

Accelerated DCE Breast Imaging with Isotropic Spatial Resolution and a Small Temporal Footprint

Leah C Henze-Bancroft¹, Frederick Kelcz², Kevin M Johnson³, and Walter F Block^{1,3}

¹Department of Biomedical Engineering, University of Wisconsin - Madison, Madison, WI, United States, ²Department of Radiology, University of Wisconsin - Madison, Madison, WI, United States, ³Department of Medical Physics, University of Wisconsin - Madison, Madison, WI, United States

INTRODUCTION: Debate exists over what qualifies as adequate temporal and spatial resolution in DCE breast MRI. Malignant lesions often have heterogeneous uptake patterns as well as a characteristic washout pattern that is most distinct from that of benign lesions during the first 90 seconds. Standard clinical sequences achieve 60-second temporal resolution and spatial resolution of 1mm or less in plane but 1-3 mm through plane¹. We present initial results of our attempt to determine whether a tight temporal footprint (15 s) and spatial resolution (1 mm isotropic) can better characterize heterogeneously enhancing lesions.

THEORY AND METHODS: Eight patients being sent for breast biopsy entered the study, which prescribed two days of scanning per patient; one day using the standard clinical breast MRI protocol, the second day using a rapid imaging technique, 3D radial (VIPR) SPGR^{2,3}. The settings for the 3D-VIPR SPGR sequence were as follows: 10° flip, 4 half echoes, 5.2 ms TR, 20 cm FOV. Data acquired near the beginning and end of each multiple echo train near the center of k-space is de-emphasized to effectively shorten the data acquisition interval and reduce the sensitivity to B_0 inhomogeneity⁴. Fat suppression was achieved through subtraction of a precontrast mask, which also increases the ability to accelerate through undersampling by making the image volumes sparse. Image reconstruction parameters were chosen retrospectively to provide a true 15 second or 105 second temporal footprint and 1.04 mm isotropic spatial resolution. Parameters for the standard Cartesian clinical DCE were as follows: 6.84ms TR, 3.33ms TE, 10° flip, .625x.625x5.6 mm resolution. Fat suppression for this sequence was achieved through an inversion pulse.

RESULTS AND DISCUSSION: Figure 1 shows the results from the first two time frames (60s) of one conventional DCE scan, which can only be viewed in the sagittal plane. The lesion margins have visible spicules though enhancement is fairly homogeneous. The three orthogonal reformats of the corresponding 3D-VIPR SPGR exam, shown in Figure 2, were chosen to depict the margin of the lesion. In the sagittal and axial planes, the lesion displays a ring-like enhancement pattern (lesion enhances from the outside towards its center) characteristic of malignancy, while in the coronal frames (from anterior tip of lesion), one can appreciate a spiculated appearance of a rim that enhances in the first 30-45 s due to the short temporal footprint and the reduction in averaging in the slice dimension. To date, this method has only been used on unilateral acquisitions but due to the multicoil acquisition and the sparsity created by the precontrast mask, it should be possible to use the PILS⁵ effect and compressed sensing⁶ to expand to bilateral imaging and reduce the noise-like undersampling artifact.

CONCLUSION: We have presented an accelerated 3D-VIPR SPGR sequence capable of providing 1mm isotropic spatial resolution and temporal resolution selected retrospectively by the user. Mask subtracted images provide good depiction of lesion enhancement and margin.

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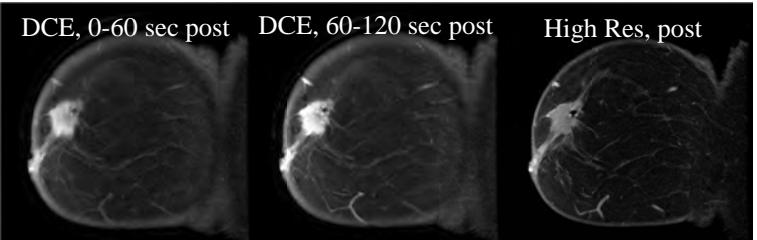


Figure 1: Conventional DCE scan and high resolution post contrast scan. Lesion margins and heterogeneous uptake patterns are less

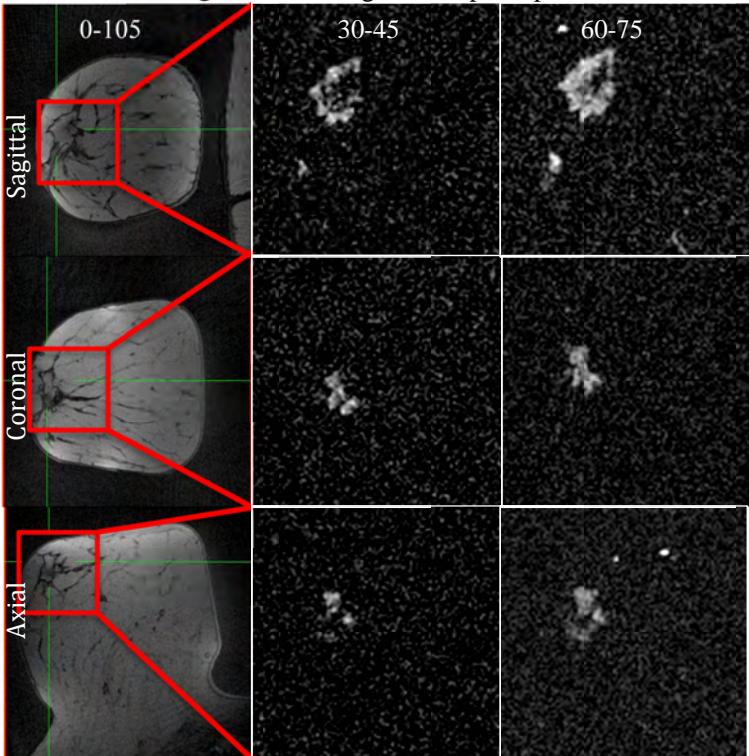


Figure 2: Isotropic 3D-VIPR SPGR DCE images with a 105sec temporal footprint (left) and with a true 15 second temporal footprint (center / right) and mask subtraction (only select frames shown). Heterogeneous, ring like, enhancement is seen in the sagittal and axial planes with margins enhancing in the early and later frames while the lesion interior enhances in the later frame. In the coronal plane spicules become more apparent in the later frame.