A Comparison of Breast Tissue T1 Mapping Using Conventional Multi-flip Angle and 2-point Dixon Techniques

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Target Audience: Clinical scientists' interested in quantitative mapping in the breast.

Introduction: Dynamic contrast enhanced (DCE) MRI applications particularly for breast imaging, utilize high spatiotemporal resolution acquisitions to assess enhancement kinetics. Quantitative pre-contrast T_{10} mapping is required in order to convert signal intensity changes to gadolinium concentration in order to apply quantitative pharmacokinetic models. Whilst DCE-MRI acquisitions typically use some form of fat-suppression/water excitation, T_{10} mapping is generally performed without fat suppression. Recently DCE studies have used 2-point Dixon (2PD) acquisitions as a time-effective method of obtaining robust water-only images. In this work, we compare B_1-corrected pre-contrast T_{10} relaxation times obtained using a conventional non-fat suppressed variable flip angle (VFA) approach with a VFA 2PD method in a cohort of patients with locally advanced breast cancer at 3T.

Methods: Data Acquisition: Following IRB approval and informed consent, six patients (range 51- 67, mean age = 56 years) with proven breast malignancy (5 invasive ductal, and 1 mucinous carcinoma) referred for DCE-MRI were recruited into the study. Imaging was preformed on a 3T MR system (MR750, GE Healthcare, Waukesha, WI) using an 8 channel-breast coil. Following the localizer scans, standard three-dimensional (3D) axial, non-fat suppressed, SPGR T_{10} images were acquired at three flip angles (2°, 3°, 5°) TE/TR= 2.3/5.3ms, 256x256 matrix with slice thickness of 1.4mm, slices=112, parallel acceleration = 2. The acquisition time at each flip angle was 41s. Subsequently a dedicated breast 3D 2PD sequence was acquired with the same geometrical parameters and TE/TR = 1.2, 2.2/5.3ms, parallel acceleration = 2 generating water-only images. The acquisition time for each flip angle was 32s. B_1-mapping was performed using a multi-slice 2D Bloch-Seigert shift method (TR/TE/α= 30/13.5ms/20°, 128x128 matrix). DCE data was then acquired for 8 minutes with a 9s temporal resolution using a 3D segmented *k*-space SPGR sequence with fat suppression and an in-plane resolution of 1x1x1.4mm. Contrast agent (Magnevist, BayerSchering, Berlin, Germany) at 0.1mmol/kg body weight was administered using a power injection. The total scan time was 20 minutes.

Image Analysis: Both the conventional and water-only T_{10} maps were calculated and corrected for B_1 transmit non-uniformity using DCETool[2] in Osirix (Pixmeo, Geneva). Representative regions of interest (ROIs) of the malignant breast tumour and the fibroglandular tissue (FGT) in the ipsilateral and contralateral breasts were drawn on the maximally enhancing DCE images and copied to both T_{10} maps. The ROIs were manually adjusted in the case of misregistration between the T_{10} maps and the DCE data.

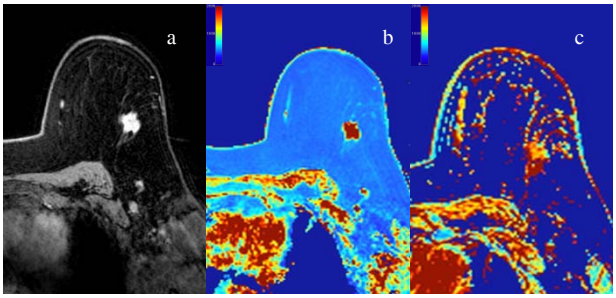

Figure 1 shows a) T_1W CE image b) standard non fat-suppressed c) water-only T_{10} maps.

Results: Figure 1 shows the acquired DCE series, standard and thresholded (10 %) water-only T_{10} maps corrected for B_1 non-uniformity. The mean T_{10} values for FGT tissue measured in both ipsilateral (T_{10} = 1200 ± 240 ms) and contralateral (T_{10} = 1230 ± 160 ms) breasts using the standard sequences were lower when compared with the 2PD technique in the ipsilateral (T_{10} = 1450 ± 230 ms) and contralateral (T_{10} = 1340 ± 330 ms) breasts. Whereas, the mean T_{10} values of the malignant breast lesions were lower using the 2PD technique (T_{10} = 1450 ± 230 ms) compared to the standard method (T_{10} = 2070 ± 360ms) (Figure 2).

Discussion: Fat is a possible confounder for DCE-MRI of the breast. As far as we are aware this is the first report of B_1-corrected T_{10} measurements in both FGT and breast tumour at 3T. Rakow-Penner et al have previously reported native T_1 values in the right breast of five normal volunteers at 3T using an IR-FSE sequence with and without IDEAL processing[1]. They reported mean values for FGT of 1324.42±167.63ms and 1444.83±92.7ms using the non-IDEAL and IDEAL methods respectively, which are consistent with our results. The mean difference in T_{10} values between the 2PD and the standard method of approximately 200ms in tumors is a little surprising given the relative paucity of fat in tumors but this may be attributed to either partial volume effects or increased uncertainty of the techniques at the longer T_{10} values observed in tumors compared to FGT. Further studies will optimize the choice of flip angles to improve the accuracy and reproducibility of these measurements.

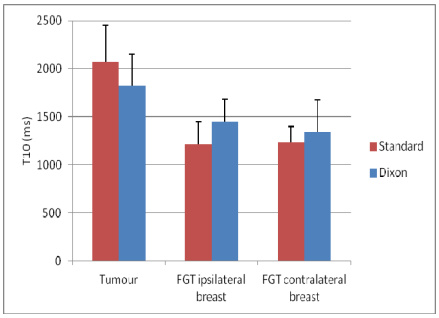

Figure 2 shows the mean T_1 relaxation values measured in tumor, ipsilateral FGT and contralateral FGT.

Conclusion: This pilot study demonstrates the application of a rapid VFA 2PD technique for the measurement of water-only T_{10} values suitable for subsequent quantitative DCE-MRI analysis without the confounding influence of fat.

References: [1] Rakow-Penner *et al*. JMRI 2006 23:87-91 [2]Sung K *et al.* RSNA 2011