed to the left breast. C. healing is done after the reconstruction and the both breast are been similar to each. [24]

5. MAGNETIC RESONANCE ANGIOGRAPHY

There is little evidence associating preoperative Magnetic resonance angiography (MRA) with improved clinical outcomes.[39-42] Contrast enhanced MRA delineates accurately the intramuscular trajectory of the perforators and can identify vessels >0.8mm in diameter.[11,40-42]

Rozen et al. suggested that despite high sensitivity (100%) MRA was inferior to preoperative CTA due to low specificity (50%),[43] while Chernyak et al. reported a 97% concordance of MRA imaging with intraoperative findings in DIEP flap breast reconstruction.[44]

Despite its higher cost, MRA has certain advantages over CTA, namely elimination of exposure to ionizing radiation and safer required contrast medium. Nevertheless, gadolinium may also be nephrotoxic for patients with renal insufficiency. [11,12,40-44]

Masia et al. demonstrated that non-contrast magnetic resonance imaging was associated with high specificity and provided reliable information on the perforator branching within the subcutaneous abdominal tissue and the vascular connections between the superficial and the deep inferior epigastric vessels [45]

Nevertheless, a serious limitation of MRA is possible patient discomfort, as it requires breath-hold for 10-20 seconds to avoid motion artifacts. Distress levels may increase in claustrophobic patients, while the technique is contraindicated in severely obese and patients with metallic implants.[11,39,45]

6. OTHER METHODS

The use of dynamic infrared thermography (DIRT) for perforator mapping in DIEP flaps was first described in 1993.[46] DIRT has been used in the preoperative planning, intraoperative and postoperative monitoring of flap perfusion. Thermal images are captured with an infrared camera before, during and after exposure to a cold challenge provided by a fan blowing air for 2 min over the abdomen. After a recovery period of 3 min, the first appearing hot spots correlate with reliable perforator location. [17,47] Although a simple, low cost and patient safe method it can obviously provide only 2D perforator mapping, while there is no evidence supporting its accuracy

Laser-assisted indocyanine green fluorescence angiography (LA-ICGFA) [48] involves peripheral injection of indocyanine green and capture of the cutaneous vascularity with the use of infrared energy. Images are recorded and software analysis data on flap perfusion and patency of anastomosis are collected. Apparently, the method, of anyway limited use, may be useful for intraoperative assessment and less for preoperative and postoperative monitoring. [17]

7. CONCLUSIONS

Recent improvements in the predictability and efficiency of DIEP flap in breast reconstruction are to a great extend technology-driven and attributed to integrated imaging technologies. Advances in accurate preoperative perforator imaging have resulted in significantly reduced operative time and stress, increased flap survival and consequently patient satisfaction.

The choice of imaging technique depends on patient history, equipment availability and radiologic expertise. Standardization of protocols may further increase precision in vascular anatomy imaging and patient comfort and safety.

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