MONITORING LOW-RISK PROSTATE CANCER WITH DIFFUSION-WEIGHTED MRI: ADC AND ITS RELATIONSHIP TO GROWTH RATE

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Target Audience: Radiologists, radiographers, physicists and clinicians with interest in Diffusion Weighted (DW) MRI of the prostate

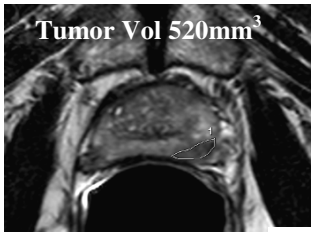
Purpose: In patients managed by active surveillance, DW-MRI has increased the sensitivity and specificity for identifying prostate cancer when used in conjunction with conventional T2 weighted (T2W) imaging[1]. In addition, the quantified ADC value has been shown to be a prognostic indicator of upgrade on repeat biopsy and progression to treatment[2]. ADC has also been linked to Gleason grade at biopsy and prostatectomy[3,4]. The purpose of this study was to explore the relationship between ADC and tumor growth rate in order to determine the potential value of ADC as a marker of proliferative status of prostate tumors.

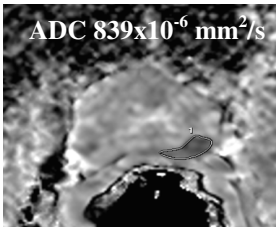
Methods: 33 consecutive patients with prostate cancer monitored using MRI between June 2011 and Sept 2013 who had undergone a baseline as well as a follow up scan without intervening treatment to the prostate were included. Of these 2 had tumors invisible on MRI and 1 had haemorrhage.The final cohort comprised 23 patients aged 52-74 yrs (mean±std 66 ± 5 years). Images were acquired at 3T using an endorectal technique, filling the balloon with 60 ml of perfluorocarbon. T2W images in 3 planes orthogonal to the prostate (FSE, TR 2500ms, TE 110ms, FOV 14 cm, slice thickness 2.2 mm, 0.1mm gap, matrix 220x184, extrapolated to 256x256 were complemented by ZOOM-DW images in the transverse plane (single shot EPI, TR 3544ms, TE 51ms, FOV 100 cm, slice thickness 2.2 mm, matrix 80x79, extrapolated to 128x128). Images were assessed by an experienced observer using a combination of T2W and DW images. Regions of interest (ROIs) were drawn around tumor (defined as low signal-intensity on T2-W images with focal restricted diffusion and positive biopsy from that sextant of the prostate) on every slice of the T2-W images on which it was visible. Tumor volume was calculated from total ROI area multiplied by slice thickness. A ROI around the focus of restricted diffusion on the slice of the ADC map on which tumor appeared largest was used to derive a representative ADC value for tumor. Volume measurements were repeated by the same observer on a separate occasion and an average of the measurements obtained to reduce measurement variability. Growth rate was calculated from the change in volume (mm^3) of the tumor with time (weeks). A Pearsons correlation coefficient was used to define the relationship between tumor growth rate and ADC.

Results: Patients were re-scanned at a median interval of 62 weeks (LQ 53.5, UQ 90.1 weeks). 20 tumours were graded as Gleason 3+3, 2 as Gleason 3+4 and 1 as 4+3. There was no significant difference between the first and second measurement at time-point 1 or timepoint 2, but differences between the averaged measurements at time-point 1 and timepoint 2 were significantly different (p=0.001). Descriptive data for baseline PSA, tumor volume and ADC are given in Table 1 together with percentage change in these parameters at the second time point. Tumor growth rates ranged from 0- 22 mm^3/week (median 0.71, LQ 0.21, UQ 3.21 mm^3/week). There was a significant negative correlation between tumor growth rate and ADC at presentation (r = -0.47, p<0.022). Growth rate was near zero in 5 patients; in the remaining 18, doubling time ranged from 1.1 to 11.1 years (median 3.1, LQ 2.3, UQ 5.2 years).

Table 1 : Baseline values of PSA, tumor volume and ADC and their % change

	Mean ± std	Median (LQ, UQ)
PSA ng/mL	8.4 ± 4.6	7.0 (5.9, 9.4)
Tum vol [mm^3]	493.4 ± 816.5	192.8 (99.9, 565.9)
ADC [$X10^{-6}$ mm^2/s]	1080.2 ± 223.8	1106.0 (884.5, 1260.0)
PSA velocity [ng/mL/yr]	0.05 ± 0.11	0.03 (0, 0.08)
% change in tum vol	34.4 ± 31.3	34.3 (12.3, 45.7)
% change in ADC	0.11 ± 14.8	-5.2 (-10.4, 12.0)





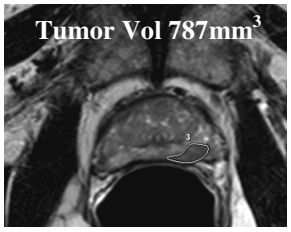
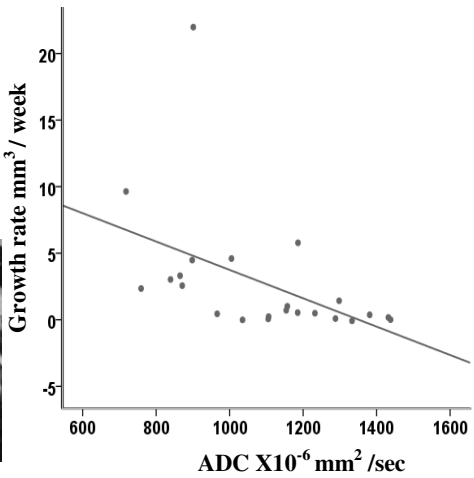


Fig.1a, T2W Axial time-point 1 1b, ADC map time-point 1 1c, T2W Axial time-point 2

Scatter plot of growth rate vs. ADC at presentation



Discussion and Conclusion: In low-risk prostate cancer patients, doubling time is around 3 years, although a wide range is apparent, with some doubling in 1 year. Cancers with lower ADC at the outset tended to grow more quickly. A larger study to determine threshold values of ADC on which to base management decisions for early treatment options is warranted.

References: (1) Morgan et al, 2007, Acta Radiologica, Jul;48(6):695-703 (2) Giles et al, 2011, AJR, Mar;196(3):586-91, (3) Kitajima et al Eur J Radiol. 2013 Aug;82(8):1219-26, (4) Bittencourt, Eur Radiol. 2012 Feb;22(2):468-75

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