Decreased Diffusion Coefficients in Suspected Prostate Cancer Regions in Peripheral Zone: A Comparison with Increased (Cho + Cr)/Cit ratios from Magnetic Resonance Spectroscopy

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Introduction: High spatial resolution endorectal coil (ecoil) T1- and T2-weighted imaging of the prostate is generally considered helpful for prostate cancer staging but has limited specificity for cancer detection (1). Magnetic resonance spectroscopy (MRS) can enhance the specificity of MR prostate examinations by detecting focal areas of abnormally high (choline + creatine)/citrate ((Cho + Cr)/Cit) ratios within the gland (2). The main limitations of MRS are low spatial resolution, low signal-to-noise and susceptibility related artifacts. Diffusion imaging is currently being explored as a tool for prostate cancer detection (3). In this study diffusion coefficients D, from regions suspicious for cancer (SC) are compared with suspect healthy (SH) regions in the peripheral zone (PZ) of biopsy confirmed prostate cancer patients. MRS studies of the same patients allow for a comparison of D values in SH and SC regions with the corresponding (Cho + Cr)/Cit ratios in these regions.

Methods: Men with biopsy proven prostate cancer (N=13) underwent prostate ecoil MR examinations for staging with a 1.5 T scanner (General Electric Medical Systems, Milwaukee, WI). Conventional T1-spin echo and T2-weighted fast spin echo scans were performed in the oblique axial plane to obtain images throughout the prostate with nominal voxel volumes of 0.002 ml. A 17 minute 3D spectroscopic imaging sequence with the manufacturer supplied PROSE sequence (TR/TE = 1000/130 ms/ms) was performed to obtain (Cho + Cr)/Cit ratios from nominal voxel volumes of 0.5 ml (2). A 5 to 7 minute line scan diffusion imaging (LSDI) sequence (TR/TE = 2000/65 ms/ms, 5 and 750 s/mm^2 b-factors, 3 direction diffusion sensitization) was applied to extract trace D values throughout the prostate with nominal voxel volumes of 0.02 ml (4). From each of the 6 to 10 T2-weighted axial images through each man's prostate, 2 to 4 regions of interest (ROIs) in the peripheral zone (PZ) were outlined using a free hand software drawing tool and labeled as suspected cancer (SC) or suspected healthy (SH) tissue on the basis of the T2-weighted signal intensity. T1-weighted images were used to exclude ROIs containing hemorrhage. Quantitative D values and (Cho + Cr)/Cit ratios from the ROIs were extracted and statistical differences between the SC and SH median values were sought using two-tailed Mann-Whitney tests. In all 13 cases, histology results from radical prostatectomies were available for qualitative assessment of SC and SH ROI identification as based on the T2-weighted images.

Results and Discussion: In 9 of the 13 men, bilateral SC regions were sampled and confirmed histologically. In 3 of 13 men, unilateral SC sampling was performed though bilateral disease was reported histologically. In one case, right only SC sampling was confirmed histologically and in one case, no obvious SC ROIs were identified despite bilateral disease reported histologically. Figure 1 shows a typical D map in which the right PZ shows a clear diffusion decrease (arrow). Figures 2 and 3 are plots of the mean D and (Cho + Cr)/Cit ratios for SH and SC ROIs for each subject. The SH ROIs consistently showed higher D values and generally lower (Cho + Cr)/Cit ratios than the SC ROIs. Mean D values ranged from 1.42 to 2.31 μm^2/ms in SH regions and from 1.03 to 1.59 μm^2/ms in SC regions. In 10 of 14 cases, the mean SC D values were significantly lower ($p < 0.05$) than the SH D values while in 6 of the 14 cases the mean SC (Cho + Cr)/Cit ratios were statistically higher than those in SH ROIs. We conclude that D maps with reasonably high spatial resolution demonstrate reduced D values in suspected regions of cancer within the PZ and may be acquired in reasonable scan times. As such, D maps may prove useful for helping target regions within the PZ for localized therapies or biopsies.

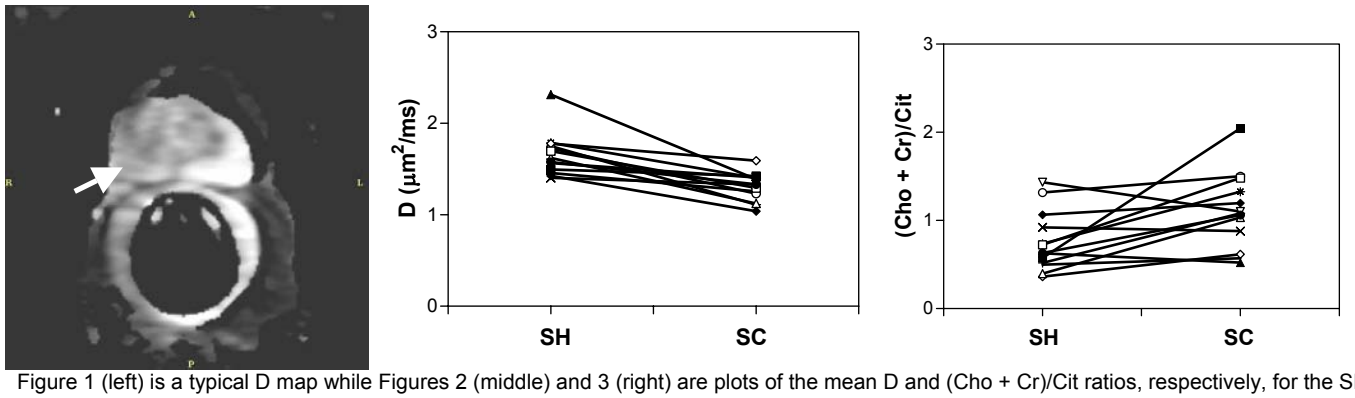

Figure 1 (left) is a typical D map while Figures 2 (middle) and 3 (right) are plots of the mean D and (Cho + Cr)/Cit ratios, respectively, for the SH and SC ROIs of all 13 subjects.

References

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