High-Resolution 3D Bilateral Breast Imaging Using Slice Direction Autocalibrated Parallel Imaging

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INTRODUCTION

Dynamic Contrast-Enhanced (DCE) imaging of the breast has been shown to provide high sensitivity in the detection of cancer [1]. Because the typical DCE protocol requires a time series of images to provide information on contrast uptake, the use of traditional scanning techniques can limit image coverage to a single breast because of time constraints. However, the advantages of bilateral breast imaging are receiving greater recognition [2]. In addition to the economic benefits of a single contrast-enhanced exam, bilateral imaging eliminates estrogen-level dependent contrast uptake when separate breast exams are performed. The breast imaging protocol at our institution includes a high-resolution sagittal 3D fat-suppressed study to provide anatomic data for diagnosis. To date we have imaged more than 400 patients using a bilateral version of this sequence that incorporates an auto-calibrated parallel acquisition scheme. Here we demonstrate the excellent image quality that can be obtained in a scan time comparable to a traditional single breast technique.

MATERIALS AND METHODS

All imaging was done at 1.5T using Signa scanners (GE Healthcare, Milwaukee, WI, USA). The sequence used for the high-resolution anatomical breast studies was a 3D spoiled gradient-recalled echo (SPGR) sequence modified to collect k-space data suitable for an auto-calibrated parallel imaging reconstruction. Excitation was done with a 16 ms spatial-spectral pulse, and a 1 ms on-resonance magnetization transfer (MT) pulse was used for additional background tissue suppression. Imaging was done in the sagittal plane with an eight channel breast coil (GE Healthcare, Milwaukee, WI, USA), before and following gadolinium contrast injection. A typical imaging volume consists of approximately 160 slices, 1.5-2 mm thick, to provide coverage over both breasts. The frequency direction was placed in the anterior-posterior direction to limit artifacts from cardiac motion, while aliasing in the superior-inferior direction is limited by the sensitivity of the coil. The in-plane matrix was set to 512 points in the readout direction and 192 phase encodes. A fractional echo was used to reduce the echo time (TE), and the typical repetition time (TR) and TE was 29.8 ms and 8.6 ms, respectively. An elliptic-centric phase encode order is used to capture the post-contrast enhancement early in the scan time.

Parallel imaging was performed in the slice direction using an outer reduction factor of 2. To provide autocalibration data for the reconstruction, a region of 20×96 central phase encodes in the $k_z \times k_y$ direction was fully sampled. This reduces the total number of excitations necessary for a complete study from 30720 to 16320 (a 47% reduction) for a scan time of 6.2 minutes for 160 sections. The accelerated data were then unaliased using the Autocalibrating Reconstruction for Cartesian sampling (ARC) method [3] using a 3-dimensional reconstruction kernel.

RESULTS

Figure 1 shows representative pre- and post-contrast results in a patient with a 9 cm multifocal intermediate grade ductal carcinoma in situ (DCIS). These images have a resolution of 0.4 x 1.0 x 1.8 mm, with 160 sagittal sections. Excellent image quality is obtained in both the native sagittal and reformatted axial planes, with the latter demonstrating the lack of residual aliasing artifacts in the slice direction. The spectral-spatial excitation provides very consistent fat suppression while the MT pulse gives additional suppression of fibroglandular tissue.

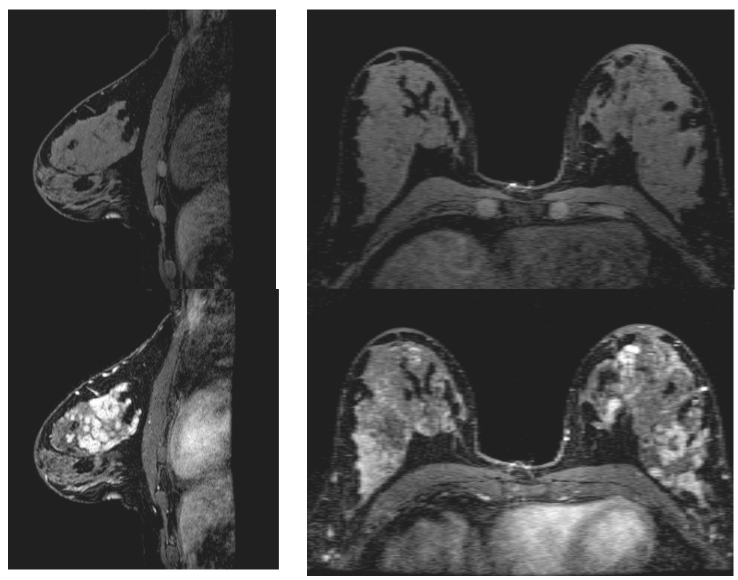

Figure 1: *Pre-contrast and post-contrast sagittal (left) and axial-reformatted (right) bilateral breast images using 2x ARC in the slice direction and spectral spatial excitation.*

CONCLUSION

We have demonstrated that it is possible to obtain a high quality slice-accelerated bilateral breast study using an autocalibrated parallel imaging technique in a scan time comparable to an equivalent unilateral study. Future work will investigate further time savings through the use of a bilateral spatial-spectral pulse [4]. This would allow the simultaneous excitation of each breast volume, and would eliminate the need to phase encode the central area in between.

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