Diffusion Weighted Imaging of Normal and Pathological Prostate Tissue at 3.0T

M. D. Pickles[1], P. Gibbs[1], M. Sreenivas[1], A. Knowles[2], L. W. Turnbull[1]

[1]Center for Magnetic Resonance Investigations, University of Hull, Hull, East Yorkshire, United Kingdom, [2]GE Healthcare, Waukesha, Wisconsin, United States

Introduction Diffusion weighted imaging (DWI) has been demonstrated to be of potential benefit in the diagnosis (1) and management (2,3) of prostate cancer. Most human in vivo studies have been performed using clinical 1.5T MR systems. In this study we aim to demonstrate the ability to undertake DWI and record apparent diffusion coefficients (ADC) for prostate tumour and normal appearing peripheral zone on a commercially available 3.0T clinical MR system.

Methods Patients are routinely referred to this centre for staging of prostate cancer. Between May and Oct 2004 fifty-three patients and 9 volunteers were scanned using a GE Healthcare Signa Excite 3.0T scanner and an eight-channel phased array coil. Imaging comprised of axial T2W images of the pelvis, high spatial resolution axial T2W, DWI, and DCE-MRI targeted to the prostate gland. DWI was acquired utilising a single shot spin echo EPI technique, b values (0 and 500s/mm^2), TE 65.7ms, TR 4000, asset factor 2, 16 NEX, zoom gradients, 5mm slices, 26cm FOV and a 224x224 matrix. Regions of interest were drawn by consensus around prostate tumour and normal appearing peripheral zone (PZ) on the b 0 images, with reference to the high resolution T2W images and the radiologist's report. Tumour was indicated by hypointense signal intensity while normal appearing PZ was indicated by hyperintense signal intensity within the PZ (see fig Ia).

Results In four patients ADC calculations were not possible due to susceptibility artefacts arising from bilateral hip replacement (1) or air filled rectum (3). In a further ten patients normal PZ could not be identified, therefore tumour ADC was calculated for 49 patients while normal PZ ADC was calculated for 39 patients and 9 volunteers. Central gland (CG) ADC was additionally calculated for volunteers (see table I). Whilst table I demonstrated that mean tumour ADC values were lower than normal PZ, and further analysis, paired sample t-test, revealed that this was a highly significant difference ($p < 0.001$), fig Ib demonstrates that there was crossover between the two tissue types. However ROC analysis revealed that ADC values alone resulted in a diagnostic accuracy of 0.845 (see fig Ic). Volunteer data also demonstrated significantly ($p=0.031$) higher ADC values for PZ compared to tumour. CG ADC was shown to be significantly ($p=0.005$) lower than PZ ADC and patient PZ ADC was higher than volunteer PZ ADC ($p=0.038$).

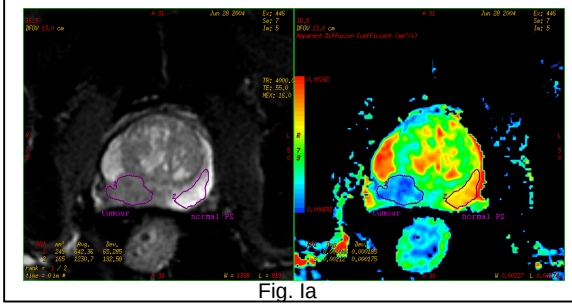

Fig. Ia

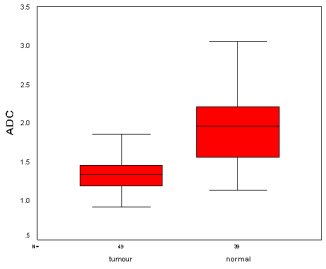

Fig. Ib

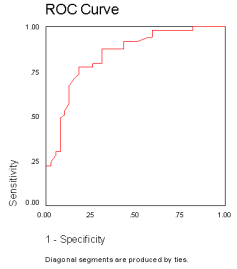

Fig. Ic

Conclusion We have demonstrated the feasibility of DWI of the prostate at 3T using a phased array coil and an asset factor of two. Analysis of patient results has demonstrated that tumour tissue has a highly significant lower ADC value than normal appearing PZ while ROC analysis suggests that the ADC value may be a useful discriminator between these tissue types. DWI may also be useful in monitoring response to therapy as a change in ADC values are expected prior to a change in tumour volume(2,3). Volunteer data also demonstrated lower PZ ADC values than tumour and CG. The noted differences in PZ ADC values for patients and volunteers is believed to be age related.

Table 1 – all values x 10^{-3}mm^2/s

Tissue	N	Min.	Max.	Mean	S.D.
Tumour	49	0.72	2.29	1.38	0.32
Pat. PZ	39	1.14	3.26	1.95	0.50
Vol. PZ	9	1.24	1.91	1.60	0.25
Vol. CG	9	0.95	1.43	1.27	0.14

References [1] Issa B. JMRI. 2002: **16** 196-200 [2] Dodd NJF, Zhao S. Phys Medica. 1997: **13** 56-60 [3]Dominique J et al. Neoplasia. 2002: **4** 255-262

This work was supported by Yorkshire Cancer Research.