Diffusion weighted endorectal imaging of the prostate: differentiation of malignant from benign regions

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Introduction: The introduction of prostate specific antigen (PSA) screening has led to an increase in the incidence of prostate cancer. The variety of management options currently available demands accurate identification and staging of the disease. Transrectal ultrasound (TRUS) using 2-D or 3-D techniques has poor sensitivity and specificity for disease detection (1). Conventional T2-W magnetic resonance imaging (MRI) using an endorectal coil offers some improvement in sensitivity for tumor detection (2), but the specificity remains low (3). Diffusion weighted MRI exploiting the signal to noise advantage provided by an endorectal coil has potential for improving the detection of tumor within the prostate (4). However, its value at differentiating benign from malignant nodules has not been demonstrated. The purpose of this study was to determine the diffusion coefficients of malignant regions within the peripheral zone (PZ) of the prostate and compare them with values obtained from the central gland (CG) comprising benign prostatic hypertrophy and from non-malignant PZ tissue.

Methods: Patients with low signal intensity lesions within the PZ on conventional T2-W images, with TRUS guided biopsy confirmation from that region positive for cancer, were included in the study. Patients were aged 52-77 yrs (mean±sd, 68.3 ± 6.4 yrs) with PSA 2.9-45.1 IU (mean±sd, 12.8 ±10.0 IU). Imaging was done on a 1.5-T Intera (Philips Medical Systems, Netherlands) using a balloon design endorectal coil inflated with 50 ml of air. Hyoscine butyl bromide 20 mg was administered intramuscularly to reduce peristalsis. Conventional T2-W fast spin echo images were obtained in 3 orthogonal planes to the prostate (FSE 2000/90 ms [TR/effective TE]) with a 512 matrix, 3mm slice thickness and a 14cm FOV (Fig. 1a). In addition, echo-planar diffusion weighted sequences (DWI 2500/69 [TR/TE]) with b values of 0, 300, 500 and 800 sec/mm^2 were obtained transverse to the prostate. Twelve 4mm thick slices (20 cm FOV, matrix 128) provided coverage of the prostate with an image acquisition time of 1min 24secs. Apparent diffusion coefficient (ADC) maps were generated using the system software (Fig 1b). Regions of interest (ROIs) were drawn around focal low signal intensity lesions within the PZ on the T2-W scans as well as around the whole CG on three consecutive slices. In patients in whom all 3 or 4 biopsies from the opposite PZ were negative for tumor, ROIs were drawn around "non-malignant" PZ on the three selected slices. ROIs were overlaid on the ADC maps and ADC values obtained.

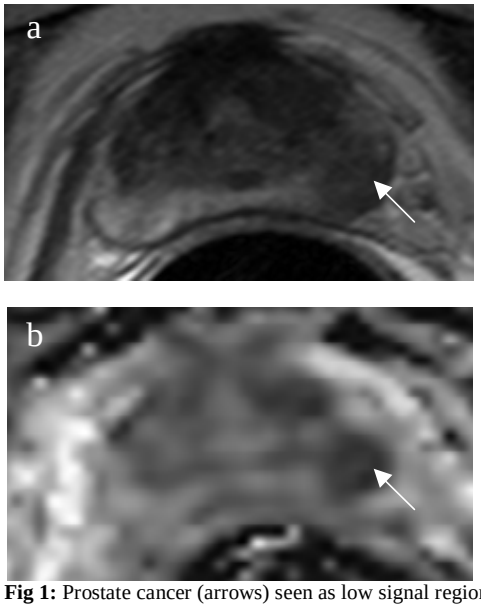

Fig 1: Prostate cancer (arrows) seen as low signal region on conventional T2-W image (a) and as focal area of restricted diffusion on the ADC map (b).

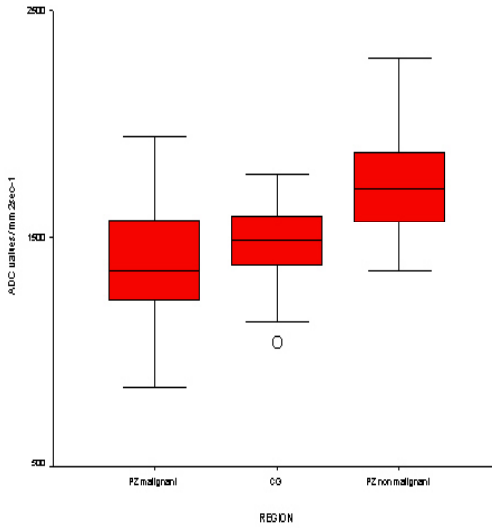

Fig 2: Comparison of ADC values in malignant PZ, central gland and non-malignant PZ

Results: Nineteen malignant PZ lesions in 22 patients were identified (3 patients had no T2-W abnormality and no identifiable tumor on 8 biopsies) whilst 15 patients had all biopsies from one side classified as no tumor (15 non-malignant PZ). Distortions on echo-planar DWI images were judged to be <4 pixels at air-tissue interfaces and <2 pixels within the prostate (antero-posterior or left-right). Given an average ROI size of ~40 pixels, sufficient overlap between ROIs on the T2-W and DWI images was ensured. ADC values from malignant PZ (median 36 pixels, quartiles 22 and 57) were 1.4 ± 2.6 x 10^{-3} mm^2/sec, from CG (median 204 pixels, quartiles 154 and 358) were 1.5 ± 1.6 x 10^{-3} mm^2/sec and from non-malignant PZ (median 53 pixels, quartiles 41 and 63) were 1.7 ±2.0 x 10^{-3} mm^2/sec (Fig. 2). The differences between these regions were statistically significant (Mann Whitney U, malignant PZ vs. CG p <0.006, malignant vs. non malignant PZ p <0.0001, non-malignant PZ vs. CG p <0.0001).

Discussion and Conclusion: DWI allows differentiation of malignant from benign regions within the prostate. However, a limitation of this study is that malignant lesions not visible on T2-W images have not been included in the analysis. In order to establish the sensitivity and specificity of the technique, correlation with prostatectomy specimens is planned.

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References: (1) Sedelaar JP et al. Urology. 2001; 57: 914-920. (2) Nakashima J et al. Urology 2004; 64: 101-105 (3) Purohit RS Urol Clin North Am. 2003; 30:279-293 .(4) Hosseinzadeh K. JMRI 2004; 20: 654-661