Evaluation of the diagnostic differentiation of prostate cancer from benign prostate hyperplasia using Intra-voxel incoherent motion MR imaging

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Target Audience: Physicians and Scientists who interested in IVIM MR imaging and clinical diagnosis of prostate diseases.

Purpose: To assess the value of Intravoxel incoherent motion (IVIM) MR imaging for differentiating prostate cancer (PCa) from benign prostate hyperplasia (BPH).

Introduction: Adenocarcinoma of the prostate gland has become the leading malignancy in men in most west countries. Diffusion-weighted imaging (DWI) has shown great importance as a noninvasive functional diagnostic tool for the detection and differentiation of PCa. PCa shows restricted diffusion with high signal on DWI and low signal on ADC maps with decreased extracellular space when compared with BPH. However, this ADC values from Gaussian diffusion depend heavily on the choice of b-values with different sensitivity and specificity in previous studies[1]. The intravoxel incoherent motion (IVIM) theory was proposed to account for molecular diffusion driven by thermal energy as well as perfusion-based pseudo-diffusion[2]. As most previous studies focused on difference between PCa and normal tissues, the purpose of this study is to assess the diagnostic value of IVIM imaging in differentiating PCa from BPH that may appear similar features on conventional MR imaging.

Methods: This retrospective study was approved by the institutional review board and informed consent was waived. Thirty patients (mean age, 71.12 years; range, 51-88 years) with 18 PCa and 12 BPH underwent IVIM MR imaging. Axial IVIM MR imaging sequences (b=0, 20, 50, 100, 200, 400, 600, 800, 1000, 1200 s/mm^2) were obtained using a 3.0 T MR imager (GE Signa HDxt, USA) with a pelvic eight-channel phased-array coil. The ADC and fraction of fast ADC values were computed using the Funtool post-processing software equipped at an Advantage Workstation (GE, USA) then averaged in regions of interest (ROIs) at the target area of tumor proven by histopathology. The standard apparent diffusion coefficient (ADC), slow ADC, fast ADC and fraction of fast ADC were compared using independent-samples *t* test. A cut off value of standard ADC and slow ADC was evaluated with receiver operator characteristic (ROC) analysis. And the sensitivity, specificity, positive predictive value and negative predictive value were calculated respectively. The performance of standard ADC and slow ADC for distinguishing PCa for BPH was evaluated with the area under the curve (AUC).

Table 1 ADC of PCa and BPH groups (mm^2/s)

	PCA（n=18）	BPH（n=12）	P
standard ADC（$\times10^{-4}$）	5.78±2.25	10.13±1.34	0.000
slow ADC （$\times10^{-4}$）	7.07±2.58	12.80±1.78	0.000
fast ADC（$\times10^{-3}$）	14.34±10.91	32.30±76.35	>0.05
fraction of fast ADC	0.22±0.15	0.26±0.05	>0.05

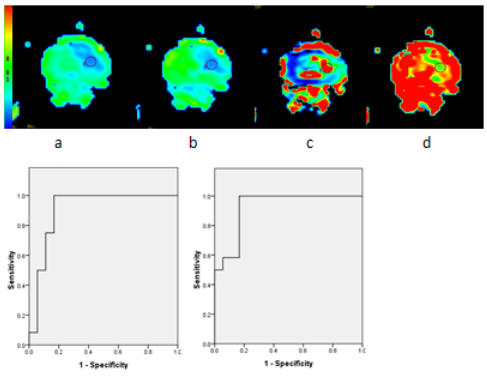

Figure 1 a-d illustrate the standard ADC (a), slow ADC (b), fast ADC (c) and fraction of fast ADC (d) of PCa. e,f illustrate ROC curve of standard ADC (e) and slow ADC (f) for diagnosis of PCa.

Results and discussion: The mean standard ADC was 5.78±2.25×10^{-4} mm^2/ s for PCa group, and 10.13±1.34×10^{-4} mm^2/ s for BPH group. The mean slow ADC was 7.07±2.58×10^{-4} mm^2/ s for PCa group, and 12.80±1.78 10^{-4} mm^2/ s for BPH group. The mean standard ADC and slow ADC for PCa was significantly lower than that of BPH (p<0.05). The mean fast ADC was 14.34±10.91×10^{-4} mm^2/ s for PCa group, and 32.30±76.35×10^{-4} mm^2/ s for BPH group. The mean fraction of fast ADC was 0.22±0.15 for PCa group, and 0.26±0.05 for BPH group. There was no significant difference between the two groups in terms of fast ADC or fraction of fast ADC. A threshold of 7.57×10^{-4} mm^2/ s for the maximum standard ADC value and 8.99×10^{-4} mm^2/ s for the maximum slow ADC value in the diagnosis of PCa resulted in an identical sensitivity of 83.33% (15 of to 18 patients), and a specificity of 100% (12 out of 12 patients). The positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy for PCa were 100% (15 out of 15 patients), 80.00% (12 out of 15 patients)and 90.00% (27 out of 30 patients), respectively. The AUC of standard ADC and slow ADC for differentiation between these two groups were 0.907 and 0.926.

Conclusions: From the observation of this study, it might be indicative that standard ADC and slow ADC from IVIM MR imaging maybe a significant MRI biomarkers to differentiate PCa from BPH with satisfying sensitivity and specificity.

References: [1] Aydm H. J Comput Assist Tomogr 2012; 36: 30-45 [2] Pang Y. Magn Reson Med. 2013 Feb; 69 : 553-62