Improved Prostate Cancer Detection using DCE-MRI and Probability Maps

X. Huang[1], Q. Wang[2], Y. Xu[3], X. Wang[3], S. Bao[1]

[1]The Key Lab of Medical Physics and Engineering,Peking University, Beijing, Beijing, China, People's Republic of, [2]The Medical School of Peking University, Beijing, Beijing, China, People's Republic of, [3]The First Hospital of Peking University, Beijing, Beijing, China, People's Republic of

Introduction

Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) has been used for the assessment of prostate diseases. By examining the kinetic properties of MR time-intensity curve (TIC) variations [1], DCE-MRI can be used for improved detection and localization of the diseases and thus valuable for diagnosis, therapy planning and treatment monitoring. To date, most of the empirical models have used only the feature parameters (such as the slope of early phase (k_1), the medium or late phase (k_2), and time to peak of enhancement (t_p)) to describe the enhancement of TIC. Each of these parameters is evaluated and referenced separately or combined by color-code for qualitative visualization [2]. In this work, we combined these parameters with logistic regression to determine the statistical probability for characterizing the prostate tissue. The statistical probability combines the information from several parameters describing the TIC and thus can be more useful and easier for clinicians to use.

Materials and Methods

MR images were acquired from 22 patients and 8 normal volunteers using a GE Signa 1.5-T scanner. MR studies started with conventional coronal, sagittal and axial T2-weighted scan and T1-weighted scan. These images were used to select the optimal scan plane for the dynamic sequence. The technique used for DCE-MRI was a T1-weighted 2D fast spoiled gradient echo (FSPGR) pulse sequence with the following parameters: TR=51ms; TE=4.2ms; flip angle=90°; NEX=1; slices=4; slice thickness=7mm; reconstruction matrix=256*256. The contrast agent used was Gd-DTPA and the dose was 0.1mmol/kg of body weight.

A total of 52 regions-of-interests (10 malignant, 26 benign and 16 normal) in peripheral zone of prostate were generated by a clinical radiologist and the underlying TIC of each ROI was extracted for subsequent data analysis. The diagnosis of these ROIs were made by the radiologist and confirmed with biopsy. The statistical model was derived using logistic regression to analyze the feature parameters (k_1, k_2 and t_p) from the ROI TICs. With this model, a map of the probability on whether a prostate region is cancerous or not was computed on pixel level. This probability map was overlaid on a conventional T1-weighted image and was used by two radiologists to make a diagnosis. The results were compared with those based on other diagnostic technique.

Results and Conclusions

Based on the logistic regression analysis, a combination of k_1, k_1*k_2 and k_1^2 was found to be the best predictor for prostate cancer. Comparing the model prediction results of ROI with the histopathologic results, the total agreement rate was 90.4%; the agreement rate was 60% for malignant, 100% for benign and 87.5% for normal. The diagnostic results based on the probability maps showed high agreement in tissue characteristic and lesion location with the combining results from other diagnostic technique such as PSA level and MRS (Figure 1). We conclude that the prostate cancer probability maps derived from DCE-MRI data can be used for improved detection of prostate cancer.

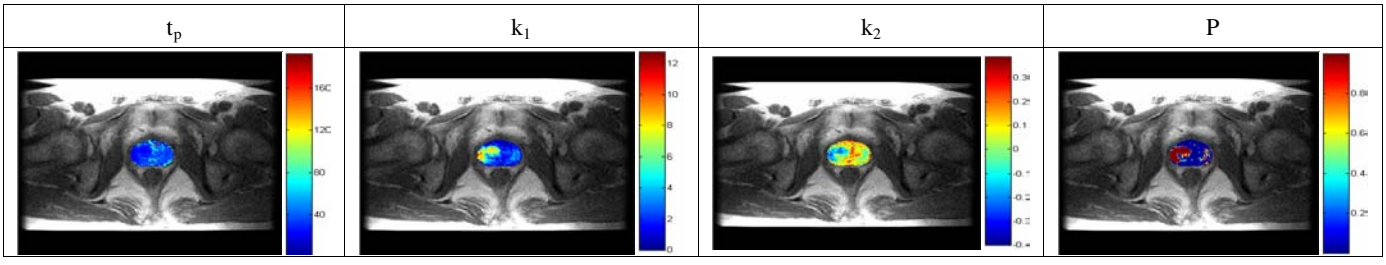

Figure 1 the parametric images of prostate DCE-MRI data on a malignant patient

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Reference

1 Brown G，Macvicar DA，Ayton V，et al. Clin. Radiol., 1995, 50: 601-606

2 http://wdic2005.aprs.org.au/CDROM/papers/23.pdf