Title: Human Prostate Cancer Characterization Using Tissue Sodium Concentration Measured from Sodium MRI

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Structured Abstract:

Introduction: Prostate cancer is the most common non-cutaneous cancer in males, affecting one in seven men in their lifetimes. Prostate gland under sampling in standard biopsy is a major concern, resulting in conservative decision making by clinicians when staging patients for active surveillance or treatment. Non-invasive lesion characterization can greatly improve this situation by providing reliable information to clinicians about cancer stage, reducing instances of overtreatment. This study was preformed to demonstrate that in vivo tissue sodium concentration (TSC) can be used to distinguish between low and high-grade prostate lesions.

Methods: We acquired sodium MRI data in conjunction with mpMRI data (diffusion weighted imaging, T1 weighted, and T2 weighting imaging) from ten patients with biopsy proven prostate cancer. These patients underwent prostatectomy after imaging and whole mount histology sections of the prostates were subsequently Gleason graded by a pathologist's assistant. All imaging and histology data were co-registered using a previously validated registration pipeline. Sodium imaging acquisition was preformed using custom built MRI RF hardware, including transmit only birdcage and receive only endorectal RF coils. After imaging and registration, imaging data were overlaid onto histology sections, allowing for direct comparison of imaging data to Gleason grade. TSC data were assessed using percent changes in TSC (ΔTSC) from healthy prostate tissue in the same patient.

Results: Of the ten patient datasets, nine possessed more than one Gleason grade of cancer. These nine individual patient datasets all showed an increasing trend of ΔTSC with Gleason grade. ΔTSC data showed a significant Spearman's correlation with Gleason score ($rs = 0.791$, $p < 0.01$). Averaged patient cohort data shows monotonic, statistically significant increases in ΔTSC with Gleason score ($p < 0.001$).

Discussion: This study has shown that sodium MRI has utility to non-invasively characterize the grade of prostate lesions in vivo. The ΔTSC data is strongly correlated with tumour grade in human prostate cancer. Sodium MRI can be an invaluable tool to clinicians, providing better information for risk stratification decisions and non-invasive whole gland assessment for active surveillance of low risk prostate cancer. This could ultimately reduce the frequency of overtreatment of this disease.