Combined use of endorectal MRS and apparent diffusion coefficients to increase accuracy in prostate tumour detection

S. A. Reinsberg[1,2], G. S. Payne[1], S. F. Riches[1], S. Ashley[3], N. M. deSouza[1]

[1]Cancer Research UK MR Group, Institute of Cancer Research, Sutton, Surrey, United Kingdom, [2]Department of Physics and Astronomy, University of British Columbia, Vancouver, BC, Canada, [3]Royal Marsden NHS Trust, Sutton, Surrey, United Kingdom

INTRODUCTION: In men with elevated serum prostate specific antigen, the definitive diagnosis of prostate cancer requires histology obtained invasively. With endorectal MR imaging, the sensitivity and positive predictive value for detection of tumour foci <1cm diameter can be as low as 26.2% and 75.9%, respectively [1]. MR spectroscopy offers improved sensitivity and specificity for prostate cancer diagnosis [2] and diffusion-weighted imaging (DWI) also shows potential for improving tumour detection [3]. The purpose of this study therefore, was to examine whether a combination of metabolic ratios and apparent diffusion coefficients (ADCs) detects prostate cancer with improved sensitivity and specificity compared to either parameter alone.

METHODS: We prospectively examined 42 men (mean age 69±5 years) with histologically proven prostate cancer. A 1.5 T Intera and an endorectal balloon receiver coil (Philips Medical Systems, Netherlands) inflated with 55ml of air were used. In addition to standard T2-weighted imaging, chemical shift imaging (2D-CSI) with a 16x16 grid (voxel size 8.75x8.75x15mm^3) was performed with BASING water suppression and lipid suppression by frequency-selective inversion prior to PRESS excitation (T_r/T_e=1500/120). Isotropic apparent diffusion coefficients (ADCs) were calculated from diffusion-weighted echo-planar images. The spectroscopy data were voxel shifted and exported for analysis with LCModel[4] using a basis set containing metabolite spectra from choline, creatine and citrate. Regions of interest (ROIs) were drawn by an experienced radiologist for the entire gland, the central gland (CG) and tumour (designated as areas of low signal intensity on T2-weighted images within the peripheral zone (PZ) that were biopsy-positive for tumour). CSI voxels that contained >70% prostate (n=398) were classified into non-tumour PZ (no tumour ROI and >70% PZ, n=24), non-tumour CG (no tumour and >70% CG, n=180), mixed non-tumour voxels (no tumour, <70% CG, <70% PZ, n=68) and tumour (tumour ROI occupying >70% of the voxel, n=15). ADC maps were co-registered with high-resolution T2-weighted images and CSI spectroscopy. Metabolite levels and their ratios as well as average ADCs were calculated for every voxel. Receiver operating characteristic (ROC) curves were used to demonstrate the power of Cho/Cit and ADC alone and in combination as predictors of tumour at histology.

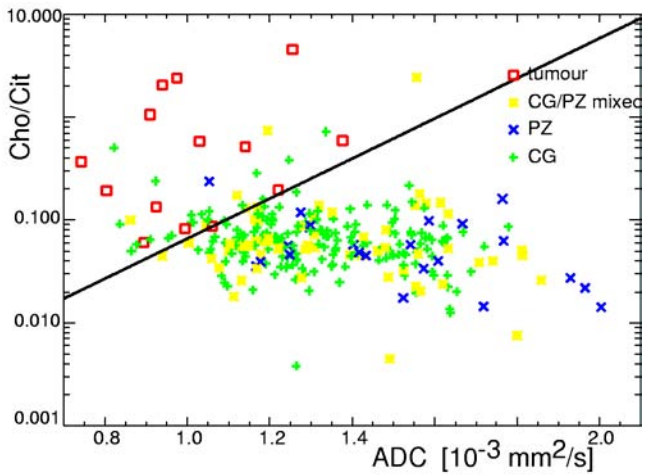

Fig 1: Metabolite ratio (Cho/Cit) vs. apparent diffusion co-efficient (ADC) for voxels containing at least 70% tumour (red square) and non-malignant voxels (all other symbols) as identified on T2-weighted images in 42 patients. Tumour foci were confirmed on histology.

	sensitivity	specificity	AUC
Cho/Cit	93	73	0.92
ADC	93	57	0.85
combined	93	91	0.98

RESULTS: Fig. 1 shows a plot of metabolite log-ratios vs ADC. A line best separating malignant and non-malignant voxels was drawn whose slope maximised the area under the curve (AUC) in an ROC analysis.. Fig.2 shows the significantly improved ROC curve of a predictor based on the combined measure of Cho/Cit and ADC (solid blue) in comparison with metabolite log-ratio alone (dashed red) and ADC alone (dotted black). Results of the ROC analysis are summarised in the table. The specificity of the combined predictor is significantly improved as compared to Cho/Cit or ADC based predictors alone ($p<0.0001$).

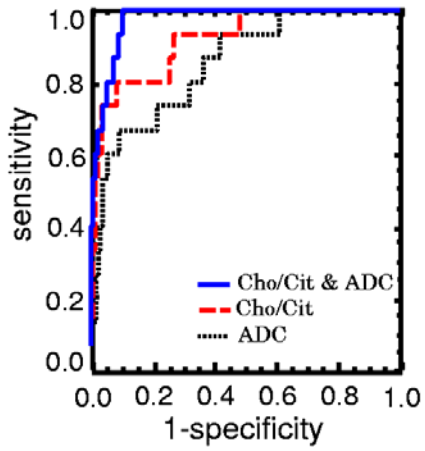

Fig 2: ROC curve showing the improved discrimination of tumour from non-malignant voxels using a combined score (blue) vs ADC(black) or metabolite ratio(red) alone.

CONCLUSION: We have shown that a combination of metabolite ratio and ADC derived from chemical shift imaging has an improved specificity (91%) in the detection of prostate tumour while retaining a high sensitivity (93%).

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