Original Article

The combination single CT scan for breast cancer staging and reconstruction

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Background: Computerised tomography (CT) scans are necessary for breast cancer staging. Abdominal based free flap breast reconstruction is aided by preoperative CT angiograms (CTA). However, this additional scan increases the radiation dose to the patient, uses valuable resources and may be an inconvenience to the patient.

Methods: We developed a new CT protocol that combined both the breast cancer staging CT with a CTA to look for suitable abdominal perforators for free flap reconstruction.

Results: This new protocol was used in 68 consecutive patients who were considered possible candidates for abdominal based breast reconstruction. The scan quality was excellent, with high consistency with intraoperative findings. There were no free flap failures.

Conclusions: We propose this novel combination CT scan for all patients who will be considered for breast cancer staging.

Keywords: Breast cancer staging; transverse rectus abdominal muscle (TRAM); deep inferior epigastric perforator (DIEP); computerised tomography angiograms (CTA)

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Introduction

Abdominal based flap reconstruction is considered by most to be the gold standard for breast reconstruction as it allows a large volume, autologous reconstruction. A systematic review by Tsoi has shown that it leads to a reduced risk of reconstructive failure as compared with prosthetic reconstruction (1). Since its description in 1994 by Allen and Treece (2) the deep inferior epigastric perforator (DIEP) flap is superior to the transverse rectus abdominal muscle (TRAM) flap, as it preserves abdominal wall musculature, leading to less post-operative pain, shorter post-operative stays and faster recovery (3). It also minimises donor site complications such as a bulge or hernia. Preoperative imaging has become routine in many centres around the world as it identifies perforators which are suitable for flap harvest (4). Computed tomographic angiography (CTA) has been shown to be superior to Doppler with intraoperative findings, reducing partial and total flap failure (5). This allows a preoperative decision to me made, as to which abdominal wall flap to use, which shortens the overall operating time. A common criticism is that CTA increases the radiation dose to the patient, due to the necessity of doing an extra scan. We have developed a technique of combining the CTA with the patient's staging CT scan (chest, abdomen and pelvis) for breast cancer surveillance, thereby reducing both the number of scans and the subsequent radiation to the patient.

Table 1 CT scan parameters for DIEP protocol

Scanner	Toshiba Aquilion One, helical multidetector
Slice thickness	0.5×80
Detector pitch	Standard PF 0.813, HP 65
Gantry rotation speed	0.6 sec (arterial) and 0.5 (portal venous and delayed)
Tube potential	120 kV
Tube current	Smart mA: dose modulation varies with patient size and body region
IV contrast	Omnipaque 350 100 mLs
IV contrast rate	Single injector, 20 G Iv cannula, 4mLs/sec
Range 1	Arterial phase—symphysis pubis to supraclavicular region
Range 2	Portal venous phase—started 40 secs post arterial scan—diaphragm to pubic symphysis
Range 3	Delayed liver at 5 minutes
Bolus tracking	No ROI used. Smart Prep sample at groin; "Go" when contrast seen in femoral artery. Manual trigger; scan delay is 4 secs from the press of the button

DIEP, deep inferior epigastric perforator; PF, pitch factor; HP, helical pitch; CT, computed tomographic; ROI, region of interest.

Figure 1 Axial image from CT scan, illustrating excellent scan quality. CT, computerised tomography.

Methods

The CT scan parameters are summarized in *Table 1*. The first range is similar to Rozen's CTA for DIEP protocol (5), in that the scan is in the arterial phase and performed in a caudal to cranial direction from the symphysis pubis. Our protocol differs in that instead of the scan finishing at 3 cm above the umbilicus, it is continued cranially to include the chest and finishes in the supraclavicular region. The second range is of the hepatic portal venous phase to identify hepatic metastases. This is performed in a cranial to caudal direction from the diaphragm to pubic symphysis. The third (equilibrium) phase looks for hypervascular tumours (HCC), blood pooling (haemangiomas) or scar tissue. This is delayed by 5 minutes and runs in a cranial to caudal direction again directly over the liver.

Results

Since Jan 2012 we have used this CTA protocol technique in 68 consecutive patients with breast cancer, who have been referred to the senior author for breast reconstruction and were considered for immediate free DIEP or TRAM flap reconstruction. This has formed part of our previously published 'reverse protocol' (6) whereby patients who have locally advanced breast cancer undergo preoperative neoadjuvant chemotherapy then also receive radiotherapy before having a single stage mastectomy and autologous reconstruction. We have also used this CTA protocol successfully in patients who required staging prior to a mastectomy and reconstruction.

Of the total patients 66 underwent immediate DIEP reconstruction and 2 were done as delayed cases.

The scan quality achieved was universally excellent (*Figure 1*). The scan was then reformatted using the OsiriX programme (*Figure 2*) allowing preoperative planning of which perforators and type of flap to select. Intraoperative findings in both groups were consistent with the preoperative CTAs such that the intraoperative plan did not need to be changed compared with the preoperative findings. There were no complete or partial flap failures.

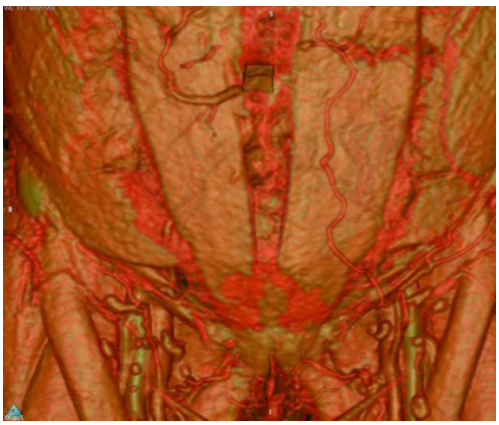

Figure 2 3D reconstruction using OsiriX system of CT scan in *Figure 1*. CT, computerised tomography.

Discussion

Whilst CT scans are invaluable to the breast clinician for both staging and reconstructive purposes; there are unfortunately competing aims of each investigation and prior to this protocol it necessitated 2 separate scans (7). The main reason a staging CT scan could not be used for preoperative DIEP flap reformatting was due to the fact that the arterial phase of the scan was performed in a craniocaudal direction which is counterproductive to seeing the perforators of the deep inferior epigastric artery.

By reversing the direction of scanning in the arterial phase we can obtain the required information for DIEP planning whilst not affecting the oncologic staging all in the same scan. Radiology reporting of the staging scan has been unaffected by the change in protocol. Obviously, this is of great value to both the patient and the broader healthcare system in terms of time, resources and costs.

Another specific advantage of the "Combination Scan" is the reduction of the total irradiation to the individual, which may elevate a person's lifetime risk of developing radiation induced cancer. To this end, there is a public health drive to reduce the amount of lifetime radiation that a patient is exposed to wherever possible (7).

The radiation dose range for this new staging-CTA is 8–14 mSv, which is the same as a staging chest, abdominal and pelvis CT. The range for a standalone CTA of the abdominal wall vasculature is 7–13 mSv—equivalent to 350–650 chest X-rays (7), which is therefore avoided with the new protocol. Whilst some authors suggest MRA as another option (8,9), this involves a further inconvenience to the patient, possibly delay in management and increased costs. Furthermore, there is a greater propensity for movement artefact with an MRA versus a CTA.

The "Combination Scan" has become the standard of care in our institution and has no downside. It has been successfully implemented with a DIEP flap survival of 100%.

Conclusions

We therefore propose this novel CT protocol for all patients who will be considered for breast cancer staging. It allows comprehensive staging in the appropriate patient and simultaneously allows the same images to be used for reformatting for DIEP flap reconstructions either as an immediate or delayed reconstruction.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/abs.2018.03.01). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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