

Textural entropy may help identify significant tumour within the prostatic transition zone on mp-MRI

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Target audience: Radiologist and oncologist with an interest in multi-parametric prostate MRI

Background: Increasing recognition of anteriorly located prostate cancers has resulted from the gradual transition of a diagnostic pathway reliant primarily on prostate specific antigen (PSA) and transrectal ultrasound (TRUS) guided biopsy – a strategy that selectively identifies peripheral zone cancers - to one that incorporates imaging, notably multi-parametric MRI [1]. Although multi-parametric (mp) MRI facilitates identification of more anterior cancers, its overall diagnostic accuracy is likely lower in this part of the prostate compared to the posteriorly located peripheral zone [2]. The reason for this relates to benign hyperplasia nodules. Against the heterogeneous signal of an expanded transition zone, tumour is much more difficult to differentiate [3]. Here we explore whether assessment of textural entropy of prostatic transition zone can help confirm the presence significant prostatic tumour.

Material and Methods: 92 men underwent multi-parametric prostate MRI. All mp-MRI was performed using a 1.5T static magnet (Avanto, Siemens, Erlangen, Germany) and pelvic phased array coil.

TABLE 1: MRI SEQUENCES	T2w TSE axial / coronal	EPI-DWI	T1 3D FLASH*
Repetition time (ms)	5170 / 5240	2100	5.61
Echo time (ms)	92 / 104	98	2.5
Flip angle (degrees)	180 / 150	90	15
Slice thickness (mm)	3 / 3	5	3
Slice gap (mm)	0.3 / 0.3	0	0.6
Averages	2 / 2	16	1
Base matrix	256 / 256	172	192
Matrix phase %	95 / 95	100	100
b-values (s.mm ⁻²)	n/a	0, 300, 500, 1000	n/a
No. of acquisitions	1 / 1	1	35
Temporal resolution (seconds)	n/a	n/a	16

0.2mg/kg (maximum 20mg) of spasmolytic (Buccopan; Boehringer Ingelheim, Ingelheim, Germany) was administered intravenously to reduce peristalsis. The mp-MRI included axial and coronal small field of view T2-weighted imaging; supplemented by axial diffusion weighted imaging (DWI) and dynamic contrast enhanced (DCE) imaging (table 1 below).

All patients then proceeded to transperineal template mapping biopsy. Briefly, systematic biopsy of the whole gland was conducted through a brachytherapy template-grid and 5mm sampling frame conforming to a

sampling density of approximately 1 core/cc of tissue uniformly over the prostate. Biopsies were grouped and potted into 20 zones, modified from a technique reported by Barzell et al [4].

Biopsy cores were classified by two cancer definitions: (i) no disease or <4mm maximum cancer core length (MCCL) and Gleason 3+3 (normal/insignificant cancer); (ii) >Gleason 3+4 or ≥4mm MCCL (significant disease).

An experienced radiologist carefully matched mp-MRI and TPM biopsy histological findings within the transition zone of the prostate; identifying the imaging slice on T2 and matched ADC and early T1 post contrast images that best represented location of the highest definition positive transition zone biopsy core. Where no positive histology was present within the transition zone the radiologist selected the slice with the largest transition zone antero-postero diameter. For each patient matched T2, ADC and T1 images were analysed and the mean entropy within the entire transition zone of the prostate recorded by a second radiologist who was unaware of the histopathology results. The second radiologist contoured the entire transition zone on each of the images. Using TexRAD software a spatial band-pass filter was applied at a range of scales from 2 mm to 6 mm (incrementing at 1 mm intervals) to the entire transition zone. The entropy within the entire transition zone for each of the filtered images was recorded for each patient on T2, ADC and T1 weighted images. For each filter and image type, transition zone entropy values were compared between patients with no tumour/insignificant verses those with significant cancer using a Mann-Whitney test. Receiver operator characteristic (ROC) area under curve (AUC) analysis was performed to determine whether assessment of entropy within the entire transition zone could help identify images containing significant tumour.

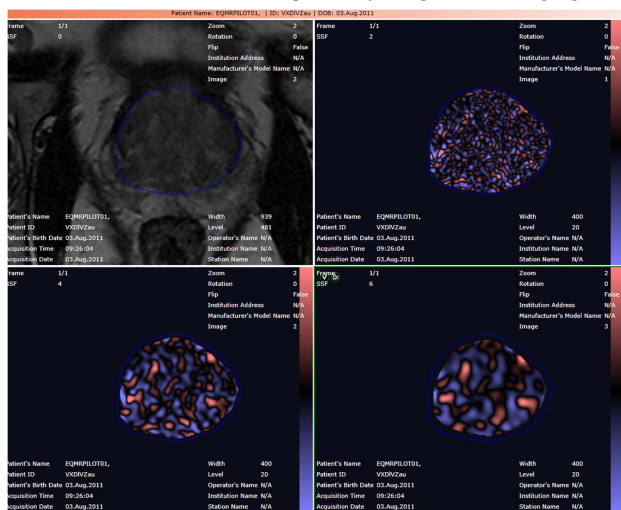


Figure 1: unfiltered T2 weighted image of a prostate (top left) and increasingly coarse filtered images (2mm – top right; 4 mm – bottom left and 6 mm – bottom right) – no transition zone tumour on histology

Results: An example of an unfiltered T2 weighted image and filtered images at different scales is given in figure 1. 55 patients were classified to the normal/insignificant cancer group; and 37 to the significant cancer group based on biopsy. There were significant differences between all parameters for all spatial filters except for ADC applied with a 4,5 or 6 mm filter. ($p > 0.05$) – with entropy reduced on all image types in the presence of significant tumour. ROC-AUC of unfiltered ADC, T2 and T1 entire transition zone signal for detection of significant tumour was 0.71, 0.62 and 0.67 respectively. With increasingly coarse filters ROC-AUC for ADC progressively reduced to 0.59 (reaching a minimum for the 6 mm spatial filter); and progressively increased for T2 to 0.79 and T1 to 0.79 reaching a maximum for the 6 mm spatial filter.

Conclusion: For T2 and T1 weighted images, application of spatial filters to the entire transition zone and derivation of transition zone entropy provides a new tool to potentially help radiologists identify slices that likely to contain significant tumour. Textural analysis may have a role in the development of multi-parametric MRI computer aided diagnosis software.

References: [1] Dickenson et al European urology 59(4):477-494; [2] Langer L et al Journal of magnetic resonance imaging : JMRI 30(2):327-334; [3] Chesnais AL et al Clinical radiology 68(6):e323-330; [4] Barzell WE Urology 70(6 Suppl):27-35;