

Geometric Distortion in Diffusion Weighted MR Imaging of the Prostate using Air vs. Per-fluorocarbon filled Endorectal Coil at 3.0 T

M. Jafar¹, V. A. Morgan¹, S. Giles¹, D. J. Collins¹, M. A. Schmidt¹, and N. M. deSouza¹

¹Clinical MR, Institute of Cancer Research & Royal Marsden NHS Foundation Trust, Belmont, Sutton SM2 5NG, United Kingdom

Introduction Diffusion weighted imaging (DWI) has been used in both clinical and research settings for detecting cancer-related disease. In prostate cancer DWI is proving useful in tumour detection [1] but it suffers from severe artefacts [2]. This affects echo-planar imaging (EPI) which is very sensitive to off-resonance effects and is subject to distortions due to air-tissue susceptibility differences around a balloon endorectal coil particularly at high field strengths. Per-fluorocarbon (PFC) filled endorectal coils have demonstrated improved field homogeneity in spectroscopic imaging [3] compared with air-filled coils. The purpose of this study was to investigate the amount of geometric distortion on DWI of the prostate arising from air vs. PFC inflated endorectal coil at 3.0T.

Materials and methods A group of 20 prostate cancer patients managed by active surveillance and referred for clinical evaluation underwent single shot EPI DWI in addition to their standard T2W MRI of the prostate. MRI studies were performed on a 3.0T Achieva (Philips Medical Systems, Best, the Netherlands) using an endorectal coil (MEDRAD, USA) inflated with 60 ml of either air or PFC in combination with a cardiac coil. The axial T2W and DWI images were transferred offline for analysis using MATLAB (The MathWorks, USA). Three slices were chosen from each patient, a centre slice and two non-contiguous edge slices off the centre slice. Regions of interest (ROIs) were drawn by an experienced observer around the prostate on the selected slices of the axial T2W image and on the b0 DWI image without reference to the T2W images. The b0 images were chosen from the diffusion series as the higher signal intensity increases the accuracy of ROI outlining. The radiologist did not have prior knowledge of which patients were scanned using an air-filled or a PFC filled endorectal coil. Distortion associated with off-resonance effects is expected to be independent of b-value, although potential eddy currents associated with large diffusion gradients can introduce additional geometric distortion. The concordance and discordance of the two ROIs drawn on the axial T2W and b0 DWI in the selected slices were determined. The ratios were plotted for each group of patients $ratio = (ROI_T2W \cap ROI_DWI) / (ROI_T2W \cup ROI_DWI)$.

Results and discussion ROIs drawn on two patients with the worst ratios for an air-filled and a PFC filled endorectal coils are shown in Figure 1. The concordance/discordance ratios for the Air-filled versus the PFC filled endorectal coil at each position are shown in Figure 2. Apex, Centre and Base denote the chosen slices from each patient at each anatomical location. At the apex, geometric distortions in the PFC filled endorectal coil were much greater compared with the Centre and Base slices of the PFC filled coil. Distortion at the apex of a PFC filled coil were greater than all slice positions of the air-filled coil indicating maximal field inhomogeneity close to the prostate apex. Trapping of air inside a PFC filled coil at its most superior point in a supine patient (Figure 3) may well account for this. However, a smaller standard deviation of the distortions was also observed at the Centre and Base slices using the PFC filled coil compared with the air-filled one.

Conclusions Our initial results indicate that inflating the endorectal coil with PFC in DWI prostate examinations results in a greater confidence interval for slices in the middle and in the base of the prostate but not at the prostate apex. More rigorous extraction of air and an increased volume of PFC might reduce this effect. However, the difference in geometric distortion between a PFC vs. an air-filled endo-rectal coil is not large enough to justify the use of PFC rather than air for DWI studies, although when considering MR spectroscopy significant improvement in linewidth is likely.

Acknowledgments We acknowledge the support received from the CRUK and EPSRC Cancer Imaging Centre in association with the MRC

Figure 1

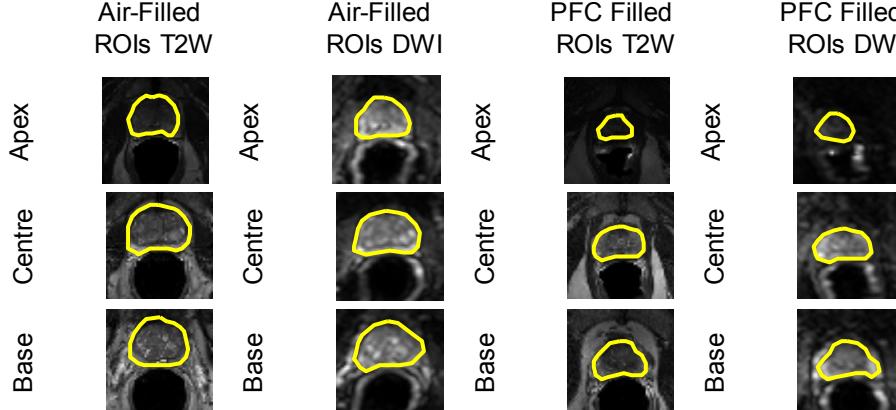


Figure 2

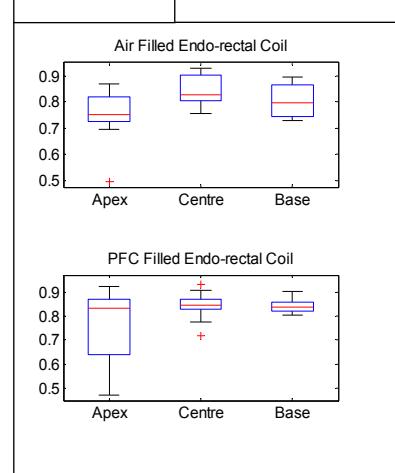
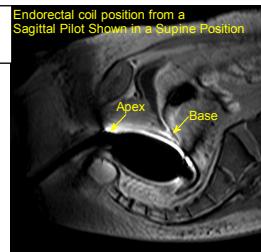


Figure 3



References

1. N. M. deSouza et. al. Clinical Radiology (2008) 63, 774-782
2. J. Finsterbusch, MRM (2009) 61, 748-754
3. Y. Rosen et. al. MRM (2007) 57, 898-904