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Time Resolved Contrast-Enhanced Breast MR with 0.6 Isotropic Spatial Resolution

INTRODUCTION

Contrast-enhanced breast MR is increasingly used for the evaluation of breast lesions and the dynamic contrast uptake curve is crucial in separating malignant from benign tumors. In the past, spatial resolution has often been sacrificed in order to achieve the frame rate needed for time resolved acquisitions. Pixel size has typically hovered around 1 mm in-plane and 2 to 4 mm in the slice-select direction. We have explored the use of a new sequence TWIST in combination with parallel imaging to achieve higher spatial resolution for dynamic evaluations with 60 second temporal resolution of breast morphology and lesions.

METHODS

Imaging was performed using a dedicated phased-array breast coil and a 1.5T whole body system (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany). We have evaluated this in tow volunteers.

With TWIST imaging, k-space is divided into a center region A, and a peripheral region B. All k-space points are sorted according to their radial distance k_r from k=(0,0), and azimuthal angle Φ. A radial threshold k_c divides region A and B. The k-space trajectory in both region A and B is starting and ending at k_c. Fig. 2 shows that the trajectory starts in region A at point 1 to take every other k-space point of the sorted k-space distribution until the center is reached at point 2. From here the missing k-space point are used outwards to point 3. In region B we use a bigger, variable stepping rate until point 3 is reached, and come back to the interface at point 4. Region A will be repeated similar to the first time (point 5 – 7) followed by region B with a different trajectory to fill the missing point of the first B scanning. The key advantage of this technique is that a full range of k-space coverage from k=0 to kmax occurs for every repetition of the basic cycle. Thus, high-frequency information is updated at the same rate as the central region A. In addition, TWIST imaging was performed with parallel imaging (with acceleration factor of 2) to achieve near isotropic voxel size of 0.7 x 0.6 x 0.8 (phase x read x slice) mm.

The parameters used were: TR = 4.48 ms TE = 1.98 ms, 160 slices were acquired in 93 s (1st) and 60 s subsequent scans, matrix size was 415x512 (phase x read) with 0.8 mm slice thickness (effective thickness 1 mm, 76% under-sampling); region A = 30 % of total k-space, region B = 50 % under-sampling.

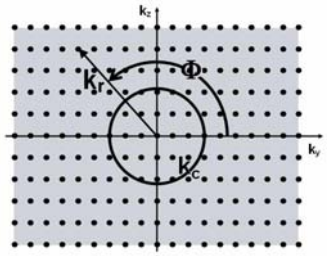

Fig.1: Sorting of k-space sampling points.

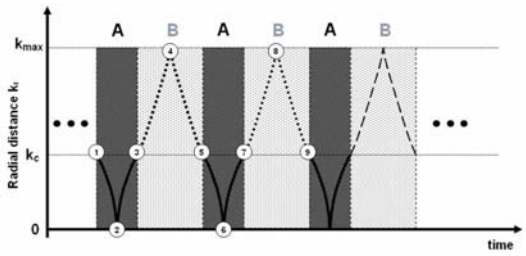

Fig. 2: k-space trajectory of TWIST

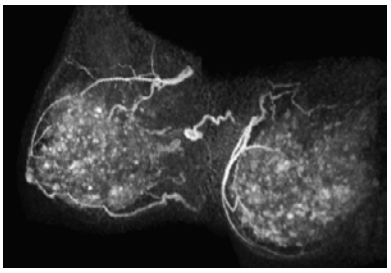

Fig 3: Medial-lateral-oblique (MLO) reconstruction from 1 min subtraction.

RESULTS

3D TWIST enabled isotropic spatial resolution to be achieved within a 60 second temporal resolution constraint. The images resulted in improved multi-planar as well as oblique reconstructions. The spatial resolution was greater than those of standard dynamic scans without TWIST.

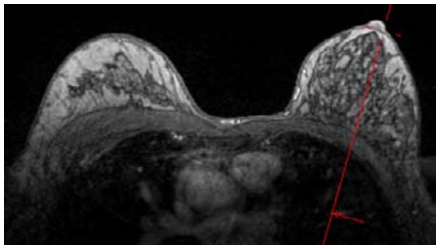

Fig. 4: Reconstruction reference of 1 min acquisition

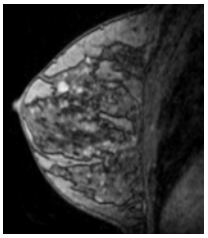

Fig. 5: Sagittal reconstruction of acquisition data

CONCLUSION

We have demonstrated high resolution time-resolved 3D imaging of the breast using TWIST and parallel imaging. This provides improved spatial resolution coupled with dynamics of contrast enhancement for breast evaluations.