Utility of Magnetic Resonance Imaging and Spectroscopy In Prediction of Insignificant Prostate Cancer: Initial Analysis

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Introduction

Prostate cancer is the most commonly diagnosed cancer in American men (1). With the widespread use of prostate-specific antigen (PSA) testing, there has been a dramatic shift to early stage cancers (2). Insignificant prostate cancers (PCa) pose little risk to life or health, but they are difficult to identify clinically. Keeping this in mind, the present study was designed to develop new, more accurate predictive nomograms incorporating the results of MR imaging (MRI) and MR spectroscopic imaging (MRSI) with clinical variables and assess their value in predicting the probability of insignificant prostate cancer.

Materials and Methods

Retrospective study of 220 patients with low-risk PCa (Gleason score ≤6, PSA <20 ng/ml) who underwent combined MRI/MRSI prior to radical prostatectomy. Surgical pathology was used as the standard of reference. Data were acquired on a 1.5 Tesla G.E. Signa scanner (GE, Milwaukee, WI). The study consisted of MR imaging using a pelvic phased array and expandable endorectal coil followed by standard MRSI protocol with PRESS voxel excitation and water and lipid suppression (3, 4). MRSI data were obtained and processed using software developed at UCSF (3, 5). A choline+creatine/citrate (CC/C) ratio >0.5 (2 standard deviations greater than mean normal healthy PZ) was considered suspicious for cancer (3). The criteria for MRI analysis were based on reported MR findings (6). The probability of insignificant cancer by MRI and MRSI findings were recorded on a 0-3 scale (0, definitely insignificant PCa (no abnormality) - 3, significant PCa (definite abnormality >0.5cm^3). The MRI model combines PSA, clinical stage, percentage of biopsy cores positive, prostate volume on MR imaging and MRI score. The MRI/MRSI model has the same variables except that the MRI score is replaced with the overall MRI/MRSI score (Figure1). The biopsy Gleason score is omitted from the MR nomograms because patients with only Gleason score 3+3 were included in the study, so the grade would not contribute to the point scale in the nomograms. We used receiver operating characteristic (ROC) curves to assess the incremental value of the 2 new MR models to the existing clinical nomogram models (7).

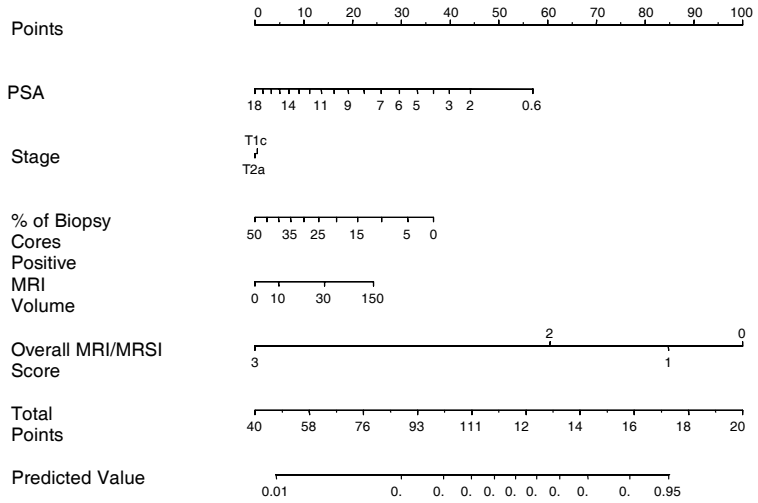
Results

At pathology, forty one percent of the patients had insignificant PCa defined as organ confined cancer ≤ 0.5cm^3 in volume without poorly differentiated elements. The MRI (AUC=0.803) and MRI/MRSI (AUC=0.854) models performed better than the basic (AUC=0.574) and the more comprehensive medium (AUC=0.726) clinical models. Both MRI and MRI/MRSI models resulted in statistically significant (p=0.001) improvement over purely clinical models. It was observed that the MR data is useful in distinguishing the two extremes i.e., definitely or probably insignificant PCa (MR score 0,1) and definitely significant PCa (MR score 3). Indeed, 30/32 (94%) patients with an MRI score of 0 or 1 had tumor volume <0.5 cm^3 and 25/32 (78%) had insignificant PCa. For the majority of the cancers misclassified was due to underestimation of the Gleason grade that was judged to be higher upon review of the surgical specimen. Similarly, 57/67 (85%) patients with an MRI score of 3 had tumor volume >0.5cm^3. The addition of MRSI to MRI allowed more definite classification of 42 patients who had been assigned to the indeterminate category (MR score 2) based on MRI. The reclassification with MRSI was correct in 22/24 patients who changed from indeterminate to insignificant (the two exceptions were patients that had tumor volume <0.5cm^3 but Gleason score >6), and in 18/18 patients whose classification was changed from indeterminate to significant (all had tumor volume >0.5cm^3). Overall the addition of MRSI improved predictive accuracy.

Discussion

The initial analysis demonstrates that MRI and MRI/MRSI models contributed significant incremental value for the predicting of insignificant PCa. After appropriate validation, the new MR models may help in counseling prostate cancer patients who are choosing deferred therapy.

Figure1. MRI/MRSI nomogram model.



In the MRI/MRSI model for locating the patient's pretreatment PSA on the PSA axis. Draw a line straight upwards to the Points axis to determine how many points towards having an insignificant cancer the patient receives for his PSA. Repeat this process for the remaining axes, each time drawing straight upward to the Points axis. Sum the points achieved for each predictor and locate this sum on the Total Points axis. Draw a line straight down to find the patient's probability of having insignificant prostate cancer.

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