Apparent Diffusion Coefficient as a prognostic biomarker in early stage prostate cancer

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Introduction

There is an increasing incidence of early stage prostate cancer, particularly with the introduction of screening programmes. The disease can often behave in an indolent fashion even without treatment, with no effect either on health or longevity. In such cases, radical treatment, with its risks of incontinence and impotence, could be worse than the 'disease'. So, the challenge of managing localised prostate cancer is to distinguish patients with clinically relevant cancers, who may benefit from radical treatment, from the remainder who do not need any intervention. Thus, there is a major unmet need for markers of prostate cancer behaviour that could be used to inform the decision whether or not to undergo radical treatment. The aim of this study was to investigate apparent diffusion coefficient (ADC) obtained on diffusion-weighted imaging (DW-MRI)[1, 2] as a prognostic biomarker in patients with early stage prostate cancer currently managed by active surveillance.

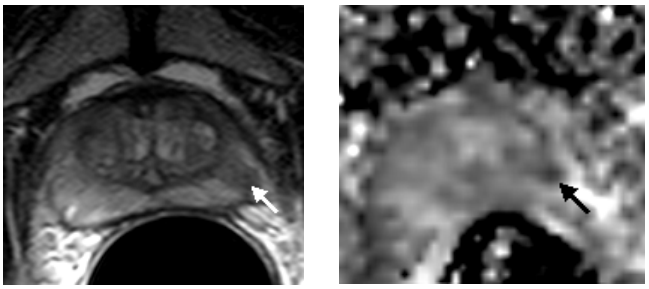
Methods

86 consecutive patients with localized prostate cancer eligible for active surveillance (Stage 1 or 2a disease, Gleason 3+3, PSA <10ng/ml, <2 cores positive) and who had elected for this management option underwent DW-MRI in addition to their standard T2-W MRI. MR studies were performed using a 1.5-T Intera (Philips Medical Systems, Netherlands) using a balloon design endorectal coil (Philips Medical Systems, Netherlands) inflated with 55ml of air. Hyoscine butyl bromide 20 mg was administered intramuscularly immediately prior to centering the patient in the scanner in order to reduce peristalsis. Conventional T_2-W fast spin echo images were obtained in 3 orthogonal planes (TSE 2000/90 ms [TR/effective TE], echo train length 16, 2 signal averages) with a 256x512 matrix (interpolated to 512 x 512), 3mm slice thickness, no gap and a 14cm FOV (total imaging time 12 mins). Echo-planar DW images (2500/69 [TR/TE]) with b values of 0, 100, 300, 500 and 800 s/mm^2 were obtained transverse to the prostate and parallel to the corresponding set of T_2-W images. The phase-encoding gradient was from left to right in order to minimize motion artifacts in the prostate. Twelve 4mm thick slices (no gap, 20 cm FOV, matrix 128x128) provided coverage of the prostate with an image acquisition time of 1min 24s.

The tumor region was identified as a low signal intensity lesion on the T2-W images in a sextant that was biopsy positive for tumor by a radiologist with 10 years experience of prostate MRI. Regions of interest (ROIs) were drawn on axial ADC maps by visual matching with normal PZ, central gland and tumor on T2-W images.

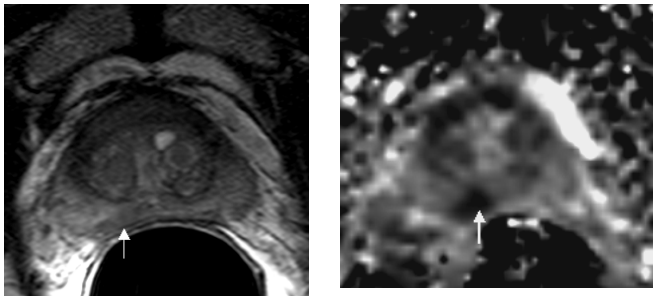
Results

Patients were followed for a mean of 29 months, repeat biopsy data was available in 78. 34 (40%) patients had adverse repeat biopsy findings, and 39 (45%) had deferred radical treatment. Radical treatment was initiated in the event of PSA velocity >1ng/ml/year or adverse repeat biopsy findings (primary Gleason grade >4, or %positive biopsy cores >50%). On univariate analysis tumor ADC was a significant predictor of both adverse repeat biopsy findings (p<0.0001, HR 1.3 CI 1.1-1.6) and time to radical treatment (p<0.0001, HR 1.5 CI 1.2-1.8). ROC curves for ADC showed an area under curve (AUC) of 0.70 for adverse repeat biopsy findings and 0.83 for prediction of radical treatment. ADC performed better than all other baseline clinical variables (PSA, Gleason score, stage, number of positive cores, % tumor in cores).



A B

Fig 1 *T2-W tranverse image (A) and corresponding ADC map (B) in a patient who did not progress to require radical treatment showing low signal intensity tumor on T2-W with moderate diffusion restriction on ADC map (arrows).*



A B

Fig 2 *T2-W tranverse image (A) and corresponding ADC map (B) in a patient who progressed, requiring radiotherapy showing low signal intensity tumor on T2W with marked diffusion restriction on ADC map (arrows).*

Conclusion

Functional information provided by DW-MRI at presentation is potentially useful for identifying patients with localized prostate cancer at risk of disease progression. Its utility in selecting patients for active surveillance versus radical treatment warrants further study.

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References

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2. Morgan VA et al Acta Radiol. 2007; 48: 695-703.