THE EFFECTIVENESS OF A BISAGITTAL POWER OPTIMISATION APPROACH IN THE REDUCTION OF B1 INHOMOGENITY IN BREAST MRI AT 3T

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Introduction

Dynamic contrast-enhanced (DCE)-MRI is considered to be one of the most sensitive techniques for the detection and staging of breast cancer [1]. Recently high field scanners (3T) have become more available in imaging departments worldwide. The main advantage of this high field system is the improvement in signal to noise ratio. However, a significant disadvantage in 3T scanning is the increased radiofrequency (RF) B_1 transmit field inhomogeneity across the field of view particularly in breast scanning due to the asymmetric position of the patient in the scanner. This problem is mainly caused by the interference from standing waves which are induced by the shorter RF wavelength used at higher field strengths which approaching the diameter of the human body [2]. The resulting inhomogeneity in B_1 caused by this standing wave effect will cause variations in the accuracy of the effective flip angles generated in the subject and hence the image intensity when using T_1-weighted FLASH sequence (as commonly used in DCE-MRI). If uncorrected during DCE-MRI of the breast, this will influence any semi-quantitative measure of tumour tissue enhancement as well as reducing the accuracy of pharmacokinetics parameter (e.g. K^{trans}, v_e and K_{ep}) estimation.

For breast imaging in the transverse plane RF power optimisation is typically performed on both of the breasts at the same time. Recently, Philips Medical Systems have proposed a new approach which optimises the RF power separately for the left and right breast when imaging is performed in sagittal plane. The aim of this study is to investigate the effectiveness of this new approach in the reduction of B_1 inhomogeneity for breast DCE-MRI at 3T.

Methods

3D B_1 maps using both the conventional (images acquired in transverse plane) and bisagittal (images acquired in sagittal plane) power optimisation approach were acquired on 25 healthy volunteers (mean body mass index (BMI)= 24.7 ± 4.0 kg m^{-2}) using proprietary software, that is based on "actual flip-angle imaging" [3] pulse sequence ($TR_1/TR_2/TE/\alpha$= 30ms/150ms/2.4ms/60°). The resulting B_1 map generated using this sequence visually depicts the B_1 field received by the subject. For each volunteer regions of interest (ROI) were placed at the centre of each breast on the B_1 map to measure the average values of the B_1 field. The measurements were performed on the slice closest to the centre of the breast coil. All scans were performed using a Philips Achieva 3T scanner and a seven channel breast coil (Philips Medical Systems, Best, the Netherlands). This study has been approved by the local ethics committee.

Results and Discussion

The measured B_1 field for imaging using the conventional and bisagittal power optimisation approaches approach is shown in Fig. 1. It can be observed that when the RF power is optimised using the conventional approach the B_1 field is always reduced on the right breast. By using bisagittal power optimisation approach, the difference could be reduced significantly. For some volunteers the right breast receives a slightly higher B_1 field.

The relationship between the difference of measured B_1 field and body mass index (BMI) of the volunteer is shown in Fig. 2. For conventional power optimisation approach, the difference in B_1 field between the left and right side is dependent on the size of the volunteer, represented as body mass index (BMI). Using the bisagittal approach, the difference could be reduced to less than 50% of the variation of the conventional approach.

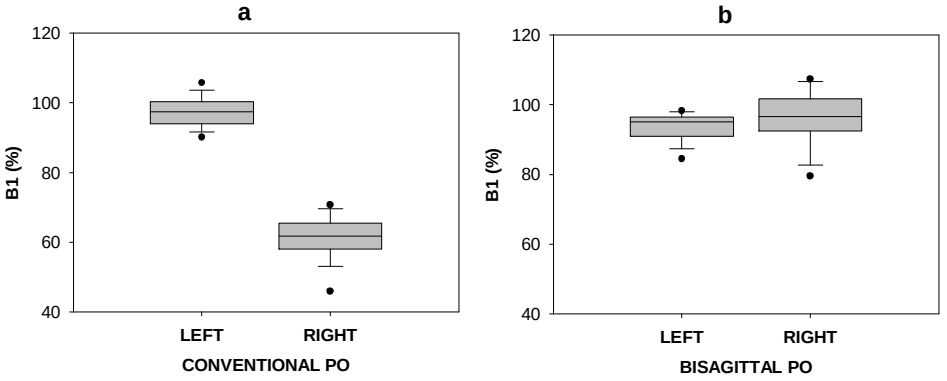

Fig. 1 Box and whiskers plots showing B1 values (as a percentage of the nominal 60° flip angle) measured on the left and right breast obtained using conventional (a) and bisagittal (b) power optimisation (PO) approach.

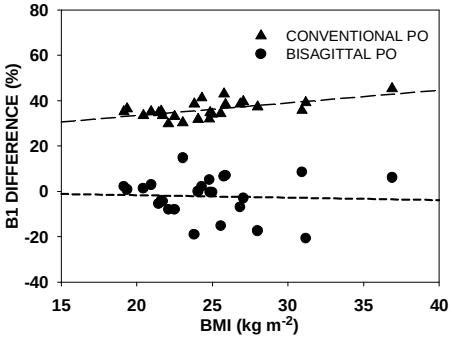

Fig. 2 The relationship between B1 field difference of the left and right breast and BMI using conventional and bisagittal power optimisation approaches.

Conclusion

B_1 inhomogeneity is a critical problem in DCE-MRI of the breast at 3T. This inhomogeneity will cause errors in any method that attempts to quantify the enhancement of a tumour e.g. pharmacokinetics parameters estimation and enhancement ratio measurement. To minimise this problem, Philips Medical Systems have proposed the employment of bisagittal power optimisation approach in the scanning protocol. We have shown that this new technique is able to reduce the B_1 differences between the right and left breast compared to the conventional power optimisation approach and provides a promising solution in minimising B_1 inhomogeneity in breast DCE-MRI applications at 3T.

References

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