Diagnosis of Prostate Cancer: Comparison of MR Diffusion Tensor Imaging, Quantitative Dynamic Contrast-Enhanced MR Imaging and the Two Techniques Combined at 3.0T

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Purpose:

To investigate the characteristics of combined diffusion tensor imaging (DTI) and quantitative dynamic contrast-enhanced MR imaging (DCE-MRI) at 3.0 T in differentiating prostate cancer from noncancerous prostatic tissue in peripheral zone.

Methods:

A total of 33 patients with the suspicion of prostate cancer underwent MR examination at 3.0 T MR. DTI with ss-EPI and DCE-MRI with FFE of each patient was acquired. TRUS-guided prostate biopsy was performed after the MRI examination. Images were analyzed by two radiologists. ROIs were drawn according to biopsy zones which were apex, mid-gland, base on each side of the peripheral zone. ADC and FA values from DTI, as well as K^{trans}, k_{ep}, v_e values from DCE-MRI in prostate cancer and noncancerous prostatic tissue were compared using independent-samples t-test. Logistic regression models were generated for DTI parameters, DCE-MRI parameters and their combination, respectively. Receiver operator characteristic (ROC) curves were used to compare and determine the ability of these models in differentiating prostate cancer from noncancerous prostatic tissue.

Results:

There were statistically significant differences in ADC, FA, K^{trans}, k_{ep} and v_e values between prostate cancer and noncancerous prostatic tissue (P<0.01). The area under the ROC curves (AUC) of ADC, FA, K^{trans}, k_{ep} and v_e was 0.84, 0.76, 0.84, 0.81 and 0.79, respectively. The AUC for DTI and DCE-MRI combination was significantly greater than either DTI (0.93 vs. 0.86, P<0.01) or DCE-MRI parameters (0.93 vs. 0.84, P<0.01) alone.

Discussion:

DTI demonstrates tissue microstructure at the level of micron which may reflect physiological features and pathologic changes by providing the apparent diffusion coefficient (ADC) and fractional anisotropy (FA) of water. DCE-MRI is a promising technique to diagnose and stage prostate cancer through its ability to evaluate microvascular density and permeability which usually increases significantly in tumors due to tumor angiogenesis. Recently, several studies have evaluated prostate cancer by DTI or quantitative DCE-MRI alone (1-4). However, few reports have focused on the efficiency of combined DTI and quantitative DCE-MRI (5). To confirm whether combined DTI and quantitative DCE-MRI can improve the diagnostic accuracy of prostate cancer, we created three models for DTI parameters, DCE-MRI parameters and combined DTI and DCE-MRI parameters. The subsequent ROC curve analysis shew that the AUC for DTI and DCE-MRI combination was greater than either DTI (0.93 vs. 0.86) or DCE-MRI parameters (0.93 vs. 0.84) alone, similar to Kozlowski's report (5). As we know, these two techniques reflect different aspects of physiological features and pathologic changes. The low ADC is associated with high cellular density while K^{trans} is related to increased microvessel density and permeability. Thus DTI and quantitative DCE-MRI can be mutually complementary. This may be the reason for the better accuracy of the two techniques combined. Since the case numbers of both our studies were not large enough, the efficiency of combined DTI and quantitative DCE-MRI needs to be evaluated further in the future.
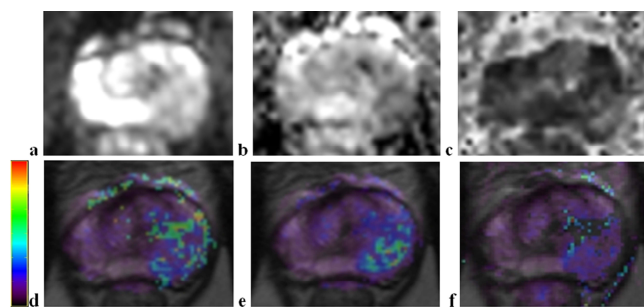

Figure 1. A 72-year-old patient with biopsy-confirmed prostate cancer, PSA 16.405ng/ml, Gleason score 4+3=7. a: T2-weighted MRI, showing a hypointense nodule in left peripheral zone. b: ADC map. c: FA map. d: K^{trans} map. e: k_{ep} map. f: v_e map. T2-weighted MRI and ADC map showed a hypo-intense nodule in left peripheral zone. K^{trans}, k_{ep} and v_e map showed increased value in the nodule.

Conclusion:

The combination of DTI and DCE-MRI has better accuracy in the diagnosis of prostate cancer in peripheral zone than either technique alone.

Table 1 Average Values (mean±S.D.) of DTI and DCE-MRI parameters

	Prostate cancer	Noncancerous prostatic tissue
ADC (×10^{-3}mm^2/s)	1.02±0.16	1.22±0.14
FA	0.38±0.09	0.31±0.06
K^{trans} (min^{-1})	0.32±0.23	0.09±0.07
k_{ep} (min^{-1})	1.44±0.77	0.72±0.53
v_e	0.12±0.07	0.08±0.13

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