Adaptive Bilateral Breast Imaging Using PR-TRICKS

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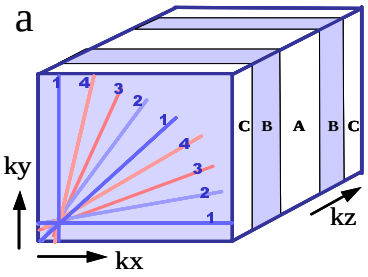
Introduction: The idea of adaptive reconstruction allows one to reconstruct images sets having different spatial and temporal resolutions from a single large data set. This is an attractive idea in the field of breast imaging, where diagnosis relies on both high temporal resolution images to track contrast kinetics, and high spatial resolution images to examine lesion morphology. With standard MRI protocols, these two requirements cannot be met in single examination, especially if the examination is done bilaterally. Successful implementation of adaptive reconstruction would eliminate the cost and inconvenience of multiple visits.

Projection reconstruction (PR) imaging using radial in-plane k-space trajectories has previously been used for adaptive imaging of the breast (1). These trajectories oversample the centre of k-space, so that low-resolution images can be obtained very quickly. PR-TRICKS, a 3D imaging technique originally developed for use in MR angiography (2), uses radial trajectories in the kx-ky plane, combined with time ordered Cartesian sampling scheme in the kz direction. Fast low-resolution images can be obtained by reconstructing only a low number of projections in-plane, together with the most central kz planes. Alternatively, more projections and data from outer regions of kz can be included to give images with high spatial resolution and low temporal resolution. We have adapted this sequence for breast imaging, optimizing the parameters, and including k-space interleaved bilateral imaging (3).

Methods: After informed consent, 8 healthy subjects were imaged on a 1.5T GE Signa scanner. The PR-TRICKS sequence was a modified 3D SPGR sequence, with 256 readout points along each trajectory, (TR/TE/FA)=(15.6ms/3.2ms/30°), 2.0mm slices, and an FOV of 20 cm. The k-space data were interpolated to a 256x256 Cartesian grid using a Kaiser-Bessel kernel. Figure 1a shows the PR k-space. In the kx-ky plane, there were 256 projections divided into 4 "dither groups" containing 64 projections each. In the kz direction, 36 partitions were organized into 3 "frames" A, B and C, with the A frame containing planes closest to the centre of kz. The time order of k-space sampling is indicated in the table in Figure 1b. For each breast, twelve low-resolution images were reconstructed from each A frame. These images included only the 64 projections of a single dither group, and took 12 seconds to acquire. Reconstruction of high-resolution images involved groups of 16 frames (as shown in Figure 1b), and included all 256 projections and all 36 kz values. Each set of high-resolution images had 36 slices per breast and took 192 seconds to acquire.

a



b

Frame	BACA	BACA	BACA	BACA…
Dither Group	1	3	2	4…

Figure 1. The diagram on the left shows the organization of k-space into 4 dither groups in the kx-ky plane, and into 3 frames in the kz direction. The table below indicates the order in which the elements of k-space were acquired. Each frame takes 12 s, each dither group, 48 s.

Results: Typical images are shown in Figure 2. The number in the lower left of each panel is the time to acquire a complete set of bilateral images of the given type. The low spatial resolution PR-TRICKS image shown in Figure2a has high temporal resolution and would be used to track the kinetics of contrast enhancement. The high-resolution PR-TRICKS image in Figure 2b shows well-resolved structures within the breast, and would be used to study the morphology of abnormalities. Figure 2c shows a Cartesian 3D SPGR image (15.6ms/3.2ms/30°, 256x256, same slices as PR-TRICKS), which is comparable to the PR-TRICKS high-resolution image in resolution and general contrast. The quality of the PR-TRICKS images was consistent for all volunteers, and for both breasts.

Discussion: These images clearly demonstrate that this adaptive reconstruction technique is feasible for use in clinical studies. Since both low high temporal and high spatial resolution images can be obtained from a single bilateral scan, a complete contrast enhanced breast exam can be done in a single visit and with a single injection of contrast agent.

References: (1) Song et al, MRM 2001; **46:**503-509 (2) Peters et al , MRM 2000; **43**:91-101 (3) Greenman et al, MRM 1998; **39**:108-115

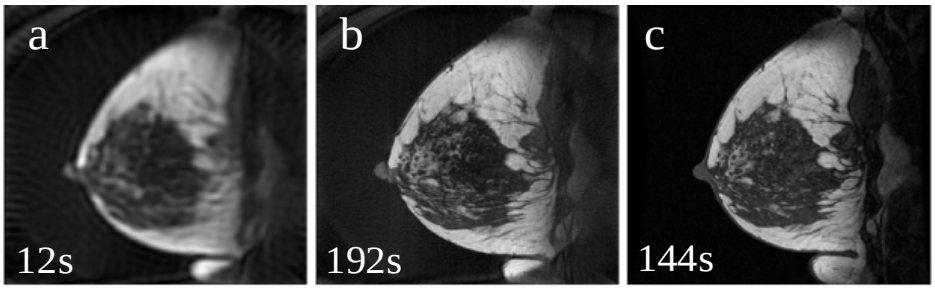


Figure 2. a) Low resolution PR-TRICKS image, b) high resolution PR-TRICKS image, and c) Cartesian 256x256 image with same TR for comparison. The acquisition time for each image type is shown in the lower left corner, for the bilateral case. Times for unilateral exams would be half these values.