Addition of MR Spectroscopic Imaging to MRI Significantly Improves Detection and Localization of Prostate Cancer.

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Purpose The goal of this study was to assess whether the addition of metabolic information provided by 3D ^{1}H MR spectroscopic imaging (MRSI) can improve the MRI detection and localization of cancer within the prostate.

Introduction : The anatomic information provided by MR imaging (MRI) has become an important local staging modality for the differentiation between organ-confined cancers and those with extracapsular extension. Emerging treatment strategies for patients with prostate cancer require not just staging information, but in addition, more precise information on tumor presence, size and location. Cancer localization within the prostate by combined endorectal and phased-array coil MRI has demonstrated high sensitivity but very low specificity (1). This low specificity can be attributed to factors other than cancer (e.g., post-biopsy hemorrhage, prostatitis, therapy) causing a decrease in signal intensity on T2W images (Fig.1).

The recent development of MR spectroscopic imaging (MRSI) of the prostate expands the diagnostic assessment of cancer beyond the anatomic information provided by MRI. In a preliminary study of 85 prostate cancer patients who had a combined MRI/MRSI exam prior to radical prostatectomy, significantly higher choline levels and significantly lower citrate levels were observed in regions of cancer as compared to normal prostatic tissues. The ratio of these metabolites (choline/citrate) demonstrated very high specificity in discriminating regions of cancer from normal healthy peripheral zone tissues (2). In the current study, we demonstrate for the first time, that by combining the specificity of MRSI with the sensitivity of MRI, the ability to localize cancer to a sextant of the prostate can be significantly increased.

Methods MR imaging and 3D MRSI were performed on 62 biopsy proven prostate cancer patients prior to radical prostatectomy and step-section pathologic examination.

MR studies were carried out on a GE 1.5 Tesla clinical scanner using the body coil for signal excitation and an endorectal coil in combination with a pelvic phased array for signal reception. All images were analytically corrected for the coils' reception profile. Using a water and fat suppressed double-spin echo (PRESS) sequence, optimized for the quantitative detection of both choline and citrate, either an 8x8x8 or 16x8x8 phase encoded ^{1}H spectral array was acquired with a resolution of between 0.24cc and 0.7cc.

Based on anatomic landmarks, the prostate was divided into six sites (Left/right apex, midgland, and base). All images were evaluated retrospectively for tumor presence at each site by two independent radiologists (R1/R2), blinded to findings from MRSI and histopathology. MRSI diagnosis of cancer was based on a (choline + creatine)/citrate peak area ratio elevated by more than three standard deviations above normal values for healthy peripheral zone tissue **(H)** (2). A tumor site on MRI or MRSI was considered to match pathology if the tumor was present in the same sextant of the prostate as indicated on the step-section pathology report. Sensitivity (sen) and specificity (spec) were calculated as sen=TP/TP+FN and spec=TN/FP+TN, where T=true, F=false, P=positive and N=negative.

Results and Discussion On a site-by-site basis, sensitivity and specificity for MRI were 79%/60% (R1) and 79%/50% (R2) with good interreader agreement (κ=0.45). MRSI rendered significantly higher specificity (73%, $p<0.05$), but lower sensitivity (61%, $p<0.05$) than MRI due presumably to the lower spatial resolution.

Combining the specificity of MRSI with the sensitivity of MRI, the ability to localize cancer to a sextant of the prostate was significantly ($p<0.05$) increased. When both MRI and MRSI were positive for cancer, specificity was increased to 91%. When either MRI or MRSI were positive for cancer, sensitivity was increased to 96%.

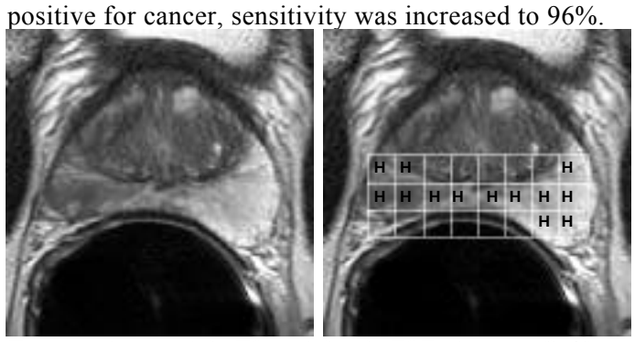

Figure 1. Axial T2-weighted FSE image (left) and overlaid MRSI grid (right) from a 54 year old patient with stage pT2a prostate cancer and a Gleason score of 6. Both radiologists rated the right side area of low signal intensity as definite cancer. However, all voxels on MRSI showed spectral patterns indicative of healthy (H) peripheral zone tissue, in agreement with the step-section pathology report.

Conclusion The addition of MRSI significantly improved the ability of MRI to identify the location and spatial extent of cancer within the prostate. There are several areas of prostate cancer management that benefit from this information: 1) Targeting TRUS guided biopsies for patients with prostatic specific antigen (PSA) levels indicative of cancer but negative previous biopsies. 2) Better stratification of patients in clinical trials. 3) Monitoring the progress of patients who select "watchful waiting" or other minimally aggressive management's of their cancer. 4) Guiding emerging "focal" prostate cancer therapies.

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References

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