16-Channel Custom-Fitted Bilateral Breast Coil for Parallel Imaging in Two Directions

A. N. Nnewihe[1,2], T. Grafendorfer[3], B. L. Daniel[1], P. Calderon[3], M. T. Alley[1], F. Robb[3], and B. A. Hargreaves[1]

[1]Radiology, Stanford University, Stanford, CA, United States, [2]Bioengineering, Stanford University, Stanford, CA, United States, [3]GE Healthcare

Introduction. Screening dynamic contrast MRI (DC-MRI) is recommended for women at high risk for breast cancer, but the low specificity of DC-MRI has limited its widespread adaptation to clinical practice (Saslow et al., 2007). High spatial and temporal resolution imaging could be used to better classify lesions with the potential to improve diagnosis (Konyer et al., 2002; Zhu et al., 2007; Orel et al., 2001). With the appropriate coil geometry, parallel imaging acceleration in two directions can enable high spatial and temporal resolution imaging. In addition, a bilateral coil is recommended for performing diagnostic patient exams (Friedman et al., 2006). In this work we compared a novel 16-channel bilateral breast coil to a standard 8-channel industrial coil, in terms of SNR and parallel imaging capability.

Methods. We built a 16-channel close-fitted array of small surface coils using a mold from a medium-sized (cup B) woman's chest as a template (Fig. 1). The coil element geometry was designed to facilitate acceleration in two directions and decoupling of adjacent coil elements through overlap. The coil consisted of 14 coil elements of 7.5cm diameter and 2 coil elements of 5cm diameter. The coils were arranged in two hexagonal arrays with the extra coil placed at the axilla on each side.

Two normal volunteers were imaged using a 3D spoiled gradient recalled echo sequence and a water-only excitation for fat suppression. Two scans were performed using each coil: no acceleration and 6.6x effective acceleration including calibration lines [4x R/L and 2x S/I]. The following parameters were used: axial, 0.31x1.67x2.2 mm resolution and 5:43 scan time for the non-accelerated scan, and axial, 0.31x1.25x2.2 mm resolution and 1:05 scan time for the accelerated scan. All imaging experiments were performed on a 3.0T GE MR750 scanner. Accelerated images were reconstructed using Autocalibrating Reconstruction for Cartesian (ARC) reconstruction.

For the non-accelerated scans, the SNR was measured in a glandular ROI at the center of the breast. The SNR was defined as the mean of a small ROI in the glandular region divided by the standard deviation of an ROI away from the breast, on the edge of the field of view.

Results. The results from one volunteer are shown in Figure 2. For the non-accelerated images, the SNR was 1.8x higher using the custom 16-channel coil versus the industrial 8-channel coil (Fig. 2a, 2d). The accelerated images using the custom coil (Fig. 2b, 2c) showed fewer artifacts when compared with the industrial coil (Fig. 2e, 2f). Both the accelerated and non-accelerated images with the industrial coil have significant heart motion artifact (Fig.2d-f). Regions of increased noise as well as aliasing are evident in the accelerated images with the industrial coil (Fig. 2e, 2f).

Discussion. We have demonstrated that our custom 16-channel coil can perform high-quality bilateral breast imaging at 6.6x parallel imaging acceleration with high spatial and temporal resolution. Our design allowed for 2D imaging acceleration with readout in the A/P direction to avoid cardiac motion artifact. In addition, the geometry of the coil limited sensitivity to cardiac motion. Overall, we have shown that a close-fitted surface array can substantially improve both SNR and parallel imaging capability compared with standard 8-channel bilateral breast coils.

References. Saslow et al., *CA Cancer J Clin* 57:75-89, 2007. Konyer et al., *Radiology* 222:830-4, 2002. Zhu et al., *JMRI* 25:96-103, 2007. Orel et al., *Radiology* 220:13-30, 2001. Friedman et al., *AJR* 187:345-9, 2006.
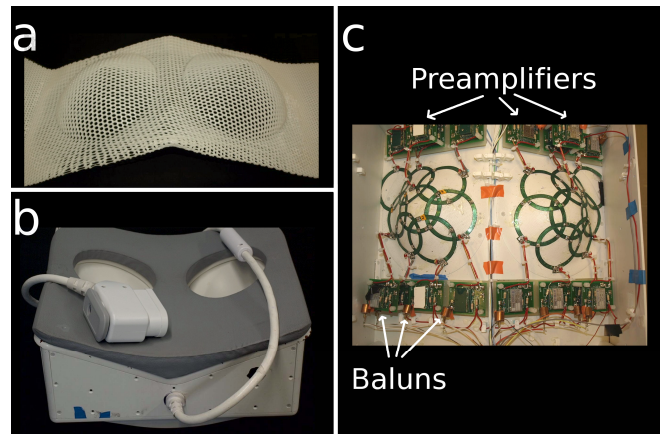
Figure 1. 16-Channel Custom Breast Coil. *a)* Thermoplastic mold of medium-sized (cup B) breasts. *b)* Mechanical housing and *c)* Electronics for custom 16-channel breast coil. The thermoplastic mold was used as a template in designing the 16-channel breast coil.
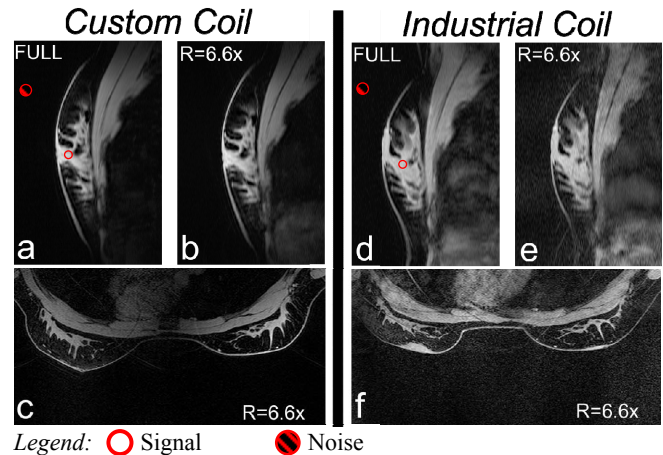

Figure 2. Normal Volunteer Scans Comparing 16-Channel Custom Coil and 8-Channel Industrial Coil. All accelerated images had 6.6x effective acceleration [4x R/L and 2x S/I], and all images were acquired using a 3D spoiled gradient recalled echo sequence with a water-only excitation for fat suppression. All sagittal images are reformats. Using the 16-channel custom coil, we show *a)* full acquisition sagittal, *b)* accelerated sagittal, and *c)* accelerated axial slices. Using the 8-channel custom coil, we show *d)* full acquisition sagittal, *e)* accelerated sagittal, and *f)* accelerated axial slices. The non-accelerated custom coil image has 1.8x higher SNR in a glandular region at the center of the breast (see red circles) when compared to the corresponding industrial coil image. There is little difference between the full acquisition image and accelerated image using the 16-channel custom coil. On the contrary, in the accelerated industrial coil image, there are significant parallel imaging artifacts.