Reduced B1-inhomogeneities in breast MRI using optimized RF excitation

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Introduction

B1-inhomogeneities are well known to occur at high field strengths [1]. Only recently [2] this issue has been raised for breast imaging at 3.0T: apart from the basic problem of image homogeneity, severe concern was expressed regarding possible misinterpretations of contrast uptake if the actual excitation angle deviates too strong from the nominal FLASH angle in gradient echo sequences used for dynamic studies. In this work, a novel method [3] to improve the homogeneity that uses optimizations for the feeding of the body coil was tested and compared on volunteers. While different approaches to reduce B1-shading have been suggested previously, such as parallel transmission [4,5] or the use of B1 saturation pads, this method provides a cost-effective solution using the standard transmit setup of a clinical 3T scanner.

Methods

All experiments were performed on a 3T Siemens Magnetom Verio, 70 cm wide bore scanner using 4- or 7 channel breast coils. For testing purposes the scanner's RF transmission could be switched between conventional and optimized settings for the 2-port birdcage body coil.
Nine healthy volunteers (age 22-61 years) were scanned in prone position with their arms positioned either along the body or below/along their heads. All scanner adjustments such as transmitter voltage, shim etc were reset completely before each scan. B1 maps were acquired using the body coil in order to have a flat sensitivity profile. All B1 maps were acquired with phase encoding in left/right direction to avoid heart motion artifacts. The evaluation of the calculated B1 distribution maps was performed by applying several regions-of-interest (ROI) in areas that exhibited very high or low signal intensities. The maximum and minimum measured flip angles were considered for each breast and normalized to a nominal flip angle of 90 degree to enable a direct comparison. As a final measure for each scan the absolute of the maximum deviation from 1.0 was reported.

Results and Discussion

Fig. 1 displays a direct comparison for 11 experiments performed on the same volunteers in the same position with conventional (black) and optimized (TrueForm) body coil feed along with additional data taken on further volunteers for TrueForm excitation only. Highest and lowest deviation values range from 0.36 to 0.23 for conventional excitation while the highest measured deviation for TrueForm was 0.22 and the lowest maximum deviation in one volunteer was 0.09; the variety within each data set can be attributed to the weight and supposedly body composition of the volunteers but also the positioning. Further investigations are required but the deviation seems to correlate with the position of the arms (positioning along the body results in smaller maximum deviations). Figures 2, 3 are flip angle maps of the same volunteer acquired with conventional (left) and optimized transmitter setting showing a noticable difference between the left and right breast whereas a smooth flip angle distribution can be seen with the optimized setting.
It has to be stressed that the data shown here cannot be readily generalized as the B1 distribution is characteristic for a certain magnet and body coil design. Furthermore, several sequence technique developments, for example the use of adiabatic RF pulses provide solutions to this problem.

References

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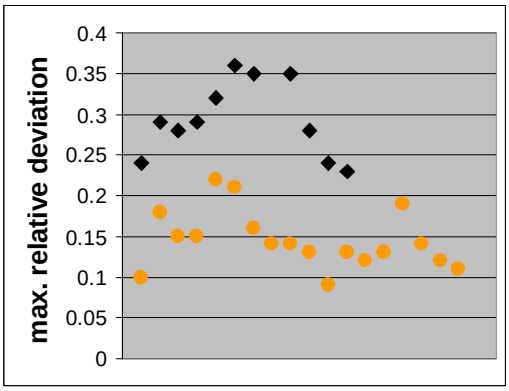

Fig. 1: maximum relative deviation (either left or right breast) of the measured flip angle from the nominal flip angle (90deg := 1) for conventional (black) and TrueForm RF (orange) excitation for different volunteers and positioning.

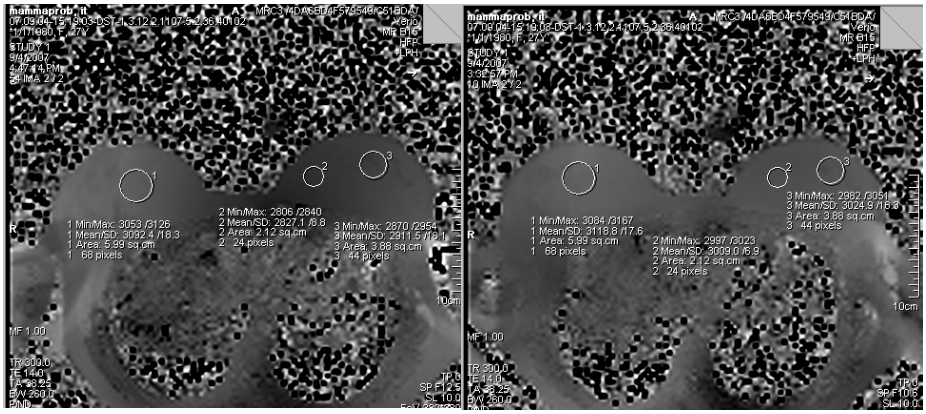

Fig. 2,3: Measured flip angle distribution maps of conventional and TrueForm RF excitation. Regions of interest were evaluated in brightest and darkest areas of the left and right breast. Grey scale values 0-4095 represent -180 to +180 degree.