31 channel, flexible breast coil for 3T imaging

Ileana Hancu[1], Eric Fiveland[1], Keith Park[1], Kenneth Rohling[1], Seung-Kyun Lee[1], and Luca Marinelli[1]
[1]*GE Global Research Center, Niskayuna, NY, United States*

Target Audience: Clinicians/scientists interested in breast imaging

Purpose: Diffusion weighted imaging (DWI) is increasingly used in breast MRI, in an attempt to increase the specificity of cancer detection [1]. DWI is usually performed using EPI acquisitions; the long echo times of such scans cut deeply into image SNR, therefore limiting the spatial resolution of the images. The typical 8-30 μl DWI voxel volume makes image interpretation difficult and hampers the detection of small lesions. There are limited ways to increase DWI image SNR; one of the straight-forward such approaches relies on an increase in the number of receive channels for the breast array [2]. In this work, we present a novel, 31 channel breast coil designed for 3T imaging. This receive (Rx) array is flexible, and allows it to conform to different breast sizes, therefore preserving the high filling factor for all subjects. Results obtained with this coil in phantoms and in vivo are presented and compared to similar results obtained with the 8 channel GE breast coil.

Methods: The design of the breast coil is presented in Figure 1. The 31 coils, of approximately square shape and 3.5 inch on the side, are arranged on 3 rows along the superior/inferior (S/I) direction, with 10/11/10 coils on each row. The electrical and mechanical components of the coil are decoupled; should a different support for the women be designed, it will require no redesign of the flexible array. All components of the coil (inductors/capacitors/diodes) are aligned along 8 different lines (running S/I), which are covered with ribs. This setup allows for maximal right/left flexibility, allowing the coil to conform to different anatomies. Overlaps between neighboring coils were slightly changed going from the sternum to the axilla, to account for the average bending of each coil. The coils were tuned on a phantom made out of a torso compartment and two ~500ml breast compartments, all filled with water, 1g/l $CuSO_4$ and 1.1g/l NaCl. Imaging was performed using this torso/breast phantom to obtain SNR and g factor maps in a manner previously described [3], using both this flexible array coil, and the 8 channel GE coil. In vivo images were also obtained with both the 31 channel coil and the 8 channel coil using a 3D spoiled GRE sequence (TE/TR=1.7/3.8ms), and no acceleration factor (r=1). All experiments were performed on a GE, MR750 3T system.

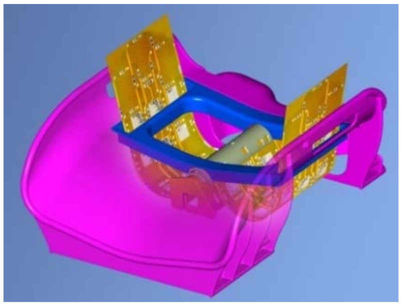

Figure 1: CAD design of breast coil

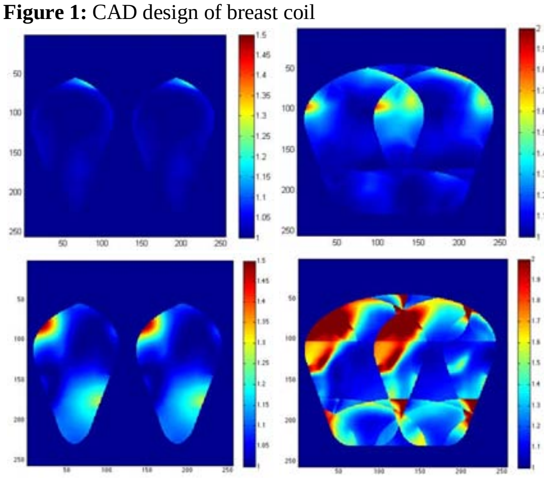

Figure 2: g-factor maps for 31 (top) and 8 channel coil (bottom), for acceleration factors of 2x1 (left) and 3x2 (right)

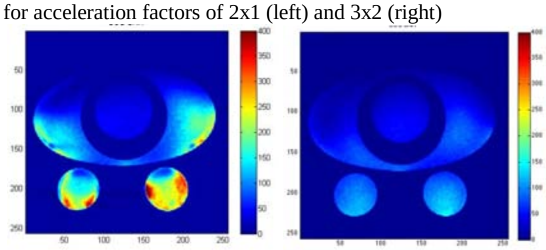

Figure 3: SNR maps for the 31 (left) and 8 channel coil (right)

Results: Figure 2 displays g factor maps for the torso/breast phantom setup for both the 31 (top) and 8 channel coils (bottom). Acceleration factors of 2x1 (R/L) are shown for both coils in the left column and 3x2 (R/L and A/P) are presented for the two coils in the right column of Figure 2. As expected, the increase in the number of channels translates in significantly higher capability of accelerating imaging. Note that for the 31 channel coil, g-factors of less than 1.25 exist for acceleration factors of up to 6. This could lead to higher temporal resolution dynamic contrast enhanced (DCE) imaging, which allows better kinetic modeling of data and higher specificity in cancer detection [4]. Figure 3 presents signal to noise (SNR) maps (sum of squares) for both coils, using the same phantom configuration. Note the a factor of 2 higher SNR in all areas of relevance for breast imaging (breasts and axilla). Figure 4 presents a slice of a 3D SPGR acquisition, using the 31 channel (left) and the 8 channel coil (right). Note that subjects were scanned feet first (31ch) and head first (8ch); this explains the different signal intensities in the right/left axillas in the 2 cases, with the transmit image shading remaining on one side of the magnet. The significantly higher SNR seen in the phantom experiments of Figure 2 was also visible in vivo; an average ~70% signal increase could be seen with the 31 channel coil than with the 8 channel coil. Higher gains in SNR will be seen as acceleration factors are increased, as typically needed for DCE-MRI.

Discussion and Conclusions: A novel, flexible 31 channel breast coil designed to operate at 3T is presented. This coil can conform to each subject's body, and offers significantly increased performance (higher SNR, capability of higher acceleration, etc) than a standard, 8 channel clinical coil. The higher SNR seen here when increasing the channel count by a factor of 4 are consistent with results seen in brain imaging in a similar situation [5]. Due to the smaller size of the Rx coils, however, correction for receive shading may be needed.

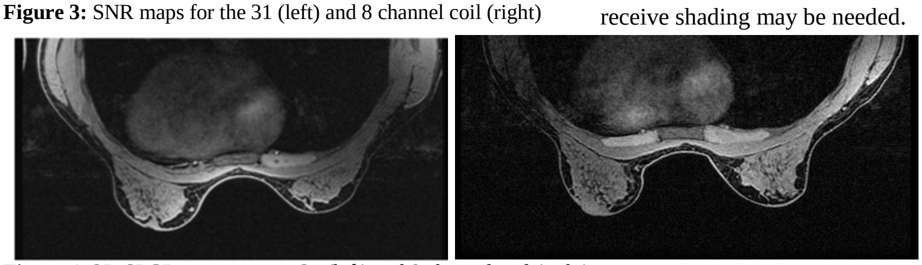

Figure 4: 3D SPGR images using 31 (left) and 8 channel coil (right)

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References: [1] Thomassin-Naggara et al, Eur J Radiol, in press [2] Marshall et al, J Magn Reson Im, 31:328 (2010) [3] Nnewihe et al, Magn Reson Med 66:281, 2011 [4]Jansen et al, Phys Med Biol, 55:N473, 2010 [5] Wiggins et al, Magn Reson Med 56: 216, 2006.