Uniform bilateral breast MRI at 7T with dual transmit and 30-channel receive

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Introduction

7.0 Tesla (7T) breast MRI may be used to improve the specificity in the detection of breast cancer. While higher fields coincides with more RF power deposition, it has been shown that local transmit coils can be used to maintain high flip angle duty cycles and thus strong T1 weighting[1]. Combined with one-dimensional RF compensating RF pulses (orthogonal to the transmit coil) still uniform flip angles can be provided without compromising T1 weighting as validated in the unilateral breast[2]. Here we demonstrate the extension to a bilateral breast setup that maintains low SAR while enabling B1 steering in the second dimension using a dual transmit setup (i.e. independent control of B1 in left versus right breast). Equipped with 30 independent receiver elements, this new setup enables uniform bilateral breast MRI at ultra high spatial and temporal resolution.

Methods and results

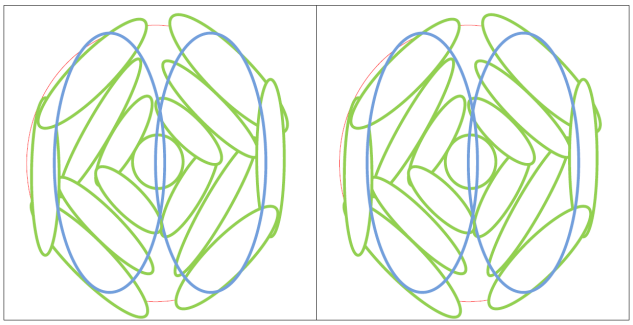

Fig 1*. Schematic overview of the bilateral coil setup using 4 inductively decoupled transmitters (driven as two channels in quadrature) and 30 channels as receivers.*

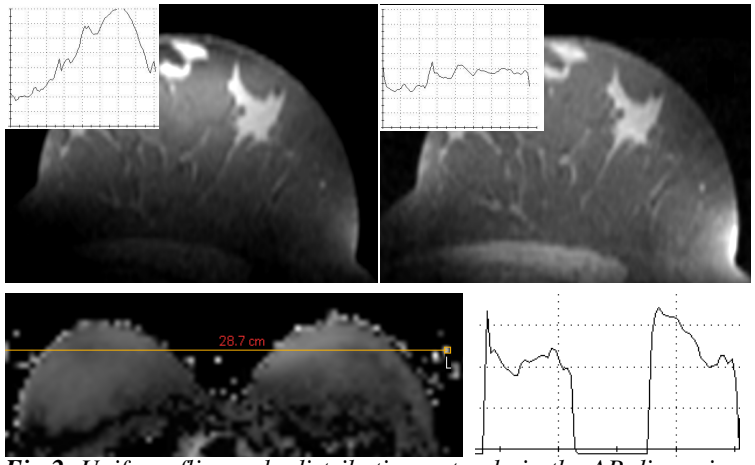

Fig 2*. Uniform flip angle distribution not only in the AP dimension using a compensating pulse (up right versus normal pulse up left), but also in LR using B1 amplitude shimming (below, prior to B1 shimming, subsequent scans reducing B1 of one channel with 20%.)*

Two unilateral quadrature RF coil designs[3] were merged and interfaced to a dual-transmit 7T MR system (Philips), while 30 preamplifier decoupled receivers (**Fig 1**) were interfaced via two 16 channel receiver boxes (Philips). B1 mapping was applied to adjust the transmit power of the independent channels to provide equal B1 in the two breasts (**Fig 2**). Due to the low SAR of the efficient transmit coils [3], strong T1 weighting could be obtained (flip = 8° at TR = 5.3 ms) as demonstrated in one breast cancer patient after receiving gadolinium (**fig 3**, left, circle). Likewise the high SNR of the 30 receivers was used to obtain high spatial resolution (0.5x0.7x0.7 mm^3, Fig 3, right).

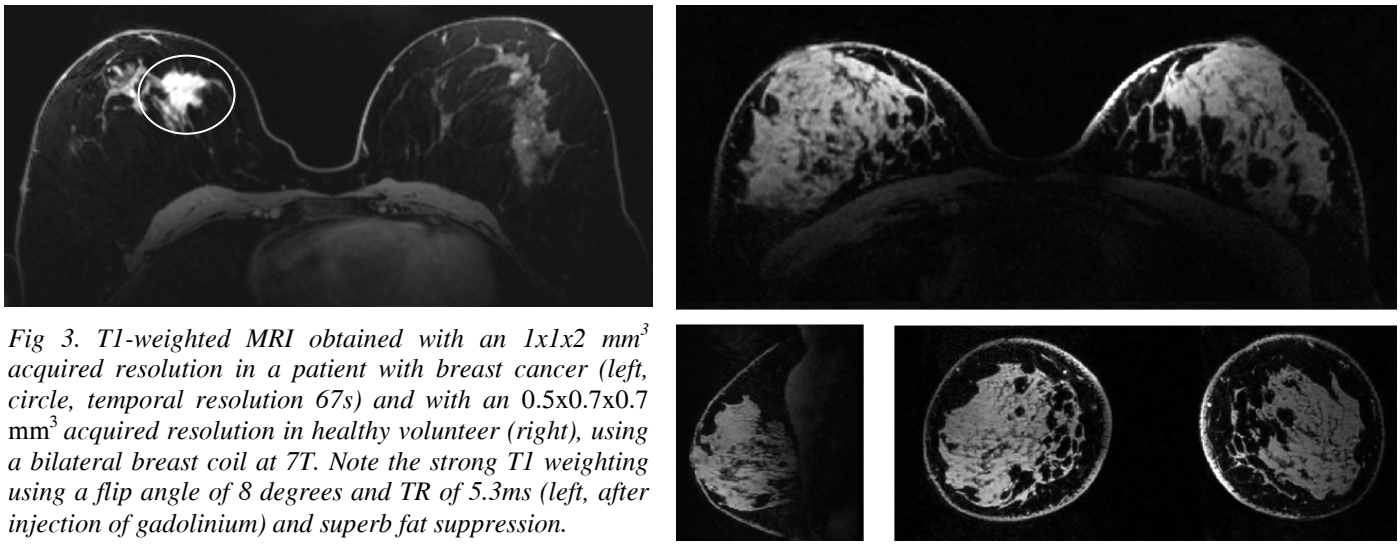

Fig 3. T1-weighted MRI obtained with an 1x1x2 mm^3 acquired resolution in a patient with breast cancer (left, circle, temporal resolution 67s) and with an 0.5x0.7x0.7 mm^3 *acquired resolution in healthy volunteer (right), using a bilateral breast coil at 7T. Note the strong T1 weighting using a flip angle of 8 degrees and TR of 5.3ms (left, after injection of gadolinium) and superb fat suppression.*

Conclusion

Bilateral breast MRI at 7T may improve specificity in contrast-enhanced MRI when using efficient RF surface coil arrays for transmitting high density of strong flip angles. Combined with B1 compensating RF pulses, the strong and uniform contrast can be obtained at high resolution enabling detailed morphologic assessment, while detecting kinetic effects of the infused contrast agent.

References: 1.. B. Stehouwer et al. MRI 2012. **2.** I. van Kalleveen et al. ISMRM 2012. **3.** D. Klomp et al. NMR in Biomed 2011