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RESEARCH

Comparison of PI-RADS and LIKERT scoring systems in the diagnosis of prostate cancer and the contribution of radiologist experience

Prostat kanseri tanısında PI-RADS ve LIKERT skorlama sistemlerinin karşılaştırılması ve radyolog deneyiminin katkısı

Ali Can Topaloğlu[1], Hüseyin Akkaya[2], Ömer Kaya[3], Gökhan İpek[4], Okan Dilek[4], Selim Özdemir[5], Bozkurt Gülek[4], Gökhan Söker[4]

[1]Şanlıurfa Training and Research Hospital, Şanlıurfa, Türkiye
[2]Ondokuz Mayis University, Samsun, Türkiye
[3]Çukurova University, Adana, Türkiye
[4]University of Health Sciences, Adana, Türkiye
[5]Düziçi State Hospital, Osmaniye, Türkiye

Abstract

Purpose: The aim of this study was to investigate the concordance of these two scoring systems with histopathological data and the relationship between this concordance and radiologist experience.

Materials and Methods: A total of 347 patients who underwent multiparametric prostate MRI (mpMRI) with a preliminary diagnosis of prostate cancer were retrospectively reviewed. The assessors independently scored the images according to PI-RADS v2.1. Two weeks later, they independently scored the images using the LIKERT system while blinded to their previous PI-RADS v2.1 scores. The study investigated the correlation of these scores with the pathology results and the inter-reader agreement.

Results: The mean age of the patients was 65.5±7.7 years. In the kappa analysis, which evaluated the concordance of both scoring systems with the reference standard pathology, it was observed that concordance increased with radiologist experience. For the entire gland, the kappa values for readers 1, 2, 3, and 4 with PI-RADS v2.1 were found to be 0.669, 0.669, 0.711, and 0.771, respectively, and with the LIKERT system, they were 0.589, 0.669, 0.701, and 0.771, respectively. The AUC values were 0.901 (0.893–0.921) for PI-RADS and 0.895 (0.871–0.922) for LIKERT.

Conclusion: The PI-RADS v2.1 and LIKERT scoring systems provided similar inter-reader agreement in evaluating mpMRI. Among less experienced radiologists, PI-RADS v2.1 demonstrated higher concordance with

Öz

Amaç: Bu çalışmanın amacı iki skorlama sisteminin histopatolojik verilerle uyumunu ve bu uyum ile radyolog deneyimi arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntem: Prostat kanseri ön tanısı ile multiparametrik prostat MRG (mpMRI) yapılan toplam 347 hasta retrospektif olarak incelendi. Değerlendiriciler görüntüleri bağımsız olarak PI-RADS v2.1'e göre puanladı. İki hafta sonra, önceki PI-RADS v2.1 puanlarına kör olarak LIKERT sistemini kullanarak görüntüleri bağımsız olarak puanladılar. Her iki skorlama sisteminde de 1, 2 ve 3 skorları benign olarak kabul edilirken, 4 ve 5 skorları malign olarak kabul edilmiştir. Çalışma, bu skorların patoloji sonuçlarıyla korelasyonunu ve okuyucular arası uyumu araştırmıştır.

Bulgular: Hastaların yaş ortalaması 65.5±7.7 yıldı. Her iki skorlama sisteminin referans standart patoloji ile uyumunu değerlendiren kappa analizinde, uyumun radyolog deneyimi ile arttığı gözlendi. Tüm prostat için, PI-RADS v2.1 ile okuyucu 1, 2, 3 ve 4 için kappa değerleri sırasıyla 0.669, 0.669, 0.711 ve 0.771 ve LIKERT sistemi ile sırasıyla 0.589, 0.669, 0.701 ve 0.771 olarak bulundu. Eğri altında kalan alan değerleri PI-RADS için 0,901 (0,893-0,921) ve LIKERT için 0,895 (0,871-0,922) idi.

Sonuç: PI-RADS v2.1 ve LIKERT skorlama sistemleri mpMRI değerlendirmesinde benzer okuyucular arası uyum sağlamıştır. Daha az deneyimli radyologlar arasında PI-RADS v2.1 patoloji ile daha yüksek uyum gösterirken, daha deneyimli radyologlar arasında iki skorlama sistemi arasında fark gözlenmedi.

Address for Correspondence: Hüseyin Akkaya, Ondokuz Mayis University, Faculty of Medicine, Department of Radiology, Samsun/Türkey, dr.hsynakkaya@gmail.com
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pathology, whereas no difference was observed between more experienced radiologists.
Keywords:. Prostate cancer, PI-RADS v2.1, LIKERT, Multiparametric MRI, PSA

Anahtar kelimeler: Prostat kanseri, PI-RADS v2.1, LIKERT, Multiparametrik MRG, PSA

INTRODUCTION

Radiologic imaging modalities gain importance in the evaluation of prostate lesions. However, the radiology report is the single most important material for accurate communication with clinician doctors and patients. Especially multiparametric magnetic resonance imaging (mpMRI)is the main radiologic modality with the highest sensitivity and specificity in the evaluation of prostate lesions. Historically, imaging reports have often lacked clarity, were missing expected elements, or contained a gap between the intended and the received message[3]. Recently, structured radiological reporting has been proposed as a strategy to ensure adherence to the expected elements of a good report, such as clarity, accuracy, precision, completeness and standardization, and the number of template-based reports is increasing.

There are two widely accepted structured reporting systems for the interpretation of mpMRI of the prostate: PI-RADS v2.1 and Likert. Both of these radiologic reporting systems have good diagnostic performance with high cancer detection rates, but have important, indeed obvious, conceptual differences. However, the evaluation of mpMRI is relatively challenging and requires experience. Additionally, various pathologies, such as infections, can be confused with malignancy[4]. The challenges in evaluating mpMRI have led to the need for a standardized reporting system[1,5]. The previously used LIKERT system, which did not include objective criteria, and the more recent PI-RADS v2.1 system, revised in 2019, have made it easier to identify prostate cancer, but inter-reader variability has emerged as a problem[6-8].

The study aimed to assess the differences between evaluators using both systems and their concordance with pathology results, with the goal of identifying variations based on experience level.

MATERIALS AND METHODS

The study was approved by the Ethics Committee of Adana City Training and Research Hospital 4 November (2021/1621). Since the study was retrospective, the requirement for informed consent was waived. After the ethics committee of the study was obtained, new authors were added to the study in order to screen the clinical information of the patients in order to ensure that the 4 radiologists remained unaware of the patient information.

Sample

A total of 347 patients who underwent prostate mpMRI with a preliminary diagnosis of prostate cancer between January 2018 and September 1, 2021 at Adana City Training and Research Hospital were retrospectively analyzed. Our center is a tertiary hospital where prostate surgery is performed most frequently in the region and where this surgery is also trained. The inclusion criteria were as follows: patients with a histopathologic diagnosis of prostate cancer and a baseline prostate-directed MpMRI examination. Exclusion criteria were as follows: no pathology diagnosis, patients with radical prostatectomy or radiotherapy before prostate MRI, no MpMRI examination or MpMRI examination was not suitable for evaluation due to artifact (Figure 1).

Procedure

Demographic data, free and total PSA values, PSA ratio, and PSA density were recorded for each patient. The PSA ratio was calculated by dividing the free PSA value by the total PSA value, and the PSA density was determined by dividing the total PSA value by the prostate volume. Assessors were blinded to the pathology result and other assessors' scores but had access to other data.

The evaluations were conducted by four radiologists with 20, 10, 4, and 4 years of experience in abdominal radiology. The radiologists had 6, 5, 1, and 1 years of experience in prostate mpMRI. Prostate MpMRI images of 202 patients were scored according to PI-RADS v2.1, and the results were recorded. Two weeks later, the images were scored according to the LIKERT system, while the assessors were blinded to the previous PI-RADS v2.1 score and each other. All images were examined retrospectively by four radiologists independently of each other. All 4 readers included in the study were radiologists

working in the same institution. The two most senior assessors are the ones who routinely perform prostate MRI evaluation in our institution. The two junior radiologists had a similar specialization and were responsible for abdominal radiology reporting in our institution and did not receive special training for prostate MRI. Since one of the aims of our study was the importance of radiologist experience for PI-RADS v2.1 and LIKERT, we made sure that the main difference in the selection of assessors was experience in prostate MRI. Radiologists were also blinded to patients' identification, pathology results, all clinical information, and all inclusion criteria. All images were evaluated using the Philips IntelliSpace Workstation (Philips Healthcare, Best, The Netherlands).

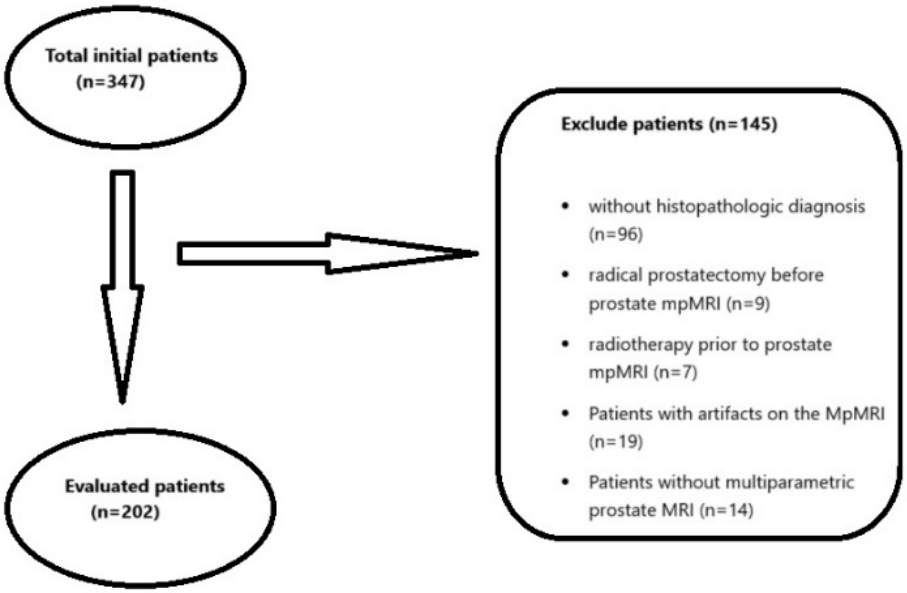

Figure 1. Flowchart of the study.

For each patient, LIKERT and PI-RADS scores were obtained from all four radiologists. (Figure 2). The study investigated the correlation of these scores with the pathology results and the inter-reader agreement.

Philips MRI device with 1.5 and 3.0 Tesla magnetic strength and a 16-channel phased-array body coil was used. Axial and coronal T2-weighted images were routinely obtained. Field of view (220 × 220 × 72) were obtained using a 440 × 238 matrix, a slice thickness of 3 mm, no interslice spacing, and an echo time (TE) of 110 ms.

Statistical analysis

Statistical analysis of the data was conducted using SPSS 25.0. Categorical measurements were summarized as count and percentage, while continuous measurements were summarized as mean and standard deviation (with median and minimum-maximum values provided where necessary). We performed power analysis with G-power (version 3.0.10, Franz Faul, Universitat Kiel, Germany), according to previous data[5]. Categorical variables were expressed as numbers and percentages, while continuous variables were summarized as median and range (min-max). The Kolmogorov-Smirnov test assessed the distribution of numeric variables. Normally distributed data were expressed as mean ± standard deviation and analyzed using the independent sample Student's t-test. Cohen's kappa coefficient was used for both intra- reader and inter-reader assessments. Total PI-RADS and LIKERT scores for the cases were calculated, and receiver operating characteristic curve analysis was performed to determine the area under the curve (AUC), sensitivity, and specificity. Kappa concordance values were interpreted as follows: <0, worse than chance-

level agreement; 0.01–0.20, negligible agreement; 0.21–0.40, poor agreement; 0.41–0.60, moderate agreement; 0.61–0.80, substantial agreement; and 0.81–1.00, almost perfect agreement (9).

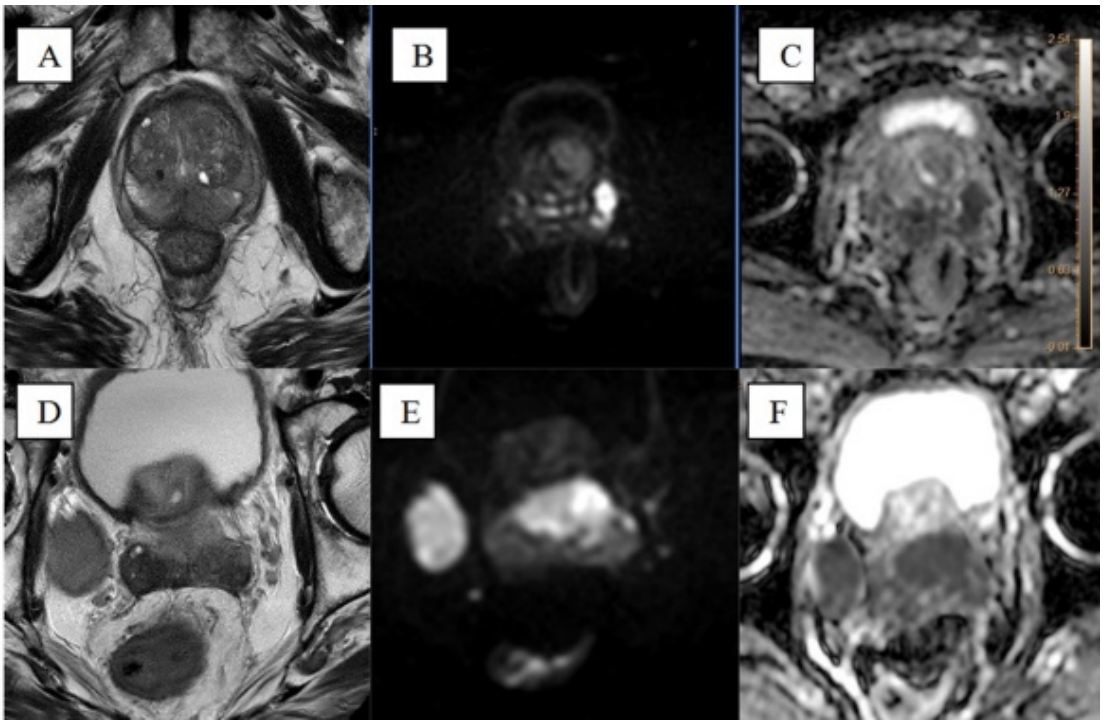

Figure 2. There is a more prominent hypointense appearance in the left half of the peripheral zone on T2A (A). A hyperintense lesion on DWI (B) and a hypointense lesion on ADC (C) with marked restriction is seen in the same location. LAP in the obturator chain on the right with invasion of the seminal vesicles is noted on T2A (D), DWI (E) and ADC (F). The evaluators scored 5 according to PI-RADS and LIKERT. Histopathologic result was Gleason 4+3 adenocarcinoma.

RESULTS

The study included 202 patients. The mean age of the patients was 65.5±7.7 years (median: 66, min: 47, max: 88). The mean values for PSA density, prostate volume, total PSA, free PSA, and fPSA/PSA were found to be 1.20±8.8 (Median: 0.13, min: 0.01, max: 115.0), 62.5±35.2 (Median: 54.5, min: 15, max: 235), 60.7±427.5 (Median: 7.98, min: 0.1, max: 5395), 10.7±34.6 (Median: 1.21, min: 0.03, max: 246.6), and 0.17±0.11 (Median: 0.17, min: 0.02, max: 0.63), respectively (Table 1).

For the total PI-RADS scores of the entire gland, a high level of agreement was found between the reference standard and reader 1 (κ: 0.669). There was a high level of agreement between the reference standard and reader 2, reader 3, and reader 4 (κ: 0.669, κ: 0.711, and κ: 0.771, respectively), (Table 2).

For the total LIKERT scores of the entire gland, a moderate agreement was found between the reference standard and reader 1 (κ: 0.589). There was a high level of agreement between the reference standard and reader 2, reader 3, and reader 4 (κ: 0.669, κ: 0.701, and κ: 0.771, respectively) (Table 3).

Histopathological results for the cases included in the study showed that 108 were benign and 94 were malignant neoplasms. Biopsy types were identified as follows: 176 cases (87.1%) underwent transrectal ultrasound-guided needle biopsy, 23 cases (11.4%) underwent radical prostatectomy, and 3 cases (1.5%) underwent transurethral resection of the prostate.

When lesions above LIKERT 3 and PI-RADS 3 were considered malignant, AUC values were 0.895 ((95%-

Cl (0.871-0.922)), 0.901 (((95%-Cl (0.893-0.921)), respectively (Table 4).

Table 1. Demographic and laboratory data

	Mean ±Sd	Standard deviation	Median (Min -Max)
Age (year)	65.5 ±7.7	7.7	66 (47-88)
PSA density (ng/mL^2)	1.20 ±8.8	8.8	0.13 (0.01-115)
Prostate volume (cc)	62.5 ±35.2	35.2	54.5 (15-235)
Total PSA (ng / mL)	60.7 ±427.5	427.5	7.98 (0.1-5395)
Free PSA (ng / mL)	10.7 ±34.6	34.6	1.21 (0.03- 246.6)
fPSA/PSA (ng / mL)	0.17 ±011	0.11	0.17 (0.02- 0.63)

Table 2. Distribution of Kappa values obtained for inter- reader agreement in PI-RADS scoring for the peripheral zone, central zone, and entire gland

	Reference standard	Reader 1	Reader 2	Reader 3
Central gland (n = 14)				
Reader 1	0.512			
Reader 2	0.650	0.186		
Reader 3	0.696	0.553	0.391	
Reader 4	0.811	0.317	0.432	0.533
Peripheral zone (n = 94)				
Reader 1	0.645			
Reader 2	0.691	0.467		
Reader 3	0.822	0.467	0.383	
Reader 4	0.822	0.289	0.537	0.537
Total score (n = 202)				
Reader 1	0.669			
Reader 2	0.669	0.672		
Reader 3	0.711	0.717	0.677	
Reader 4	0.771	0.677	0.738	0.760
Benign (n = 94)				
Reader 1	0.537			
Reader 2	0.561	0.387		
Reader 3	0.646	0.390	0.344	
Reader 4	0.654	0.325	0.412	0.390
Malignant (n = 108)				
Reader 1	0.631			
Reader 2	0.696	0.420		
Reader 3	0.719	0.563	0.438	
Reader 4	0.736	0.339	0.525	0.563

* Reference standard scoring was recorded as Benign (1, 2, 3) and Malignant (4, 5). **Kappa values for the readers, excluding the total score, were calculated with respect to the reference standard reader.

Table 3. Distribution of Kappa values obtained for inter-reader agreement in LIKERT scoring for the peripheral zone, central zone, and entire gland

	Reference standard	Reader 1	Reader 2	Reader 3
Central gland (n = 14)				
Reader 1	0.432			
Reader 2	0.432	0.300		
Reader 3	0.576	0.054	0.054	
Reader 4	0.659	0.186	0.186	0.317
Peripheral zone (n = 94)				
Reader 1	0.639			
Reader 2	0.644	0.423		
Reader 3	0.679	0.410	0.457	
Reader 4	0.752	0.389	0.587	0.549
Total score (n = 202)				
Reader 1	0.589			
Reader 2	0.669	0.692		
Reader 3	0.701	0.667	0.686	
Reader 4	0.771	0.640	0.760	0.791
Benign (n = 94)				
Reader 1	0.554			
Reader 2	0.622	0.531		
Reader 3	0.716	0.494	0.432	
Reader 4	0.653	0.321	0.511	0.584
Malignant (n = 108)				
Reader 1	0.535			
Reader 2	0.596	0.415		
Reader 3	0.697	0.344	0.369	
Reader 4	0.737	0.366	0.494	0.503

* Reference standard scoring was recorded as Benign (1, 2, 3) and Malignant (4, 5). **Kappa values for the readers, excluding the total score, were calculated with respect to the reference standard reader.

Table 4. Diagnostic test performance according to LIKERT and PI-RADS

	LIKERT	PI-RADS
AUC	0.895 (0.871–0.922)	0.901 (0.893–0.921)
Cut-off	>3	>3
Sensitivity (95%-Cl (%))	86.1-90.7	88 -90.7
Specificity (95%-Cl (%))	72.3-88.3	75-86.2
Youden index	0.585-0.772	0.663-0.769
P	**<0.001****	**<0.001****

*p < 0.05, **p < 0.001, ROC curve test

DISCUSSION

International guidelines recommend prostate mpMRI as the primary diagnostic test for men with suspected prostate cancer[8]. Prior to the development of PI-RADS, the LIKERT scoring system was used[9]. The main difference between the LIKERT system and PI-RADS is that it examines images along with clinical information and evaluates all sequences equally, unlike PI-RADS, which uses zone-specific sequences[10]. In the present study, PI-RADS v2.1 and LIKERT scoring systems were compared with histopathological verification, and the contribution of radiologist experience to the accuracy of the systems was investigated.

PI-RADS was introduced in 2012 and revised to version 2 in 2015. PI-RADS has now become the most widely accepted standard for interpreting mpMRI of the prostate[11]. The current version 2.1,

published in 2019, has been validated by several studies. Although PI-RADS promotes a standardized lesion-based scoring approach, interpretation remains subjective in many cases. Current limitations of version 2.1 include the need to clarify some interpretation criteria, the lack of precise criteria for scoring the central zone, the lack of assessment of prostate background potentially influencing cancer detection and, importantly, still limited specificity, which translates into too many unnecessary biopsies[12,13].

Comparable to PI-RADS, the Likert score expresses the risk of an mpMRI observation being a PCa on an ascending scale of 1-5, but this system works as a subjective assessment that does not rely on a dominant order or specific criteria to define each risk category[14]. This allows for a lot of flexibility when interpreting findings that are difficult to categorize with PI-RADS and the possibility to take into account clinical information such as age, PSA level, PSA density (PSAD), family history, for example[15]. Several studies comparing both systems on an in-patient basis have revealed that the Likert score has the potential for higher diagnostic accuracy and improved specificity compared to PI-RADS version 2. This demonstrates the potential of prostate mpMRI to maximize cancer detection while still avoiding unnecessary biopsies[16]. On the other hand, the absence of standardized image interpretation rules implies dependence on the experience of the radiologist and the potential for limited reproducibility between different institutions and practice settings compared to the relatively objective PI-RADS[17].

When studies that have investigated a similar issue are examined; a study conducted by Zawaideh et al.[16] in 2020, 129 patients underwent biopsy using a fusion technique guided by transrectal and transperineal ultrasound/MRI approaches. The PI-RADS and LIKERT scoring systems were compared for detecting clinically significant prostate cancer, and it was found that the accuracy of LIKERT category 3 was slightly higher than that of PI-RADS category 3. AUC values were found to be 0.92 for PI-RADS and 0.87 for LIKERT, similar to our study.

In 2013, Rosenkrantz et al.[1] evaluated mpMRI images of 70 patients obtained using a 3T MRI machine with a pelvic phased-array coil. Inter- reader agreement for PI-RADS and LIKERT was assessed as moderate for both the entire gland and the peripheral zoneIn this study, it was found that interreader agreement was decently good in both scoring systems. In the transition zone, inter-reader agreement was low for PI-RADS and moderate for LIKERT.

Also agreement for PI-RADS was low among inexperienced readers and moderate among experienced readers. For the LIKERT system, low levels of agreement were observed in both groups. It was similar to the current study among experienced observers for the transition zone. The emergence of this difference in the entire gland and peripheral zone may be attributed to the increased familiarity with both scoring systems, as well as the use of PI-RADS v2.1 for evaluation in the current study. The percentage agreement between all readers and pathology for the entire gland ranged from 82.7% to 89% for PI-RADS and from 87.9% to 89.2% for LIKERT[6]. The percentage agreement between all readers and pathology for the entire gland ranged from 83% to 88% for PI-RADS and from 79% to 88% for LIKERT. While the rates for PI-RADS were consistent, the agreement was lower for inexperienced readers using the LIKERT system.

In a 2015 study by Raphaëlle Renard-Penna et al.[5] mpMRG images of 118 patients, obtained with a 1.5 T MRI without an endorectal coil, were evaluated using PI-RADS and LIKERT systems by two experienced radiologists with over 10 years of experience in prostate MRI. The kappa values between the two reader were 0.73 for PI-RADS and 0.80 for LIKERT, indicating higher agreement with the LIKERT system. In the this study, the kappa values between all reader were 0.672–0.760 for PI-RADS and 0.640–0.791 for LIKERT, and no difference was found between the scoring systems. Furthermore, Fleiss kappa values were calculated to evaluate the agreement between the four reader, and these values were found to be 0.707 for PI-RADS and 0.706 for LIKERT. Findings are similar between the two systems. In the study conducted by Penna et al.[5] AUC values were 0.90 for PI-RADS and 0.91 for the LIKERT system. As can be seen, these values are similar to the AUC obtained in the current study. Furthermore, in the study conducted by Penna et al. (5), the sensitivity and specificity for PI-RADS scores of ≥3 were found to be 86.6% and 82.4%, respectively. For LIKERT scores of ≥3, the sensitivity and specificity were found to be 93.8% and 73.6%, respectively, with no significant difference observed. For scores of ≥3, the sensitivity and specificity values were calculated as follows: for PI-RADS, sensitivity ranged from 88% to 90.7% and

specificity from 75% to 86.2%; for LIKERT, sensitivity ranged from 86.1% to 90.7% and specificity from 72.3% to 88.3%. Findings are similar between the two systems.

In the 2019 study by Khoo et al.[17] images of 373 patients who underwent transperineal fusion biopsy after prostate mpMRI were evaluated using the PI-RADS v2.1 and LIKERT scoring systems by four experienced uro-radiologists. The LIKERT scoring system was found to be more successful in detecting clinically significant cancer. For the group with malignant pathological diagnoses, the concordance between less experienced radiologists and pathology was good with PI-RADS but moderate with LIKERT. For experienced radiologists, the concordance with pathology was good with both scoring systems. In the LIKERT system, the impact of the patient's history and laboratory data on the scoring allows for a more flexible assessment and provides a more accurate result among experienced radiologists[17-20].

The present study has certain limitations. In our study, imaging was performed with 3 T and 1.5 T MRI devices using phased-array coils instead of endorectal coils. Although not using an endorectal coil might be seen as a disadvantage, the results in the current study were similar to those in the literature among experienced radiologists, suggesting that the phased-array coils may also be sufficient for experienced observers. In less experienced radiologists, the differing results from the literature suggest that the lack of an endorectal coil may be a limitation, especially as radiologist experience decreases. We believe that in the future, more comprehensive studies will clarify the relationship between the diagnostic performance of endorectal coil use and radiologist experience. Another limitation is that the study included patients who underwent not only radical prostatectomy but also systematic needle biopsy. Apex and anteriorly located lesions are generally not detected with systematic needle biopsy. This situation leads to false negatives and reduces pathological concordance in the transitional zone, which may have resulted in the lower specificity and sensitivity values obtained in the study.

In conclusion, The PI-RADS v2.1 and LIKERT scoring systems provided similar agreement between reader in mpMRI evaluation. Among less experienced radiologists, PI-RADS v2.1 demonstrated higher concordance with pathology, whereas no difference was observed between the two scoring systems among more experienced radiologists.

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