Evaluation of Local Prostate Recurrence after Radical Prostectomy using Magnetic Resonance Spectroscopic Imaging

V.L.M. Scharen-Guivel, R.G. Males, S.J. Nelson, U.G. Mueller-Lisse, J. Scheidler, D.B. Vigneron and J.Kurhanewicz

Magnetic Resonance Science Center, Department of Radiology, University of California, San Francisco

Purpose

In this study we evaluated whether combined volume high resolution MR imaging and spectroscopic imaging could determine the presence and spatial extent of local prostate cancer recurrence after surgery.

Introduction

The presence of Prostate Specific Antigen (PSA) at a level higher than 0.2 ng/ml[1] is used to infer the existence of either benign or malignan prostatic tissue. after radical prostatectomy. Unfortunately PSA is not specific for cancer and provides no information about the location (local or metastatic) or the spatial extent of the cancer.

Both Transrectal Ultrasound (TRUS) and Magnetic Resonance Imaging (MRI) can be used to visualize residual/recurent cancerous tissue within the prostatic bed after surgery [2]. However they cannot differentiate between scar tissue, benign prostatic hyperplasia (BPH) and cancer.

Preliminary reports have demonstrated the ability of Magnetic Resonance Spectroscopic Imaging (MRSI) to discriminate cancer within the prostate from necrosis, BPH and benign prostatic tissues prior to and after therapy[3]. In this study, the ability of combined MRI/MRSI to determine the presence and spatial extent of locally recurring cancer was examined in 14 post radical prostatectomy patients with detectable PSA levels.

Material and Methods

Our study included 14 post radical prostatectomy patients (mean age 58.8 +/- 4.53) with detectable PSA (3.38 +/- 7.78). The patient PSA values covered a wide range from 0.23 to 30.2 ng/ml. Three patients had metastatic disease, as indicated by bone scans, prostascint and chest CT.

MRI and 3D MRSI were performed at a mean follow-up of 46 months after surgery (range 2 to 156 months), on a 1.5 T clinical scanner (General Electric) using the body coil for signal excitation and the endorectal coil in combination with a pelvic phased array for signal reception. The MRSI and MR images were analytically corrected for the reception profiles of the coils. Water and fat suppressed spectral data were acquired using a double-spin echo (PRESS) sequence with BASING water and lipid suppression. This sequence was optimized for the quantification of both choline and citrate. After selection of a PRESS volume encompassing the prostate, a phase encoded ^{1}H spectral array of 8x8x8 or 16x8x8 were acquired with a resolution of 0.24cc or 0.42cc.

Ratios of (choline+creatine)/citrate and choline/mean spectral noise were calculated. Voxels were considered to contain viable tissue if choline or citrate peak area to noise ratios were greater than 5:1. Among the viable voxels, normal voxels were characterized by a ratio (choline +creatine)/citrate less than 0.74. The later ratios were determined using prior radical resection data[4]. MR imaging was considered positive for tissue with signal intensity higher than muscle and scar tissue, but lower than nomal prostatic hyperplasia was detected and both readers were in agreement.

Results

In all 14 patients T2 weighted MR imaging identified tissue within the prostatic bed (Figure 1). MRI identified (right, left) recurent cancer in only 3 of the 14 cases. In all 3 positive findings, the location of recurrent/residual cancer coorresponded to a region (left, right) of cancer demonstrated by histopathology of the resected gland. One of the three recurrent cancers had evidence of extracapsular spread (positive margins) of cancer at surgery.

The metabolic data provided by MRSI demonstrated abnormal metabolism in 10 out of 14 patients (Figure1). Five of these 10 patients also had had positive margins at surgery. In all these cases there were multiple abnormal voxels (7.5+/-2.75) and in 6 of these patients there were also multiple voxels (2.83+/-2.32) with healthy metabolism. Two of the 14 patients demonstrated only voxels with healthy metabolism, and the remaining two demonstrated only metabolic atrophy (no signal above 5:1 signal to noise). In all cases the location of residual/recurent normal or abnormal metabolism correlated with normal and abnormal regions prior to surgery based upon step histologic analysis of the resected gland.

Conclusion

In this study, we have shown that combined MRI/MRSI distinguished cancer recurrence from necrosis, BPH and healthy tissue more often than MRI alone (10 out of 14 instead of 3 out of 14). The information provided by the combined MRI/MRSI exam could be used to target regions for subsequent biopsy and therapy.

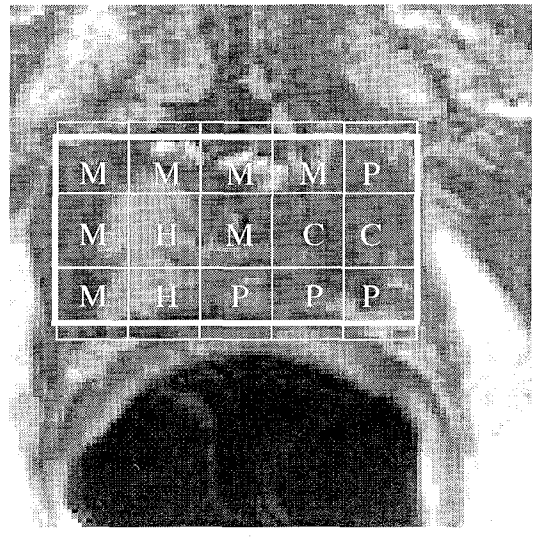

Figure 1. T2 weighted MR image demonstrates tissue in the prostactic bed. Spectroscopy identifies regions of normal (H) and abnormal metabolism (P= 2 standard deviations from normal and C= 3 standard deviations from normal). M is mixed tissue.

References

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