

High Resolution Breast MRI: Comparison of Coils in Patients with Breast Lesions

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Introduction. Recent developments in breast RF coil arrays allow high SNR and bidirectional parallel imaging due to the higher channel counts and coil array geometry [1-3]. These advances have enabled acquisition of high spatial resolution clinical breast data in reasonable scan times. The purpose of this study was to assess the potential diagnostic impact of very high-resolution breast MRI scans with a newly designed, fitted coil array versus lower resolution scans with a standard commercially available array. In this work, we present the initial findings from this study.

Methods. Seven patients (ages 40-81) with suspicious lesions on mammography participated in this study with IRB-approved informed consent. We performed all imaging on a GE MR750 3T scanner. The high-SNR array is a previously described 18-channel custom-fitted array [3] (Figure 1), and the standard volumetric array is an 8-channel HD Breast Array [GE Healthcare]. Axial images were used to acquire the entire breast volume.

A standard clinical breast MRI includes a T2-weighted (T2W) scan and a multiphase T1-weighted dynamic contrast-enhanced (DCE) series. We directly compared the T2W acquisitions with both coil arrays since the T2W scans do not require contrast. However, for the DCE scans, this direct comparison was not possible since imaging must be performed within a certain time and it is impractical to inject contrast twice. Therefore, we acquired DCE data with only the high-SNR fitted coil array and synthesized DCE images corresponding to the standard array using a recently validated coil array synthesis technique. The coil array synthesis equates sensitivity, resolution, and SNR of the acquired image to those that would have been attained using the standard coil array [4]. Due to the substantially higher SNR of the fitted coil array, it is possible to synthesize lower resolution and lower acceleration factors for the standard coil array resulting in comparable SNR between the 'acquisitions' for the two coil arrays.

We used a 3D SPGR sequence for acquiring the DCE data (4-5 phases) with the 18-channel array -- 2 min scan time per phase, 3x LR and 2x SI acceleration, and $0.3 \times 0.5 \times 1.0 \text{ mm}^3$ resolution. To create the synthesized images, we low-pass filtered and added appropriate noise to the original DCE data to synthesize images that would have been acquired using the 8-channel array at lower acceleration and spatial resolution -- 1.9 min scan time per phase, 2x LR acceleration, and $0.6 \times 1.0 \times 1.5 \text{ mm}^3$ resolution. We used a uniform-sensitivity SENSE reconstruction for all DCE data [5].

For the T2W scans, we used CUBE, which is a 3D Fast Spin Echo sequence that uses a variable flip angle schedule to allow for increased echo train length [5]. Based on *a priori* knowledge, we chose imaging parameters so the T2W 18-channel and 8-channel images have similar SNR. Imaging parameters for the T2W 18-channel array are 4.5 min scan time, 3x LR and 2x SI parallel imaging, and $0.7 \times 1.1 \times 1.0 \text{ mm}^3$ resolution. The parameters for the T2W 8-channel array scans are 5.0 min scan time, 3x LR parallel imaging, and $1.1 \times 1.1 \times 2.0 \text{ mm}^3$ resolution.

A radiologist trained in breast MRI evaluated the depiction of lesion morphology and kinetics for both the higher and lower resolution scans using the MRI BI-RADS lexicon.

Results. Two representative cases are shown, and they both received a BI-RADS 5 (highly suggestive of malignancy) diagnosis due mainly to irregular margins and shapes. For these cases, the T2W images did not change the diagnoses. Case 1 (Figure 2) is a patient with invasive ductal carcinoma. In both DCE images, the lesion is a mass with an irregular shape and irregular margins. The anterior portion of the lesion has spiculations, and these features are better seen in the 18-channel DCE image (Fig. 2a) as opposed to the synthesized image (Fig. 2b). Case 2 (Figure 3) is a patient with a sclerosing papilloma involved by usual ductal hyperplasia in the medial side of the left breast. In both DCE scans, the lesion appears as an irregularly shaped mass with some smooth and circumscribed margins but a few angulated margins. Figure 3a shows better defined margins and improved visualization of internal enhancement than Figure 3b). In Case 2, the core biopsy pathology was discordant with imaging findings, meaning that there is still a possibility that the lesion is malignant. In both cases, the lesion morphology has significantly more detail with the higher resolution than the lower resolution images in roughly equivalent scan time.

Discussion. The purpose of this study was to present initial findings evaluating the diagnostic quality of very high versus lower resolution clinical breast MRI. Shape and the margins of the lesions were the most defining factors for the diagnoses. The general impressions from qualitatively evaluating all the patients were: 1) BI-RADS diagnosis of malignant lesions is consistently 5 for both resolutions and 2) the relative depiction of the lesion morphology is significantly better with the high resolution especially on the T2W comparison. Therefore, high resolution may be more useful diagnostically in BI-RADS 3 or 4 (probably benign or suspicious) lesions where there is less diagnostic certainty and the T2W images have a greater role. A wider range of cases is necessary to assess the diagnostic benefits of high-resolution breast MRI and further studies are underway.

Acknowledgements. P41RR009784, R01-EB009055, and GE Healthcare. **References.** [1] Giaquinto et al. ISMRM 2006. [2] Marshall et al. JMRI 2010; 31:328. [3] Nnewiwe et al. MRM 2011; 66:281. [4] Nnewiwe et al. MRM 2011; (in review). [5] Pruessmann et al. MRM 1999; 42:952. [6] Busse et al. ISMRM 2007.

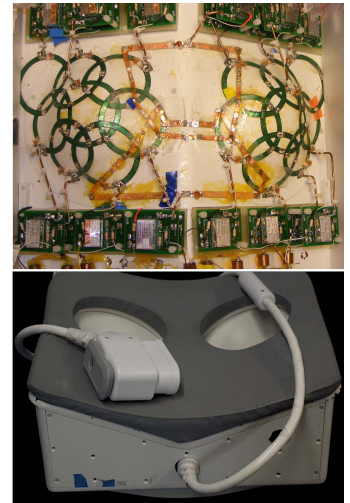


Figure 1. 18-channel custom-fitted array provides high SNR and allows bidirectional parallel imaging.

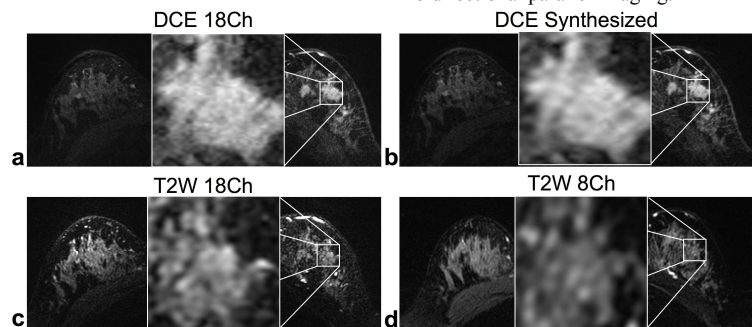


Figure 2. Invasive ductal carcinoma. Lesion morphology and spiculations are clearer in (a) than (b).

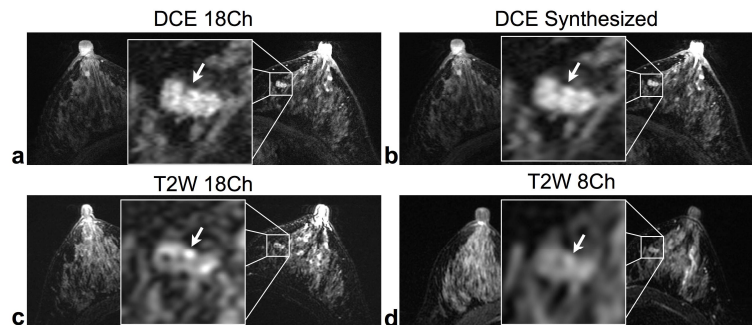


Figure 3. Sclerosing papilloma involved by usual ductal hyperplasia (see arrows). Smooth and angulated margins are present in (a) and (b).