PARALLEL IMAGING CAPABILITIES OF AN 11-CHANNEL COIL FOR MRGHIFU IMAGING.

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Introduction: The purpose of this work was to evaluate the parallel imaging capabilities of an 11-channel RF coil designed and constructed for a breast-specific MRI guided high intensity focused ultra-sound (MRgHIFU) system

Methods: A 10-channel cylindrical ladder phased-array coil with a loop coil at the chest was built (**Figure 1**) for its relatively high SNR, ease of implementation, and parallel imaging capabilities. The capacitively decoupled non-overlapping coils allowed for more unique (reduced overlapping) coil sensitivity profiles, which aided in parallel imaging. All experiments were performed in a Siemens TIM Trio 3T MRI scanner (Siemens Healthcare, Erlangen, Germany) For SNR comparisons (**Figure 2**), a gradient echo sequence was used with (1 mm)^3 isotropic spatial resolution, TR/TE 500/4.12 ms and 25^o flip angle. Inverse g-factor maps were calculated for several reduction factors (**Figure 3),** and the mean g-factor value is reported. MRgHIFU experiments were performed with the MRI compatible 256-element phased array HIFU transducer system (IGT, Inc. Bordeaux, France). A homogeneous agar phantom was heated with 60 acoustic watts for 30s. Temperature maps were acquired using a phase difference calculation using a 2D GRE sequence, TR/TE = 13/10ms, 2x2x3mm resolution, 20° flip angle, 5 slices. Temperature maps were computed using the chest loop only, and the MRgHIFU coil with no GRAPPA, and R=2, and R=4 reduction factors (**Figure 4**). With no GRAPPA the time of acquisition was 5.8s. Using an R=2 reduced the acquisition time to 4s and R=4 reduced the acquisition time to 3s.

Results: The 11-channel cylindrical coil compared to the single loop chest coil had 2.4 times the SNR in the center of the breast and 4.5 times more SNR at the skin of the breast. The mean g-factor for a circular region of interest (radius = 4cm) in the center of the treatment cylinder for each reduction factor is equal to 1.446 (2x2), 1.551 (2x3); 1.566 (3x2), and 1.990 (1x4). The temperature maps were less noisy for the MRgHIFU coil compared to the chest coil and with parallel imaging the curves were noisier for 1x4 but still described the heating region of interest well**.**

Discussion: The breast ladder coil gave much better SNR than the single chest loop. This increase translates directly to higher resolution both spatially and temporally. The g-factor maps and values show that a reduction factor of 1x2 can be achieved throughout the breast volume while maintaining a higher SNR than the chest coil. The temperature maps for the breast ladder coil have less noise giving more accurate temperature maps. The temporal resolution can be increased, which allows for more precise heating of the tumors and increases patient safety and treatment efficacy.

Conclusions: The multiple channels of the MRgHIFU breast coil allow the use of parallel imaging techniques, which are not possible with a single loop chest coil and due to the increased SNR compared to the chest loop coil, the SNR when using parallel imaging does not suffer greatly. By obtaining more rapid temperature acquisitions monitoring the tumor ablation should be improved.

References: [1.] Jevtic J. 2001. Proceedings of ISMRM; p 1434. [2.] Roemer PB, et al. 1990. Magn Reson Med 16: 192-225. [3.] Jolesz FA, et al. 1994. Magn Reson Q 10(2):85-96.

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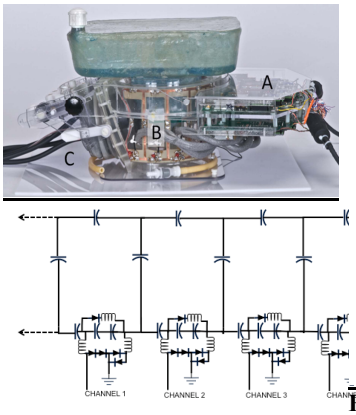

Figure 1. The MRgHIFU coil with integrated MRgHIFU treatment cylinder. The fiberglass MRI homogeneous phantom is placed in the system. Circuit diagram showing three of the ten channels in the ladder phased array MRgHIFU breast coil.

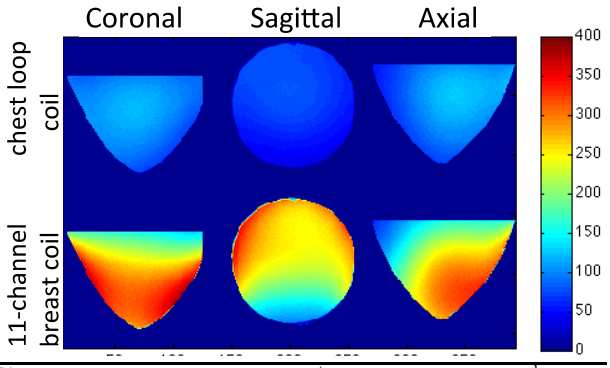

Figure 2. SNR maps using 1st row: chest coil 2nd row: MRgHIFU coil.

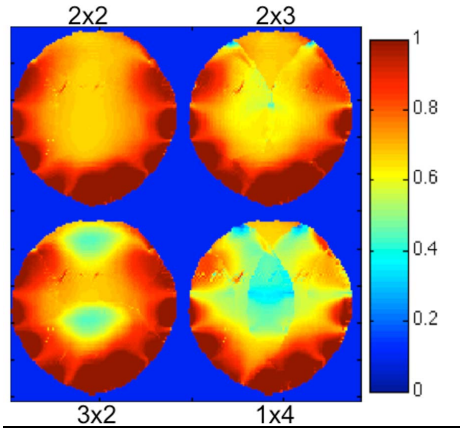

Figure 3. Inverse g-factor maps of a homogeneous phantom in coronal plane.

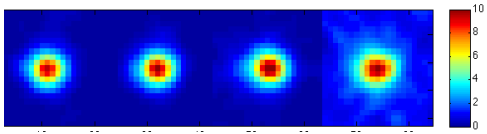

Figure 4. Maps of the hottest heating point in time using A. Chest coil only, B. MRgHIFU coil (R=0), C. MRgHIFU coil (R=2), D. MRgHIFU coil (R=4).