Combined Endorectal/Phased-Array MR Imaging and 3-D 1H-MR Spectroscopic Imaging For Improved Diagnosis of Extracapsular Extension in Prostate Cancer

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Purpose The goal of this study was to assess whether the addition of metabolic information provided by 3D 1H MR spectroscopic imaging (MRSI) can improve the MRI diagnosis of extracapsular extension in prostate cancer.

Introduction Knowledge of the spread of cancer outside the prostate is critical for choosing an appropriate therapy (cryosurgery, brachytherapy, confomal radiation, resection, etc.). While combined endorectal and pelvic phased array MRI has demonstrated higher accuracy than body or phased-array coil MRI alone in the detection of extracapsular cancer extension (ECE)(1), there remains a great deal of variability in the MRI diagnoses of ECE. This variability arises from the reduced ability to visualize the peripheral zone and the prostatic capsule on MRI due to the near-field high signal intensity artifacts caused by the endorectal surface coil, as well as the lack of imaging criteria that can reliably identify or exclude ECE. Elimination of near-field high signal intensity artifact can be achieved via a post-processing analytic correction of images for the reception profile of the MR coils (2). Additionally, it has been recently determined that the most reliable imaging findings for detecting extracapsular extension were obliteration of the rectoprostatic angle and asymmetry of the neurovascular bundles (3).

The addition of clinical information such as, tumor volume, grade and PSA level to the MRI assessment should further increase the accuracy of ECE diagnosis. Since cancer volume is known to correlate with the probability of extracapsular extension, and MRSI can provide an estimation of tumor volume within the prostate (4), the addition of MRSI findings should improve the MR assessment of ECE.

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 choline (cho), creatine (cr), and citrate, either an 8x8x8 or 16x8x8 phase encoded 1H spectral array was acquired with a resolution of between 0.24cc and 0.7cc.

MRI studies were evaluated by two independent radiologists (R1/R2) without knowledge of histopathologic findings. Diagnosis of ECE (Fig. 1) was based on 1) obliteration of the rectoprostatic angle and 2) asymmetry of the neurovascular bundle. Right/left side ECE was recorded and rated on a three-grade scale (definite, possible, no ECE). Tumor volumes were calculated for each prostatic lobe based on the number of pathologic voxels in MRSI. For each voxel (0.24-0.7cc), a (Cho+Cr/citrate) ratio of >3SD above normal was considered as cancer. MRI and MRSI findings were compared with step-sectioned pathologic specimens. Sensitivity (sen), specificity (spec), positive predictive value (ppv) and negative predictive value (npv) were calculated as sen=TP/TP+FN, spec=TN/FN+TN, ppv=TP/TP+FP and npv=TN/TN+FN, where T=true, F=false, P=positive and N=negative.

Results and Discussion Sensitivity, specificity, PPV, and NPV values of MRI for ECE were 50%, 93%, 67%, 86% (R1) and 14%, 94%, 40%, 79% (R2), respectively. Using a threshold of 1cc tumor volume per lobe, sensitivity, specificity, PPV and NPV of MRSI for ECE was 68%, 70%, 40% and 88%, respectively. When either MRI or MRSI were positive, sensitivity improved to 79%(R1)/75%(R2) (p<0.05), whereas a positive result of both MRI and MRSI led to an increase in specificity to 100% (both radiologists). Tumor volume per lobe was significantly (p<0.01) higher in patients with ECE (2.14±2.3cc) than in patients without ECE (0.98±1.1cc).

Figure 1. Reception profile corrected axial T2-weighted FSE images at the mid-gland (left) and prostatic apex (right) of a 53 year old patient with biopsy proven prostate cancer. ECE can be clearly visualized on the T2-weighted images at the right mid-gland and left apex. Ten 0.24cc MRSI voxels demonstrated metabolic patterns consistent with cancer yielding a tumor volume estimate of 2.4 cc. The definitive diagnosis of ECE by both MRI and MRSI indicated the need for external beam radiation in conjunction with radiation seed implantation.

Conclusion An estimation of tumor volume provided by MRSI significantly improved the ability of MRI to identify extracapsular extension of prostate cancer. Diagnosis of ECE is critical for choosing the appropriate therapy or combination of therapies.

References