The Impact of Multiparametric Pelvic Magnetic Resonance Imaging on Risk Stratification in Patients With Localized Prostate Cancer

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OBJECTIVE To determine the impact of multiparametric magnetic resonance imaging (MP-MRI) of the prostate on established risk stratification criteria in patients with clinically localized adenocarcinoma of the prostate (ACP).

METHODS The cohort included 71 patients who underwent MP-MRI of the prostate at a tertiary care referral center as part of their initial workup for ACP. Tumor characteristics comprising traditional risk stratification criteria (prostate-specific antigen, clinical T stage, and biopsy Gleason score) were recorded, and the initial National Comprehensive Cancer Network risk group was calculated. The National Comprehensive Cancer Network risk group was then recalculated incorporating MRI findings. The impact of MRI findings on changes in risk group classification was evaluated using the Stuart-Maxwell test. For patients undergoing radical prostatectomy, MRI findings were correlated with pathologic findings.

RESULTS The cohort included 11 (15.5%), 39 (54.9%), and 21 patients (29.6%) with low-, intermediate-, and high-risk disease, respectively. MRI findings led to risk group upstaging in 12 cases (16.9%). The highest yield was demonstrated in patients with intermediate-risk disease, in whom MRI led to upstaging in 25.6% of patients. There was a significant difference between pre-MRI and post-MRI risk group classifications ($P < .01$) for the entire cohort. Compared with radical prostatectomy specimens, the specificity of MRI for T3 disease was 92.9%.

CONCLUSION In our cohort of patients undergoing MP-MRI for previously untreated, clinically localized ACP, MRI findings led to changes in risk stratification in a substantial proportion of patients. Our findings support the use of MP-MRI in the workup of patients with localized ACP. UROLOGY ■: ■—■, 2014. © 2014 Elsevier Inc.

Prostate cancer is the most common noncutaneous cancer in men, with an estimated 238,590 cases expected to be diagnosed in the United States in 2013.[1] Since the advent of prostate-specific antigen (PSA) screening, the vast majority of patients with prostate cancer are diagnosed with early stage disease. Risk group stratification for localized prostate cancer, as defined by the National Comprehensive Cancer Network (NCCN), incorporates the serum PSA level, the biopsy specimen Gleason score, and the clinical T stage based on digital rectal examination.[2]

According to NCCN guidelines, workup for a patient with newly diagnosed prostate cancer includes evaluation of the skeletal system with a bone scan and evaluation of the lymph nodes with computed tomography or magnetic resonance imaging (MRI) for select patients. In the past, the role of computed tomography or MRI in the workup of patients with prostate cancer has been largely to detect metastases in the pelvic lymph nodes. However, with modern multiparametric techniques (incorporating not only T2 sequences but also dynamic contrast-enhanced sequences and diffusion weighting), MRI now has the capacity to provide significantly more information than older staging techniques. Recent studies have shown that MRI incorporating diffusion weighting is effective in identifying high-grade disease that may be missed on standard transrectal ultrasound—guided core biopsies.[3,4] Similarly, MRI has been shown to be accurate and reliable in the detection of both extraprostatic extension (EPE) and seminal vesicle (SV) invasion.[5-8] The information gleaned from multiparametric pelvic MRI is useful in decision making for patients with localized prostate cancer as a complement to the risk stratification variables

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included in the NCCN algorithm referenced previously. In our study, using an institutional database of patients who underwent MRI of the pelvis as part of the initial workup of their clinically localized prostate cancer, we aimed to quantify the extent to which MRI results impacted risk stratification. To do this, we compared the pre-MRI NCCN risk group with the post-MRI risk group incorporating MRI findings, and we additionally recorded changes in patient management that occurred as a direct result of the MRI.

MATERIALS AND METHODS

After obtaining approval from our institutional review board, we defined our study cohort from a retrospective database of consecutive patients who had undergone MRI of the abdomen or pelvis for an indication of "prostate cancer" at an academic tertiary care center between 2011 and 2013. The database was reviewed to identify patients who had undergone MRI as part of their workup for an initial diagnosis of prostate cancer (a decision which is generally provider-dependent at our institution). Patients without a biopsy-proven diagnosis of prostate cancer were excluded, as were patients with known metastatic disease. Patient, disease, and treatment characteristics were recorded post hoc from the medical record, including patient age (calculated at the date of the MRI), clinical T stage based on digital rectal examination, initial pretreatment PSA, and biopsy Gleason score. The initial NCCN risk group was calculated based on this information. Patients for whom pre- or post-MRI risk group assignment could not be performed (based on information available in the medical record) were excluded from the analysis.

MRI was performed according to the institutional protocol for prostate imaging, including multiparametric techniques (incorporating T2, dynamic contrast enhanced, and diffusion weighted sequences) for all patients. A Trio (Siemens, Malvern, PA) 3 T MRI scanner was used to obtain high-resolution T2 and 3D breath-held spoiled gradient echo imaging (3D volumetric interpolated breath-hold examination [VIBE]) images. Axial high-resolution T2 imaging of the pelvis was performed using a sampling perfection with application optimized contrasts using different flip angle evolution (SPACE) sequence with 1-mm contiguous slices and no fat suppression. A 3D VIBE sequence with fat saturation was performed pre- and post-contrast administration with slice thickness of 2.5 mm, scan time of 14 seconds, and a 256 × 256 resolution matrix. A fast-spin echo T2-weighted imaging sequence was performed with slice thickness of 3 mm. Dynamic contrast-enhanced sequences were performed with slice thickness of 2.5 mm and with 12 mL of Multihance (gadobenate dimeglumine, Bracco) contrast delivered at a rate of 3 mL/second. These phases were repeated 10-12 times depending on the gland volume. Diffusion weighted imaging sequences were performed with slice thickness of 3.6 mm and B values of 0, 50, 100, 500, 800, 1000, and 1500. A surface 32-channel coil was used for all patients (and no endorectal coil). Postprocessing pharmacokinetic analysis was used to generate perfusion graphs.

Each MRI examination was interpreted at the study site by one of several radiologists at our institution with specific training in genitourinary radiology. The interpreting radiologist incorporated findings from each sequence (including signal intensity from the T2-weighted sequences, presence or absence of restricted diffusion, and the degree of contrast enhancement on perfusion imaging) into the final reading of each MRI study. The MRI findings as specified in the final report were recorded post hoc for our analysis. Findings were categorized as follows: no tumor visualized, rT1; tumor visualized but not extending beyond the prostate capsule, rT2; EPE, rT3a; SV invasion, rT3b; invasion into adjacent structures, rT4; lymph node involvement, rN+; and distant metastases, rM+. Pathologic T stage was recorded for the patients who underwent radical prostatectomy (RP). This information was subsequently compared with T stage as defined by MRI to calculate the specificity of MRI in our cohort.

The MRI findings were then combined with the clinical T stage, serum PSA, and biopsy Gleason Score data to derive a post-MRI NCCN risk group, with radiographic findings incorporated in place of clinical findings. For example, if MRI demonstrated EPE in a patient with clinical T1 or T2 disease (and no other high-risk factors), the risk group was adjusted to "high risk" to reflect the presence of EPE. In addition, the impact of MRI on therapeutic decision making was estimated by reviewing the medical record to determine whether the MRI findings had changed the overall treatment plan. A change in treatment was recorded only when there was clear documentation within the medical record that the MRI findings had directly altered the treatment plan. In cases in which the impact of the MRI on the treatment plan was ambiguous, no change was recorded. Additionally, minor changes in treatment, such as a change in external beam radiation therapy (EBRT) dose, are not often documented in the treatment record and were thus generally not captured by this analysis.

Statistical analysis of changes in risk group stratification was performed by using the Stuart-Maxwell test, which is a standard test to compare nondichotomous decisions in 2 dependent populations (as opposed to the Chi-square test, which compares independent populations).[9,10] A P value below the specified significance level would indicate that the 2 dependent sample means are different. In our analysis, we considered a P value of $<.05$ to be statistically significant. All statistics were calculated using SPSS version 20.0 (IBM Corporation, Armonk, NY) and Stata version 9.2 (StataCorp, College Station, TX).

RESULTS

Patient and Treatment Characteristics

A total of 71 patients were included in the analysis. Median age of all patients was 67.2 years (range, 41.7-85.6 years). By NCCN risk stratification criteria, there were 11 (15.5%), 39 (54.9%), and 21 patients (29.6%) classified as low, intermediate, and high risk, respectively. The median Gleason sum score was 7 (range, 6-9). The majority of patients (75.7%) had clinical stage T1c disease. MRI was performed at a median of 5.8 months (range, 0.1-15.2 months) before completion of definitive treatment. The most common definitive treatments delivered were RP (28.2%) and EBRT with androgen deprivation therapy (28.2%), followed by EBRT alone (19.7%). Patient characteristics are illustrated in Table 1.

Impact of MRI on NCCN Risk Group Classification

The most common MRI finding leading to a change in risk group classification was SV invasion. Other findings