Comparison of apparent diffusion coefficients derived from histology-defined versus T2-W defined regions in prostate cancer

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Introduction: Prostate cancer is poorly visualized with current imaging techniques, with high-resolution T2-weighted imaging (T2W) offering the best chance of defining the disease. Tumors are usually recognized as low signal intensity regions within the normal high signal-intensity peripheral zone, or homogeneous low signal intensity masses within the central gland with mass effect. Tumor regions thus defined are often used to obtain functional data from corresponding diffusion weighted images. How accurately these regions correspond to tumor regions defined on the histopathology sections has not been documented. Also, the difference in the values of apparent diffusion coefficient (ADC) obtained from T2-W derived compared to histopathology derived regions is unknown. The purpose of this study was to determine the mismatch between T2-W derived and histopathology derived tumor regions and to compare the ADC values obtained with each method.

Methods: Twenty patients referred for routine clinical evaluation prior to prostatectomy at our MR centre were recruited. Patient characteristics were: mean age 60 yrs, (range:49-76yrs), stage T1 (n=14) or T2 (n=6), Gleason Grade 3+3 (n=11), 4+3(n=2), 3+4(n=6), 5+3 (n=1) PSA=7±3 ng/mL (mean ± sd). A Philips Intera 1.5T scanner, with a balloon design endorectal receiver coil inflated with 55mls of air was used for all studies. In addition to standard 3-plane imaging (FSE, TR/TE=2000/90, 20 slices, 3mm thickness, 256x512 matrix, 140mm FOV), 12 axial slice diffusion-weighted images (TR/TE 2500/69, 4mm thickness, 200mm FOV, 128x128 matrix, 4 b-values 0,300,500,800 s/mm2 in three directions) were acquired and isotropic ADC maps were generated using all b-values using scanner software.

The fresh whole mount prostate was cut and digitally photographed (Fig 1a; [1]) and processed. Areas of tumor were outlined on the histology slides by an experienced histopathologist and also digitally photographed (1b). Regions of interest (ROIs) were drawn around the whole prostate, central gland and tumor (Fig 1c) on all slices of the T2W axial scans, and around the whole prostate on the ADC maps by an experienced radiologist. Tumor regions were transferred from the histopathology slides to the corresponding T2W axial scans using a 2 step non-rigid registration of landmarks based on the prostate outline and internal structures on the fresh slice photographs, histopathology photographs and axial T2W images [2]. The number of pixels that did not overlap between these 2 regions to the total number of tumor pixels on histopathology was calculated for each patient. The mean ADC for each patient was calculated for tumor (TU), peripheral zone (PZ) and central gland (CG), using boundaries identified by both T2-w MRI and by histology.

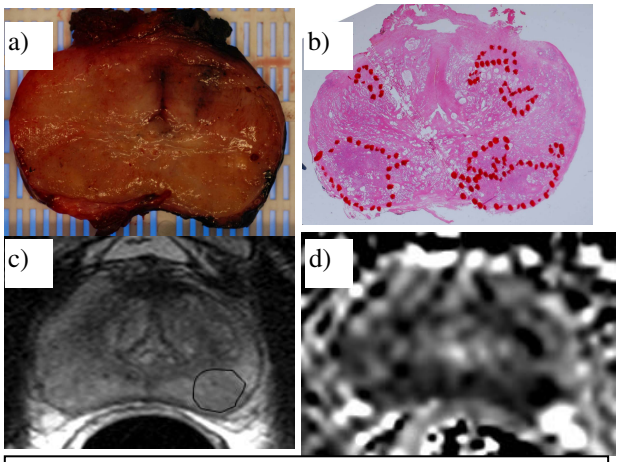

Figure 1. Corresponding slices from a) fresh prostate b) whole mount H&E histology c) T2w image d) ADC map

Results:

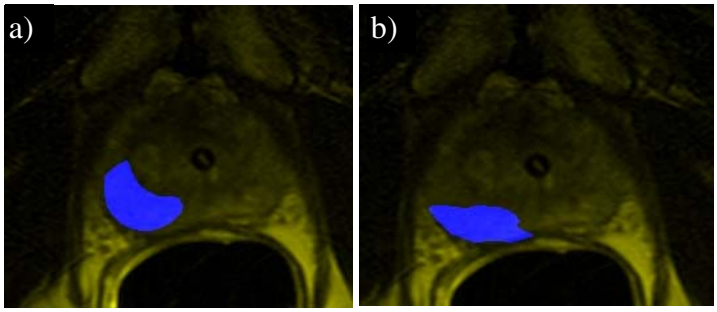

Figure 2. Axial T2w image of prostate with example pair of tumor regions identified by a) T2-weighted MRI b) histology

Correspondence between T2 and histological lesions: An example of the tumor regions identified by histology and by T2-w MRI is shown in figure 2. In the twenty patients a total of 41,135 pixels were identified as abnormalities on T2-weighted images, and 79,022 pixels identified within the histologically-confirmed lesions that had been transferred to the T2w images. 17,190 pixels were common to both lesions.

ADC Values from T2 and histological lesions: The mean ADC values for the different regions are summarised in the following table. The ADC values for PZ and CG are the same in each case, while there is a slightly lower ADC value for the histologically identified tumor region.

	Tumor	PZ	CG
T2w	1497 ± 300	1520 ± 140	1417 ± 151
Histology	1439 ± 340	1517 ± 144	1428 ± 164

Discussion: The data show a very substantial difference in the regions identified as tumor depending on whether T2-w MRI or histology is used. This agrees with previous findings that T2-weighted imaging is not a very sensitive method for identifying tumor regions, and confirms the need for histological validation of tumor regions.

Since both ADC and T2 are NMR parameters that reflect the local microenvironment, it was anticipated that the ADC lesion might more closely match the T2 lesion than the histological lesion. However the evidence here suggests that the reverse is true – that there is a greater fall in ADC in the histological lesion than in the T2 lesion. This suggests that different mechanisms may give rise to the changes in T2 and in ADC. From a clinical point of view, the relationship between T2 and histology deserves further attention.

Conclusion: There is a large mismatch between lesions identified by T2-weighted MRI and by histology. Amongst other consequences, this leads to different values of the mean apparent tumor ADC.

References:[1] Jhavar S G et al J. Clin. Pathol. 2005;58;504-508, [2] Reinsberg S et al, *Proc Intl Soc Mag Reson Med* 11(2004).

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