



Accuracy of Multiparametric Magnetic Resonance Imaging for Extracapsular Extension of Prostate Cancer in Community Practice

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Abstract

Knowledge of extracapsular extension improves surgical planning of radical prostatectomy for prostate cancer. The present study examined the overall and risk-stratified accuracy of multiparametric magnetic resonance imaging in community radiology practice. The overall specificity among 133 patients was excellent (93.1%); however, the sensitivity was low (12.5%). Therefore, preoperative magnetic resonance imaging findings in the community practice setting should be interpreted with caution.

Introduction: The presence of extracapsular extension (ECE) in prostate cancer (PCa) can influence a surgeon's decision to perform a nerve-sparing approach during radical prostatectomy (RP). Preoperatively, multiparametric MRI (mp-MRI) is often used to stage PCa. More recently, the use of mp-MRI has gained wide acceptance in fusion biopsy of the prostate. In this framework, the reported accuracy of mp-MRI has been highly variable, with data often originating from large referral centers with experienced radiologists. We sought to determine the sensitivity and specificity of mp-MRI for detecting ECE in the community. **Materials and Methods:** We reviewed a prospectively maintained database of men with PCa who had undergone RP. We recorded the prevalence of ECE at RP and determined the sensitivity, specificity, positive predictive value, and negative predictive value of MRI for detecting ECE. We assessed these values according to the D'Amico risk groups and compared the predictive value of MRI to that of the Partin tables. **Results:** The prevalence of ECE was 11.5%, 28.1%, and 47.1% in the low-, intermediate, and high-risk groups, respectively, with an overall prevalence of 24.1%. The overall sensitivity, specificity, positive predictive value, and negative predictive value of MRI was 12.5%, 93.1%, 36.4%, and 77.0%, respectively. **Conclusion:** The reduction in the sensitivity of preoperative mp-MRI to determine ECE in the community setting is significant. Even with stratification using the D'Amico criteria and Partin tables, the performance of mp-MRI was not significantly improved. Because most cases of PCa are diagnosed and treated in the community, it is questionable whether mp-MRI is a suitable staging modality in the community.

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Introduction

Recently, multiparametric magnetic resonance imaging (mp-MRI) has become an accepted preprostatectomy imaging modality for men diagnosed with prostate cancer (PCa). In the preoperative

setting, mp-MRI attempts to predict the presence of extracapsular extension (ECE) or seminal vesicle invasion (SVI) of PCa and can influence the surgeon's decision to spare the neurovascular bundles (NVBs). More recently, mp-MRI has been used to enhance the accuracy of transrectal ultrasound-guided biopsy of the prostate using image fusion technology. However, the reported accuracy of mp-MRI is highly variable, with such reports originating from large referral centers, often with highly experienced radiologists.

In a study by Bloch et al,¹ 3 Tesla (3T) mp-MRI scans were reviewed before radical prostatectomy (RP), with an overall sensitivity for ECE of 75% (range, 64% to 83%). A study by Jeong et al² examined 922 high-risk—only patients and found that the sensitivity of mp-MRI for ECE and SVI was 43% and 34.9%,

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respectively. In a third study by Somford et al,³ the predictive value of endorectal (ER) 3T mp-MRI for ECE was examined in patients with low-, intermediate-, and high-risk PCa. The overall sensitivity was 58.2% and the specificity was 89.1%; the overall staging accuracy was 73.8%.³ In that study, the radiologists had 8 and 18 years of experience reading prostate MRI scans.

Extrapolation of such results to the community setting is limited. Given that most cases of PCa are diagnosed and treated outside of such referral centers and with the increasing usage of mp-MRI in the community setting, assessing the accuracy of mp-MRI in the community setting is of critical importance. In the present study, we sought to determine the sensitivity and specificity of mp-MRI for predicting ECE before RP in patients who had undergone mp-MRI in a community-based setting.

Materials and Methods

Patient Selection

After approval was obtained from our institutional review board, the patients were selected from a prospectively maintained database of men diagnosed with PCa. Our inclusion criteria included men who had undergone RP by a single surgeon from October 2011 to August 2014. Patients were excluded if they had not undergone a preoperative 3T mp-MRI scan before RP. From the database, 133 patients had undergone a preoperative 3T mp-MRI scan of the pelvis at a radiology center not affiliated with an academic center. We reviewed the demographic information, preoperative staging characteristics, and MRI results before RP for these patients.

MRI Technique

Patients underwent mp-MRI at a community center. mp-MRI entails integrating high-resolution T₂-weighted imaging, diffusion-weighted imaging, and dynamic contrast-enhanced imaging. T₂-weighted imaging provides the spatial resolution and normal anatomy of the prostate. Diffusion-weighted imaging distinguishes between the diffusion properties of protons in water in normal prostatic tissue and that of abnormal prostatic tissue. Dynamic contrast-enhanced imaging assesses the different signal enhancements after administration of a gadolinium-based contrast agent in normal and abnormal prostatic tissue.⁴ The MRI scans were performed at several different community centers, each with its own MRI system and specific sequencing protocol. Board-certified radiologists at each center interpreted all the images; however, their specific level of experience with prostate pathology was not ascertained.

Clinical Staging of PCa

PCa was staged in accordance with the 2010 American Joint Committee on Cancer TNM classification system. A single board-certified urologist performed a digital rectal examination on all patients. Clinical staging data were abstracted from the patients' medical records and recorded in the database before RP.

Pathologic Staging of PCa

A single board-certified urologist at a single large academic center harvested the prostate specimens in our study population at the time of RP. All prostate specimens were sent to the pathology laboratory at the same institution. Primary and secondary Gleason scores, the

presence of pelvic lymph node involvement, prostate weight, the presence of tumor at the surgical margins, and the percentage of tumor involvement in the prostate lobes was determined. ECE was defined as pT3 disease or greater. Board-certified pathologists familiar with evaluating PCa analyzed all the specimens.

Statistical Analysis

The prevalence of ECE on the MRI scans and in the pathologic findings was calculated. The patients were differentiated into low-, intermediate-, and high-risk groups using the D'Amico criteria. The probability of ECE for each patient was calculated using the updated version of the Partin tables.⁵ The sensitivity, specificity, positive predictive value, and negative predictive value of 3T mp-MRI and the Partin tables were calculated for the patient population as a whole and for the D'Amico risk-stratified subgroups. For the Partin table calculations, a 50% probability of organ-confined disease (OCD) was used as a binary cutoff for these calculations; values $\geq 50\%$ equated to no predicted ECE, and values $< 50\%$ probability equated to predicted ECE.⁶ The Partin table predictive accuracy was determined using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) was calculated and compared against the null hypothesis (AUC of 0.5), with 95% confidence intervals. $P < .05$ was considered statistically significant. Statistical analysis was conducted using SPSS Statistics for Windows, version 21.0 (IBM Corp, Armonk, NY) and R, version 3.2.1 (CRAN: Comprehensive R Archive Network; available at <http://cran.r-project.org>). The statistical test results were defined as $2P < .05$.

Results

The prospectively maintained database included 133 patients who met our criteria of having undergone a 3T mp-MRI scan at a community radiology center before RP. The complete clinical and demographic information for these patients is listed in Table 1. Preoperatively, patient age, prostate-specific antigen level, and the biopsy results were used to categorize the patients into low-, intermediate-, and high-risk groups using the D'Amico criteria. Of the 133 patients, 52 were in the low-risk group, 64 in the intermediate-risk group, and 17 in the high-risk group.

The average age for the cohort was 60.4 years (range, 42-72 years), and the median age was 61 years. The mean preoperative prostate-specific antigen was 6.56 ng/mL. The preoperative prostate biopsy results showed that most patients had a Gleason score of 3+3 (59 of 133; 44.4%). Of the remaining patients, 35 (26.3%) had a Gleason score of 3+4, 23 (17.3%) a score of 4+3, 11 (8.3%) a score of 4+4, and 2 (1.5%) a score of 4+5 (Table 1).

In our patients, the most common pathologic stage was pT2c (82 of 133), followed by pT3a in 25, pT0 in 2, pT2a in 11, pT2b in 6, and pT3b in 7. The most common postoperative Gleason score was 3+3 (55 of 133 patients) followed by Gleason 3+4 ($n = 46$). Sixteen patients had Gleason score 4+3 and 8 had Gleason score 4+4. More detailed information is provided in Table 2.

Overall, pathologic features demonstrating ECE or SVI was noted in 32 of the 133 patients (24.1%) after RP. After differentiating these patients into low-, intermediate-, and high-risk groups according to their preoperative D'Amico criteria, the prevalence of pT3a or pT3b at RP was 11.5% (6 of 52) in the low-risk, 28.1%

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