

Diagnostic performance of prostate imaging reporting and data system v2.1: Single center experience

Tumay Bekci¹, Ural Oguz², Alptekin Tosun¹, Erhan Demirelli², Ercan Ogriden², Demet Sengul³

¹Giresun University Faculty of Medicine, Department of Radiology, Giresun, Turkey

²Giresun University Faculty of Medicine, Department of Urology, Giresun, Turkey

³Giresun University Faculty of Medicine, Department of Pathology, Giresun, Turkey

Copyright © 2019 by authors and Annals of Medical Research Publishing Inc.

Abstract

Aim: To assess the diagnostic accuracy of PI-RADS v2.1 using multi-parametric magnetic resonance imaging (mpMRI) to detect prostate cancer (pCa) and comparison with transrectal biopsy/radical prostatectomy results.

Material and Methods: Between June 2017 and April 2019, 124 patients who underwent mpMRI prior to transrectal biopsy/ radical prostatectomy were evaluated by a pathology results-blinded urologist using PI-RADS v2.1 categories, retrospectively. PIRADS v2.1 category results were compared with transrectal biopsy/radical prostatectomy results. All clinical data were used in statistical analysis.

Results: The sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of mpMRI using PI-RADS v2.1 categorization were 96%, 44%, 73%, 88% and 75%, respectively. A significant correlation was observed between a high PI-RADS score and high pathological grade ($p < 0.001$). The inter observer agreement expressed as the ICC was 0.65 (95% CI: 0.33–0.84, $p < 0.001$).

Conclusions: The mpMRI, used in conjunction with PI-RADS v2.1, is a useful and promising imaging method in detection of pCa.

Keywords: Prostate cancer; multiparametric MRI; PI-RADS; transrectal biopsy; radical prostatectomy.

INTRODUCTION

Conventional diagnostic method of prostate cancer is prostate-specific antigen (PSA) test and transrectal ultrasound (TRUS)-guided prostate biopsy following rectal examination (1). However, this method can be insufficient in the diagnosis of prostate cancer (pCa) and also it has disadvantages such as not being able to detect extra-prostatic extension of the lesion (1). There are also biopsy-related complications such as infection and haemorrhage (1). At this point, multiparametric magnetic resonance imaging (mpMRI) has recently begun to play a significant role in the diagnosis, staging and risk stratification of prostate cancer and in guiding biopsy. mpMRI of prostate can be defined as a combination of T2-weighted, diffusion weighted and dynamic contrast enhanced MRI images (2). Prostate Imaging Reporting and data System (PI-RADS) (Table 1), which was first developed in 2012 to standardize this imaging method, was developed in years and it was last published in 2019 as PI-RADS v2.1 (2).

Table 1. PI-RADS v2.1 categories

PI-RADS 1	Very low risk (clinically significant cancer is highly unlikely to be present)
PI-RADS 2	Low risk (clinically significant cancer is unlikely to be present)
PI-RADS 3	Intermediate risk (the presence of clinically significant cancer is equivocal)
PI-RADS 4	High risk (clinically significant cancer is likely to be present)
PI-RADS 5	Very high risk (clinically significant cancer is highly likely to be present)

PI-RADS: Prostate Imaging Reporting and Data System

In the present study, our purpose was to assess the diagnostic accuracy of mpMRI in detecting prostate cancer when used with PIRADS v2.1 categorization. Our study is the first one in literature to assess the efficiency of PI-RADS v2.1 in the diagnosis of prostate cancer.

Received: 26.04.2019 **Accepted:** 27.05.2019 **Available online:** 02.07.2019

Corresponding Author: Tumay Bekci, Giresun University Faculty of Medicine, Department of Radiology, Giresun, Turkey

E-mail: tmybkc@gmail.com

MATERIAL and METHODS

Patients

Institutional ethics committee approved this retrospective study. Informed and written consents of patients obtained from the patients before MRI and TRUS guided transrectal biopsy. One hundred and twenty-four patients were identified who underwent mpMRI prior to TRUS guided prostate biopsy/radical prostatectomy between June 2017 and April 2019 in our university hospital. Clinical and demographic characteristics of the patients and histopathological characteristics of prostate lesions were collected from the hospital data retrospectively in order to use in statistical analysis.

Imaging protocol and interpretation

Prostate mpMRI examination was made in 1.5-T MR system (Magnetom Symphony, Siemens Medical Solutions, Erlangen, Germany) by using pelvic phased-array multicore. Endorectal coil was not used. mpMRI protocol was as follows: axial, coronal, sagittal fast spin-echo T2-weighted images (T2WI) with a small field of view, dynamic contrast-enhanced (DCE) images using 3D gradient-echo T1-weighted VIBE sequence and diffusion weighted imaging (DWI) using multiple b-values (50-800-1400 s/mm²) with an apparent diffusion coefficient (ADC) map. mpMRI images of the patients were assessed by an uroradiologist who was blind to histopathological results of the patients under the guidance of PIRADS v2.1 scoring system (Figure 1 and 2). In addition, 20 patients were chosen randomly and they were categorized according to PIRADS v2.1 for interobserver agreement statistical assessment by a second experienced radiologist.

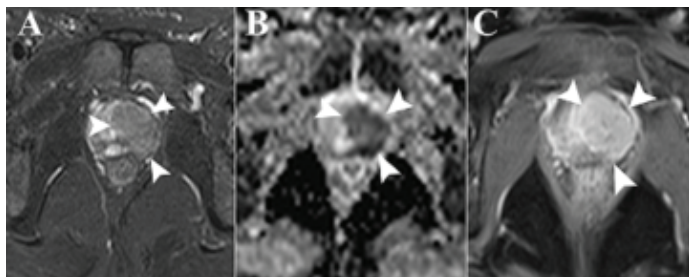


Figure 1. A 68 year old man. Because of high PSA value (6.9 ng/ml) the patient underwent mpMRI examination prior to TRUS-guided biopsy. PI-RADS 5 lesion identified (arrowheads) on the left half of the prostate gland on axial T2-weighted (A), axial diffusion weighted (B) and axial dynamic contrast-enhanced (C) MRI images. Histopathological result was Gleason 4+3 prostate cancer

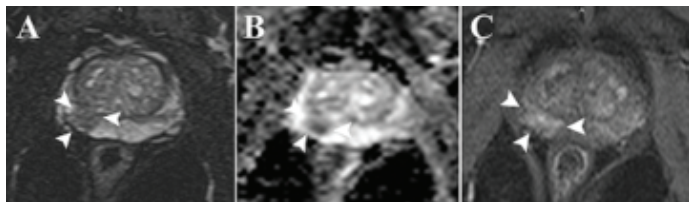


Figure 2. A 55 year old man. Because of high PSA value (5.6 ng/ml) the patient underwent mpMRI examination prior to TRUS-guided biopsy. PI-RADS 4 lesion identified (arrowheads) on the right half of the peripheral zone of prostate gland on axial T2-weighted (A), axial diffusion weighted (B) and axial dynamic contrast-enhanced (C) MRI images. Histopathological result was Gleason 3+4 prostate cancer

Histopathological analysis

Systematic 12-core TRUS-guided prostate biopsy was performed by an experienced urologist. TRUS-guided biopsy and radical prostate surgery specimens were evaluated by an experienced pathologist and the results were categorized as pCa (with Gleason score), atypical glands or no cancer (e.g., benign prostate tissue, benign prostatic hyperplasia and prostatitis). Postoperative pathology results of patients with both TRUS-guided biopsy and prostatectomy were determined as final pathology result. Following histopathological examination, groupings of patients diagnoses with prostate cancer according to Gleason scores between 1 and 5 were as follows: Group 1: Gleason 3+3 (least aggressive); Group 2: Gleason 3+4; Group 3: Gleason 4+3; Group 4: Gleason 4+4, 3+5 and 5+3; Group 5: Gleason score 9-10 (most aggressive).

Statistical Analysis

The Statistical Package for Social Sciences (SPSS), Version 22.0 (Chicago, IL, USA), was used for the statistical analysis. The descriptive data were presented as means \pm standard deviation and medians (minimum-maximum). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy values were calculated. Spearman's rank-correlation coefficient was used to determine an association between the PI-RADS score and histopathological groups. The interclass correlation coefficient (ICC) between the two radiologists was also evaluated. The correlation was classified as poor (ICC < 0.40), fair to good (ICC = 0.40 to 0.75), or excellent (ICC > 0.75). A p-value of less than 0.05 was considered statistically significant.

RESULTS

Average age of 124 patients who underwent mpMRI was 68 (ranged between 50-88 years), average PSA was 9 ng/mL (ranged between 4 and 120). All the patients underwent mpMRI examination routinely before 12-core TRUS guided systemic biopsy. 24 of the patients received radical prostatectomy and final pathology results were considered as prostatectomy specimens. Table 2 shows the patients' distribution according to PI-RADS groups and histopathological grade groups. mpMRI detected 73 of 76 pCa lesions. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy values of mpMRI using PI-RADS v2.1 categorization were 96%, 44%, 73%, 88% and 75%, respectively. A significant correlation was observed between a high PI-RADS v2.1 score and high pathological grade group ($p < 0.001$). The interobserver agreement expressed as the ICC was 0.65 (95% CI: 0.33-0.84, $p < 0.001$). Of the patients who were reported as PI-RADS 1-2 ($n=24$), Gleason 3+3 prostate cancer was found in 2 of the 3 false positive patients (12%), while Gleason 4+3 prostate cancer was found in 1. Of the 41 patients reported as PI-RADS 5, 2 (5%) were reported as false negative and one of these patients had benign pathological results, and the other had necrotizing prostatitis. In the patient who was pathologically

diagnosed as benign, the lesion was found to be localized at anterior fibromuscular stroma in the apex. Of the 100 patients reported as PI-RADS ≥ 3 , 27 were pathologically diagnosed as benign. Of these 27 patients, PI-RADS score was assessed as 4-5 in 9 patients and re-biopsy was suggested for the patients and clinician was informed.

Table 2. Patient characteristics	
Parameter	Value
Age (year)	68 (50-88)
PSA (ng/ml)	9.1 (4-120)
Grade Group	
Grade Group 1 (Gleason score 3+3)	30
Grade Group 2 (Gleason score 3+4)	16
Grade Group 3 (Gleason score 4+3)	8
Grade Group 4 (Gleason score 8)	8
Grade Group 5 (Gleason score 9-10)	14
mpMRI findings	
Total number of patients	124
PI-RADS score for each patient	
PI-RADS 1-2	24
PI-RADS 3	33
PI-RADS 4	26
PI-RADS 5	41

PSA: Prostate Specific Antigen; PIRADS: Prostate Imaging Reporting and Data System; mpMRI: Multiparametric magnetic resonance imaging

DISCUSSION

The use of mpMRI with PI-RADS scoring system has a significant role in the diagnosis and treatment guidance of prostate (3-9). PI-RADS is a continually developing scoring system with its continuing limitations and following each new version, it is improved by taking into consideration the observations of experts in this area and published articles on this topic. The most recently published PI-RADS v2.1 is the most up-to-date version of the PI-RADS scoring system and mpMRI assessment and PI-RADS scoring was based on PI-RADS v2.1 in our study (2). To the best of our knowledge, this is the first study in literature conducted by using PI-RADS v2.1.

In our study, mpMRI detected prostate cancer with PI-RADS v2.1 with a sensitivity of 96%, specificity of 43% and a high rate of accuracy (75%). In a meta analysis which included 13 studies and a total of 2049 patients, Zhang et al. reported that PI-RADS v2 was used in the diagnosis of prostate cancer with an average of 0.85 (0.78-0.91) sensitivity and 0.71 (0.60-0.80) specificity (10). In the meta analysis, PPV values were reported to be between 0.54 and 0.97, while NPV values were reported to be between 0.26 and 0.92 (10). The results of this meta analysis showed that there was significant heterogeneity between studies. Sensitivity and specificity results in our study showed

similar results with some previous studies in literature, while it showed different results with some others (10). However, in general it can be said that our results overlap with the results of the meta-analysis. Studies conducted in literature with 2 or more readers have reported interobserver agreement as good to excellent (10). In our study, interobserver agreement is high (ICC=0.65 (95% CI: 0.33-0.84, $p < 0.001$). In our study, PI-RADS scores and pathological grade of prostate tumor were correlated and positive correlation was found between high PI-RADS score and high histopathological grade group. In the study of Lee et al. conducted for PIRADS v2 and Borkowetz et al. conducted for PIRADS v1, correlations similar to our study were reported (1,11). We think that this result can be associated with prostate lesions having more cellularity in case of having high histopathological grade. Thus, T2W images will have less liquid content due to increased cellularity and they will look more hypointense on imaging. Similarly, increased cellularity will decrease the diffusion of fluid on DWI and cause diffusion restriction; thus, lesion will be detected more easily. In the present study, high value of NPV (87%) when compared with values reported in literature and it can be considered that PI-RADS v2.1 is an imaging method that can be used safely in scanning prostate cancer.

In our study, we analyzed 3 pCa patients reported as PI-RADS 1-2. Two were found to be in Group 1 histopathological group. This can be explained with that, the lesions cannot be differentiated from the background parenchyma in T2W and DWI images due to low tumoral cellularity in patients with Gleason score 3+3. In our study, the presence of tumor was not shown histopathologically only in 2 of the patients scored as PI-RADS 5. When the literature is reviewed, accuracy rates reaching 100% can be seen in PI-RADS 5 cases (4). In our study, the rate of detecting prostate cancer was quite high in patients scored as PI-RADS 5 (95%). When these two patients were analyzed, one patient was found to have lesion localized at apical anterior fibromuscular stroma. This lesion area is known to be a difficult localization in which biopsy can give negative results and MRI can fail to notice the lesions and it has been emphasized by PI-RADS Steering committee in PI-RADS versions and redefined in PI-RADS v2.1. In our study, while lesion was detected in this area with mpMRI, it was missed with TRUS guided biopsy. Interestingly, another patient was diagnosed with necrotizing prostatitis with TRUS guided biopsy. In our literature review, we came across studies which have reported that necrotizing prostatitis can be mistaken for prostate adenocancer and we found that such a challenge was not mentioned in previous PI-RADS studies (12). In necrotizing prostatitis, cytotoxic edema forming in necrotizing areas of prostate parenchyma cause diffusion restriction and the patient is presented with low ADC values in ADC images. These imaging characteristics are also seen in cases which are found to have a tumor and this situation is a real diagnostic challenge. PSA values

also increase in cases with necrotizing prostatitis and at this point clinical characteristics and symptoms of the patient come to the forefront. For this reason, especially in patients who are thought to have infectious process in the prostate, it should be kept in mind that necrotizing prostatitis can also have similar imaging characteristics with pCa and the clinician should inform the radiologist. This way, false interpretations in PI-RADS scoring system can be prevented. In our study, lesion was not found histopathologically in 27 of the patients who were scored as PI-RADS ≥ 3 (n=100) (27%). This can be explained with high false positive rates of mpMRI; however, there can also be cases missed by 12-core systematic TRUS-guided biopsy. This problem can be solved by performing cognitive fusion TRUS-guided biopsy.

Our study has disadvantages such as being retrospective and most of the cases not having radical prostatectomy specimens because it is known that in radical prostatectomy specimens, Gleason scores in TRUS-guided transrectal biopsy can be upgraded or downgraded (10). However, this limitation was ignored since there are sufficient numbers of studies comparing TRUS guided biopsy and PI-RADS scoring. Another limitation of our study is the use of 1.5 T MR system. However, PI-RADS Steering committee report that multiparametric prostate examinations can also be made in 1.5 T MR devices when sufficient technical parameters are applied. For this reason, this limitation was also ignored since we had sufficient parameters. Another limitation was not using endorectal coil. However, image quality was optimized with suitable parameters and reliable assessment was ensured.

CONCLUSION

In conclusion, the mpMRI, used in conjunction with PI-RADS v2.1, is a useful and promising imaging method in detection of pCa. PI-RADS v 2.1 promises to be a categorization system that can increase the clinical utility of PI-RADS scoring with high interobserver agreement and high sensitivity rates. In the development of PI-RADS scoring system, it is important for radiologists and urologists to cooperate and the radiologists should be aware of the possible pitfalls in PI-RADS scoring system.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports

Ethical approval: This work has been approved by the Institutional Review Board.

Tumay Bekci ORCID: 0000-0002-3147-2786

Ural Oguz ORCID: 0000-0003-0652-7957

Alptekin Tosun ORCID: 0000-0003-1783-9171

Erhan Demirelli ORCID: 0000-0002-0187-2156

Ercan Ogreden ORCID: 0000-0002-3779-740X

Demet Sengul ORCID: 0000-0002-0416-0621

REFERENCES

1. Lee CH, Ku JY, Park WY, et al. Comparison of the accuracy of multiparametric magnetic resonance imaging (mpMRI) results with the final pathology findings for radical prostatectomy specimens in the detection of prostate cancer. *Asia Pac J Clin Oncol* 2019;2:20-7.
2. Turkbey B, Rosenkrantz AB, Haider MA, et al. Prostate imaging reporting and data system version 2.1: 2019 update of prostate imaging reporting and data system version 2. *Eur Urol* 2019;18.
3. Gosein M, Pang E, Chang S, et al. Outcomes of Magnetic Resonance Imaging–Ultrasound Fusion Prostate Biopsy of PI-RADS 3, 4, and 5 Lesions. *Can Assoc Radiol J* 2018;6:303-10.
4. Patel NU, Lind KE, Garg K, et al. Assessment of PI-RADS v2 categories ≥ 3 for diagnosis of clinically significant prostate cancer. *Abdom Radiol (NY)* 2019;44:705-12.
5. Demirel HC, Davis JW. Multiparametric magnetic resonance imaging: Overview of the technique, clinical applications in prostate biopsy and future directions. *Turk J Urol* 2018;44:93-102
6. Greer MD, Shih JH, Lay N, et al. Interreader Variability of Prostate Imaging Reporting and Data System Version 2 in Detecting and Assessing Prostate Cancer Lesions at Prostate MRI. *AJR Am J Roentgenol* 2019;6:1197-205
7. Liu C, Liu SL, Wang ZX, et al. Using the prostate imaging reporting and data system version 2 (PI-RADS v2) to detect prostate cancer can prevent unnecessary biopsies and invasive treatment. *Asian J Androl* 2018;20:459-64.
8. Alessandrino F, Taghipour M, Hassanzadeh E, et al. Predictive role of PI-RADSV2 and ADC parameters in differentiating Gleason pattern 3+ 4 and 4+ 3 prostate cancer. *Abdom Radiol (NY)* 2019;44:279-85.
9. Inan I, Aktan A, Ozkanli SS, et al. Comparison of likert and PI-RADS v2 scoring in the diagnosis of prostate cancer. *J Turgut Ozal Med Cen* 2018;4:651-5
10. Zhang L, Tang M, Chen S, et al. A meta-analysis of use of Prostate Imaging Reporting and Data System Version 2 (PI-RADS V2) with multiparametric MR imaging for the detection of prostate cancer. *Eur Radiol* 2017;27:5204-14.
11. Borkowetz A, Platzek I, Toma M, et al. Direct comparison of multiparametric magnetic resonance imaging (MRI) results with final histopathology in patients with proven prostate cancer in MRI/ultrasonography-fusion biopsy. *BJU Int* 2016;118:213-20.
12. Lee S M, Joshi J, Wolfe K, et al. Radiologic presentation of chronic granulomatous prostatitis mimicking locally advanced prostate adenocarcinoma. *J Radiol Case Rep* 2016;11:78-82.