Eight Channel Custom Breast Coil for Parallel Imaging in Two Directions

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Introduction. Screening dynamic contrast enhanced MRI (DCE MRI) is recommended by the American Cancer Society for all women at high risk for breast cancer[1]. We hypothesize that high resolution MRI could delineate morphological and architectural features such as internal septations, spiculated margins and rim enhancement as well as newly described smaller scale features such as peri-ductal enhancement. However, the tradeoff with high resolution MRI is that its time-consuming acquisition can miss cancers characterized by a strong washout[2].

As with many applications, parallel imaging has revolutionized breast MRI. However, the specific geometry of breast imaging requires attention. It is desirable to perform breast MRI with the readout in the anterior-posterior direction to avoid cardiac motion artifact in the breast. This leaves the other two directions for possible acceleration with parallel imaging. Most commercial breast coils do not offer very good parallel imaging in the superior-inferior direction, and most compromise SNR in order to allow biopsy, which is rarely performed at the time of diagnostic imaging. Literature has suggested that smaller coils could be used to better characterize intraductal lesions[3]. The purpose of this work is to investigate breast imaging using surface arrays that provide 2D parallel imaging acceleration, but also a high base-line SNR.

Methods. We built a unilateral 8-coil breast array (3 inch diameter circular elements) coil on a custom former and mounted the array inside a closed breast housing. In order to construct a customized breast former, we acquired a thermoplastic mold of a medium-sized woman's chest. We measured the dimensions of the thermoplastic mold and constructed a hand crafted replica using G10 fibercomposite – a sturdier, MR compatible mold. For small and medium-sized breasts, the former allows coils to be placed much closer to the breast without compressing the breast. Similar design concepts could be applied to accommodate for larger size breasts. An outside vendor built a closed robust breast coil housing to support the breast former, on-coil preamplifiers, and cables. Coils were laid in a hexagonal element array with the seventh coil in the middle and the eighth coil covering the upper outer quadrant (axillary nodes) of the breast. The main advantages of the hexagon pattern are that the central coil is decoupled via geometric overlap with the neighboring six coils and that parallel imaging acceleration could be performed in both the superior/inferior [S/I] and left/right [L/R] directions.

All imaging experiments were performed on a 3.0T GE Signa scanner. In order to compare the performance of the custom coil to the industrial coil, three sets of images were acquired: spherical saline phantom images for SNR comparison, grapefruit images for emphasis on high resolution detail, and *in vivo* breast images of a normal volunteer. Accelerated images (2x S/I and 2x L/R) were also acquired of the grapefruit and normal volunteer using Autocalibrating Reconstruction for Cartesian (ARC) imaging.

Results. From the saline phantom scan, we found that the SNR of our custom coil was three times higher than the industrial coil. Using the custom coil, the high resolution grapefruit images show finer detail than the industrial coil images. In addition, the breast images with the custom coil have higher SNR than the industrial coil images while still covering the entire breast.

Discussion. We havc demonstrated the high potential of a surface breast coil array for both high SNR and better parallel imaging in the breast. The design allows 2D parallel imaging with A/P readout to avoid cardiac motion artifact in the breast. Our current coil requires further tuning to improve overall intensity variation and we plan to assemble an additional eight elements to enable bilateral breast imaging. We expect this to enable us to double the net 2D acceleration factors of 3.3 that we have demonstrated, while maintaining reasonable SNR. Although continued studies will be necessary to assess whether improved imaging warrants the use of multiple coils to fit different patients, these initial results are promising.

References. [1] Saslow et al., *CA Cancer Journal* 57, 2007. [2] Kuhl, *Radiology* 244, 2007. [3] Kanemaki et al., *AJR* 182, 2004. **Acknowledgements.** We would like to acknowledge Mohammad-Medhi Khalighi, Michael Nelson, and Fraser Robb for technical support in setting up the custom coil. **Funding.** NIH Regenerative Medicine Training Grant, California Breast Cancer Research Program IDEA Grant, and GE Gift Grant.

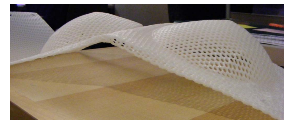

Figure 1. Thermoplastic mold of medium-sized breast. Mold was used as template to create a custom breast former.

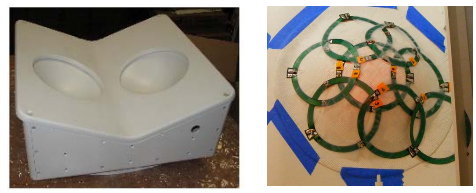

Figure 2. **a)** Finished breast coil housing. **b)** Coil element layout on custom former.

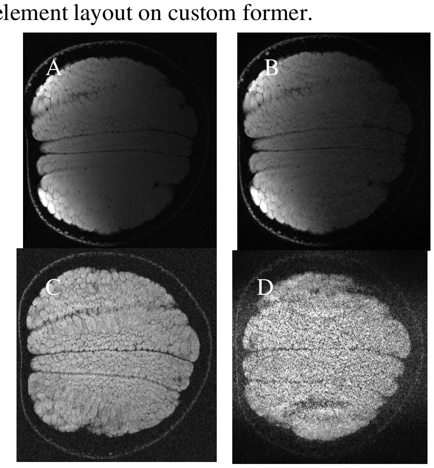

Figure 3. Grapefruit phantom [3D 384x256x64] imaged with **a)** custom coil image and no acceleration [3:56 scan time] **b)** custom coil with 3.3x acceleration [1:04 scan time] **c)** industrial coil with no acceleration **d)** industrial coil with 3.3x acceleration. Acceleration was performed in L/R and S/I directions. Note custom coil has three times SNR in full acquisition images.

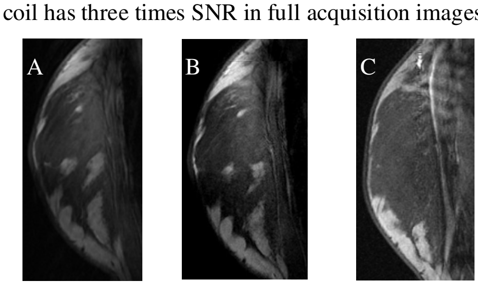

Figure 4. In vivo image [3D 256x256x56] from a normal volunteer using **a)** custom coil and no acceleration, **b)** custom coil and 3.3 acceleration and **c)** industrial coil.