

Local excitation important for breast MR: signal energy from outside the FOV decreases contrast using non-Cartesian acquisitions

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INTRODUCTION

Non-Cartesian sampling strategies such as spiral and radial have been extensively explored in breast MR imaging for their data acquisition efficiency and their ability to produce a relatively benign appearance of undersampling effects. Regardless of the sampling technique, the volume of interest is degraded by excited signal outside the FOV [1]. Commercial receive only breast coils require slice/slab excitation from the body coil. This global excitation creates signal outside the FOV. In Cartesian acquisitions, the detrimental effect is a phase wrapped image and is avoided by placing the frequency encoding direction along the dimension that has signal beyond the FOV. For non-Cartesian acquisitions, active suppression of signal outside the FOV can be performed with saturation pulses, but these pulses are not time efficient and contribute to RF energy deposition and are therefore undesirable for fast imaging sequences like ‘stack-of-spirals’ [2] and 3DPR SSFP [3]. A local transmit/receive breast coil based on a solenoid design is compared with a commercial receive-only coil to demonstrate that local excitation minimizes the signal energy contaminating the FOV for non-Cartesian breast MR by minimizing signal outside the volume of interest.

METHODS

A large water phantom filled with NaCl simulating the signal from the body was placed over a gel breast phantom (Fig 1). A sagittal 3D radial bSSFP sequence (3DPR SSFP) acquired isotropic data (TE/TR/FA 2.5ms/2.7ms/15°, matrix 320x320, FOV 20cm) using a 1.5 T scanner (GE SignaHD, Milwaukee, WI). The FOV covered the volume of interest (breast phantom) but did not cover the large water phantom. This experiment was performed using a receive-only 8-channel commercial breast coil (GE, Milwaukee, WI) and a previously described transmit/receive solenoid breast coil (Fig 2) [4]. Several regions of interest were measured for the relative contrast between the volume of interest and the background calculated as $(S_o - S_b)/S_b$, where S_o is the signal within the object and S_b is the signal in the background.

RESULTS

The appearance of coherent signal energy using the receive-only coil can be appreciated qualitatively when the image is windowed to express the background (Fig 3a). This signal energy from outside the FOV is minimized with the transmit/receive coil (Fig 3b). The contrast measurements using a non-Cartesian acquisition are displayed in Table 1. Not only are the contrast values higher for the transmit/receive coil, they are also much more consistent across the image.

DISCUSSION

Using a non-Cartesian acquisition, signal energy from outside the FOV adversely affects the volume of interest, possibly of clinically relevant structures in the breast. Local excitation with a transmit/receive breast coil minimizes the excited tissue outside the FOV. Future work will include in-vivo experiments to quantify the reduction in noise using a localized excitation as well as extension to the 3T field strength where the reduced SAR deposition and artifact level will partially benefit contrast in T2-weighted scans. Since bilateral breast exams are clinically performed due to the high rate of contralateral breast cancer, two transmit/receive solenoid coils will be used together to repeat the experiment during a bilateral acquisition.

REFERENCES

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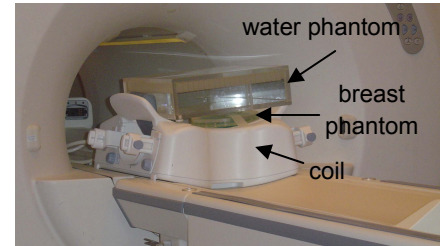


Fig 1. Experimental setup of water phantom containing NaCl water on top of the 8-channel commercial breast coil.

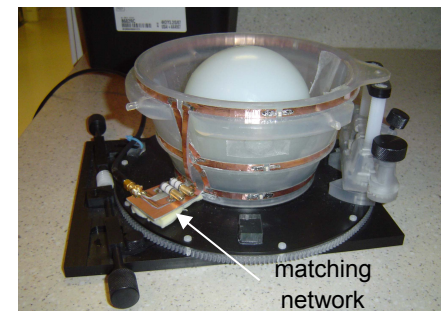


Fig 2. Transmit/receive solenoid coil. The coil was designed for use with an interventional breast system and consists of a single channel conductor with three turns of varying radii to replicate the breast shape.

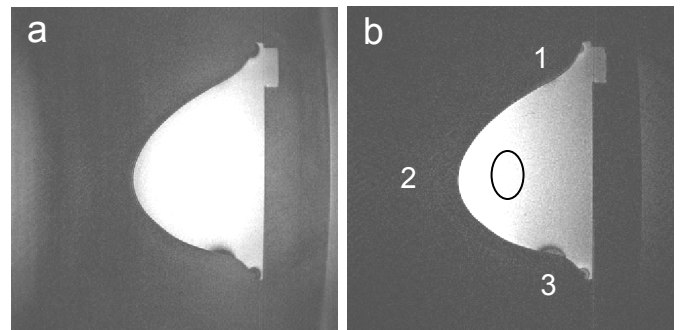


Fig 3. Non-Cartesian 3DPR SSFP results for (a) commercial receive-only 8-channel breast coil and (b) transmit/receive solenoid coil. Images are windowed to improve visibility of the background. Numbers designate regions where the contrast was measured. The circled region designates the region where the object signal was measured.

ROI	8-Channel	Solenoid
1	6.6	16.5
2	10.7	15.6
3	5.5	17.9

Table 1. Contrast measurements for regions designated by numbers in Fig. 3b.