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Prostate magnetic resonance imaging: The truth lies in the eye of the beholder

Joseph C. Riney, M.D.[a], Nabeel E. Sarwani, M.D.[b], Shehzad Siddique, M.D.[c], Jay D. Raman, M.D.[a,*]

[a] *Department of Surgery, The Pennsylvania State University, College of Medicine, Hershey, PA*
[b] *Department of Radiology, The Pennsylvania State University, College of Medicine, Hershey, PA*
[c] *Department of Psychiatry, The Pennsylvania State University, College of Medicine, Hershey, PA*

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Abstract

Purpose: To determine the diagnostic accuracy and interobserver variability of radiologic interpretation of magnetic resonance imaging (MRI) performed for surgical planning before prostatectomy.

Patients and methods: The records of 233 men undergoing prostatectomy with presurgical multiparametric 3T surface body coil MRI were reviewed. All initial films were read by a fellowship-trained body radiologist provided with relevant clinical information. A senior radiologist then reread all pelvic MRIs blinded to the initial interpretation with findings from both readings compared to final pathology. Kappa (κ) scores as well as sensitivity, specificity, positive predictive values (PPV), negative predictive value (NPV), and accuracy were determined.

Results: When considering extraprostatic extension (EPE), there was low concordance comparing the initial vs. repeat MRI interpretation ($\kappa = 0.22$). Additionally, when the senior radiologist reread his own initial interpretation ($n = 93$, blinded to initial result), concordance for EPE was greater ($\kappa = 0.36$) albeit similarly low. With regard to EPE, a comparison of initial MRI interpretation vs. reread by senior radiologist noted universal improvements in diagnostic characteristics including sensitivity (30.3% vs. 56.1%), specificity (80.2% vs. 88.6%), PPV (37.7% vs. 66.1%), NPV (74.4% vs. 83.6%), and accuracy (66.1% vs. 79.4%). In contrast, seminal vesicle invasion interpretation was more uniform whereby initial MRI interpretation vs. reread yielded similar sensitivity (18.2% vs. 27.3%), specificity (97.2% vs. 93.8%), PPV (40.0% vs. 31.6%), NPV (91.9% vs. 92.5%), and accuracy (89.7% vs. 87.6%).

Conclusions: Even at a tertiary referral center, interobserver variability among radiologists regarding local extent of disease on prostate MRI is high. These observations underscore the importance of uniformity when defining criteria for EPE and seminal vesicle invasion to allow for optimal presurgical planning.

Keywords: Prostate cancer; Pelvic MRI; Extraprostatic extension; Accuracy

1. Introduction

Technological advances along with access and availability have increased utilization of multiparametric magnetic resonance imaging (MRI) in the detection, staging, and treatment planning phases of prostate cancer [1,2]. At present, radical prostatectomy remains the mainstay surgical therapy for localized prostate cancer. With regard to surgical planning, accurate preoperative assessment of local disease extension in prostate cancer is paramount to the urologic surgeon's treatment decisions [3]. Specifically, by evaluating for extraprostatic extension (EPE) and seminal vesicle invasion (SVI), preoperative pelvic MRI can potentially affect decision-making regarding a nerve-sparing approach and extent/width of resection. Such surgical nuances clearly can affect quality of life and functional outcomes in men after the operative procedure.

With this in mind, MRI has increasingly become the widespread modality of choice for prostate imaging [4], although prior studies have presented conflicting and inconsistent results [1,5–12]. Some of the limitations of

*Corresponding author. Tel.: +1-717-531-6979; fax: +1-717-531-4475.
E-mail address: jraman@pennstatehealth.psu.edu (J.D. Raman).

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prior studies include heterogeneous cohorts, different MRI sequences such as 1.5T vs. 3T MRI, and endorectal vs. surface body coil MRI [5,6].

A few prior studies have evaluated interobserver agreement of prostate MRI albeit with smaller sample sizes and varying degrees of radiologic experience [8,9,11]. Therefore, the goal of this study was to critically evaluate a series of MRIs performed for surgical planning with initial review by fellowship-trained body radiologists and subsequent rereview (in a blinded fashion) by a senior radiologist. We aim to determine if variability issues persist in a tertiary referral center with fellowship-trained radiologists and, if so, the relative accuracy of preoperative MRI imaging.

2. Patients and methods

A single institution retrospective review identified 269 individuals who underwent prostatectomy from 2010 to 2015 for suspected localized prostate cancer. Of this cohort, 233 (86.7%) were able to obtain a preoperative multiparametric pelvic 3T surface body coil MRI. Multiparametric MRI was routinely ordered for all patients but was not performed in those with contraindications (pacemaker, metal fragments, claustrophobia) or cost with insurance reimbursement issues. Protocols for image acquisition and sequences were similar to that in prior publications [13].

In the postbiopsy (and presurgical) setting, as part of institutional practice, radiologists are provided clinically relevant information including prostate-specific antigen (PSA), digital rectal examination (DRE) results, and prostate needle biopsy pathology. The rationale for such information is to augment our surgical planning further by avoiding our radiologists interpreting the films in a vacuum. Each initial MRI was read by 1 of 5 fellowship-trained body radiologist at our institution with specialized training in abdominal and pelvic axial cross-sectional imaging. The experience of the radiologists for prostate MRI ranged from 25 cases to over 200 cases including fellowship and attending staff experience. Radiology residents participated in the initial read and interpretation in 80% of cases.

Surgical approach was altered based on preoperative MRI based upon extent of EPE suspicion on imaging. In short, extensive EPE on MRI prompted a nonnerve sparing operation for that ipsilateral nerve bundle. Focal EPE or suspicion of EPE prompted incremental nerve sparing whereby a portion of the bundle was removed and thereafter frozen sections deemed if this was the appropriate surgical plane. Suspicious lymph nodes (LNs) (those >1 cm in size in suspected landing zones—obdurator, external, and internal iliac chains) were biopsied as part of protocol before planned surgery. If positive, then these patients were recommended systemic therapy with and without radiation treatment. Therefore, these patients did not factor into our cohort of interest. Finally, the Prostate Imaging Reporting and Data System (PIRADS) grading system was not considered within this study for a few reasons. Firstly, it is principally designed to be used in a pretherapy patient and not necessarily in the setting of presurgical planning where the focus is EPE and SV invasion. Secondly, over the study period, PIRADS was not routinely reported at our institution until 2013, and 2 different PIRADS systems were in use across the study interval thereby potentially further confounding the interpretation.

Two years following the last study included in this cohort, 1 senior radiologist was selected to reread all prostate MRIs in an Institutional Review Board-approved study with blinding to the initial MRI interpretation and the final surgical pathology. The radiologist was provided with the same relevant clinical information available at initial reading including preoperative PSA, DRE results, and prostate needle biopsy results. A 2-year time lag was selected to minimize the risk of recall bias as approximately one third of included studies were initially read by this radiologist. Figs. 1 and 2 highlight representative cases whereby the initial and repeat interpretations were discordant.

Data were collected on all MRI interpretations with regard to EPE and SV invasion. Kappa (κ) scores were calculated as a measure of interobserver agreement between the initial MRI read and the subsequent interpretation by the senior radiologist with respect to EPE and SVI. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy for EPE and SV invasion were calculated for all initial radiology reads and compared to that of the senior radiologist's reads. Final surgical pathology following prostatectomy was used as the referent standard from which the test characteristics were calculated.

3. Results

The cohort had a median age of 62 years old with a median PSA of 6.2. Of the 233 patients, 143 (61.4%) had clinical stage T1 disease and the remaining 90 (38.6%)

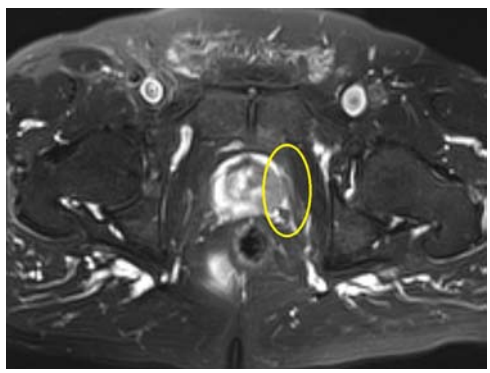

Fig. 1. Axial T2-weighted image of prostate with initial interpretation suggesting a left midzone anterior nodule (yellow) *without* EPE. Repeat interpretation indicated EPE with final prostatectomy pathology noting Gleason $4+3=7$ carcinoma with extensive EPE. (Color version of the figure available online.)