

Diffusion weighted magnetic resonance imaging (DW-MRI) for locally recurrent prostate cancer after external beam radiotherapy (EBRT)

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Introduction: Following external beam radiotherapy, the prostate gland reduces in size and in water content. Detection of disease recurrence within the gland on T2W images is limited therefore because of lack of contrast between tumor and post irradiated non-tumor tissue. Diffusion-weighted MRI offers improved contrast between tumor and non-tumor tissue (1) through measurement of water diffusivity, although its utility in the irradiated prostate gland has not been established. The purpose of this study was to evaluate the accuracy of T2W plus DW-MRI for detecting recurrent tumor within the prostate following external beam radiotherapy (EBRT) and document the ADC values of recurrent tumor and irradiated non-tumor tissue.

Methods: This retrospective study included all patients who had undergone i) endorectal T2W-MRI with diffusion-weighted imaging between 2004 and 2010, ii) evidence of biochemical failure following definitive external beam radiation therapy to the prostate prior to MRI, iii) transrectal US guided biopsy of the prostate within 14 months of MRI. A total of 26 patients aged 57-78 years were included. PSA rise was 0.05 – 23.8 ng/ml above nadir. Mean time from radiation therapy to MRI was 64 months (range 24-130 months). 21 biopsies were performed using a standard random sampling technique (17 octant, 5 sextant). 2 patients had biopsies of 2 and 12 cores respectively and 2 patients had TURPs.

MRI was performed on a 1.5T Philips Intera using an endorectal coil inflated with 55ml of air and following administration of 20mg Hyoscine butyl-bromide i.m. to reduce bowel peristalsis. T2-W images in 3 orthogonal planes (TR2000 ms, TE90 ms FOV140 cm, matrix 256x179, slice thickness 3.0mm, 20 slices) and single shot EPI-DWI in the axial plane (bvalues 0,300,500,800 s/mm²) were acquired. Regions of interest were drawn around a focal area of restricted diffusion on ADC maps generated from a monoexponential fit of all b values using scanner software.

MRI was scored positive for tumor based on the prospective report of a focally restricted area within the prostate on the ADC map with a corresponding low signal intensity mass on T2W imaging. A region of interest was drawn around the suspicious lesion on a single slice with a corresponding ROI around presumed non-tumor irradiated tissue on the opposite side of the prostate on the same slice (n=19). Where no focally restricted diffusion was identified and histology was negative, two ROIs on non-tumor irradiated tissue were drawn on opposite sides within the peripheral zone of a single central slice and a mean non-tumor value obtained (n=6). If no focally restricted lesion was identified and histology was positive an ROI was drawn within the positive octant with a corresponding ROI on the opposite side of the same slice (n=1).

Sensitivity, specificity, positive and negative predictive values were calculated per patient against a biopsy gold standard. Mean tumour and non tumor irradiated tissue ADCs were obtained.

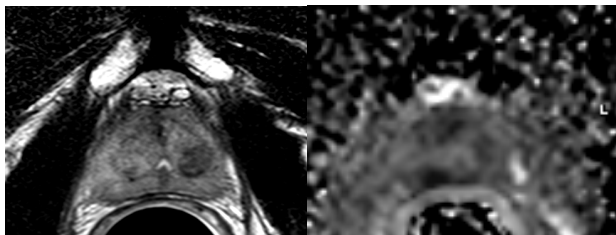


Fig 1: T2W & DWI in a patient +ve for tumor on MRI & Histo. (TP)

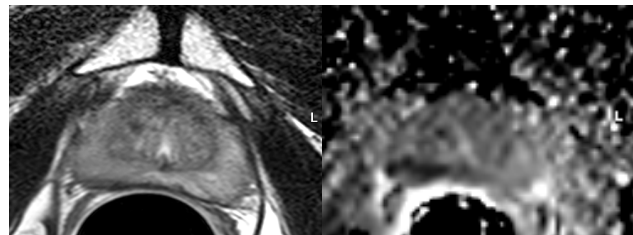
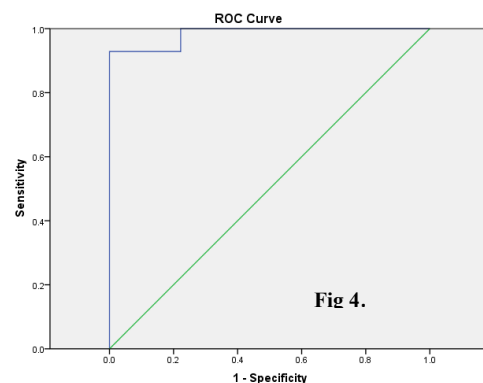
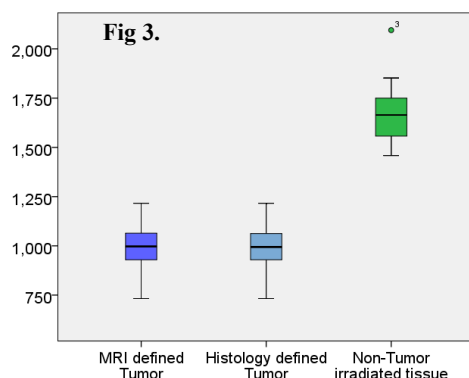


Fig 2: T2W & DWI in a patient +ve for tumor on MRI but -ve on Histo. (FP)

Results: 18/26 (69.2%) of patients had positive histology. Sensitivity, specificity, positive and negative predictive values for T2W + DWI MRI detecting tumor were 94.4%, 75%, 89.5% & 85.7% respectively. Examples of a true positive (TP) and a false positive (FP) are given in Figs. 1 & 2 respectively. ADCs (x10⁻⁶ mm²/s) of 19 MRI-defined tumor ROIs (17TP, 2FP) were 993 +/- 125, of 18 histology-defined tumor ROIs (17TP, 1FN) were 994 +/- 133 and of 26 non-tumor ROIs were 1660 +/- 146 (Fig 3). Independent samples t-test showed differences between tumor and non-tumor irradiated tissue were significantly different for both MRI and histology-defined tumor ROIs (p<0.001). In addition, a paired samples t-test showed significant differences between tumor and non-tumor irradiated tissue in the 17 TP cases (p<0.001). ROC analysis indicated that a cut-off ADC of 1337 x10⁻⁶mm²/s predicted tumor with 92.9% sensitivity and 100% specificity (AUC 98.4) (Fig.4).



Discussion: DWI MRI is a useful tool for identifying tumor recurrence within the prostate following external beam radiotherapy as irradiated prostate has a significantly higher ADC than recurrent tumor with ADC values equivalent to those published for non-irradiated prostate (2). However, there were 2 cases where ADC values appeared to be positive for recurrence with negative histology; biopsy used as the gold standard may have been subject to sampling error. Correlation with MR guided biopsy would be ideal.

References: ¹ Morgan VA et al, 2007 *Acta Radiol* 48(6):695-703, ² deSouza NM et al, Nov 2010 BJR in press

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