Original Article

A correlation of PI-RADS score and pathological grading outcome post radical prostatectomy: A retrospective review

Wichaya Pripatnanont, Julin Opanuraks, Kriangsak Prasopsanti, Apirak Santi-ngamkun, Supoj Ratchanon, Kavirach Tantiwongse, Kamol Panumatrassamee, Dutsadee Sowanthip

Division of Urology, Department of Surgery, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand

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Abstract

Objective: To investigate the correlation between the PI-RADS score and the pathologic Gleason score in the final pathological grading and to detect risk factors associated with the outcomes.

Materials and Methods: Data from January 2017 to September 2019 were reviewed. Inclusion criteria included patients who had undergone standard protocol prostate magnetic resonance imaging (MRI) in King Chulalongkorn Memorial Hospital and underwent radical prostatectomy during the period. Data collected were age, PI-RADS score, Gleason score (GS), prostate-specific antigen (PSA), prostate size, PSA density, lesion size, and extraprostatic extension (EPE) evident in MRI.

Results: One hundred and eight patients were included. PI-RADS was significantly associated with GS (Chi-Square p = 0.039). The percentage of significant tumors found in PI-RADS 3, 4, 5 were 66%, 86% 90% respectively. Analysis of independent risk factors only found PI-RADS 5 to have a statistically significant association with GS ≥ 7 (OR6.67 (1.24-35.71) p = 0.03). The cut-off value of lesion size ≥ 15 vs < 15 and PI-RADS 4 had a higher odds ratio than other parameters (OR 3.89 (0.82-18.41) p = 0.09, OR 3.29 (0.79-13.86) p = 0.11 respectively).

Conclusion: The PI-RADS scoring system was found to be highly associated with Gleason's grading score. No association was found between any significant risk factor and significant prostate cancer. Lesion size could be used to combine with the PI-RADS scoring system in the detection of significant tumors. A high percentage of significant tumors were found with a PI-RADS 3 score and it may be worth taking a biopsy in the case of a PI-RADS 3 lesion.

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Corresponding author: Wichaya Pripatnanont

Address: Division of Urology, Department of Surgery, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand

E-mail: wichaya.pn@gmail.com

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Introduction

Prostate cancer is the 4th most common cancer in Thai males with a prevalence of 7.1:10000.[1] The presentation of the disease varies extensively, ranging from indolent cancer to aggressive metastatic-potential disease, the range being defined in categories from very low-risk to very high-risk disease.[2] Studies have shown that the majority of prostate cancer patients do not die from the cancer itself.[3,4] The modern practice is to not only diagnose the condition but to differentiate between a significant tumor from one that is non-significant to maximize the benefit of definitive treatment and minimize the complications of overtreatment.

The pathology is defined using the Gleason Score, non-significant prostate cancers being given a score of 6, while significant cancers have a Gleason score ≥ 7.[5] In 2014 the International Society for Urological Pathology (ISUP) proposed a grading system which stratified the Gleason Score into grades 1-5.[6]

Multiparametric Magnetic Resonance Imaging (mpMRI) consisting of T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCEI), have had an increasing role in prostate cancer diagnosis and staging.[7] Prostate Imaging Reporting and Data System (PI-RADS) version 2 was proposed in 2015 to improve the accuracy and consistency in the use of imaging for the diagnosis for prostate cancer.[8]

The use of MRI for diagnosis of prostate cancer is an accepted diagnostic method with increasing evidence of a correlation between PI-RADS and Gleason score (GS)[9-12] A recent meta-analysis showed a correlation between ISUP grade ≥ 2 (GS ≥ 7) lesion and PI-RADS 3, 4 and 5 in PPV of 12%, 48%, 72% respectively.[13] The correlation between MRI and final pathological diagnosis is gradually receiving more attention but most of the studies reviewed the relationship between MRI and pathological specimen from the MRI fusion biopsy. A study by Radtke et al.[14] into mpMRI showed a promising result of 92% successful detection of a lesion when correlated to radical prostatectomy (RP) specimens while a study by Lashay et al. which also studied correlation between mpMRI and final pathology, showed an accuracy in detection of significant prostate cancer of 76.3%.[15] A greater understanding of the correlation between these 2 methods is important and would be beneficial for improving the diagnostic accuracy of screening and treatment regimes for of prostate cancer. The primary objective of the study was to examine the correlation of the PI-RADS score to the pathologic Gleason score in the final pathological grading and the secondary objective was to detect risk factors affecting the outcomes.

Materials and Methods

Study design and population

Data from patients who underwent radical prostatectomy regardless of operation method from January 2017 to September 2019 were enrolled onto the study. Inclusion criteria included patients with standard protocol prostate MRI, officially reported in PI-RADS version 2 system by radiologists at King Chulalongkorn Memorial Hospital (KCMH) and who later underwent radical prostatectomy during the period. One hundred and sixty nine patients were included initially. The patients who had multiple lesions with multiple PI-RADS scores on the MRI were excluded from the study due to the lack of whole-mount pathologic sections, which precluded the ability to relate multiple different lesions from MRI to the pathological specimen. After exclusion, there were 108 patients eligible for the study. Data on age, PI-RADS score, Gleason score (GS), prostate-specific antigen (PSA), prostate size, PSA density, lesion size, and extraprostatic extension (EPE) on MRI were collected

Study endpoint

The primary outcome was to investigate the correlation between the PI-RADS score and the pathologic Gleason score in the final pathological specimen. The secondary outcome was to determine the risk factors associated with significant cancer. Significant cancer was defined as Gleason score ≥ 7. PSA level, prostate size, PSA density, lesion size, and EPE on MRI were investigated as potential risk factors.

Imaging

Multiparametric MRI (mpMRI) was performed in all patients using a 3 Tesla machine without an endorectal coil. The imaging protocol consisted of T1 and T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic

contrast-enhanced imaging (DCEI). The lesions on the MRI were reported using the PI-RADS scoring system version 2 and 2.1 by radiologists at KCMH. Two radiologists reported the findings from the initial imaging results in this study.

Surgery

Radical prostatectomy was performed by experienced urologists at KCMH. The recruited data regardless of the type of procedure, including open radical prostatectomy, laparoscopic radical prostatectomy, and Robotic-assisted laparoscopic radical prostatectomy. Six urologists performed the surgery.

Histology

The final pathological specimens from the radical prostatectomy were analyzed by 3 pathologists at KCMH. Gleason scores were evaluated using ISUP 2014 (modified) definitions.

Statistical analysis

Descriptive data are presented as percentage, and mean values with standard deviation. Median and inter-quartile range were used if the data were not normally distributed. A Chi-square test was used to evaluate the association between PI-RADS and Gleason score. Independent factors affecting Gleason score ≥ 7 were calculated using binary logistic regression. Statistical analysis was performed using STATA version 15.1.

Results

Demographic data

Data from 108 patients with a mean age of 66 ± 5.2 years was included in the study. The characteristics of patients and general demographic data are shown in Table 1. The mean PSA was 12.9 ± 16.8 ng/ml and lesion size was 1.4 ± 0.6 cm. Nearly all patients were treated with laparoscopic surgery, only 2 patients were treated with open surgery. Mean time of patients who underwent MRI before biopsy was 86 ± 52.8 days and the MRI after biopsy was 100.9 ± 67.4 days. No patients underwent MRI within 3 weeks of the biopsy but 8 patients had an MRI in the fourth week after the biopsy.

Table 1. Demographic data

Data	Median (IQR)	Mean (SD)
Age (years)	66 (62-70)	66 (5.2)
Prostate size (ml)	36.2 (27-48)	41.7 (22.4)
PSA (ng/ml)	9.3 (7.3-13.5)	12.9 (16.8)
PSA density (ng/ml^2)	0.27 (0.19- 0.42)	0.36 (0.41)
Days of MRI before Bx	72 (48-117)	86 (52.8)
Days of MRI after Bx	90 (48-159)	100.9 (67.4)
Lesion size (cm)	1.4 (1-1.7)	1.4 (0.6)
Method of surgery	n (%)	
LRP	22 (20.2)	
RALRP	84 (78)	
Open radical prostatectomy	2 (1.8)	

PSA = prostate-specific antigen, MRI = magnetic resonace imaging, Bx = biopsy, LRP = laparoscopic radical prostatectomy, RALRP = robot-assisted laparoscopic radical prostatectomy.

The pathological outcomes defined by the ISUP grade group were categorized in accordance with PI-RADS and are shown in Table 2. The grade was statistically significantly correlated with the PI-RADS score (p = 0.039). Significant

Table 2. Pathological outcomes categorized by PI-RADS

Characteristics	PI-RADS 3	PI-RADS 4	PI-RADS 5	Total (%)
Number, n (%)	12 (11.1)	53 (49.1)	43 (39.8)	108 (100)
Grade group*				
Grade 1	4	7	4	15 (13.8)
Grade 2	7	37	22	66 (61.5)
Grade 3	1	6	6	13 (11.9)
Grade 4	0	3	6	9 (8.4)
Grade 5	0	0	5	5 (4.6)
% of significant tumors	66.6	86.7	90.6	86.1

*Grade group had statistical significant correlation with PI-RADS group at p = 0.039 by Chi-square test.

tumors were found in 66.6% with PI-RADS 3, 86.7% with PI-RADS 4, 90.6% with PI-RADS 5, giving an overall total of 86.1%. Most patients were in PI-RADS 4 (49.1%), reducing to PI-RADS 5 (39.8%), and PI-RADS 3 (11.1%).

Independent risk factor analysis

Analysis of independent risk factors found no statistically significant results as regards age, prostate size, EPE on MRI, range of PSA, PSA density, and lesion size, as shown in Table 3. PI-RADS 5 showed a significant association with GS ≥ 7 with the highest odds ratio (6.67, 1.24-35.71, p = 0.03). The lesion size ≥ 15 vs < 15 mm (OR 3.89 (0.82-18.41) p = 0.09) and PI-RADS 4 (OR 3.29 (0.79-13.86) p = 0.11) showed high OR but no statistical significance.

A subgroup analysis was carried out in relation to PI-RADS lesions as shown in Table 4. It was found that PI-RADS 5 had the highest density of PSA (0.52 ± 0.57 ng/ml^2) and the largest size of the lesion (18.88 ± 5.97 mm), significantly more than any other PI-RADS score (p < 0.05).

Data relationship

From the previous analysis, the most significant-tumor-related data were further analyzed by each grade group, specifically lesion size and PI-RADS score. From the PI-RADS to grade group aspect, high PI-RADS score was reported in all grade groups. PI-RADS 3 was reported only in grade group 1-3 with only 1 case of PI-RADS 3 in grade group 3, PI-RADS 3 was not reported at all in grade group 4 and 5. In grade groups 4 and 5 only PI-RADS 4 and PI-RADS 5 were reported from the MRI. The data are shown in Figure 1.

From lesion size to grade group aspect, relationships of lesion size of 15 cm and 20 cm cut

Table 3. Risk factors associated with Gleason score ≥ 7

	OR (95%CI)	P-value
Age	1.04 (0.92-1.16)	0.51
Prostate size	0.98 (0.96-1.01)	0.14
PSA ≥ 10 vs < 10 ng/ml	0.63 (0.20-1.796)	0.43
PSA ≥ 20 vs < 20 ng/ml	0.89 (0.10-7.96)	0.91
PSA density ≥ 0.15 vs < 0.15 ng/ml^2	1.56 (0.39-6.30)	0.53
Lesion size ≥ 15 vs < 15 mm	3.89 (0.82-18.41)	0.09
Lesion size ≥ 20 vs < 20 mm	2.28 (0.28-18.80)	0.45
PI-RADS score		
3	Ref	
4	3.29 (0.79-13.86)	
5	6.67 (1.24-35.71)	
EPE on MRI	1.72 (0.36-8.32)	

PSA = prostate-specific antigen, EPE = extraprostatic extension, MRI = magnetic resonace imaging.

Table 4. Distribution of baseline data in subgroup analysis of PI-RADS lesion, showing data as mean and SD.

PI-RADS lesion	PI-RADS 3	PI-RADS 4	PI-RADS 5
Age (years)	65±4.1	66±5.2	66±5.6
Prostate size (ml)	56.9±29.65	42.73±20.93	34.34±16.10
PSA (ng/ml)	10.50±5.25	10.22±5.9	16.93±25.54
PSA density (ng/ml^2)	0.22±0.16	0.28±0.17	0.52±0.57*
Lesion size (mm)	10.50±3.28	11.42±3.55	18.88±5.97*

*Statistically significant from other groups at p-value < 0.05 by oneway analysis of variance and Dunnett T3 post hoc test.

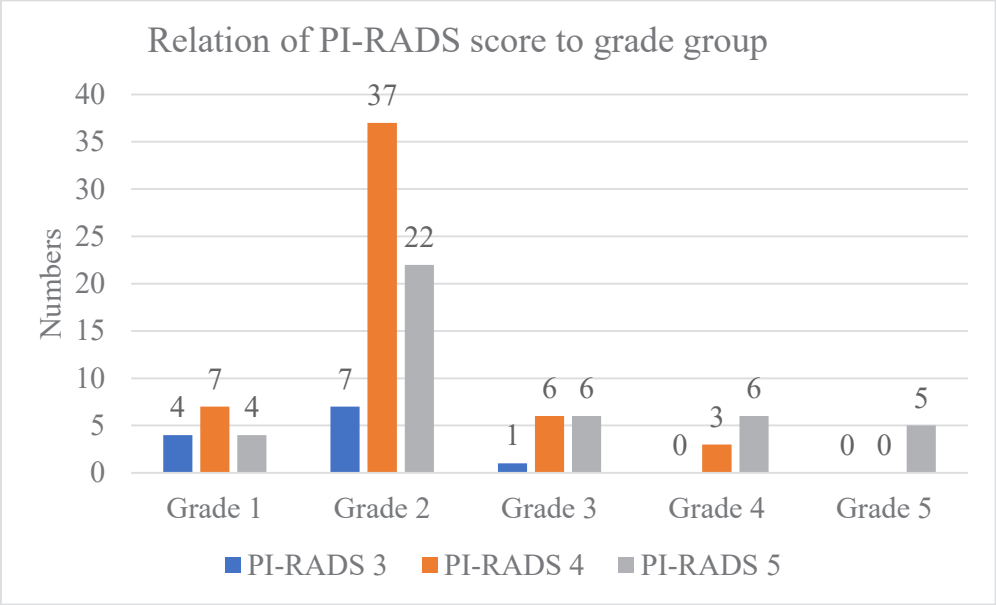

Figure 1. The relationship of PI-RADS score to Gleason grade group (ISUP)

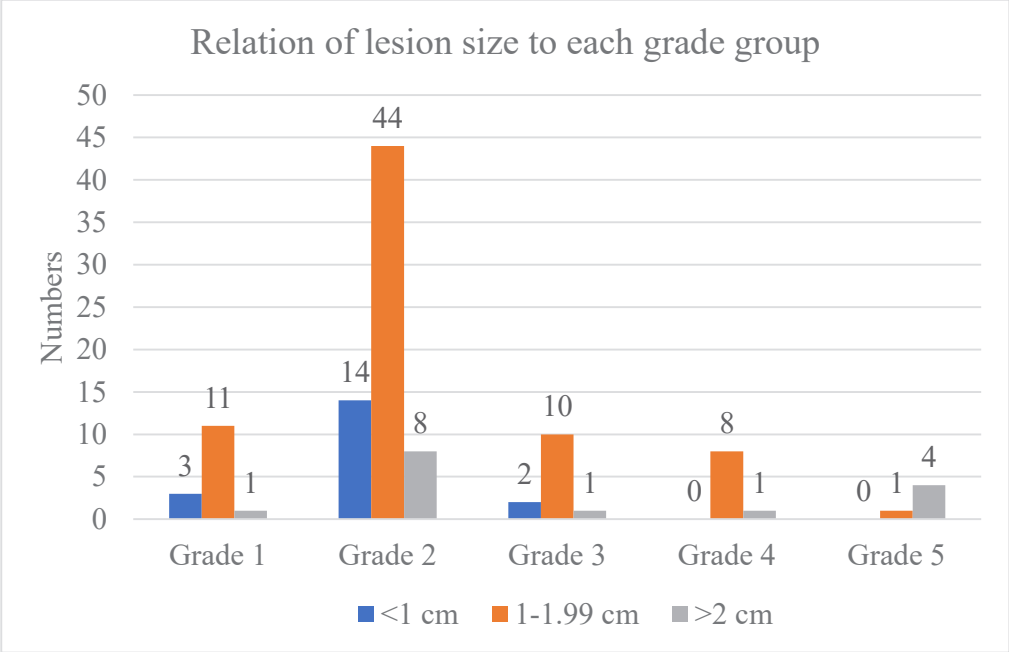

Figure 2. The relationship of lesion size in a range of <1, 1-1.99, ≥ 2 cm to each Gleason grade group (ISUP)

off points to grade group were analyzed but did not produce any significant or notable results so a further segmentation was performed using a range of < 1, 1-1.99 and ≥ 2 cm comparing them to each grade group. It was shown that small lesion size was correlated with lower grade groups. Lesions smaller than 1 cm were not found in grade group 4 and 5. These data are shown in Figure 2.

Discussion

This study primarily aimed to investigate the presence of a correlation between the PI-RADS score and the pathologic Gleason score in the final pathological specimens. A significant correlation between PI-RADS 5 and Gleason score ≥ 7 was found. Regarding the independent risk factor analysis, PI-RADS 5 was significantly associated with GS ≥ 7 with the highest odds ratio (6.67, CI1.24-35.71), PI-RADS 4 also showed a high

OR (3.29, CI 0.79-13.86) but without statistical significance. It was found that tumor grade groups 4 and 5 were observable by MRI only as PI-RADS 4 and 5.

For the secondary objective in the independent factor analysis, lesion size at cut-off point ≥ 15 mm versus < 15 mm showed a high odds ratio (3.89, CI 0.82-18.41) but statistical significance could not be demonstrated. The cut-off was elevated to ≥ 20 mm versus < 20 mm as an endeavor to evaluate significance but this also had a negative result. The relation between lesion size and each grade group showed that there was only lesion larger than 1 cm in Grade groups 4 and 5.

A high percentage of significant tumors were found in PI-RADS 3 (66.6%) reaching 90.6% in PI-RADS 5. These data suggested that it may well be worth carrying out a biopsy on PI-RADS 3 lesion.

The PRECISION study16 reported the detection rate of significant tumors in PI-RADS 3 was 12%, PI-RADS 4 60%, and PI-RADS 5 83%. These findings suggested the correlation between PI-RADS and Gleason score was especially strong with PI-RADS 4 and 5. However, the findings from our study can not be transferred to the detection rate of significant cancer in the general population due to the study design only including prostate cancer cases.

Many studies stated that the size of the lesion and PSA density were the risk factors for significant cancer.[17-19] Bratan et al.[17] studied the influence of lesion size from MRI images on histological RP specimens in 2013 and reported that the detection rates for Gleason 6 tumor size < 0.5 cc, 0.5-2 cc, and > 2 cc were 29%, 54%, 75%, for Gleason 7 were 63 %, 88%, and 97% and for Gleason ≥ 8 were 80%, 93%, and 100% respectively. In their study, the whole mount sections were used for the reading of the pathology so it could provide a false positive result. They also used a detection rate from the MRI which our retrospective study did not include. Nevertheless, the potential weakness of their study was that the MRI results were reported in a 5-point subjective suspicion score, the measurement scale used before the PI-RADS era.

Washino et al.[18] reported that patients with PI-RADS ≥ 4 with a PSA density ≥ 0.15 and PI-RADS 3 with PSA density ≥ 0.3 were highly associated with clinically significant prostate cancer. Distler et al.[19] showed a 79-89% negative predictive value (NPV) of significant prostate cancer when the PSA density ≤ 0.15. Despite trying many different cut-off points to find significant independent risk factors in our study (showed in table only for PSA density ≥ 0.15 vs < 0.15 ng/ml^2), there was only lesion size ≥ 15 vs < 15 mm that showed a high odds ratio and a trend of association with significant cancer.

The limitation of this study was mainly the selection bias due to the retrospective nature hence there may have been data errors. Also the lack of a whole mount section which may have shown other lesions. The patient with multiple lesions and different PI-RADS were excluded from the study to reduce complexity in the analysis, therefore the study consisted of only single lesion or multiple but homogeneous lesion prostate cancer patients. The sensitivity, specificity and detection rate could not be demonstrated due to this reason. Secondly, a small sample size makes a large difference in the number between a patient in the non-significant and significant cancer groups making the statistical analysis less robust. A larger sample size could improve the statistical value of both parameters and the outcomes.

Conclusion

The PI-RADS scoring system was found to be closely associated with Gleason's grading score. In this study no significant risk factor showed a correlation with significant prostate cancer. Lesion size showed the highest odds ratio with significant cancer therefore could be combined with the PI-RADS scoring system in the detection of significant tumors and a high percentage of significant tumors were still found in PI-RADS 3 therefore it may be worth carrying out a biopsy on the PI-RADS 3 lesion. A larger prospective study is encouraged to identify potential risk factors for significant tumors and improve the diagnosis of prostate cancer enabling more effective outcomes for the patient.

Conflicts of Interest

The authors declare no conflict of interest.

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