Potential of 3D ^{1}H MRSI and DWI in men with increased PSA

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Objective: The potential of proton magnetic resonance spectroscopic imaging (MRSI) and diffusion weighted imaging (DWI) was evaluated in men with increased prostate specific antigen (PSA).

Introduction: Early detection and localization of prostate cancer at a treatable stage is important and is the focus of current research. Even though MRI has high sensitivity for detection of cancer, it has limited utility in distinguishing benign versus malignant prostate. Role DWI in prostate cancer has been evaluated and recent reports have shown its possible diagnostic potential. In vivo magnetic resonance spectroscopy (MRS) may help to characterize the cancer at the cellular level. Recent studies have shown that magnetic resonance spectroscopic imaging (MRSI) provides metabolite distribution from multiple voxels of the entire prostate. Thus, combining DWI and MRSI improvement in the early detection and spatial localization of malignancy can be achieved. However, it is clinically challenging to diagnose accurately areas of malignancy in patients whose PSA level is in range of 4 – 20 ng/mL, especially when TRUS guided biopsy has low sensitivity in these patients.

Materials and Methods: 40 men [controls (Group I, n = 7, age = 31.4 ± 3.6 years) and patients (Groups II with PSA > 20 ng/mL; n = 13, age = 69.4 ± 9.8 years, PSA = 66.4 ± 46.9 ng/mL and Group III with PSA level 4 – 20 ng/mL; n = 20, age = 61.7 ± 8.7 years, PSA = 9.9 ± 4.0 ng/mL)] were investigated at 1.5 T (Sonata/Avanto, Siemens, Germany) prior to transrectal ultrasound (TRUS) guided biopsy using endorectal coil. Both MRSI and DWI were carried out prior to sextant biopsy during the same scanning session. For ^{1}H MRS, point resolved spectroscopy (PRESS) localized 3D-MRSI sequence was used with simultaneous suppression of lipid and water. MRSI matrix with scan resolution of 16 x 16 x 8 was used in the weighted acquisition mode with following parameters: TR = 1300 ms, TE = 120 ms, Average = 3, with total acquisition time of 17 min. Based on earlier literature reports voxels which showed [Cit/(Cho+Cr)] ratio < 1.4 were taken as indicative of malignancy [1]. DWI was acquired using identical slice position on T2-weighted images that were used for planning MRSI. Three different b values; 0, 500, and 1000 s/mm^2, were used to acquire different diffusion weighted images. The grid used for MRSI was superimposed over the ADC map. Metabolite ratio [Citrate/(Cho+Cr)] and apparent diffusion coefficient (ADC) were calculated for identical voxels (Fig.1). After completion of MR analysis, the results were correlated with TRUS guided biopsy.

Results and Discussion: Statistically higher ADC was noticed for the peripheral zone (PZ) ($1.5 \pm 0.2 \times 10^{-3}$ mm^2/s) compared to central gland (CG) ($0.9 \pm 0.1 \times 10^{-3}$ mm^2/s) in controls while there was no significant difference in metabolite ratios (PZ = 2.4 ± 0.6, CG = 2.9 ± 1.2). In patients, voxels which showed lower metabolite ratio showed reduced ADC in the PZ of prostate, and voxels with increased metabolite ratio showed higher ADC. All patients of Group II had lower metabolite ratio (0.3 ± 0.2) and ADC ($0.8 \pm 0.1 \times 10^{-3}$ mm^2/s) in the PZ compared to controls. 13/13 showed positive for malignancy in MR while 12/13 were positive on TRUS guided sextant biopsy. In Group III, certain voxels of PZ which showed reduced metabolite ratio also showed lower ADC ($1.00 \pm 0.2 \times 10^{-3}$ mm^2/s). A positive correlation was observed between metabolite ratio and ADC (r = 0.6 to 0.9, Fig.2). MR data revealed areas of malignancy in PZ in 15/20, however only 6 were positive on TRUS guided biopsy perhaps due to high false negative rate of TRUS guided biopsy. Longitudinal evaluation over a period of 1 year with MRSI and TRUS guided biopsy would validate this interesting finding and such an investigation is in progress. However, our results indicate that in 9 out 15 cases, MR is able to show the early changes associated with malignancy. MRSI and DWI may allow detecting early changes of malignancy thereby improving the diagnosis especially in patients with PSA level 4 - 20 ng/mL.

Conclusion: It is observed that the region of the prostate that showed reduced metabolite ratios also showed low ADC. For clinically challenging cases of patients with PSA level in the range of 4 – 20 ng/mL, MRSI and DWI may show early changes of malignancy thereby improving detection of malignancy.

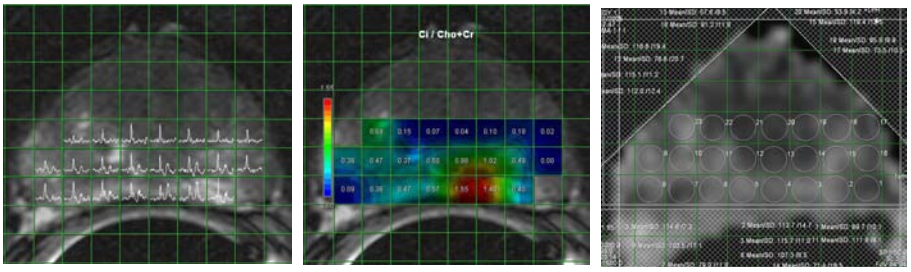

Fig.1 (A) 3D ^{1}H MRSI Spectral map and (B) metabolite ratio map superimposed over T2 weighted image of prostate .(C) Identical grid superimposed over ADC map showing circular ROIs to determine ADC from the identical voxel

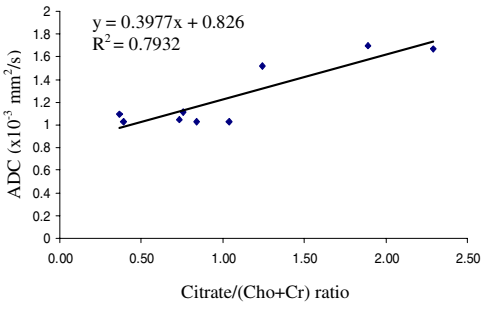

Fig.2 Representative plot of Cit/(Cho+Cr) ratio and ADC in PZ of prostate for Group III

Reference:

1. DiBiase SJ HK, Gullapalli RP, Jacobs SC et al. Int J Radiat Oncol Biol Phys 2002, 52, 429-438.