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One hundred cases of abdominal-based free flaps in breast reconstruction. The impact of preoperative computed tomographic angiography

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Summary An accurate preoperative evaluation of the vascular anatomy of the abdominal wall is essential in deep inferior epigastric perforator (DIEP) flap reconstruction. We present our experience of using computed tomographic angiography (CTA) of the abdomen as part of our standard preoperative assessment of abdominal-based breast reconstruction. One hundred consecutive cases were examined retrospectively, divided equally into non-CTA and CTA periods. Following use of CTA, fewer superficial inferior epigastric artery (SIEA) flaps were performed (18% vs. 0%), although the number of DIEP and muscle-sparing transverse rectus abdominis myocutaneous (MS TRAM) 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 1 h 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. A clear knowledge of the dominant perforator(s) to the abdominal skin prior to surgery can greatly increase the success of this procedure and reduce surgical time. In addition, by choosing the largest well-placed perforator supplying the bulk of the flap, it may be possible to reduce the overall morbidity.

The use of abdominal tissue as a source of free tissue transfer in breast reconstruction is well documented.[1] Although originally described as a musculocutaneous flap with the rectus abdominus muscle included transverse rectus abdominis myocutaneous (TRAM) flap, refinements in the flap harvest technique have led to increased use of the deep inferior epigastric perforator (DIEP) flap, the muscle-sparing TRAM flap (MS TRAM) or the superficial inferior epigastric artery (SIEA) flap. Preservation of the rectus abdominus muscle in the DIEA and SIEA flaps has some

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functional advantages for the patient in terms of post-operative morbidity.[2] This is particularly the case when performing bilateral breast reconstructions where both rectus abdominus muscles may be removed or injured.[3] As a result of these considerations, muscle-sparing flaps have become increasingly popular and now represent a significant proportion of breast reconstructions in the UK.[4]

As with most perforator flaps, improvements in surgical planning and flap harvest technique have been explored extensively in the literature. Over time, each of these small refinements has reduced complications and decreased operating times. An example of this is the use of venous couplers, which have reduced anastomosis times and have increased the reliability of the venous anastomosis.[5] More recently, various radiological tools have been employed to identify the abdominal perforators prior to surgery. In particular, identification of abdominal perforators prior to DIEP flap surgery has received much attention and recent studies have shown that by locating the perforators before surgery one can improve surgical efficiency and reduce operating times considerably.[6]

Computed tomographic angiography (CTA) is an established radiological tool to assess abdominal vasculature prior to performing a DIEP flap reconstruction. Rozen et al. have performed both cadaveric and clinical studies using abdominal CTA, and they were able to demonstrate the course of the deep inferior epigastric artery, its perforators and the subcutaneous branching pattern of this vessel.[7] In addition, the accuracy of CTA has been shown to have a high sensitivity (96–100%) and a high specificity (95–100%) [8]

At the Royal Marsden Hospital, free tissue transfer from the abdomen has become the primary choice of breast reconstruction over the past 5 years. Of these flaps, the DIEP flap is the most commonly used, followed by the MS TRAM and the SIEA flap. Since April 2008, we have routinely used abdominal CTAs as part of our preoperative analysis of these cases. The aim of this article is to examine the impact of CTA imaging on our practise and also to discuss the process of image acquisition. We retrospectively studied 100 consecutive cases of DIEP flap breast reconstruction in our unit, divided equally into those with CTA images and those without.

Method

One hundred consecutive cases of breast reconstruction using abdominal free tissue transfer (DIEP flap, MS TRAM flap and SIEA flap) between August 2006 and January 2009 were included in this study. Of these, 50 cases were performed immediately before the advent of CTA imaging and 50 thereafter. Only those cases performed at the Royal Marsden Hospital were included in this study.

Image acquisition

The protocol for image acquisition at the Royal Marsden Hospital is as follows. The patient is first vetted for a history of allergy to contrast and then positioned supine on the CT table. Compression of the abdomen is avoided as this may cause artefacts on the CTA.

Computerised tomography studies are performed using a 32-detector row CT scanner (GE lightspeed, Milwaukee, WI, USA). The energy settings used are chosen to prevent overpenetration of the deep tissues, since this information is not required for this investigation (120- kVp tube voltage and 300 mA fixed tube current). Further settings included a 0.4-s gantry rotation period, collimation 20×0.625 mm, pitch 0.97, 19.4 mm table travel per rotation, 512×512 matrix and a 180–240 field of view. A standard GE reconstruction filter is used. With experience, the optimal settings to produce a good image quality with a low radiation exposure were determined (As Low As Reasonably Achievable–ALARA).

An 18-gauge intravenous (IV) catheter is inserted into the antecubital vein and 100 ml of non-ionic iodinated contrast is injected at a concentration of 350 mg ml^{-1} (Omnipaque 350; Amersham Health, Bucks, UK). The rate of administration is up to 4 ml s^{-1} via a dual-chamber injection pump (injector TC missori XD 2001; Ulrich GmbH and Co. K, Ulm, Germany). Depending on flow rate, there is a 15–20 s delay between contrast administration and image acquisition.

We obtain images from 5 cm above the umbilicus to the lesser trochanter of the hip during a single breath hold over 10–12 s. The radiation dose given to a patient using this technique is 6 mSv (average size patient with scan range of 30 cm). The images obtained are then reconstructed with a slice width of 1 mm and a reconstruction interval of 0.8 mm and transferred to a computer workstation (Advantage Workstation, GE Healthcare, Milwaukee, WI, USA). The images produced can be reformatted in coronal, axial and sagittal planes. Data are then transferred to and stored on the local picture archive communication system (Sectra, Linkoping, Sweden), which can then be easily used and managed on many computer interfaces throughout the hospital.

General patient data collection

Patient data were collected using EPR (Electronic Patient Record), a computerised patient log containing all patient files including clinic letters, operation notes as well as investigations. The patient data were analysed and a Student's *t* test used to examine for statistical significance.

Results

In total, 100 patients were included in the study equally divided between the non-CTA group and the CTA group. Of these patients, 74 cases had unilateral breast reconstructions and 26 had bilateral reconstructions. The number of bilateral cases was greater in the non-CTA group than in the CTA group (16 patients vs. 10 patients). The total number of individual flaps included in this study was 126, with 66 in the non-CTA group and 60 in the CTA group.

The age and body mass index (BMI) of the patients was similar in both groups. In the non-CTA group, the average age was 45 years (range: 36–71 years). In the CTA group, the average age was 49 years (range: 31–65 years). The BMI in the non-CTA group was 27 (range 21–40 years) and 28 in the CTA group (range: 22–40 years).