The Role of ^{68}GA-PSMA PET/CT Scan In Patients with Prostate Adenocarcinoma who Underwent Radical Prostatectomy

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Purpose: To determine whether a 68Ga-PSMA PET/CT scan evaluation before radical prostatectomy (RP) is an effective imaging modality for clinical local and lymph node (LN) staging compared with the pathological results.

Materials and Methods: We performed a preoperative 68Ga-PSMA PET/CT scan in 51 patients with prostate cancer (PCa), who were scheduled for an RP operation between January 2014 and June 2016 in our clinic. The correlation between the RP pathology and the results of the 68Ga-PSMA PET/CT scan was investigated.

Results: When the 68Ga-PSMA PET/CT scan results were evaluated according to the risk groups, intraprostatic activity was found in 5 of 12 patients (41.7%) in the low-risk group, 15 of 19 patients in the intermediate risk group (78.9%), and 90% patients in the high-risk group. The 68Ga-PSMA PET/CT scan sensitivity, specificity, positive and negative predictive values and accuracy were calculated as 58.2%, 75.3%, 84.4%, 44%, and 63%, respectively for intraprostatic tumor localization; 68.4%, 75%, 61.9%, 80%, and %72.6%, respectively for extracapsular extension; 63.6%, 92.3%, 70%, 90%, and 86%, respectively for seminal vesicle involvement; 50%, 100%, 100%, 88%, and 89.3%, respectively for LN metastasis.

Conclusion: The 68Ga-PSMA PET/CT scan accurately demonstrates intraprostatic tumor localization in high-risk group and presence of seminal vesicle involvement, which can help to accurately detect the target lesion before prostate biopsy. In addition, with its high sensitivity and specificity values, 68Ga-PSMA PET/CT is a valuable imaging method for the assessment of LN metastasis in intermediate- and high-risk groups and also provides accurate nodal staging before RP.

Keywords: lymph node dissection; PET; prostate cancer; prostate-specific membrane antigen; TNM staging

INTRODUCTION

The primary tools for the early detection of PCa are digital rectal examination, serum prostate-specific antigen (PSA) level, and transrectal ultrasound-guided prostate biopsy (TRUS-Bx). Nowadays, multiparametric prostate MRI provides valuable information in local staging, detection of intra-prostate tumor focus, and especially extracapsular extension.[1,2] Nevertheless, the diagnostic performance of mpMRI is not satisfactory, with broad sensitivity (58-97%), specificity (23-87%), and accuracy (44-87%) in detecting clinically important prostate cancer.[3] C Therefore, there is a need for more effective imaging modalities that can be used in diagnosis, risk assessment, staging, and follow-up in PCa. Molecular image information with high target-to-background ratios could therefore potentially overcome shortcomings in primary staging.

Different from PSA, prostate-specific membrane antigen (PSMA) is a glutamate carboxypeptidase II integral merman glycoprotein, found to be denser in PCa than in other tissues (kidney, small intestine proximal segment, salivary glands).[4] PSMA is a cell surface protein which is not secreted from the site it is located.[5,6] The ability of PSMA to be internalized within the cell where the ligand (e.g., antibody derivatives) is attached due to enzyme activity and its transmembrane location has made it an important target for diagnostic and therapeutic use.[7] Today, there are many radio-labeled PSMA derivatives developed for the diagnosis and treatment of PCa by targeting PSMA in nuclear medicine applications.[7-11] Recent studies have shown that Glu-NH-CO-NH-Lys- (Abx) - [HBED-CC- PSMA], a urea-based inhibitor of PSMA labeled with 68Ga, is a superior method than [18F]-FECH for the detection of PCa recurrence and metastases for these purposes.[12] 68Ga-PSMA PET/CT scan has shown improved detection specificity and detection rates for PCa compared to standard imaging approaches.[13]

The aim of this study was to determine whether a preoperative 68Ga-PSMA PET/CT scan obtained is an effective imaging modality for clinical local (T) and LN (N)

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Received April 2020 & Accepted December 2020

Table 1. Baseline characteristics of patients.

Characteristics[a]			
Mean age ± SD (year)		63.5 ± 7.06 (46-78)	
Mean PSA ± SD (ng/mL)		14.6 ± 15.2 (3.2-71)	
Preoperative Gleason Score	3+3	ISUP Grade 1	22 (43.1 %)
	3+4	ISUP Grade 2	15 (29.4%)
	4+3	ISUP Grade 3	9 (17.6%)
	4+4	ISUP Grade 4	4 (7.8%)
	4+5	ISUP Grade 5	1 (1.9%)
Clinical T Stage		≤ T2a	28 (54.9 %)
		T2b	6 (11.8%)
		≥ T2c	17 (33.3 %)
EAU Risk Classification		Low-Risk	12 (23.5 %)
		Intermediate-Risk	19 (37.2 %)
		High-Risk	20 (39.2 %)
Postoperative Gleason Score	3+3	ISUP Grade 1	7 (13.7 %)
	3+4	ISUP Grade 2	21 (41.1 %)
	4+3	ISUP Grade 3	14 (27.4 %)
	4+4	ISUP Grade 4	6 (11.7 %)
	4+5	ISUP Grade 5	3 (5.8 %)

staging in patients with PCa scheduled for RP surgery in comparison with the actual pathological data.

PATIENTS AND METHODS

Study population

Between January 2014 and June 2016, a preoperative 68Ga-PSMA PET/CT was performed on 51 patients who were planned to undergo RP operation and provided informed consent and data was collected by prospective manner.

Included in the study were patients with non-metastatic prostate cancer from all risk groups, who were scheduled to undergo RP with/without extended LN dissection. The PSMA PET/CT scan had to be performed within 12 weeks before surgery. Patients that had received hormone treatment prior to surgery, had a history of pelvic radiation, or were diagnosed with cancer elsewhere within the last five years (except for successfully treated squamous or basal cell carcinoma of the skin) were excluded from the study. The ethics committee approval was obtained with IRB number of 284452. The correlation between the pathological data obtained by RP and the results of the preoperative 68Ga-PSMA PET/CT scan was investigated. The prostatectomy specimen served as the reference standard.

PET/CT imaging with 68Ga-PSMA and image analysis

PET / CT imaging was performed using a CT-integrated PET scanner Biograph 6 (Siemens, Knoxville, Tennessee, USA) 60-90 min after the intravenous injection of 74-185 mBq mCi 68Ga-PSMA, which was prepared with a fully automated radiopharmaceutical synthesis device based on a modular concept (Eckert & Ziegler Eurotope, Berlin, Germany). The raw images

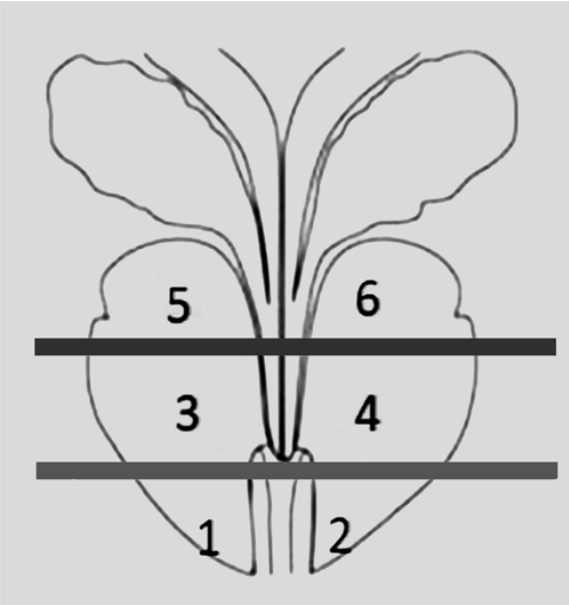

Figure 1. Diagram of the prostate with numbered localizations used to evaluate intraprostatic tumor localization.

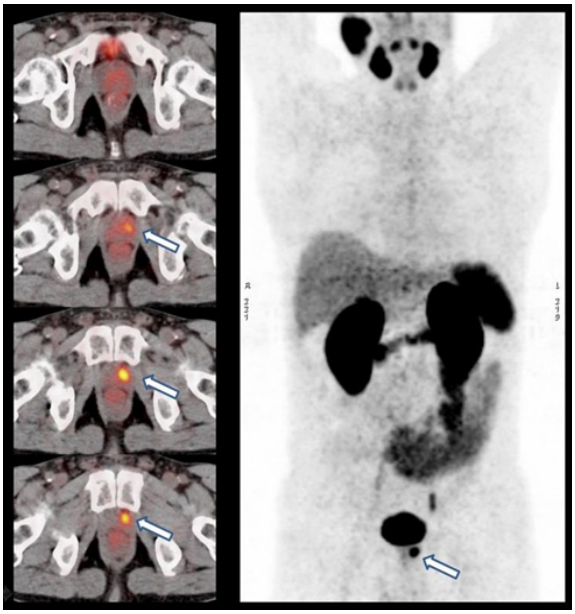

Figure 2. The PSMA PET/CT image of patient with prostate cancer showing intraprostatic tumor localization. The white arrows on the left show intraprostatic tumor localization on the PSMA PET/CT image. The white arrow in the maximum intensity projection view indicate intraprostatic tumor localization and also kidneys, ureters, small intestine, bladder wall, salivary and lacrimal glands received a physiological activity distribution.

Table 2. Comparative evaluation of the tumor volume, PSA value, biopsy Gleason score, and prostatectomy Gleason score with the results of the 68Ga-PSMA PET/CT scan.

	Area Under the Curve	95% Confidence Interval		*P* value
		Lower Bound	Upper Bound	
Tumor volume	.704	.513	.853	.034
PSA value	.620	.465	.768	.206
Biopsy GS/ ISUP Grade	.714	.547	.881	.026
Prostatectomy GS/ ISUP Grade	.817	.689	.945	.001

Abbreviations: GS, Gleason Score; ISUP, International Society of Urological Pathology; PSA, prostate-specific antigen.

were processed with appropriate iterative reconstruction techniques to obtain PET, CT and PET-CT fusion sections in the axial, coronal and sagittal planes with a thickness of approximately 0.5 cm by two experienced nuclear medicine specialists (L.K. and E.D.), who were blinded to the clinical data and evaluated the each image individually. If the findings were incompatible, the final decision was made by consensus.

In the standard pathology report, the right and left apical, median and base localizations were indicated for intraprostatic tumor localization, and tumor localization was evaluated separately in each of the six quadrants on the 68Ga-PSMA PET/CT images. Any degree of radiotracer uptake higher than intraprostatic background activity considered as "positive" according the six-quadrant template. (**Figure 1**) Using these images, extracapsular extention, seminal vesicle (SV) involvement, LN metastasis, solid organ metastasis, and bone metastasis were also assessed. The radiopharmaceutical involvement in both primary and metastatic lesions was investigated, and the results were compared with the findings of final pathology and other imaging modalities if available.

Surgical intervention and histopathological assessment

The patients included in the study underwent open surgery. A risk of nodal metastases over 5% in Briganti nomogram was excepted as an indication to perform nodal sampling by an extended nodal dissection.[14] The areas of LN dissection were planned bilaterally from the obturator fossa, LNs around the common iliac artery up to the level of the ureteric crossing, and the nodes on the external iliac artery and the vein, and the nodes around the internal iliac artery. The pathological examination of the prostatectomy material was undertaken according to the recommendations of the International Society of Urological Pathology Consensus Conference.[15] A standard pathological evaluation was carried out in a reference pathology clinic. Tumor percentage involvement (TPI) was used to determine the tumor burden of the prostate. Tumor involvement of each slide was estimated by the percentage of slides containing prostate cancer. Estimation of TPI for the entire prostate was completed by summing each individual slide and averaging the results from all slides analyzed.

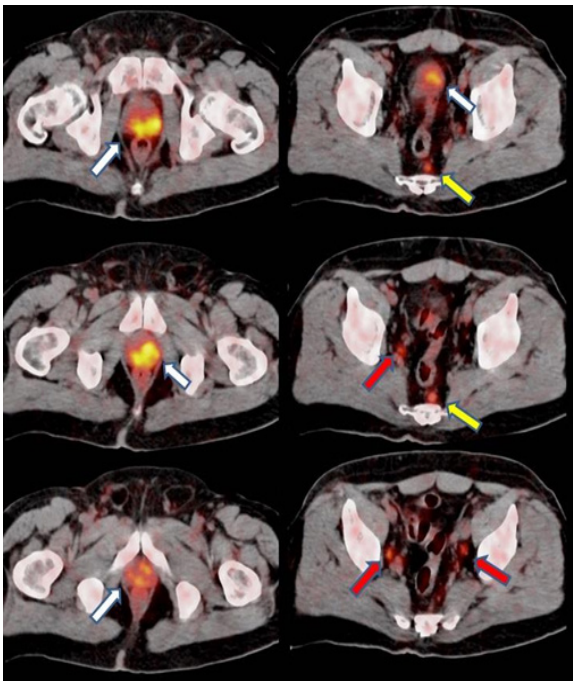

Figure 3. The PSMA PET/CT image of patient with prostate cancer showing intraprostatic tumor localization and lymph node metastasis. The white, red and yellow arrows show intraprostatic tumor localization, bilateral obturator lymph nodes, and perirectal lymph nodes, respectively on the PSMA-PET CT scan.

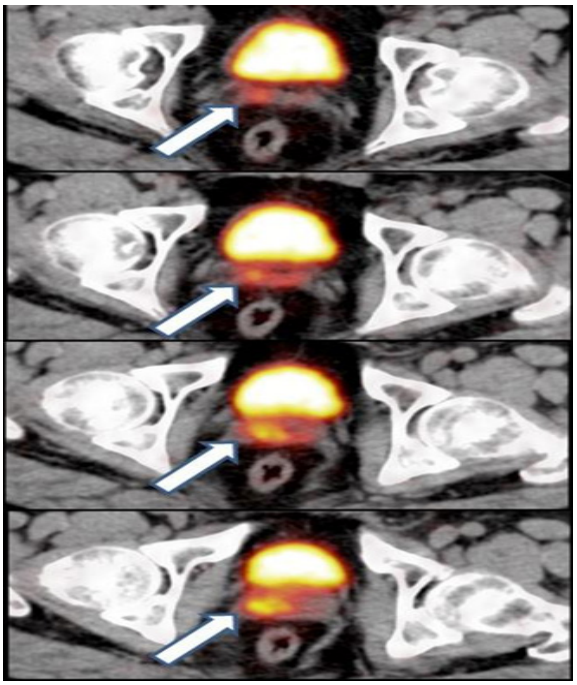

Figure 4. The PSMA PET/CT image of patient with prostate cancer showing seminal vesicle involvement. The white arrows show the seminal vesicle involvement on the PSMA-PET CT scan.

Table 3. PSMA PET-CT results according to intraprostatic tumor localization, seminal vesicle involvement, and lymph node staging.

		Sensitivity	Specificity	PPV	NPV	Accuracy	Kappa
Intraprostatic tumor localization	Total	58.2%	75.3%	84.4%	44%	63.4%	Kappa=.279, *P* < .005
	Low-risk	39%	96.9%	94.1%	58.1%	66.6%	Kappa=.141, *P* =. 076
	Intermediate-risk	43.4%	73.6%	76.7%	39.4%	53.5%	Kappa=.184, *P* = .037
	High-risk	76.5%	45.4%	86.2%	30.3%	70.8%	Kappa=.361, *P* < .005
Extracapsular extension	Total	68.4%	75%	61.9%	80%	72.6%	Kappa=.425, *P* = .002
	Low-risk	NA	NA	NA	NA	NA	
	Intermediate-risk	40%	64.3%	28.6%	71.4%	57.9%	Kappa=.038, *P* = .865
	High-risk	78.6%	50%	78.6%	50%	70%	Kappa=.286, *P* = .201
Seminal vesicle involvement	Total	63.6%	92.3%	70%	90%	86%	Kappa=.580, *P* < .005
	Low-risk	NA	NA	NA	NA	NA	
	Intermediate-risk	66.6%	87.5%	50%	93.3%	84.2%	Kappa=.477, *P* = .035
	High-risk	62.5%	91.6%	83.3%	78.5%	80%	Kappa=.565, *P* = .010
Lymph node staging	Total	50%	100%	100%	88%	89.3%	Kappa=.521, *P*=.004
	Low-risk	NA	NA	NA	NA	NA	
	Intermediate-risk	50%	100%	100%	91.6%	92.3%	Kappa=.629, *P* = .015
	High-risk	50%	91.6%	66.6%	84.6%	81.2%	Kappa=.505, *P* = .024

Statistical analysis

The study variables were stratified as numerical or categorical. The numerical variables were calculated as means and standard deviations and presented as minimum and maximum values, and the categorical variables as frequencies and percentages. The nominal categorical variables were assessed using the chi-square test. A receiver operating characteristic (ROC) curve analysis was undertaken to determine the threshold value with the best possible sensitivity and specificity. The sensitivity, specificity, positive prediction value (PPV), negative prediction value (NPV), and accuracy were calculated for the detection of intraprostatic tumor localization, extracapsular extension, SV involvement, and LN metastases, by PSMA PET/CT. To assess the agreement between the final pathology and preoperative PSMA PET/CT, we used Kappa test. The Kappa value < 0.20 is reflecting a slight, values of 0.21-0.40 are considered fair, 0.41-0.60 moderate, 0.61-0.80 good, 0.81-1 almost perfect agreement.[16] All statistical analyses were performed using SPSS version 20.0. The level of significance was set at $P < 0.05$.

RESULTS

There were 51 patients with a mean age of 63.5 ± 7.06 (46-78) years and a mean PSA value of 14.6 ng / mL ± 1 5.2 (3.2-71). GS as shown by ISUP grade, European Association of Urology (EAU) risk group classification, and clinical T stage were shown in Table 1. A total of 26 patients had an increased GS after the operation compared to the preoperative period.

The results of the 68Ga-PSMA PET/CT scan did not affect the surgical decision. In 39 patients (76.5%), the 68Ga-PSMA PET/CT scan showed an uptake of tracer in at least one intraprostatic focus. These patients had a mean TPI of 26.13 ± 24.82 %. The remaining 12 patients with a negative scan had a mean TPI of 12 ± 14.99 %. When the ROC curve analysis was performed according to TPI in the postoperative pathology, statistically significant differences were found. The ROC curve analysis revealed a cut off value of > 12% TPI with a sensitivity of 0.67, specificity of 0.75 and AUC of 0.704 (95% CI, .513-.853; $P = .034$). When the results of the 68Ga-PSMA PET/CT scan were evaluated together with the preoperative PSA values, they were not statistically correlated , and according to the ROC curve analysis, the area under the curve was 0.620 (95% CI, .465-.786; $P = .206$) (**Figure 5, Table 2**).

The preoperative prostate biopsy and postoperative prostatectomy GS/ISUP Grade was comparatively evaluated with the results of the 68Ga-PSMA PET/CT scan. Preoperative GS/ISUP Grade was statistically significant with AUC of 0.714 (95% CI, .547-.881; $P = .026$)

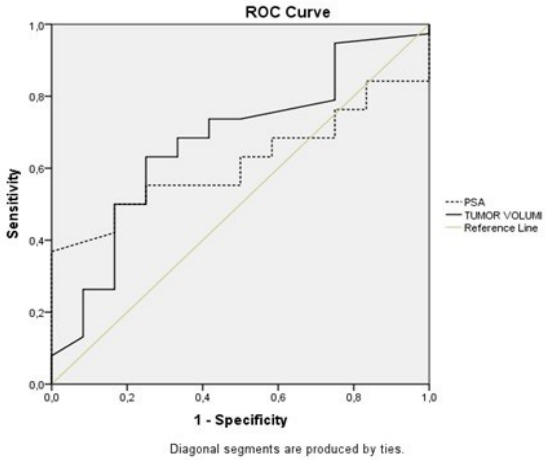

Figure 5. ROC curve analysis comparing the tumor volume and preoperative PSA values with PSMA PET-CT.

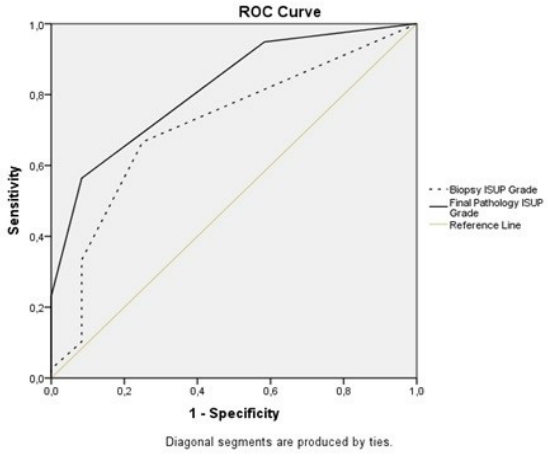

Figure 6. ROC curve analysis comparing preoperative and postoperative ISUP Grade with PSMA PET-CT.

in ROC curve analysis. For the postoperative GS/ISUP Grade, it was also achieved statistically significant level with AUC of 0.817 (95% CI, .689-.945; P = .001) in ROC curve analysis (Figure 6, Table 2). The ROC curve analysis revealed a cut off value of > ISUP Grade 1 for both preoperative and postoperative pathology.

Concerning the evaluation of intraprostatic tumor localization separately for each quadrant, the 68Ga-PSMA PET/CT scan had a sensitivity of 58.2%, specificity of 75.3%, PPV of 84.4%, NPV of 44%, accuracy of 63.4%, compared with the postoperative pathology results. When further analyzed using Kappa test, kappa value of .279 (P < .05), and the results of 68Ga-PSMA PET/CT fairly agreed those of standard pathological analysis (**Table 3**). When subgroup analysis of the 68Ga-PSMA PET/CT scan results according to the EAU risk groups were done, we found at least one intraprostatic activity in 41.7% of the patients (5 of 12) in the low-risk group, 78.9% (15 of 19) in the intermediate-risk group, and 95% (19 of 20) in the high-risk group. When we compared the pathologic intraprostatic tumor localization with the 68Ga-PSMA PET/CT scan results only for the high-risk group, we found that the latter had a sensitivity of 76.5%, specificity of % 45.4, accuracy of 70.8%, and provided better results in this group of patients compared to pathological analysis. (Kappa=.361, P < .005)

In the final pathology reports ECE were seen in 21 patients in all risk groups. While not seen in low-risk patients, it was seen in 36.8% (7 out of 19) of patients in the intermediate-risk group and 70% (14 out of 20) of patients in the high-risk group. When we compared the pathologic ECE with the 68Ga-PSMA PET/CT scan results, we found that the 68Ga-PSMA PET/CT scan had a sensitivity of 68.4%, specificity of 75%, PPV of 61.9%, NPV of 80%, accuracy of 72.6% (Kappa=.425, P = .002). In subgroup analysis high-risk group had a sensitivity of 78.6%, specificity of 50%, PPV of 78.6%, NPV of 50%, and accuracy value of 70% (Kappa=.286, P = .201).

The 68Ga-PSMA PET/CT scan was compared with the postoperative pathology findings in terms of identifying SV involvement, and the sensitivity, specificity, PPV, NPV, and accuracy values of the 68GA-PSMA PET/CT scan were calculated as 63.6%, 92.3%, 70%, 90% and 86%, respectively (Kappa=.580, P<.005). In subgroup analysis intermediate-risk group had a sensitivity of 66.6%, specificity of 87.5%, PPV of 50%, NPV of 93.3%, and accuracy value of 84.2% (Kappa = .477, P = .035) and in high-risk group this analysis was seen as 62.5%, 91.6%, 83.3%, 78.5% and 80% respectively (Kappa=.565, P = .010).(**Table 3**)

Pathologic LN metastasis was detected in six of 28 patients (21.4%) who underwent expanded pelvic LN dissection (Figures 2, 3). In patients who underwent this procedure, the mean and total number of dissected LNs were found to be 28.5 (6-41) and 829, respectively. In total, metastasis was detected in 20 LNs (2.4%). When the LN positivity and negativity rates in the 68Ga-PSMA PET/CT scan images were analyzed, this method had a sensitivity of 50%, specificity of 100%, PPV of 100%, NPV of 88%, and accuracy value of 89.3%,and 68GA-PSMA PET/CT scan moderately agreed with pathological findings (Kappa=.521, P = .004).(**Table 3**). In subgroup analysis intermediate-risk group had a sensitivity of 50%, specificity of 100%, PPV of 100%, NPV of 91.6%, and accuracy value of 92.3% (Kappa=.629, P = .015), and in high-risk group this analysis was seen as 50%, 91.6%, 66.6%, 84.6% and 81.2% (Kappa = .505, P = .024) respectively. (**Table 3**)

Lastly, according to the long term follow up two patients died, five patients lost to follow-up. The remaining 44 patients were evaluated according to the biochemical recurrence (BCR). 15 patients had biochemical recurrence with one LN metastasis and three local recurrences. Patients who occurred LN metastasis or local recurrence were all with adverse preoperative PSMA findings (such as ECE, SV involvement, and LN metastasis). BCR treated with hormonal treatment and/or external beam radiotherapy. None of the patients in low-risk group developed BCR, although, four patients in intermediate-risk group and 11 patients in high risk group developed BCR. When we evaluated adverse imaging findings in PSMA and BCR in high-risk group patients, 68Ga-PSMA PET/CT scan had a sensitivity of 63.2%, specificity of 88%, PPV of 80%, NPV of 75.9%, and accuracy value of 77.3% (Kappa=.625, $P \leq .005$)

DISCUSSION

PSMA is a cell surface protein that is not secreted from the site it is located, and it is denser in PCa than in other tissues (kidney, small intestine proximal segment, salivary glands).[5,6] The ability of PSMA to be internalized within the cell where the transmembrane location and ligand (e.g., antibody derivatives) are bound due to enzyme activity has made it an important target for diagnostic and therapeutic purposes.[17] Today, many radio-labeled PSMA derivatives have been developed for use in nuclear medicine applications in the diagnosis and treatment of PCa by targeting PSMA.[7-11] In our study, when intraprostatic tumor localization was separately evaluated for each quadrant, although the 68Ga-PSMA PET/CT scan did not completely agree those of the standard pathological analysis; it provided better results in high-risk group of patients compared to pathological analysis. In order to investigate the localization and spread of primary PCa, Fendler et al. compared the imaging and histopathological segments of the 68Ga-PSMA PET/CT scan patients before RP and the sensitivity, specificity, PPV, NPV, and accuracy of this method were found to be 67%, 92% 42% and 72%, respectively.[18] In another research, authors determined that for predicting intra-prostate tumor localization in the high-risk patient group, the sensitivity, and specificity, PPV and NPV of 68Ga-PSMA PET /CT was 92%, %92, 96%, and 85%, respectively.[19] Above mentioned studies included high-risk patients in their studies, and when we performed a subgroup analysis with a high-risk group, our results fall in range in between those two studies.

The extracapsular extension (ECE) in PCa affects both prognoses of the patient and the appropriate surgical strategy.[20] Nerve-sparing surgery is not seen as a viable option in patients with positive ECE, and therefore functional results are compromised.[21] In our study, when we compared the pathologic ECE with the 68Ga-PSMA PET/CT scan results, we found that the 68Ga-PSMA PET/CT scan had moderately agreed with final pathology (Kappa = .425, P = .002). mpMRG with high tissue recognition power has been used extensively for T staging in the last one decade. In a meta-analysis

conducted in 2016, authors demonstrated that mpMRI has a low sensitivity on ECE (0.57, 95% CI, 0.49–0.64) but a high specificity (0.91, 95% CI, 0.88–0.93).[22] In another study that evaluates head to head comparison of mpMRG and 68Ga-PSMA PET/CT, authors reported that PSMA had a higher sensitivity (78% vs. 54%, $P = 0.013$) and similar specificity (94% vs. 94%) than mpMRG according to the ECE assessment.[23] We think that the reason why our results are seen inferior from the literature may be due to the weak scatter correction of the device we use.

The SV involvement of PCa is directly proportional to increased LN invasion and increased tumor recurrence. The knowledge of SV involvement at the time of diagnosis is important for the evaluation of prognosis and planning of treatment. In the current study, for the evaluation of SV involvement, 68Ga-PSMA PET/CT was moderately agreed with postoperative pathology findings (Kappa = .580, $P < .005$). Fendler et al. used the 68Ga-PSMA PET/CT scan for local staging of the PCA and found that 11 patients (out of 21 patients 52%) had pathologically proven SV involvement. The authors also stated that the 68Ga-PSMA PET/CT scan provided acceptable results at accuracy of 86%.[18] In a recent study that compares final pathology and 68Ga-PSMA PET/CT scan results, sensitivity, specificity, positive and negative predictive value for detection of SV involvement by PSMA PET/CT were 58%, 96%, 78% and 90% respectively.[24] Our results were consistent with existing literature.[18,24]

The status of LNs in newly diagnosed PCa is an important factor in planning treatment. The gold standard of LN staging is LN dissection. In addition, EAU recommends a metastasis assessment and LN staging to be performed with CT or MRI in intermediate and high-risk patients with PCa. The guideline states that PSMA shows more sensitive detection on LN staging in an evidence-based manner. Also, it was mentioned that results from randomized controlled trials are awaited, before putting the PSMA result into the decision-making process of the treatment of prostate cancer.[25] In a meta-analysis published in 2008, Hövels et al. reported that the sensitivity of CT and MRI in LN staging was 42% and 39%, respectively, and the specificity was 82% for both.[26] However, these imaging methods only provide morphological data and assess LN metastasis based on the size of the LN; therefore, they are not adequate in LN staging. In our study, we had 28 patients (21.4%) who underwent ePLND in intermediate and high-risk groups. The 68GA-PSMA PET/CT scan had a sensitivity of 50%, specificity of 100%, PPV of 100%, NPV of 88%, and accuracy of 89.3%. In the similar group of patients Maurer et al. reported to have 65.9% sensitivity, 98.9% specificity, and 88.5% accuracy in detecting LN.[27] In a relatively small sample sized study (130 vs 27), which was conducted by Van Leeuwen et al., the authors found a sensitivity of 64%, specificity of 95%, PPV of 88%, and NPV of 82% in patient-based statistical analysis and their results were very similar with our study.[28] Meanwhile, in a study conducted by Abdollah et al., it was reported that removal of a minimum of 20 LNs in pelvic LN dissection provided 90% real LN staging.[29] In their respective studies, Maurer and van Leeuwen dissected a mean of 5.6-6 LNs, which were below the minimum number of LNs to be removed. We dissected a mean of 28.5 (6-41) LNs, thus, we consider that we achieved adequate LN staging for each patient.

PSA measurement is the most important clinical marker showing the course of the disease after prostate cancer surgery. In addition, the most important reason for PSA increases or not decreases in the postoperative period is the pre-RP clinical stage of the disease. LN involvement, extracapsular extension, and SV involvement are well described poor prognostic indicators of the initial response to RP.J[30] In our study, the relationship between advanced PSMA findings and BCR were evaluated and a good agreement was found in the Kappa test. (Kappa=.625, $P \leq .005$) In addition, in a study conducted by Nandurkar et al., it was stated that when there is an extraprostatic disease in preoperative PSMA PET, BCR can be seen at a high rate and these patients can be candidates for multimodal methods.31 We also think that the data on this subject should be increase.

This study has certain limitations such as the number of patients was relatively small. Due to the limited budget and ethical problems, we included only patients who were diagnosed with prostate cancer and scheduled to undergo RP into our study, and we did not perform external validation by imaging patients who were not diagnosed with PCa. However, the nuclear medicine specialists were aware that all patients were diagnosed with PCa and scheduled for an RP operation. Further prospective studies are essential to provide an understanding of the value of 68GA-PSMA PET/CT scan in determining the clinical stages in PCa. Well-designed controlled trials evaluating the management and outcome of patients using PSMA PET/CT are needed to make an informed decision concerning the treatment of these patients.

CONCLUSIONS

The 68Ga-PSMA PET/CT scan accurately demonstrates intraprostatic tumor localization especially in high-risk groups and may help to accurately detect the target lesion before prostate biopsy. The 68Ga-PSMA PET/CT scan accurately demonstrates presence of seminal vesicle involvement and moderately demonstrates extracapsular extenision. In addition, with its high sensitivity and specificity values, 68Ga-PSMA PET/CT is a valuable imaging method for assessment of LN staging in intermediate- and high-risk groups and also provides accurate LN staging before RP. These promising results for LN staging indicate that 68Ga-PSMA PET/CT might become the standard imaging method for this purpose in the future.

ACKNOWLEDGMENT

This work was financially supported by the Scientific Research Projects Coordination Unit of Istanbul University, under the project number 32724.

Data presented previously at 3th National Urological Surgery Congress. 2 – 6 November 2016 Antalya Turkey (oral presentation) SS - 06

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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