High temporal resolution MR imaging for more accurate diagnosis of DCIS

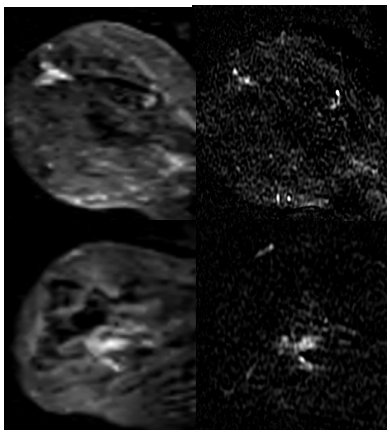
C. Yang[1], M. Medved[2], H. Abe[2], M. Zamora[2], G. Karczmar[2], G. Newstead[2]

[1]Department of Medicine, The University of Chicago, Chicago, IL, United States, [2]Department of Radiology, The University of Chicago, Chicago, IL, United States

Abstract: This study was designed to determine whether high temporal resolution imaging of contrast media uptake can help to identify and evaluate breast abnormalities in the vicinity of suspicious microcalcifications (MCs). Dynamic contrast enhanced MRI (DCEMRI) of the breast were acquired with 4 – 7 second time resolution for the first 90 seconds after contrast media injection. Data were analyzed to produce 'AUC30' images – the integral of contrast media concentration as a function of time for the first 30 seconds after bolus arrival. The images delineate small lesions more clearly than conventional difference images (venous minus arterial phase) and may help to identify DCIS at an early stage.

Introduction: The specificity of DCEMRI is poor, particularly for DCIS (1). We believe that this is in part because uptake and washout of contrast media are often inadequately sampled. As a result, very rapid contrast media uptake associated with abnormally dense vasculature in DCIS is likely to be missed. We will determine whether more complete sampling of contrast media kinetics (referred to here as high temporal resolution sampling - HiTS) improves diagnostic accuracy.

Methods: The women studied were referred for routine clinical 1.5 Tesla MRI scans to follow up suspicious mircocalcifications found on mammography. High temporal resolution sampling (HiTS) was incorporated into the standard clinical protocol. MR images from 4 slices through suspicious MCs were acquired with temporal resolution of 4-7 seconds during the first pass of the contrast media bolus following I.V. injection of Omniscan (0.1 mM/kg). We have performed 15 studies to-date of women with suspicious MCs. In 2 patients, image slices were misregistered so that they did not adequately sample the location of the MCs. The contrast media concentration as a function of time was calculated for each voxel. Then the AUC30, which is the area under the contrast media concentration-time curve for the first 30 seconds after bolus arrival, was calculated for each voxel (Evelhoch) (2).



Conventional AUC30

Figure 1

Results: **Figure 1** below shows two representative AUC30 images of breast lesions (right column) paired with conventional difference images (left column; before contrast injection image subtracted from a 2 minutes post-contrast image). In these examples, and in most breasts imaged so far, the lesion was much more clearly depicted and distinguished from non-specific background enhancement in the AUC30 image than in the conventional images.

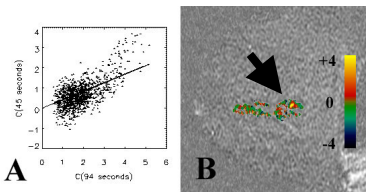


Figure 2

Changes in morphology of the enhancing region over time after injection were evaluated. To do this, we plotted the concentration of contrast agent at 45 seconds after injection ('y' axis) against the concentration of contrast media at 94 seconds after injection ('x' axis) for every pixel in the lesion. **Figure 2A** shows that although many of the pixels fall along the fitted straight line, a significant percentage do not – this means that the enhancement pattern changes during the first 90 seconds after injection. **Figure 2B** shows an image of normalized deviation of each pixel from the best-fit straight line in **Figure 2A**. The points that lie above the line in the upper right quadrant – yellow pixels in **Figure 2B** have a contrast media uptake rate that is relatively fast compared to washout.

Discussion: Lesions are shown clearly against a dark background in AUC30 images. Most of the images acquired to date demonstrate significant changes in morphology of the enhancing region over time after injection. Therefore the morphology of the region that enhances early cannot be appreciated on conventional images acquired with one minute time resolution.

Conclusions: The HiTs approach – when combined with other indicators- may improve sensitivity and specificity for DCIS.

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References:

1. Gilles R, Zafrani B, Guinebretiere JM, et al. Ductal carcinoma in situ: MR imaging-histopathologic correlation. Radiology 1995; 196(2): 415-9.

2. Evelhoch, JL. Key factors in the acquisition of contrast kinetic data for oncology. J Magn Reson Imaging 1999; 10(3): 254-9.