Twelve-Channel Receive-Only MRI Breast Coil at 3T

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Introduction

Breast MRI is the most sensitive modality for the detection of invasive and in situ breast cancer [1] and is readily available. Therefore, we expect that breast MRI in the near future will largely replace mammography as the primary imaging modality. An increase in acquisition speed will allow a more optimal use of the limited MR capacity currently present. However, this should not decrease spatial resolution, as breast lesions on MR are characterized largely by morphological assessment. Therefore, we set out to develop a 12-channel 3T receive-only coil system to enable parallel imaging with high reduction factors. The increased SNR of this system can be used to increase imaging speed, to improve spatial resolution, or just to add to the clinical imaging quality. We basically designed an 8-channel add-on to an existing 4-channel interventional breast coil.

Methods

To achieve high reduction factors, the coil couplings should be about -20dB. We used low impedance preamplifier decoupling (impedance < 5 Ω). G-factor maps are to be minimized in the region of interest. We combined four non-overlapping small rectangular loops orthogonal to two larger circular loops per breast (Figure 1a). The positions of the 8 small loops can be varied to fit different breast sizes, to a minimum distance of 7cm. In order to maintain interventional capabilities of the coil system, the add-on elements can be removed during intervention. Biot-Savart law was applied to segmented coil models to calculate g-factor maps, noise correlation matrices and total SNR. MR experiments were carried out in phantoms to validate the model and ensure patient safety of the coil system. Volunteers were scanned to prove imaging quality.

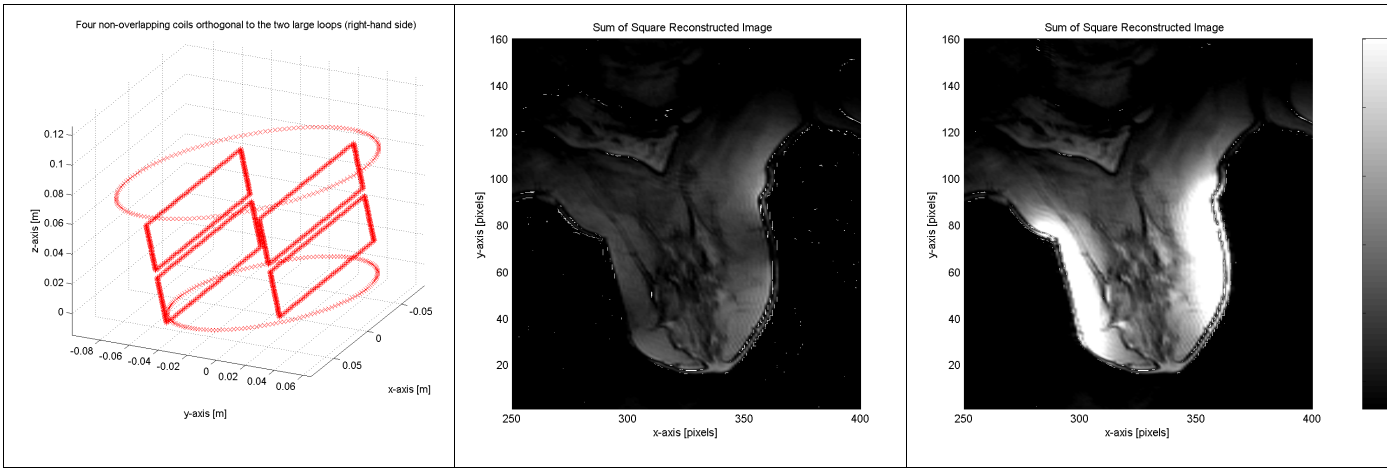
Results and discussion

In a built prototype, coil couplings were between -15 dB and –20 dB, when varying the distance of the add-on elements from 13cm down to 7cm. Compared to the 4 channel coil, the add-on elements provide an SNR improvement factor of 2 in the middle of the breast, and much higher SNRs towards the edges of the slightly compressed breast (Figure 1b,c). In the post processing of the scanner, sensitivity profiles could be filtered to obtain images with minimal sensitivity variations across images. In the region between the add-on elements, reduction factors of up to 3 are feasible in the anterior-posterior or 4 in the left-right directions, while the mean g-factor remains below 1.3. Some noise correlation coefficients were better than expected. We attribute this to the wavelength effect. The achieved higher overall SNR can be attributed to the orthogonal alignment of the coils (circularly polarized) and a better filling factor (matched for all anatomies).

Conclusion

We have shown that 8 additional coil elements to a conventional 4-channel breast coil can improve SNR more than a factor 2. In combination with the expected two-fold SNR increase at 3T compared to 1.5T, and the potentially high reduction factors 3 and 4, scan time for breast MRI can be substantially reduced without compromising conventional SNR or resolution.

Reference: 1. Boetes C, Mann RM. Lancet. 2007 Aug 11;370(9586):459-60.



Figuur 1: (a) Coil configuration per breast, (b) 2 Channels per breast, (c) 6 Channels per breast