Pre-operative Perforator Flap MRA for Autologous Breast Reconstruction

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Target Audience: Body MRI Radiologists, Mammographers, Plastic Surgeons, MR physicists.

Purpose: Breast reconstruction after mastectomy using autologous perforator flaps of skin and fat to reconstruct a natural breast are increasingly popular. Here we correlate the accuracy of pre-operative perforator flap MR Angiography with surgical findings and outcomes. This retrospective analysis also describes our experience with spiral LAVA for SIEA and IMA, 2-point Dixon for improving homogeneity of fat suppression, image post-processing, interpretation as well as automated calculation of perforator coordinates and estimated flap volumes.

Methods: MRA at 1.5T using gadofosveset (10ml) was performed in 123 perforator flap angiography (PFA) studies from October 2011 to October 2012. Perforators were visualized on axial 3D LAVA using TR/TE/Flip=4/1.9/15, matrix=512x512x (172-240), bandwidth=125 kHz, 3 mm slice thickness reconstructed at 1.5mm intervals. MRA findings were compared with surgical findings when available (n=107). A reporting tool was developed to automatically calculate perforator coordinates, flap volume, intramuscular distances and vessel diameters (n=96, Fig. 1). In selected patients plastic surgeons requested spiral LAVA for the Superficial Inferior Epigastric Artery (SIEA) and Internal Mammary Artery (IMA) and/or the 2-point Dixon fat/water separation at 3T.

Results: Among 120 patients who underwent 123 MRA exams in the last 12 months, 107 underwent 160 autologous breast reconstructions; bilateral (n=50) or unilateral (n=57) or revision (n=3) and 6 patients are awaiting surgery. Graft harvest sites included deep inferior epigastric artery perforators (DIEP, n=92), inferior gluteal artery perforator (IGAP, n=5), superior gluteal artery perforator (SGAP, n=1), profunda artery perforator (PAP, n=58) and thoracodorsal artery perforator (TDAP, n=3). Superficial inferior epigastric artery perforators (SIEP, n=1). The remaining 7 patients had anesthesia contra-indications (n=3) or metastatic disease discovered on MRA (n=4). Surgical follow-up shows MRA accurately localized candidate perforator arteries within 1cm in all cases. MRA predicted flap volumes (380 to 2345 ml, mean=884ml) correlated well with surgically harvested flaps (402 to 2234, mean =836). The initial flap design plan based on MRA was used for surgery in 94% of cases. Flap necrosis was seen in 3 cases which compares favorably to 14% reported in the literature[1]. No other complications noted.

Discussion: Since the advent of MRA and CTA for preoperative perforator localization, operating room times have shortened and outcomes have improved. Imaging also screens for metastases which we found in 4% of our patients. For pure arterial phase images, e.g. SIEA visualization or to rule out TDA/IMA stenosis, a spiral k-space trajectory LAVA reconstructed at 3sec temporal resolution allowed flexibility to find the moment of maximal arterial enhancement before venous contamination (Figs 2, 3). An automated reporting system implemented in xcode/cocoa as an Osirix plugin using objective-C language streamlined workflow issues and reduced manual data entry errors (Fig 1). Of the 27 reports created manually, 3 (10%) had manual entry errors that were rectified before surgery. Such errors were not seen in any automated reporting system case. We have also noticed superior quality using a 2 point Dixon method for fat/water signal separation (Lava flex, GE) (Fig 2).

The ratio of PAP to IGAP/SGAP was 8.6 compared to 1.7 in prior years indicating an increasing surgical preference for the posterior thigh harvest site (Fig. 5). Dissection is easier for PAP flaps, it produces a longer pedicle and there is a favorable cosmetic result achieved by tucking the PAP harvest site scar into the buttock crease. SIEA flaps are also decreasing as the large caliber peri-umbilical DIEP are preferred to the small caliber SIEA vessels.

In summary, skin MRA accurately maps perforator vessels for breast reconstruction with autologous tissue and is preferred over CTA at our institution.
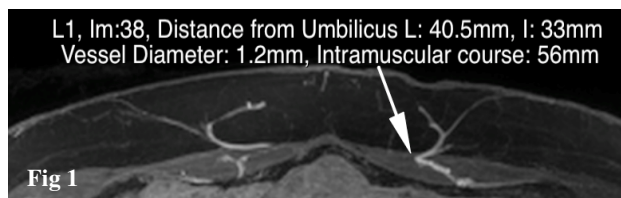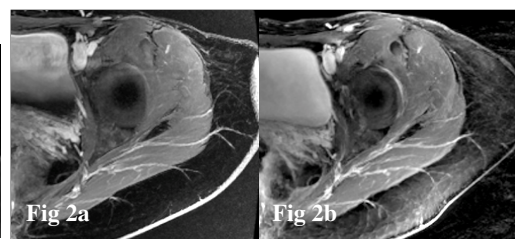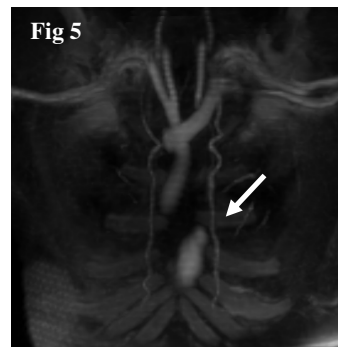
Fig 5

Fig 4a

Fig 4b

Fig 3

L1, Im:38, Distance from Umbilicus L: 40.5mm, I: 33mm
Vessel Diameter: 1.2mm, Intramuscular course: 56mm
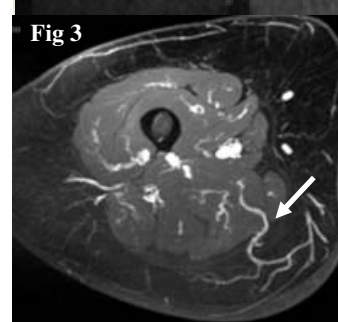Fig 1

Fig 2a

Fig 2b

Fig1. An axial image through the abdomen demonstrates the course of perforator and the co-ordinates given by the automated reporting system.
Fig2. An axial image through gluteal region demonstrates uniform fat saturation in LAVA flex images (a) compared to the regular HR LAVA (b).
Fig3. Axial image through thigh demonstrates the course of perforator through adductor magnus muscle and subcutaneous tissue.
Fig4. SIEA seen very well in Spiral lava sequence (a) compared to the vascular bundle on equilibrium phase (b).
Fig5. Internal mammary artery visualized by high temporal resolution 3D spiral lava technique.

References:[1]Minqiang X, et al. Br J Radiol. 2010 Jan;83(985):40-3. doi:10.1259/ bjr /29140440.