A new unilateral breast specific coil design and dual-modality interface configuration for MR/scintimammography

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PURPOSE

MRI is the most sensitive biomedical imaging technique in delineating various types of tumor, and it has proven to be a useful tool for local stating surgical planning for cancer.[1-2] However, the relatively low specificity of MRI, albeit its high sensitivity, could lead to redundant biopsies or over-treatment. Scintimammography (SMM) can be an excellent supplementary imaging modality for improving the diagnostic specificity in breast cancer imaging. Previously, we demonstrated the feasibility of a unilateral breast MR receiver coil for simultaneous MR/SMM in the presence of high magnetic field (3T) and the geometrical handicap of CZT detector modules.[3] It is now prominent that MR receiver coil should keeps high B1 field profile and homogeneity under MR/SMM environments. The high SNR can be achieved by proper design of the MR receiver coil's shape, size and orientation.[4] In this proceeding, we demonstrate a new unilateral breast specific coil design and MR/SMM interface configuration for MR/SMM imaging to achieve the high SNR in the MR images.

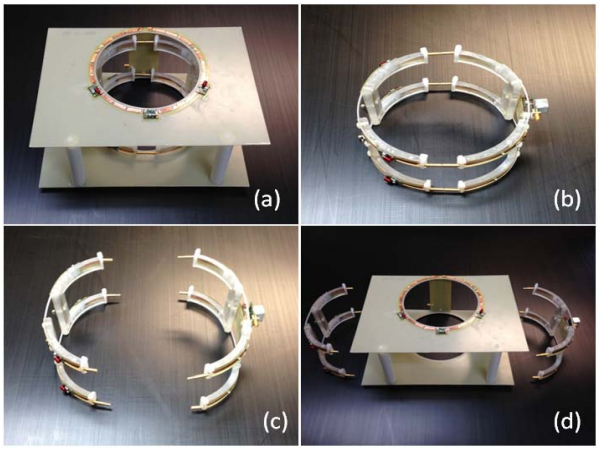

Fig. 1. The new design of the MRI coil. Besides the top and bottom circular coils, we added a transverse saddle coil (a). The transverse saddle coil can be separated into two semi-cylinder to make it easily detachable (b,c,d). When disengaged, the space left by saddle coil allows suitable positioning of CZT detector modules.

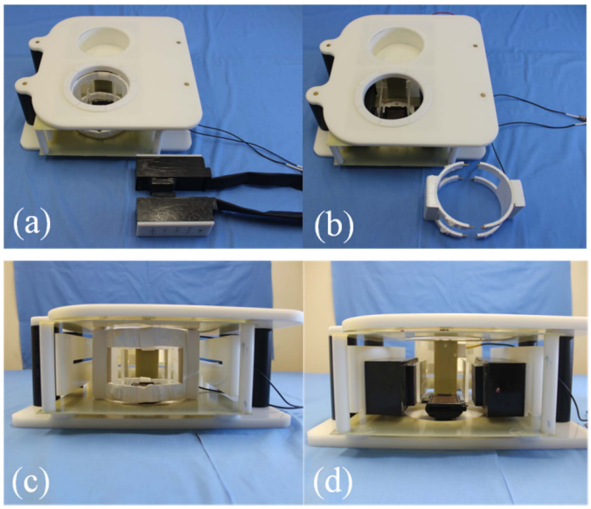

Fig. 2. The MR/SMM interface configuration. The first step of MR/SMM imaging (a) is high sensitivity MR imaging using the solenoid coil and saddle coil. The second step of MR/SMM imaging (b) is simultaneous MR/SMM imaging using the solenoid coil and CZT detector modules. The detailed geometries of the first and second imaging steps are shown in (c) and (d), respectively.

METHODS

Unilateral breast specific coils: As shown in **Fig. 1. (a)**, the new unilateral breast specific coil consisted of two-channel RF loop arrays, which were configured as the quadrature. The saddle loop channel was oriented on the x-axis, while the solenoid loop channel was aligned on the y-axis. These coils are received only coils employing combined passive/active detuning circuits to decouple the coils from the RF transmitter, which are tuned on 127.7 MHz. A circular opening made of the breast coil loops has a diameter of 15 cm and height of 10 cm, which also allow for insertion of the breast, and the saddle coil loop could be split to secure the space for insertion of breast immobilization pads. The measured channel crosstalk, originated from the mutual inductance between the coils, was less than – 20 dB, and the low noise amplifier (LNA) was connected to the coils outputs to eliminate residual coupling. As shown in **Fig. 1. (b), (c),** and **(d)**, the saddle coil was designed to be detachable not only to perform high sensitivity MR imaging, but to also secure space between the quadrature solenoid loops to accommodate CZT detector modules for simultaneous MR/SMM imaging with the solenoid loop coil and CZT detector modules.

MR/SMM interface configuration: As shown in **Fig. 2**, the MR/SMM imaging is split into two steps. Firstly, the high sensitivity MR imaging is performed with the solenoid and saddle coils [see **Fig. 2. (a)** and **(c)**]. Secondly, simultaneous MR/SMM imaging is done with the solenoid coil and the CZT detectors modules [see **Fig. 2. (b)** and **(d)**]. The CZT modules can be mounted onto the MR/SMM interface and these can be moved up and down in addition to the lateral direction. Therefore, based on the location of the tumor identified from MRI, the CZT detectors can be positioned to collect the most optimal nuclear data. The performance of the new unilateral breast specific coil was compared with a commercial 4-channel breast coil (Philips SENSE-Breast 4). The breast coils were connected to a 3T Philips Achieva MR scanner, and we collected transverse images of the middle of a breast phantom. We used a T1 weighted gradient echo sequence with the parameters: FOV = 120 × 120 mm, matrix size 512 × 512, echo time (TE) = 5 ms, repetition time = 100 ms, flip angle = 90º, slice thickness = 2 mm, and number of signal averages (NSA) = 1. MRI data were acquired without CZT detector modules to allow a fair comparison study.

RESULTS

We calculated SNR with (signal average-noise average)/(noise standard deviation). To measure the phantom signal, a rectangular region of interest (ROI) was drawn over the central 80 % of the acquired phantom image. To calculate the noise, the standard deviation was measured from the arbitrary background. The measured SNR of the new unilateral breast specific coils (the solenoid coil + the saddle coil) was 154, while the commercial breast coil's was 140.

CONCLUSION

We demonstrated a new unilateral breast specific array coil design and a novel MR/SMM interface configuration for a dedicated breast imaging system that combines high sensitivity MR and high specificity SMM imaging systems. The performance in high SNR MR imaging of the new unilateral breast coil design was superior to a commercial 4-channel breast coil in a phantom study.

REFERENCES

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