A Study of Differentiation between Prostate Cancer and BPH in the Transitional Zone by 1H Magnetic Resonance Spectroscopic Imaging (MRSI)

S. Li[1], M. Chen[1], C. Zhou[1], W. Wang[1], C. Zhang[1]

[1]Radiology, Beijing Hospital, Beijing, China, People's Republic of

Purpose

To investigate the characterization of the spectra with prostate cancer and BPH in the transitional zone using MR Spectroscopic Imaging.

Introduction

While CC/C [(Choline+Creatine)/Citrate] and C/C (Choline/Creatine) have been shown to be reliable metabolic markers for differentiating prostate caner from benign changes in peripheral zone (1-2). It is unclear whether the CC/C and C/C ratios can be used to differentiate malignant tumor from BPH in transitional zone.

Methods

Quantitatively evaluate the metabolic changes of prostate BPH and cancer in the transitional zone using MR Spectroscopic Imaging. Eighteen patients (51±12.5 years old) with surgically proved prostate cancer in the transitional zone underwent MRI/MRSI examinations. All studies were performed on a 1.5 Tesla GE Signa MR clinical scanner using the body coil for RF transmission and an endorectal coil (Medrad) in combination with ATD torso coil for signal reception. Proton spectra were collected from throughout the prostate using PRESS volume selection with 3D phase encoding (16x8x8) and very selective outer volume saturation pulses (3). Spectral data were aligned with the MR imaging data using Functool provided by GE. Choline, creatine, and citrate peak areas were calculated for voxels within the prostatic transitional zone. The (Choline+Creatine)/Citrate (C+C/C) ratio and the Choline/Creatine (C/C) ratio were evaluated in each voxel with cancer and BPH. Discriminant Analysis was used to determine the power of the (C+C/C) ratio and the (C/C) ratio in differentiation between cancer and BPH.

Results and Discussion

The CC/C ratio and C/C ratio for cancer voxels (2.36±1.31, 4.14±1.79 respectively) were significantly different from the ratios in the voxles with BPH (0.85±0.29, 1.26±0.45 respectively) ($p<0.001$) in the transitional zone due to greatly increased choline levels in the cancer voxels. In the Discriminant function, the specificity, sensitivity and accuracy are 98.6%, 85.7%, 92.9% respectively for the differentiation between cancer and BPH in the transitional zone.(Fig1)(Fig2)

Fig 1

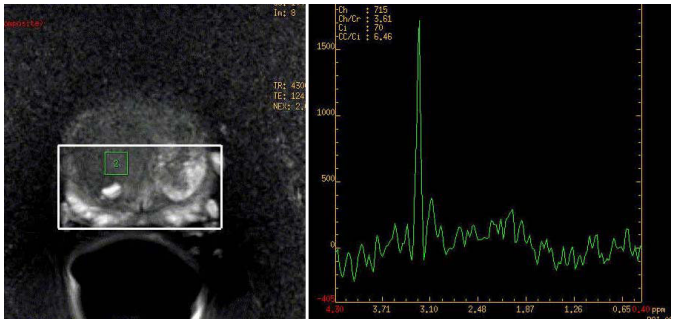

Fig 2

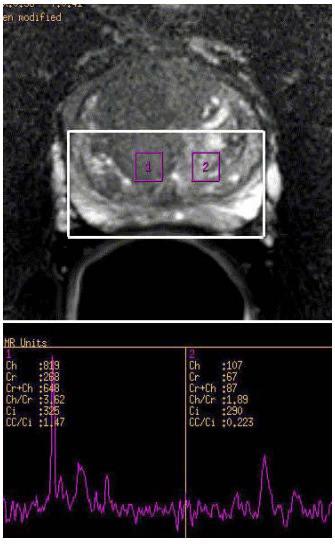

Fig1: ^{1}H MR spectroscopy shows elevated choline level in the cancer voxel of the transitional zone.

Fig 2: The comparison of the spectra in the voxels of cancer and BPH.

Each region of the prostate has a different cellular composition, metabolism, function and susceptibility to cancer. The transitional zone, one of the major zonal components, occupies only 5% of the gland in the young male, exhibits a homogeneous low signal intensity on MR T1 and T2 weighted image. Furthermore, with age, especially after the age of 40 years, this zone is enlarged predominantly due to Benign Nodular Hyperplasia (BPH), showing a heterogeneous signal intensity on T2 weighted image. However, it cannot be neglected that there is 20-24% prostate cancer originally arises from this region, also demonstrates low signal on T2WI. This makes it difficult for tissue identification by MRI. And, clinically, neither PSA nor PSA density has the satisfactory capacity to discriminate between BPH and prostate cancer (4-5). It is widely accepted that MR Spectroscopic Imaging (MRSI) can successfully distinguish cancer from benign changes in the peripheral zone by monitoring the metabolic changes in the cellular levels. In this study, the fact of that significantly higher CC/C and C/C ratios in the cancer voxles than those in BPH voxels of the transitional zone indicates that the two markers evidently reflect the metabolic differences between cancer and BPH. Moreover, elevated choline levels were observed in the cancer voxels of the transitional zone, compared with the BPH voxles, which implies that proliferation are more active in this area.

Conclusion

Prostate cancer is characterized by the higher CC/C ratio and higher C/C ratio, compared with BPH in the transitional zone. Both CC/C ratio and C/C ratio have higher specificity, sensitivity and accuracy in their discriminative power between cancer and BPH in this zonal area.

References

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