A Comparative Study of High-Resolution vs. Conventional Diffusion-Weighted Imaging of the Prostate at 3T

Maysam Jafar1, Sharon Giles2, Veronica Morgan3, and Nandita deSouza4

1Clinical Magnetic Resonance, Institute of Cancer Research, London, Surrey, United Kingdom; 2Clinical Magnetic Resonance, Royal Marsden NHS Foundation Trust, London, United Kingdom; 3Clinical Magnetic Resonance, Institute of Cancer Research and Royal Marsden NHS Foundation Trust, London, United Kingdom

Introduction Diffusion weighted imaging (DWI) is used in both clinical and research settings for detecting cancer-related disease. In prostate cancer DWI is additionally proving useful as a predictive biomarker of disease aggressiveness [1] but severe artefacts and low resolution can hamper accurate quantification and reduce value of the biomarker particularly where suspected lesions are <1cm [2]. High-resolution DWI techniques potentially improve detection of small lesions, but suffer from reduced SNR compared to conventional techniques. The purpose of this study therefore was to investigate the differences in estimated ADC values in normal prostate and prostate cancer derived from a conventional diffusion-weighted protocol vs. a high-resolution protocol.

Materials and Methods 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 perfluorocarbon (PFC) in combination with a cardiac coil. Imaging was performed on a population of 16 men managed by active surveillance (mean age 67 years). These subjects underwent both conventional and high-resolution single shot EPI DWI in addition to their standard T2W MRI of the prostate. Both diffusion protocols were planned using the axial T2-weighted images and were acquired with five b values; 0, 100, 300, 500 and 800 mm². The conventional clinical diffusion protocol had an in-plane FOV of 180 mm, an in-plane resolution of 2.5 mm and a repetition time of 6200 ms. The high-resolution protocol had a FOV of 100 mm, an in-plane resolution of 1.25 mm and a repetition time of 7400 ms. Regions-of-interest (ROIs) were drawn on a single slice at the level of the verumontanum of each prostate by an experienced observer to include the entire peripheral zone (PZ) and the entire central gland (CG) and through a slice with the largest visual tumour area (T) (defined as a low-signal focal area on T2-W showing restricted diffusion in an octant positive for tumour on TRUS biopsy). The ADC estimate with b = 0 mm² included and excluded was computed using the scanner software utilizing a mono-exponential fit.

Results Only one patient had no visible tumour. The size of lesions as delineated by the experienced observer varied from 5.5 to 425 mm² for the conventional protocol and 3.8 to 507 mm² for the high-resolution protocol. A plot of tumour size estimate using both protocols is shown in Fig. 1. Correlation between tumour size delineated on conventional and high-resolution imaging was significant (r² = 0.89; p = 0.92). Mean ADC values for the CG, PZ and tumour for both conventional (CG, PZ, T) and high-resolution (CGhigh, PZhigh, Thigh) protocols including b = 0 mm² and excluding b = 0 mm² are shown in Table 1. ADCs were significantly lower when b = 0 was excluded for all prostate regions. ADC values were not significantly different between the conventional and high-resolution protocols for any prostate region (CG: p = 0.052 including b = 0 mm²; p = 0.15 excluding b = 0 mm²; PZ: p = 0.23 including b = 0 mm²; p = 0.25 excluding b = 0 mm²; tumour: p = 0.61 including b = 0 mm²; p = 0.47 excluding b = 0 mm²). There was a significant correlation between the difference in ADC estimates between the conventional and high-resolution techniques and tumour size.

Discussion & Conclusions Excluding b = 0 mm² in the computation of the ADC resulted in a lower estimate of the ADC for CG and PZ ROIs but it resulted in a higher estimate for tumour ADC. Differences between ADC estimates from conventional and high-resolution techniques correlated with tumour size and may well be related to poorer SNR in small ROIs. Further work to improve SNR of high-resolution DWI is required in order to improve its utility for detecting tumours and monitoring changes in ADC in patients managed by active surveillance.

Acknowledgements We acknowledge the support received from the CRUK and EPSRC Cancer Imaging Centre in association with the MR CRUK and EPSRC Cancer Imaging Centre in association with the MRC and Department of Health (England) grant C1060/A10334, also NHS funding to the NIHR Biomedical Research Centre C

References