Benign Prostatic Hyperplasia: Evaluation of Vascular Characteristics with Dynamic Contrast-Enhanced T_1 weighted MRI

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Introduction: Benign prostatic hyperplasia (BPH) is a common condition in older men causing lower urinary tract symptoms. Diagnosis is currently based on digital rectal examination and measurement of serum prostate specific antigen (PSA), but the relationship between prostate size, PSA and BPH pathophysiology is unclear, and clinical tools for directly monitoring and assessing the condition are few. The vascular characteristics of BPH are important as increasing intraprostatic pressure compresses blood vessels [1], and it has been shown that current drug treatments alter the properties of prostatic microvessels [2]. This makes dynamic contrast enhanced (DCE) MRI an attractive tool for assessment of BPH. DCE-MRI has been used in an animal model of BPH [3] and in several studies of prostate cancer [4, 5] where BPH has often been cited as a confound for cancer in the central gland. The aim of this study was to evaluate the baseline MR relaxation and vascular characteristics of BPH and assess the feasibility of using these techniques for differential diagnosis and treatment monitoring.

Methods: Twelve patients (mean 71 ± 9 years) with lower urinary tract symptoms and prostatic enlargement but no evidence of cancer underwent MRI examinations on two occasions one week apart, prior to trans-urethral resection of the prostate (TURP). At the time of the study 2 of the patients were untreated, 5 were taking tamsulosin alone and 5 were taking finasteride with or without tamsulosin. The study was approved by our Local Research Ethics Committee and imaging was performed on a 1.5 T Philips Intera MR system using a phased-array receive coil. Prostate T_2 was measured using a multi-slice 2D turbo spin echo sequence employing a CPMG echo train (16 echoes, 15 ms echo spacing). T_1 was measured using an inversion recovery turbo-FLASH sequence with 5 inversion times. High temporal resolution (one 20-slice volume every 1.5 seconds) DCE-MRI data were acquired for 7.5 minutes following the injection of 0.1 mmol/kg Gd-DTPA-BMA and analysed as described previously [6] using a distributed parameter tracer kinetics model [7].

Results: Histological specimens obtained during TURP confirmed the presence of BPH and the absence of malignancy. Examination of the T_2 data using a non-negative least squares approach [8] highlighted the presence of 2 relaxing components in every prostate (Fig. 1). Subsequently biexponential analysis was used to assess these data. Mean values of DCE-MRI parameters, T_1 and the 2 T_2 components for a region of interest encompassing the whole prostate volume in each patient (averaged across visits) are shown in Table 1.

Discussion: The biexponential nature of the prostate T_2 supports a previous hypothesis [9] and may reflect the mixed glandular and stromal content of the gland. The T_1 falls between estimates made in previous studies [4, 5] while the flow estimates show excellent agreement with PET data (0.18 ± 0.05 ml ml^{-1} min^{-1} [10]). Blood flow in BPH differs from our previous estimates in normal peripheral zone and prostate cancer (0.13 and 0.36 ml ml^{-1} min^{-1}, respectively [6]); v_e is similar to cancer (0.35 ml ml^{-1}) and PS similar to normal tissue (0.12 ml ml^{-1} min). These findings suggest the possibility of differentiating BPH from prostate cancer based upon separate flow and PS estimates normally inextricable from K^{trans}, the output of conventional compartmental modelling. Further analysis of the MRI data is required to determine variation with histological sub-type (determined form the TURP specimens) and influence of drug regimen [2].

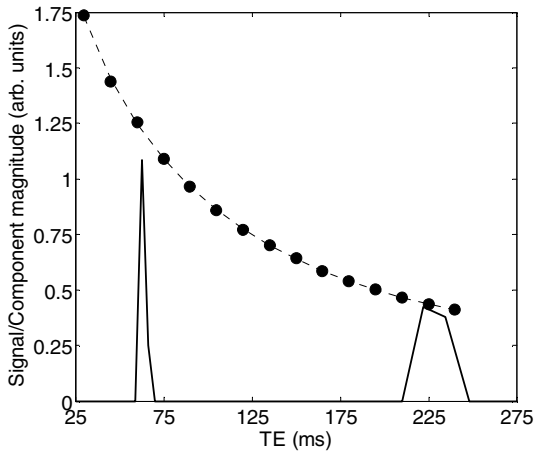

Fig. 1 - T_2 data from a typical BPH-containing prostate overlaid onto a T_2 spectrum obtained from the same data.

F_b /ml ml^{-1} min^{-1}	PS / ml ml^{-1} min^{-1}	v_b /ml ml^{-1}	v_e /ml ml^{-1}	T_1 /ms	Fraction T_{2A} /no units	T_{2A} /ms	T_{2B} /ms
0.20 ± 0.07	0.16 ± 0.05	0.14 ± 0.05	0.34 ± 0.12	1367 ± 85	0.49 ± 0.06	44 ± 3.8	231 ± 44

Table 1 – Mean and SD of parameter values across both visits for all patients; n = 12

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