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A comparative study of ^{18}F-PSMA-1007 PET/CT and pelvic MRI in newly diagnosed prostate cancer

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Abstract

Purpose To evaluate the difference in the diagnostic efficacy of ^{18}F-PSMA-1007 PET/CT and pelvic MRI in primary prostate cancer, as well as the correlation between the two methods and histopathological parameters and serum PSA levels.

Methods A total of 41 patients with suspected prostate cancer who underwent ^{18}F-PSMA-1007 PET/CT imaging in our department from 2018 to 2023 were retrospectively collected. All patients underwent ^{18}F-PSMA-1007 PET/CT and MRI scans. The sensitivity, PPV and diagnostic accuracy of MRI and ^{18}F-PSMA-1007 PET/CT in the diagnosis of prostate cancer were calculated after comparing the results of MRI and ^{18}F-PSMA-1007 PET/CT with biopsy. The Spearman test was used to calculate the correlation between ^{18}F-PSMA-1007 PET/CT, MRI parameters, histopathological indicators, and serum PSA levels.

Results Compared with histopathological results, the sensitivity, PPV and diagnostic accuracy of ^{18}F-PSMA-1007 PET/CT in the diagnosis of prostate cancer were 95.1%, 100.0% and 95.1%, respectively. The sensitivity, PPV and diagnostic accuracy of MRI in the diagnosis of prostate cancer were 82.9%, 100.0% and 82.9%, respectively. There was a mild to moderately positive correlation between Gleason (Gs) score, Ki-67 index, serum PSA level and ^{18}F-PSMA-1007 PET/CT parameters ($p < 0.05$). There was a moderately negative correlation between the expression of AMACR (P504S) and ^{18}F-PSMA-1007 PET/CT parameters ($p < 0.05$). The serum PSA level and the Gs score were moderately positively correlated with the MRI parameters ($p < 0.05$). There was no correlation between histopathological parameters and MRI parameters ($p > 0.05$).

Conclusion Compared with MRI, ^{18}F-PSMA-1007 PET/CT has higher sensitivity and diagnostic accuracy in the detection of malignant prostate tumors. In addition, the Ki-67 index and AMACR (P504S) expression were only correlated with ^{18}F-PSMA-1007 PET/CT parameters. Gs score and serum PSA level were correlated with ^{18}F-PSMA-1007 PET/CT and MRI parameters. ^{18}F-PSMA-1007 PET/CT examination can provide certain reference values for the clinical diagnosis, evaluation, and treatment of malignant prostate tumors.

Keywords Prostate cancer, ^{18}F-PSMA-1007, PET/CT, MRI, Metabolic parameters, Molecular expression, Gleason score

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Background

In the United States, prostate cancer (PCa) is the most common male malignant tumor. According to statistics, the incidence of PCa is 29%. Although the incidence is high, the prognosis of most PCa patients is good, and the overall 5-year survival rate is more than 98% [1]. Serum prostate-specific antigen (PSA) is a specific tumor marker for PCa. Clinically, PCa is often suspected due to an elevated PSA. Subsequently, a pelvic multi-parameter MRI examination is performed to identify whether there were morphological abnormalities. A transrectal ultrasound-guided biopsy (TRUS) [2] is required to confirm the diagnosis. Advances in multi-parameter magnetic resonance imaging (mp-MRI) techniques, including the use of dynamic contrast-enhanced and diffusion-weighted imaging sequences, have improved the accuracy of MRI in the diagnosis of PCa. However, MRI has a 39.0% probability of diagnostic uncertainty (i.e., PI-RADS 3), with 59.2% false positives and 7.4% false negatives [3]. A meta-analysis showed that there was a significant difference in the diagnostic accuracy of MRI in detecting csPCa (44–87%) [4]. Moreover, parallel to these developments, micro-ultrasound has emerged as a novel imaging modality characterized by its high real-time spatial resolution, showing high sensitivity in the diagnosis of clinically significant prostate cancer and comparable effectiveness to mp-MRI-guided biopsy in total prostate cancer detection. However, the available evidence is limited and should be considered preliminary [5].

Prostate-specific membrane antigen positron emission tomography (PSMA PET) imaging is receptor imaging of prostate cancer membrane antigen [6–11]. Positron-labeled PSMA can specifically bind to PCa antigen and has high specificity. However, it is not clear whether PSMA PET/CT is superior to MRI in detecting prostate cancer. Rhee et al. found that the sensitivity and specificity of PSMA PET/CT and MRI in detecting prostate cancer lesions were roughly the same (44% vs. 49%, 94% vs. 95%) [12]. However, Baris et al. found that PSMA PET/CT showed a higher positive predictive value (100%) than MRI [13]. At present, the application of PSMA PET/CT in prostate cancer is mostly reported with ^{68}Ga-labeled PET/CT [14–18]. This study aimed to evaluate the diagnostic efficacy of ^{18}F-PSMA-1007 PET/CT and MRI in primary PCa and the correlation between the two methods, histopathological parameters, and serum PSA levels.

Materials and methods

Patients

A total of 41 patients with suspected PCa who underwent ^{18}F-PSMA-1007 PET/CT imaging in our department from 2018 to 2023 were retrospectively collected. All patients underwent ^{18}F-PSMA-1007 PET/CT and MRI scans. The median time between the two examinations was 3.5 days (range: 1 to 7 days). After the completion of the two examinations, patients underwent biopsy based on the comprehensive evaluation of the two examination results, and a biopsy was performed guided by the mp-MRI imaging results to confirm prostate cancer. Clinical information, laboratory examination results, imaging information from MRI and ^{18}F-PSMA-1007 PET/CT, and pathological indicators were collected. Such as: age, serum PSA level, maximum diameter of ^{18}F-PSMA PET/CT lesions, standardized uptake value maximum (SUVmax), standardized uptake value mean(SUVmean), standardized uptake value peak(SUVpeak), metabolic tumor volume (MTV), tumor-to-background ratio (TBR), tumor-to-liver ratio (TLR), maximum diameter of MRI lesions, PI-RADS score, Gleason (Gs) score, alpha-formyl coenzyme A racemase (AMACR (P504S)) status, prostate-specific antigen (PSA) status, Ki-67 proliferation index (Ki-67 index).

Radiopharmaceutical preparation

^{18}F-PSMA-1007 was synthesized by a one-step method using an automated radiosynthesizer (Sumitomo, Japan). ^{18}F was acquired by the (^{18}F)/$H_2{}^{18}O$ nuclear reaction and then loaded onto a quaternary methylamine column (Waters, U.S.A.). After being eluted by 0.75 ml of tetrabutylammonium hydrogen carbonate (TBAHCO3) solution (ABX, Radeberg, Germany), it was transferred into a reactor, followed by the addition of 0.4 ml of anhydrous acetonitrile (Sigma, U.S.A.), and then the removal of water at a temperature of 95 °C. 1.2 ml of dimethyl sulfoxide (ABX, Radeberg, Germany), which was dissolved with PSMA-1007 precursor (ABX, Radeberg, Germany), was added to the reactor and performed a fluorination reaction at 85 °C for 10 min. Then diluted with 6 ml of 5% ethanol and loaded onto PS-H+and C18ec (ABX, Radeberg, Germany), followed by 4 ml of 30% ethanol. The final product was eluted with 4 ml of 30% ethanol and added to 0.1 ml of 100 mg/L Vitamin C solution and 36 mL of 0.9% NaCl, then sterilized by a 0.22 μm filter (Millipore, U.S.A.). High-performance liquid chromatography (HPLC, Shimadzu, Japan) was performed to test chemical purity. Further quality control (appearance, color, clarity, PH, and radionuclidic purity) was done in compliance with current pharmacopoeias.

^{18}F-PSMA-1007 PET/CT image acquisition

Patients did not need special preparation on the day of the ^{18}F-PSMA-1007 PET/CT scan. The injection activity of ^{18}F-PSMA-1007 was 330±46 MBq (range 248–429 MBq). Imaging began 180 min after the injection [19]. Siemens Biograph mCT-64 PET/CT (Siemens, Erlangen, Germany) scanning equipment was used for the examination. First CT scan: tube voltage 140 kV, effective current 42 mAs, pitch 0.8, ball tube single-ring rotation time

0.5 s, layer thickness 8 mm. The PET acquisition range was from the top of the skull to the middle of the femur, and 6–7 bed positions were collected using 3D acquisition, 1.5 min/ bed position. The ordered subset expectation maximization OSEM iterative algorithm was used to reconstruct the image, and the image fusion and post-processing were performed on the Siemens MMWP workstation.

MRI image acquisition

MRI scans(Philips Achieva) were collected at 3T. The sequences were: T1-weighted, T2-weighted, ADC, DWI, and DCE. Dobutamine (Gd-DOTA, DOTAREM, Guerbet, France) was administered intravenously with CE-T1 (pre-injection dose, 0.1 mmol/kg) [20].

Image analysis

^{18}F-PSMA PET/CT image evaluation was performed by two experienced nuclear medicine physicians with ten years of experience in prostate tumor imaging. MRI images were evaluated by two physicians with ten years of experience in prostate tumor imaging. Differences were resolved by consultation or a third physician's assessment with ten years of experience in prostate tumor imaging. Tumor size was defined as the longest diameter of a malignant prostate mass. Intra-prostatic lesions were defined as positive if the tracer uptake was focal and higher than surrounding prostate tissue [21]. SUVmax、SUVmean was quantified using the region of interest (ROI). The MTV was measured by an automatic contouring program based on SUVmax, and the tumor border was outlined on the software at 42% of SUVmax to obtain the MTV value. The maximum ratio of SUVmax of all prostate lesions to the mediastinal blood pool (TBR) and the maximum ratio of SUVmax to the liver (TLR) were calculated.

Multi-parameter MRI image interpretation was based on PI-RADS V2.1 as the scoring standard. The scoring scheme was as follows: DWI was the scoring sequence for the peripheral zone of the prostate, and the 3-point lesion was determined by T2WI instead of dynamic enhanced MRI to determine the final score. The transition zone was scored according to the PI-RADS V2.1 standard, as shown in Table 1 [20]. PI-RADS score≥4 was considered positive [22–26].

Table 1 Improved two-parameter MRI scoring scheme

Peripheral zone			Transition zone		
DWI	T_2WI	Score	T_2WI	DWI	Score
1	Any	1	1	Any	1
2	Any	2	2	≤3	2
3	≤3	3		≥4	3
	≥4	4	3	≤4	3
4	Any	4		5	4
5	Any	5	4	Any	4
			5	Any	5

Note: Any indicates that the corresponding sequence score can be any score between 1–5 points

Statistical analysis

We use SPSS (version 22.0; IBM, U.S.A.) for statistical analysis. The measurement data are expressed as mean±SD, and the categorical variables are expressed as numbers and percentages. The sensitivity, positive predictive value (PPV) and diagnostic accuracy of MRI and ^{18}F-PSMA-1007 PET/CT in the diagnosis of PCa were calculated after comparing the results of MRI and ^{18}F-PSMA-1007 PET/CT with biopsy. The Spearman test was used to calculate the correlation between ^{18}F-PSMA-1007 PET/CT, MRI parameters, histopathological indicators, and serum PSA levels. $P<0.05$ was considered statistically significant.

Results

Patient characteristics

A total of 41 patients with PCa were included, with an average age of 70 years and an average PSA level of 136.1 ng/ml. AMACR (P504S) overexpression was found in 16 patients (39.0%), PSA overexpression was found in 15 patients (36.6%), and the Ki-67 index was 11.9±8.7%. The specific characteristics are shown in Table 2.

MRI images and ^{18}F-PSMA-1007 PET/CT features

The maximum diameter of the PCa detected by MRI was 31.1±17.5 mm. The maximum diameter of PCa detected by ^{18}F-PSMA-1007 PET/CT was 36.0±13.9 mm, SUVmax was 33.2±24.2, SUVmean was 18.7±12.6, SUVpeak was 22.2±16.1, MTV was 10.5±10.3, TBR was 31.8±24.3, and TLR was 20.4±24.4 (Table 2).

Of the 41 patients, 34 (82.9%) had positive results on MRI, and 7 (17.1%) had negative results on MRI, compared with histopathological results. Thirty-nine (95.1%) patients had positive ^{18}F-PSMA-1007 PET/CT results, and two (4.9%) patients had negative ^{18}F-PSMA-1007 PET/CT results. The results of ^{18}F-PSMA-1007 PET/CT and MRI were consistent in 32 cases and inconsistent in 9 cases (Fig. 1). Among them, 7 cases (17.1%) were negative for MRI and positive for ^{18}F-PSMA-1007 PET/CT, and 2 cases (4.9%) were positive for MRI and negative for ^{18}F-PSMA-1007 PET/CT. Table 3 summarizes the detailed information about these inconsistent cases of PSMA and MRI. The sensitivity, PPV and diagnostic accuracy of MRI were 82.9%, 100.0% and 82.9%, respectively. The sensitivity, PPV and diagnostic accuracy of ^{18}F-PSMA-1007 PET/CT were 95.1%, 100.0% and 95.1%, respectively (Table 4). The GS score and Ki-67 index were positively correlated with the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUVmax, SUVmean,

Table 2 Clinical, radiological and molecular patient characteristics

n = 41	Value
Median age (range)	70 (52–85)
Median PSA (range)	136.1 (2.5–2330)
PSA ≤ 10 ng/ml	6
PSA > 10 ng/ml	32
N/A	3
PSMA PET/CT	
Positive (%)	39 (95.1)
Negative (%)	2 (4.9)
Maximum diameter of lesion (mm)	36.0 ± 13.9
Lesion SUVmax	33.2 ± 24.2
Lesion SUVmean	18.7 ± 12.6
Lesion SUVpeak	22.2 ± 16.1
MTV	10.5 ± 10.4
TLG	184.4 ± 247.1
TBR_SUVmax	31.8 ± 24.3
TLR_SUVmax	20.4 ± 24.4
MRI	
Positive (%)	34 (82.9)
Negative (%)	7 (17.1)
Maximum diameter of lesion (mm)	31.1 ± 17.5
Biopsy	
Positive (%)	41 (100.0)
Negative (%)	0 (0.0)
PIRADS MRI	
PIRADS 2 (%)	6 (14.6)
PIRADS 3 (%)	1 (2.5)
PIRADS 4 (%)	5 (12.2)
PIRADS 5 (%)	29 (70.7)
Gleason score	
6 (%)	2 (4.9)
7 (%)	13 (31.7)
8 (%)	10 (24.4)
9 (%)	14 (34.1)
10 (%)	2 (4.9)
AMACR (P504S)	
Positive (%)	16 (39.0)
Negative (%)	2 (4.9)
N/A (%)	23 (56.1)
P63	
Positive (%)	6 (14.6)
Negative (%)	20 (48.8)
N/A (%)	15 (36.6)
PSA	
Positive (%)	15 (36.6)
Negative (%)	2 (4.9)
N/A (%)	24 (58.5)
Ki-67 index (%)	
1 (%)	1 (2.4)
5 (%)	5 (12.3)
8 (%)	1 (2.4)
10 (%)	9 (22.1)
15 (%)	1 (2.4)
20 (%)	1 (2.4)

Table 2 (continued)

n = 41	Value
25 (%)	1 (2.4)
30 (%)	1 (2.4)
35 (%)	1 (2.4)
N/A (%)	20 (48.8)

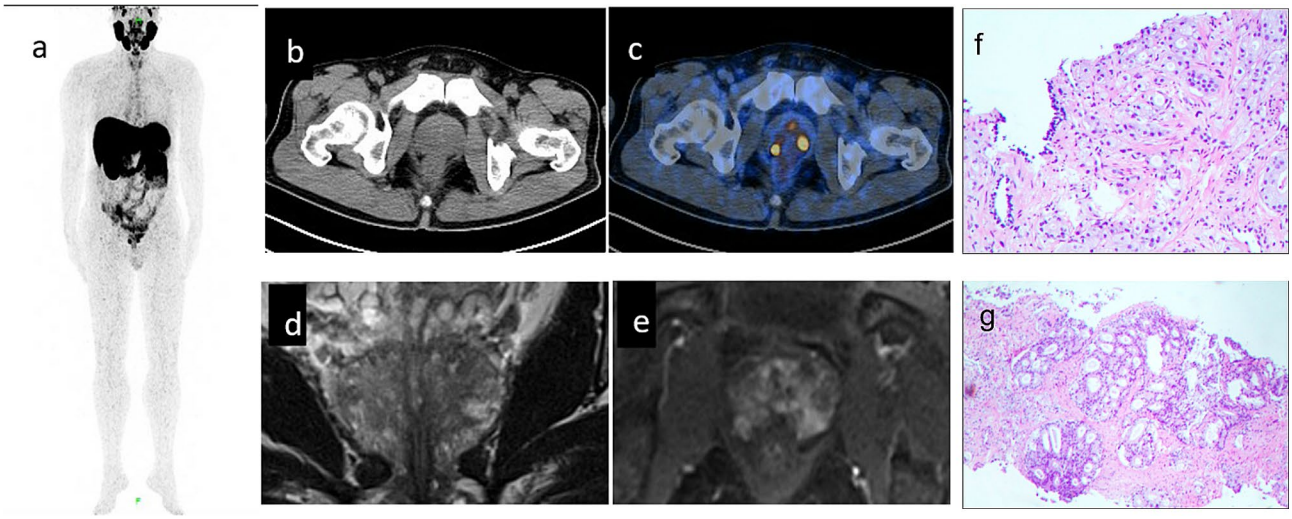

Fig. 1 Patient, with elevated PSA (9.72ng/ml), 18 F-PSMA PET/CT (**a**, MIP; **b**, local CT; **c**, local PET/CT) showed enlargement of the prostate, with several nodules of increased uptake, and the SUVmax was 23.6. T2WI (**d**) showed that the prostate signal was not uniform, and scattered T2WI high signal nodules were seen. TI enhanced image showed (**e**) uneven enhancement. The histopathological examination (**f**, **g**) showed that the Gleason score of prostate acinar adenocarcinoma was 3 + 4 = 7

Table 3 Patients with discordant magnetic resonance imaging and prostatespecific membrane antigen positron emission tomography/computed tomography findings

Age(yrs)	PSA(ng/ml)	PI-RADS	SUVmax	SUVmean	SUVpeak	MTV	TLG	Gleason's score
69	9.72	2	23.6	16.8	10.3	1.5	9.4	7
81	31.3	2	15.7	9	8.3	1.2	10.5	8
79	41.1	2	24.1	13.7	16.9	4.3	58.2	7
73	20.1	2	41.4	26.8	31.1	7.2	193.2	8
68	5.12	2	13.2	7.5	10.1	4.3	32.3	6
57	5.76	2	11.4	6.7	7.4	2.1	13.8	7
78	22.2	3	33.7	19.3	20.7	1.6	30.5	8
77	5.21	4	6.5	3.7	4.5	20.6	75.5	6
79	12.2	4	13.3	8.5	8.1	1.4	12	7

Table 4 Comparison of PSMA PET/CT and mpMRI in diagnosis of primary prostate cancer

	Sensitivity (%)	PPV (%)	Diagnostic accuracy (%)
PSMA PET/CT	95.1	100	95.1
MRI	82.9	100	82.9

SUVpeak, TBR, and TLR ($p<0.05$). There was a moderately negative correlation between the expression of AMACR (P504S) and the maximum diameter, SUV, TBR, and TLR of ^{18}F-PSMA-1007 PET/CT ($p<0.05$). Serum PSA level was positively correlated with the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUVpeak, MTV, and TLR ($p<0.05$). PSA expression was not associated with ^{18}F-PSMA-1007 PET/CT parameters ($P>0.05$) (Table 5). Serum PSA level was moderately positively correlated with the maximum diameter of PCa detected by MRI and PI-RADS score ($p<0.05$), and PI-RADS score was moderately positively correlated with GS score ($p<0.05$) (Table 6).

Discussion

In this study, we evaluated the performance of ^{18}F-PSMA-1007 PET/CT and MRI in the diagnosis of newly diagnosed PCa. Our study found that ^{18}F-PSMA-1007 PET/CT provides better detection of prostate lesions, and its sensitivity and diagnostic

Table 5 Factors affecting the diagnostic efficacy of PSMA PET/CT

	Maximum diameter of lesion (mm)	SUVmax	SUVmean	SUVpeak	MTV	TLG	TBR_SUVmax	TLR_SUVmax
Gleason score	$r=0.413$	$r=0.428$	$r=0.419$	$r=0.476$	$r=0.134$	$r=0.366$	$r=0.438$	$r=0.502$
	$p=0.007$	$p=0.005$	$p=0.006$	$p=0.002$	$p=0.404$	$p=0.019$	$p=0.004$	$p=0.001$
AMACR(P504S) status	r=-0.513	r=-0.477	r=-0.477	r=-0.477	$r=0.170$	r=-0.136	r=-0.477	r=-0.545
	$p=0.03$	$p=0.045$	$p=0.045$	$p=0.045$	$p=0.499$	$p=0.59$	$p=0.045$	$p=0.019$
P63 status	r=-0.085	$r=0.061$	$r=0.085$	$r=0.03$	r=-0.225	r=-0.158	$r=0.061$	$r=0.085$
	$p=0.679$	$p=0.768$	$p=0.679$	$p=0.883$	$p=0.268$	$p=0.44$	$p=0.768$	$p=0.679$
PSA status	$r=0.224$	$r=0.41$	$r=0.41$	$r=0.41$	$r=0.093$	$r=0.335$	$r=0.41$	$r=0.41$
	$p=0.388$	$p=0.102$	$p=0.102$	$p=0.102$	$p=0.722$	$p=0.188$	$p=0.102$	$p=0.102$
Ki-67	$r=0.469$	$r=0.526$	$r=0.564$	$r=0.623$	$r=0.170$	$r=0.518$	$r=0.526$	$r=0.561$
	$p=0.032$	$p=0.014$	$p=0.008$	$p=0.003$	$p=0.462$	$p=0.016$	$p=0.014$	$p=0.008$
PSA(ng/ml)	$r=0.605$	$r=0.253$	$r=0.224$	$r=0.342$	$r=0.413$	$r=0.526$	$r=0.265$	$r=0.279$
	$p=0.000$	$p=0.126$	$p=0.177$	$p=0.035$	$p=0.01$	$p=0.001$	$p=0.107$	$p=0.09$

Table 6 Factors influencing the diagnostic efficiency of MRI

	Gleason score	AMACR(P504S) status	P63 status	PSA status	Ki-67	PSA(ng/ml)
Maximum diameter of lesion (mm)	$r=0.284$	r=-0.478	r=-0.019	$r=0.045$	$r=0.43$	$r=0.579$
	$p=0.115$	$p=0.072$	$p=0.937$	$p=0.872$	$p=0.075$	$p=0.001$
PI-RADS	$r=0.565$	r=-0.061	r=-0.101	$r=0.133$	$r=0.364$	$r=0.456$
	$p=0.000$	$p=0.809$	$p=0.624$	$p=0.61$	$p=0.105$	$p=0.004$

accuracy are higher than mp-MRI. The sensitivity, PPV and diagnostic accuracy of ^{18}F-PSMA-1007 PET/CT were 95.1%, 100.0% and 95.1%, respectively. The sensitivity, PPV and diagnostic accuracy of MRI were 82.9%, 100.0% and 82.9%, respectively. Berger et al. showed that the PSMA PET scan has a higher NPV and accuracy than mp-MRI in detecting tumor lesions in the prostate [27]. Soni et al. found that the sensitivity and specificity of PSMA PET/CT in the detection of prostate cancer were 94.44% and 100.0%, respectively. The sensitivity and specificity of MRI in the detection of prostate cancer were 100.0% and 92.3%, respectively. PSMA PET/CT showed good sensitivity and specificity detecting PCa, and it was superior to MRI in predicting the presence of PCa [28]. Since the included patients were all diagnosed with prostate cancer and there were no patients with benign prostate diseases, this study lacked specificity and negative predictive value.

In our study, 9 patients had inconsistent results in ^{18}F-PSMA-1007 PET/CT and MRI, with PI-RADS≤4. Among them, patients with a PI-RADS score of 3 were positive in the PSMA PET/CT examination, with a higher SUVmax (33.7) and GS score of 8. PI-RADS 3 lesions on MRI pose a diagnostic challenge because the possibility of clinically significant cancer is ambiguous [22–26]. A recent retrospective analysis evaluated patients with negative MRI findings and found that during a 38-month follow-up, 12.8% of patients had a negative MRI but a biopsy detected PCa, of which 42.3% were diagnosed with clinically significant prostate cancer (csPCa) [29]. A study by Chen et al. showed that in PI-RADS 3, using 4 or higher PI-RADS cutoff values, MRI missed 24.2% of csPCa and 66.7% of csPCa [30]. Men with PI-RADS-3 lesions usually rely on biopsy to rule out invasive diseases. Chandra et al. reported in a recent study that PSMA PET/CT combined with MRI can reduce unnecessary prostate biopsy [31]. A recent study by Zhang et al. showed that PSMA PET/CT can be used as a triage tool for prostate biopsy. In the case of unclear serum PSA levels and MRI, targeted biopsy using PSMA PET/CT may be more beneficial [32]. Limitations of MRI include low specificity and low accuracy in the diagnosis of low-grade prostate tumors. For lumps around the anterior prostate corner, prostatitis or prostatic hyperplasia combined with prostate cancer, MRI may miss these prostate cancer foci [33]. PSMA is 100–1000 times overexpressed in malignant prostate tissue compared to normal tissue. In theory, PSMA PET/CT detection of prostate malignancies is relatively specific compared to mp-MRI, which is not disease-specific. According to our study results, we suggest that patients with PI-RADS≤3 points receive MRI combined with 18F-PSMA PET/CT diagnosis, which can reduce the rate of missed diagnosis of prostate cancer, improve patient prognosis, and provide a better choice for clinical practice, which also needs further research to verify our views.

Our study also found that there was a mild to moderate positive correlation between the GS score and the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUV, TBR, and TLR. There was a mild to moderately positive correlation between serum PSA level and the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUVpeak, MTV, and TLG. The maximum diameter of PCa detected by MRI was moderately positively correlated with the serum PSA level. PI-RADS score was moderately positively correlated with serum PSA level and GS score.

Our findings are consistent with previous studies. A recent study by Rowe et al. found a moderate correlation between SUV and tumor Gleason grade [34]. Paterson et al. showed a significant relationship between SUVmax, PSA levels, and GS grades [35]. An Italian team evaluated 45 patients who underwent a ^{68}Ga-PSMA-11 PET/CT-guided biopsy and found that lesions with a GS score of ≥7 had a higher SUVmax than lesions with a GS score of ≤6 [36]. According to some parameters of PSMA PET/CT and MRI, it may provide some help for clinical GS grouping and serum PSA level evaluation, but its specific application needs to be further proven.

The Ki-67 index is a quantitative index of cell proliferation in the histopathological evaluation of PCa. The Ki-67 index, AMACR (P504S), and PSA expression are related to the survival rate and prognosis of patients with PCa [37]. We found that the Ki-67 index was positively correlated with the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUV, TBR, and TLR. The expression of AMACR (P504S) was negatively correlated with the maximum diameter of ^{18}F-PSMA-1007 PET/CT mass, SUV, TBR, and TLR. PSA expression was not related to ^{18}F-PSMA-1007 PET/CT parameters. However, the Ki-67 index, AMACR (P504S), and PSA expression were not related to MRI parameters. An ^{18}F-PSMA-1007 PET/CT examination can indicate the prognosis of patients to a certain extent. In future studies, larger samples may be needed to further investigate our findings.

Limitations

First, our sample size was limited and subject to the retrospective nature of the study and the potential for selection bias. Secondly, we only included patients with PCa, lacking benign prostate disease. Finally, prostate lesions were not labeled with PSMA in immunohistochemistry, which made it impossible to evaluate the correlation between PSMA expression and PSMA PET/CT parameters. Further research on larger samples is needed to verify our results, especially the correlation findings.

Conclusion

Compared with MRI, ^{18}F-PSMA-1007 PET/CT has higher sensitivity and diagnostic accuracy in the detection of PCa. In addition, the Ki-67 index and AMACR (P504S) expression were only correlated with ^{18}F-PSMA-1007 PET/CT parameters. GS score and serum PSA level were correlated with ^{18}F-PSMA-1007 PET/CT and MRI parameters. ^{18}F-PSMA-1007 PET/CT examination can provide certain reference values for the clinical diagnosis, evaluation, and treatment of PCa.

Abbreviations

PCa	Prostate cancer
csPCa	Clinically significant prostate cancer
PSA	Prostate-specific antigen
PSMA	Prostate-specific membrane antigen
PPV	Positive predictive value
NPV	Negative predictive value
MRI	Magnetic resonance imaging
Mp-MRI	Multi-parameter magnetic resonance imaging
PET	Positron emission tomography
CT	Computed tomography
PET/CT	Positron emission tomography/computerized tomography
PSMA PET	Prostate-specific membrane antigen positron emission tomography
^{18}F-PSMA-1007 PET/CT	^{18}F-Prostate-specific membrane antigen-1007 positron emission tomography/computerized tomography
SUV	Standardized uptake value
SUVmax	Standardized uptake value Maximum
SUVmean	Standardized uptake value Mean
SUVpeak	Standardized uptake value Peak
MTV	Metabolic tumor volume
TBR	Tumor-to-background ratio
TLR	Tumor-to-liver ratio
ROI	Region of interest
Gs	Gleason score
Ki-67 index	Ki-67 proliferation index

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Author contributions

YZY, KY identified research directions, collected data and prepared preliminary manuscripts; KY, SJQ, and CZZ revised the manuscript; DJ and TXF helped collect and analyze data; JX, WXX, LH, CSR provided technical and material support.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance to the local regulations of China and was ethically approved by Ethics Committee of Sichuan Cancer Hospital (JS-2017–01–02). This article does not contain any studies with human participants performed by any of the authors.

Consent for publication

Not applicable.

Informed consent

Informed consent has been obtained for our data.

Competing interests

The authors declare no competing interests.

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