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IDEAS AND INNOVATIONS

The ideal scenario in deep inferior epigastric perforator (DIEP) flap dissection: a complete muscle and nerve-sparing approach

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Abstract
The deep inferior epigastric perforator flap (DIEP) has become the gold standard method of autologous breast reconstruction by simultaneously maximising aesthetics of the breasts and abdomen, and maximising the function of the abdominal wall. While the anatomical variability of the DIEP flap perforators have been well characterised, there has been less attention paid to the hierarchy of DIEP perforators in terms of limiting abdominal dysfunction post-operatively. In this paper, we seek to draw attention to what is, in our opinion, the ideal scenario in DIEP flap harvest. Where present, a medial paramuscular cutaneous vessel (MPCV) may be harvested using the pyramidalis separation technique enabling a complete rectus abdominis muscle-sparing and abdominal motor nerve-sparing approach. Herein, we describe the pyramidalis separation technique and the results in representative cases. In our experience, this technique enables an expeditious surgical procedure, and dramatically reduces damage to both muscles and nerves.
Level of evidence: Level V, therapeutic study

Keywords Breast reconstruction · Deep inferior epigastric artery · Perforator flap · Perforator vessel · Paramuscular cutaneous vessel · Pyramidalis separation technique

Introduction

First applied by Holmstrom in 1979 to reconstructive breast surgery, the use of abdominally based free tissue transfer has evolved to maximise safety and aesthetics and to minimise morbidity to the abdominal donor site [1, 2]. In 1989, Koshima and Soeda demonstrated the possibility of sparing the majority of the rectus abdominis muscle and overlying fascia by taking only a small cuff of muscle [3]. Autologous breast reconstruction utilising the deep inferior epigastric perforator (DIEP) flap dissection was described by Allen and Treece in 1994 and has since become the standard for microsurgical breast reconstruction [4]. The anatomical variations of the DIEP flap perforators have become very well understood, and the use of pre-operative computer tomography angiography (CTA) is now standard of care [2]. What remains less clear in the literature is the hierarchy of various perforators and algorithmic approaches to selecting ideal perforators, both in terms of maximising flap viability and minimising injury to the rectus muscle [5]. In our opinion, there is an ideal DIEP flap dissection scenario, which has been underrecognised in the literature and, when present, makes for rapid and reliable flap harvest.

This scenario has been variably described as the total medial paramuscular perforator [6], paramedian perforator [7], or circummuscular wraparound medial perforator [8]. These perforators can be raised via a complete muscle sparing [9, 10] and nerve-sparing [11, 12] approach without damaging a single rectus abdominis muscle fibre or nerve [13]. In some respects, this arterial branch of the deep inferior epigastric artery (DIEA) is not a 'true' perforator as the vessel does not take an intramuscular course [14]. This scenario is most aptly known as the medial paramuscular cutaneous vessels (MPCV) [15]. While the anatomical variation, course, and frequency of the MPCV are well-characterised, we describe

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a complete muscle and nerve-sparing approach to MPCV flap harvest — namely, the pyramidalis separation technique.

Surgical technique

It is routine in our practice to employ pre-operative CTA to evaluate the anatomical location and arterial diameter of the DIEA perforators, the superficial inferior epigastric artery (SIEA), superficial inferior epigastric vein (SIEV), and superficial circumflex iliac vein (SCIV) anatomy bilaterally. We routinely look for medial and lateral PCV on both sides of the midline, and if PCV are present, the vessel's location, calibre, and axiality are assessed (Fig. 1). Thereafter, the X and Y coordinates of the fascial exit points of all the perforating vessels and PCV, relative to the umbilicus, are transferred to the abdominal cutaneous surface.

Secondly, to provide additional venous drainage options for the superficial component of the flap, dissection of the SIEV and/or SCIV is routinely performed. Immediately following microsurgical anastomosis of the DIEA and its venae comitantes, venous outflow is checked in the superficial system and often we find considerable outflow from the superficial vein. We now routinely perform a second venous anastomosis to the retrograde inferior mesenteric vein [16].

Our third step of abdominal flap harvest is to dissect the superior and medial extent of the flap and identify the MPCV as it exits the rectus fascia. A paramedian fascial incision is made from 3 cm superior to the MPCV to 5 cm above the pubic tubercle; curving laterally in its inferior 5 cm. As the rectus abdominis is retracted laterally, a plane is developed between the free border of the rectus muscle and the reflected anterior sheath of the rectus fascia. Following this plane inferiorly, there is often an areolar plane that develops between the rectus and pyramidalis muscle bellies. Dissecting this plane inferiorly, it is possible to separate the pyramidalis muscle medially, from the rectus abdominis laterally, without division of a single rectus abdominis muscle fibre (Fig. 2).

Fourth, following the MPCV on its para-muscular course, careful attention is paid to separate the pedicle from its vascular branches and ligate them as they enter the deep surface of the muscle (Fig. 3). For additional safety, we routinely leave lateral row perforators intact while dissecting the MPCV to ensure a lifeboat is available in the unlikely event of damage to the MPCV during flap raise [17].

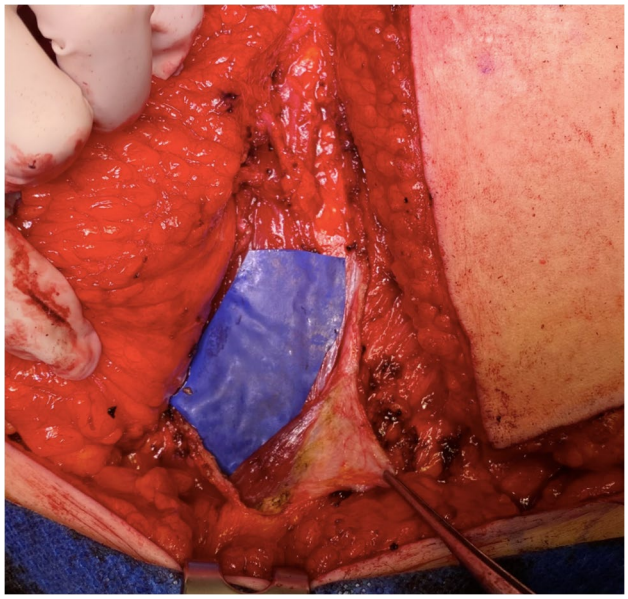

Fig. 2 Pyramidalis identified and reflected medially to rectus abdominis demonstrating the plane lying between these two muscles (blue)

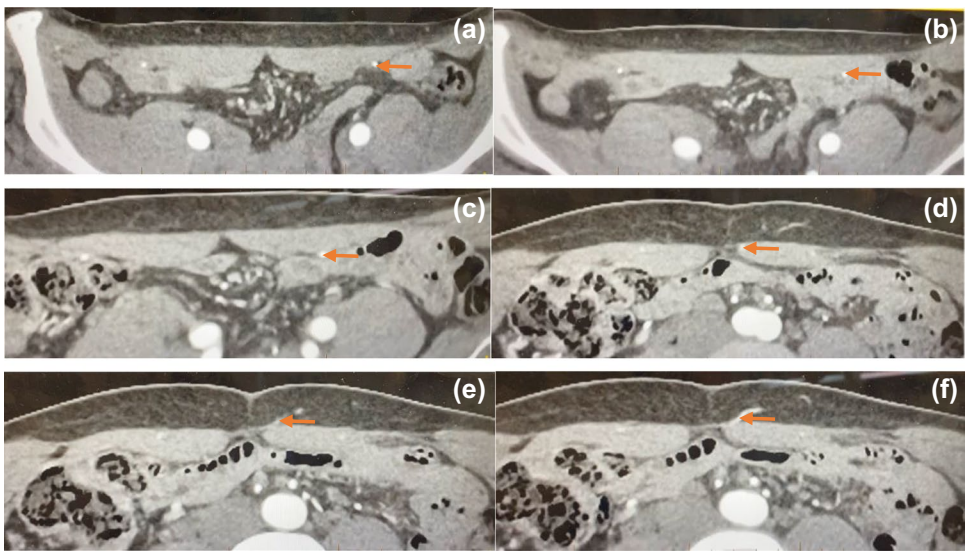

Fig. 1 Computer tomography angiography showing the progressive inferosuperior course of a PCV (orange arrow) laterally (a–b) progressing medially in a submuscular plane (c–d) and emerging around the medial border of the rectus abdominis muscle (e–f)

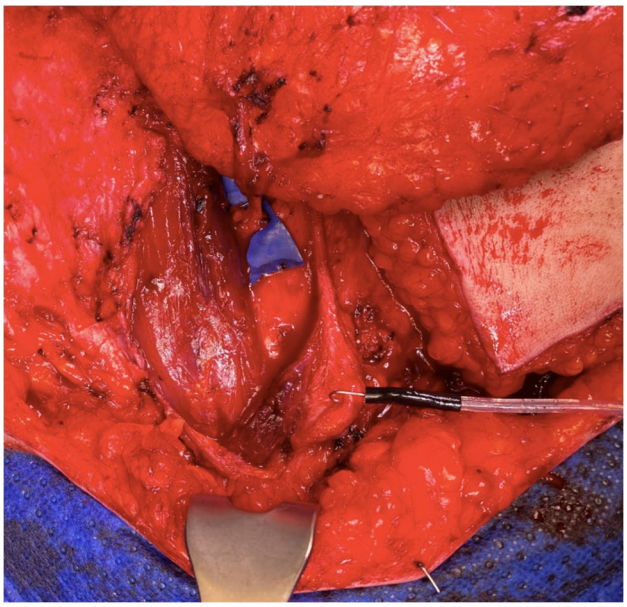

Fig. 3 With pyramidalis reflected and linea alba dissected, a MPCV is revealed emerging deep and medially to the rectus abdominis (blue)

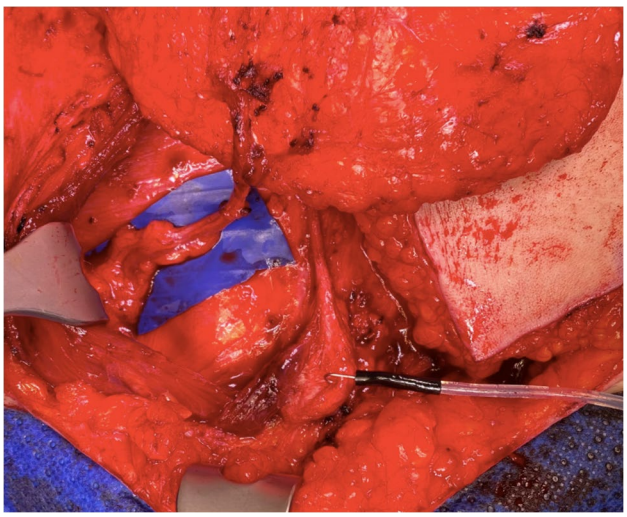

Fig. 4 Rectus abdominis and pyramidalis are retracted in the ideal scenario to reveal the oblique, submuscular course of the PCV. The dominant PCV is freed from surrounding tissue (blue)

Fifth, with the plane between pyramidalis and the rectus abdominis exposed, pyramidalis and rectus abdominis are retracted, allowing greater visualisation of the deep and oblique course of the DIEP flap pedicle (Fig. 4). In this respect, this technique achieves an ideal approach to harvesting by maximising muscle fibre preservation and sparing all motor nerve branches that enter the lateral border of the muscle. We are mindful that excessive tension on the rectus muscle from aggressive retraction laterally. As the MPCV lacks an intramuscular course, we have found that it does not coincide with motor nerves along its course. Hence, the risk of functional damage to the rectus muscle is minimised. From here, careful submuscular dissection continues until the deep inferior epigastric artery origin is demonstrated.

Representative cases

In our practise with 9 patients demonstrating an evident PCV (8 medial and 1 lateral), we have found this technique to provide an elegant and expedient approach to DIEP flap breast reconstruction. There has not been any need for revision in any of these cases. To date, the final result has been stable and enduring at mean 18-month follow-up (Fig. 5).

Discussion

By preserving the rectus abdominis muscle and minimising resection of the fascial sheath, the DIEP flap rationale aims to select adequate perforator size to ensure complete vascularisation of the free flap [18] and minimise donor site complications such as core weakness, bulge, or hernia [19]. In 11 to 15.8% of cases, PCV are present which take no intramuscular course [20, 21]. When recognised, both medial and lateral PCV have the potential to enable a more straightforward flap raise which preserves rectus muscle fibres [22]. In one study, approximately 14% of favourable perforators that facilitated dissection were paramuscular and 56% of those coursed medially to the rectus abdominis [23]. Given this high incidence, it has been suggested that PCV are within normal anatomical limits [11], and the PVC flap approach provides the ideal method for autologous transplant [24, 25].

Since 2003, CTA has been utilised to visualise the presence of PCV and other DIEA perforators [20, 26]. It has been demonstrated that the presence of PCV can decrease mean dissection times by 50 min [22] and lead to a mean dissection time of 122 min where a single PCV has been utilised as the basis for the free flap [27]. Given pyramidalis is present in approximately 83% of individuals [28], our technique of identifying pyramidalis and reflecting the rectus from its oblique border enables retraction of these two muscles to expose the retromuscular course of the paramuscular vessels. This offers a broad, safe, effective, and efficient approach to DIEP flap harvesting. In our experience in raising DIEP flaps based on PCV, we have never damaged the rectus abdominis, encountered the motor branches to rectus, nor had any complications in the breast, such as return to theatre, flap loss, or fat necrosis. Furthermore, this technique is safe to use for bilateral or unilateral DIEP flap harvest.

Fig. 5 Presenting scenario after bilateral nipple-sparing mastectomy and bilateral pre-pectoral tissue expander insertion and left-sided radiotherapy (left). Post-operative result following two-stage bilateral PCV flap reconstruction, and second stage nipple reconstruction (right)

Conclusions

The presence of MPCV represents the ideal scenario for DIEP flap harvest, and a long paramedian fascial incision with a pyramidalis separation technique can facilitate a complete muscle-sparing and nerve-sparing dissection strategy. In such cases, maximising the native anatomy at the donor site in autologous flap surgery allows a practical and streamlined procedure ensuring optimal flap viability and donor-site morbidity.

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Declarations

Ethical approval No ethical approval was required for this article in the institutions, where surgeries were performed. It adheres to the ethical principles outlined in the Declaration of Helsinki as amended in 2013.

Consent to participate The patients presented in this article provided their informed, written consent for the use of their images.

Conflict of interest Milton Louca, Nirmal Dayaratna, and Joseph R. Dusseldorp declare no competing interests.

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