Impact of TWIST View Sharing on Lesion Enhancement Profile in Dynamic Breast MRI

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Target Audience Radiologists, MRI physicists and scientists.

Introduction TWIST (Time-resolved angiography With Stochastic Trajectories) view-sharing has recently been applied in breast DCE-MRI[1-4]. The purpose of this study is to investigate the impact of such view-sharing on the signal enhancement measured in breast tumors using simulations[5].

Methods A digital 'phantom' of 36x36x13 cm^3 and 448x448x160 voxels was generated which includes spherical 'tumors' of 3, 5, 7 and 9 mm which show "wash-out" type of enhancement characteristics embedded in non-enhancing breast tissue[6]. *K*-space data were simulated for 1 pre- and 5 post-contrast time points using parameters of typical clinical breast DCE-MRI acquisition, including 80% phase resolution, 70% slice resolution and 80% partial Fourier in frequency/phase/slice direction. *K*-space view-sharing strategies (forward and sharing) and view order were the same as in actual TWIST sequence. Each k-space view was modulated according to the enhancement curve at the time of acquisition. The size of the central region of k-space (pA) was varied from 10% to 100%. The sampling density for the periphery of k-space (pB) was 50%, which is what we used in our clinical study. Temporal resolution was maintained at a constant value of 60 seconds by adjusting the size of the acquisition matrix. Reconstructed image set was interpolated back to the original size of 448x448x160 by zero-filling in k-space. RMS error of the measured signal, $1/N\sqrt{\sum_{i=1}^{N}(Signal_{measured}(i) - Signal_{True}(i))^2}$, was calculated for the 1st post contrast time point and ROIs were selected with three times the diameter of each tumor. $Signal_{true}$ is the 'true' enhancement value that has been assigned to the phantom at the time point when center k-space was acquired.

Results More accurate tumor profile (lower ringing artifact, sharper edge and more uniform signal in the center of tumor) was achieved when TWIST backward sharing was used (Fig.1). Similarly, RMS error shows the measured enhancement had the lowest overall error in tumor and the surrounding area with TWIST backward sharing. This error decreased with decreasing pA. For forward sharing, however, a pA of 30-50% provided best result.

Discussion Given a fixed acquisition time, less view-sharing requires a smaller acquisition matrix and results in lower spatial resolutions. Although TWIST view-sharing allows higher intrinsic resolution, its benefit is partially offset by artifacts due to the continuously changing contrast enhancement during the acquisition (spatial-temporal blurring). This effect is more pronounced with forward sharing where some of the peripheral k-space views for the 1st post-contrast image were actually acquired pre-contrast. However, this effect can be avoided with backward sharing, which also prevents the sharing of pre and post contrast data.

Conclusion Simulation study shows that backward TWIST view sharing theoretically provides more accurate measurements in breast DCE MRI.

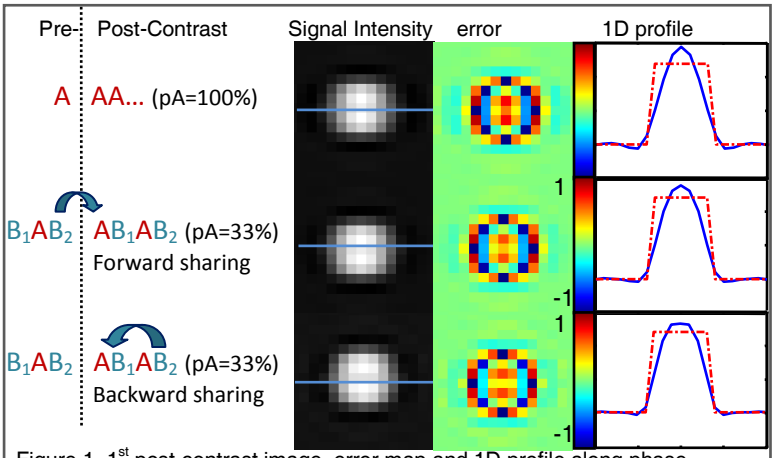

Figure 1. 1st post-contrast image, error map and 1D profile along phase encoding direction ((blue solid lines show the profile along blue line in the images, red dash lines show true value) in 5mm wash-out type tumor, with no view sharing (pA=100%), forward and backward sharing.

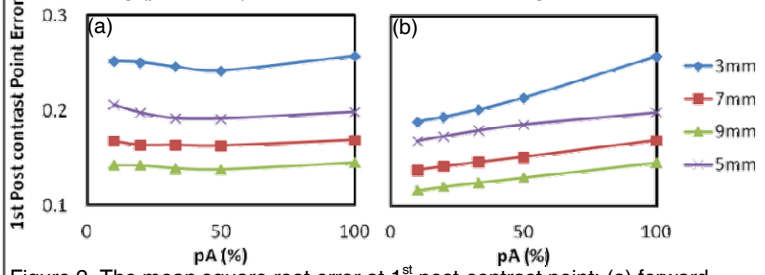

Figure 2. The mean square root error at 1st post-contrast point: (a) forward sharing, and (b) backward sharing.

Reference

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