EFFECT OF PROSTATE HAEMORRHAGE ON POST-BIOPSY T1, T2 WEIGHTED MRI SIGNAL AND DWI DERIVED ADC VALUES: A LONGITUDINAL STUDY

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Target audience: Clinicians using mutli-parametric MRI for detection of prostate cancer.

Purpose: Haemorrhage is known to alter T1 and T2-weighted signal intensity [1]. Multi-parametric (T2, diffusion and dynamic contrast enhanced) MRI of the prostate performed for disease detection is often conducted following biopsy of the gland. There is debate regarding how long to delay MRI after biopsy to avoid haemorrhage artifact; furthermore the effects of biopsy on prostate diffusion weighted imaging remain to be fully evaluated. Whilst waiting a year is believed to result in resolution of biopsy related changes, this approach is impractical as it may delay treatment of high-risk patients. Conversely there are significant resource implications if all patients with an elevated prostate specific antigen level undergo multi-parametric MRI prior to biopsy. Identifying the extent to which MRI parameters are affected and the length of time that they remain altered after biopsy is therefore vital to clinical practice. This longitudinal study aims to describe the temporal changes within peripheral (PZ) and transition zone (TZ) of quantitative multi-parametric MRI parameters following transrectal ultrasound (TRUS) biopsy of prostate; and thereby identify the most reliable parameters for cancer detection.

Methods: The institutional review board approved the study and informed consent was obtained from all participants. Fourteen patients (mean age, 63.9; range, 43.5-69.2) with elevated PSA and negative (i.e. no suspicious lesion demonstrated) multi-parametric MRI prostate finding were recruited. All patients subsequently underwent a standard 10-core TRUS biopsy. Patients returned for additional study multi-parametric MRI prostate scans at one, two and six month post-biopsy. All multi-parametric MRI studies were performed using a 1.5 T scanner (Avanto; Siemens, Erlangen, Germany) with a body coil for excitation and a pelvic phased-array coil for signal reception. Each study consisted of T2-weighted (TSE, TE= 92, TR=5170, slice thickness=3mm, NSA=2, pixel BW=191, ETL=17, imaging matrix=256*256 and number of slices=23); diffusion weighted (EPI, TE= 96, TR=21, slice thickness=5mm, NSA=16, pixel BW =969, imaging matrix=172*172 and number of slices=12, b values= 0, 150, 500, 1000); and dynamic contrast enhanced T1-weighted (VIBE, TE= 2.54 ms, TR= 5.61ms, slice thickness= 3mm, pixel BW= 299 Hz, imaging matrix= 192*192 and number of slices=26, temporal resolution = 16 s, number of time-points 35). Volumetric region of interest (ROI) analysis was performed with the prostate divided into TZ and PZ based on T2-weighted images. Pre-contrast T1 signal intensity, T2 signal intensity and ADC were calculated for each of the four volumetric regions. Pre-contrast T1 and T2 signal intensity of the right obturator internus muscle was recorded for normalization of prostate T1 and T2 signal intensity values across patients.
The Kruskal-Wallis test followed by Dunn's multiple comparison post-test was used to assess significance of changes of normalized T1 signal intensity (nT1-SI), normalized T2 signal intensity (nT2-SI) and ADC median values across pre-biopsy, and 1- 2- and 6-month post biopsy timepoints.

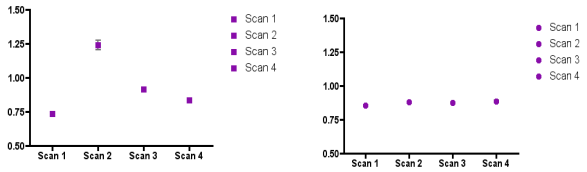

Figure 1: Temporal quantitative changes in PZ nT1-SI (Left) and TZ nT1-SI (Right);Scan 1,2,3 and 4 performed at pre-biopsy and 1,2 and 6 months post-biopsy

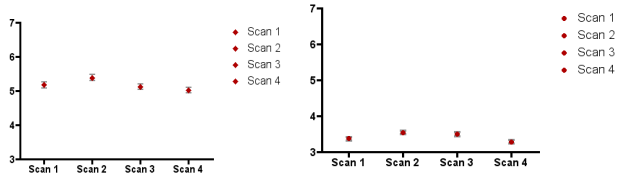

Figure 2: Temporal quantitative changes in PZ nT2-SI (left) and TZ nT2-SI (Right);Scan 1,2,3 and 4 performed at pre-biopsy and 1,2 and 6 months post-biopsy

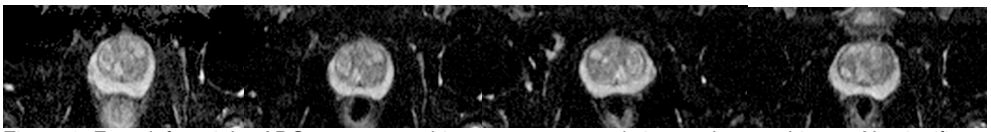

Figure 3: From left to right, ADC maps at pre-biopsy, one, two and six months post-biopsy. No significant change occurs across timepoints

Results: Figure 1(left) shows a significant increase in PZ nT1-SI at 1 month post-biopsy, followed by gradual reduction over the subsequent 5 months (median PZ nT1-SI 0.74, 1.01, 0.87 and 0.80 at pre-biopsy, 1, 2 and 6 month respectively, $p<0.01$). nT1-SI remained above pre-biopsy level after 6 month ($p<0.01$). There was no significant change in TZ nT1-SI across timepoints (figure 1(right)). PZ nT2-SI was elevated at 1 month post-biopsy, with a gradual reduction over the next 5 months ($p=0.02$). nT2-SI remained below pre-biopsy values at 6 months ($p>0.05$) (figure 2(left)). TZ nT2-SI also significantly changed across timepoints (median TZ nT2-SI 3.39, 3.48, 4.13 and 3.33 at pre-biopsy, 1, 2 and 6 months post-biopsy respectively, $p=0.01$) (figure 2). There was no significant change between pre-biopsy and post-biopsy PZ ADC or TZ ADC at any timepoint ($p=0.07$ to 0.181) (figure 3).

Discussion: Both T1 and T2 signal intensity changes follow the typical pattern of change associated with resolving haemorrhage [2]. Changes in both T1 and T2 signal persists at 6 months post biopsy; with elevated nT1-SI and reduced nT2-SI. As tumour exhibits reduced T2 signal relative to surrounding normal tissue, the reduction in nT2-SI could potentially impact tumour detection even at 6 months post biopsy. There was no significant change in ADC following biopsy at any timepoint, suggesting that diffusion weighted imaging is likely to be robust for tumour evaluation in the post-biopsy setting.

Conclusion: This study demonstrates that T1 and T2 signal changes within the prostate change dynamically and remain altered at 6-months following TRUS biopsy; and that ADC remains unaffected at all timepoints post-biopsy. Clinicians evaluating multi-parametric MRI studies should consider when after biopsy imaging has been performed and may place more confidence on ADC evaluation of disease. Future work remains necessary to evaluate the effects of biopsy on quantitative DCE parameters; and the evaluate effects on disease detection in patients with MRI visible tumour.

References: 1. Barrett et al. Radiology. **2012** 263:3:751-757 **2.** Rosenkrantz et al. J Magn Reson Imaging. **2010** 31:6:1387-1394