Can intravoxel incoherent motion (IVIM) Replace the Conventional DWI Combined with DCE in Clinical Detection of Prostate Cancer?

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Target Audience Radiologists, MR technologists and clinicians

Purpose Intravoxel incoherent motion (IVIM) MR imaging is a non-invasive method with the ability of separation of "pure" molecular diffusion and perfusion effects.[1]Radiologists perform diffusion-weighted and dynamic contrast-enhanced (DCE) MRI to provide additional diffusion and perfusion information in the routine clinical set,[2,3] but it needs intravenous contrast agent administration and requires cumbersome procedures. Therefore, in this study we applied the IVIM technique to detect the prostate cancer and to compare the diagnostic performance between IVIM and conventional DWI combined with DCE.

Methods The local ethics committee approved the study and 19 patients (mean 72±2years; range 57-84 years) with TRUS biopsy after MR examination were recruited into the study. The study was performed on a 3.0-T MRI scanner (Achieva 3.0T TX, Philips Healthcare, Best, The Netherlands) with 32-channel SENSE cardiac coil. The IVIM protocol was performed with a single-shot spin-echo echo-planar imaging sequence (five b-values 0, 188, 375, 563, 750 s/mm^2; TR/TE 4114 /75ms; FOV AP/RL/FH 160/180/66 mm; slices 22). Data were fitted with IVIM biexponential model using in-house software developed using IDL (Research Systems, Inc., USA) to obtain the diffusion coefficients (D) and perfusion fractions (f). Conventional two high-b-value DWI sequences (0/800 and 0/1200 s/mm^2) and dynamic contrast-enhanced (DCE) sequences were also performed to obtain the apparent diffusion coefficient (ADC_{800} and ADC_{1200}) and DCE parameters (enhancement degree, maximum enhancement, enhancement rate and time to peak). The regions of interest (ROIs) were placed in the 114 sextant regions based on the sextant analysis, including pathologically confirmed prostate cancer (n=37), and noncancerous peripheral zone (n=77). The average IVIM, ADC and DCE parameters for each region was computed respectively. Receiver operating characteristic (ROC) and logistic regression analysis were conducted to evaluate and compare the diagnostic performance of DWI alone and combination of DWI and DCE.

Results The sensitivity, specificity and Area Under Curve (Az) of the measured parameters were presented in Table 1. The mean D alone yielded an Az value of 0.904 (Table 1) higher than that of ADC_{800} or ADC_{1200} alone. And the combination of D and f yielded highest sensitivity, specificity and Az than other combinations (Figure 1).

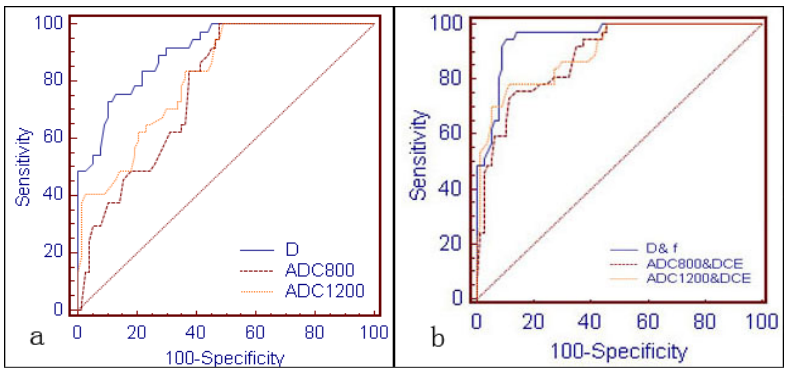

Figure 1.ROC curves show performances of mean D, ADC_{800} and ADC_{1200} individually (a) and combination of D +f and ADC +DCE parameters (b) to differentiate between cancer and benign regions.

Discussion This study demonstrates that IVIM can be used to evaluate both diffusion and perfusion characteristics of prostate cancer, and combination of D and f seemed to be more efficient than the clinical conventional DWI combined with DCE method in the diagnosis of prostate cancer. The beauty of IVIM is that without use of any contrast agents. These IVIM parameters may be useful as alternative biomarkers of malignancy to standard gadolinium chelate contrast agent. Further studies in a larger population are needed before these results can be generalized to the population at large.

Conclusion IVIM is potentially a promising and valuable non-invasive method in detecting, staging and monitoring therapy efficacy of prostate cancer.

Group	DWI alone			DWI+DCE		
	D	ADC_{800}	ADC_{1200}	D +f	ADC_{800} +DCE	ADC_{1200} +DCE
Sensitivity (%)	75.7	64.9	71.0	94.6	81.1	78.4
Specificity (%)	80.5	62.3	66.2	89.6	67.5	72.7
Az	0.904	0.776	0.816	0.952	0.885	0.900

Table 1. Sensitivities, specificities and Area Under Curve (Az) of individual parameters (D, ADC_{800}, ADC_{1200})and combination of D+ f and ADC + DCE parameters in prostate cancer detection.

References

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