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Diagnostic Accuracy of Preoperative Metabolic ^{18}F-FDG PET/CT Parameters for Patients with Endometrial Cancer Treated with Postoperative Radiation Therapy

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What is known on this subject?

The known is that pre-operative ^{18}F-fluoro-deoxy-glucose (^{18}F-FDG) positron emission tomography/computed tomography (PET/CT) can be used for staging in endometrial cancer patients.

What this study adds?

^{18}F-FDG PET/CT is not standart diagnostic image in endometrial cancer (EC). According to our results, we found out that the metabolic parameters on ^{18}F-FDG PET/CT, for prediction of lymph node metastases increase diagnostic accuracy for EC.

ABSTRACT

Objective: This study aimed to evaluate the diagnostic accuracy of preoperative ^{18}F-fluoro-deoxy-glucose (FDG) positron emission tomography/computed tomography (PET/CT) metabolic parameters for the prediction of risk factors and detection of lymph node metastasis (LNM) in patients with endometrial cancer.

Material and Methods: This study included 26 patients with endometrioid carcinoma who underwent preoperative PET/CT and treated with adjuvant local radiotherapy. The maximum standard uptake value of the tumor (SUV_{max}-T), SUV_{max} of the pelvic and/or para-aortic LNs, metabolic tumor volume (MTV), and tumor lesion glycolysis (TLG) with cut-off values of 30-40% were calculated. International Federation of Gynecology and Obstetrics stages 3 and 4, high-grade disease, lymphovascular invasion (LVI), cervical involvement (CI), and myometrial invasion (MI) ≥50% were established as high-risk features. Disease-free survival and overall survival were analyzed in comparison with ^{18}F-FDG PET/CT parameters.

Results: SUV_{max}-T was only associated with tumor diameter (p=0.01). It was not correlated with MI, high-grade disease, CI, or LNM. With SUV_{max}-P ≥2.81 as a cut-off value, the sensitivity,

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ABSTRACT

specificity, and accuracy in the detection of LNM were high (90%, 83.3%, 71.4%, respectively). For LNM, the mean MTV-30 (p=0.021), TLG-30 (p=0.030), and SUV_{max}-P (p=0.009) were significant predictors. According to the regression analysis, MTV-40 (p=0.043) was an independent predictor of LNM, and LVI (p=0.037) was the only significant predictor of MI. MTV-30 was a significant predictor of CI (p=0.04).

Conclusion: SUV_{max}-P, MTV, and TLG cut-off values, to predict LN metastases, increase diagnostic accuracy for EC.

Keywords: Brachytherapy, endometrial cancer, FDG-PET/CT, metabolic parameters

Introduction

Endometrial cancer (EC) is the most common gynecologic malignancy in developed countries, with adenocarcinoma as the most common histologic type (1). The majority of patients with EC are diagnosed at an early stage with the disease confined to the primary site (67%). However, the spread to regional organs and lymph nodes (LNs) (21%) and distant metastases (8%) are less frequent (2). Although EC staging is performed with surgery, the identification of disease extent before surgery is very important for treatment planning.

Imaging modalities play an important role for staging and treatment planning of patients with EC. ^{18}F-fluoro-deoxy-glucose (FDG) positron emission tomography/computed tomography (PET/CT) combines morphology with physiology and is the preferred imaging modality, especially in clinical oncology. Its accuracy of staging and determination of the aggressiveness of EC have also been investigated (3,4). The maximum standardized uptake value (SUV_{max}) of the tumor, the most widely used PET parameter, was considered an important indicator that reflects tumor aggressiveness, such as myometrial invasion (MI), cervical involvement (CI), LN metastases (LNM), and high-risk disease in EC (4,5). The metabolic tumor volume (MTV) and total lesion glycolysis (TLG) were reported to have prognostic effect on several cancers, including cervical, ovarian, and lung cancer; however, data regarding EC are limited (6,7,8).

In this study, we aimed to evaluate the prognostic importance and diagnostic accuracy of preoperative ^{18}F-FDG PET/CT metabolic parameters of the local tumor and pelvic and/or para-aortic LN SUV_{max} of patients with EC treated with intracavitary brachytherapy (ICRT) and/or pelvic external beam radiation therapy (EBRT) postoperatively and to examine the correlation of results with histopathology.

Material and Methods

Patients

The study was approved as a retrospective study by the İstanbul Training and Research Hospital Clinical Research Ethics Committee (decision no: 1447, date: 28.09.2018), and the requirement to obtain informed written consent was abandoned. A total of 90 patients with histopathologically verified EC treated with three-dimensional high dynamic range (3D HDR) ICRT and/or pelvic EBRT at a single center between August 2016 and October 2019 were analyzed. Of those, 26 patients who underwent preoperative ^{18}F-FDG PET/CT were included in this study. Patients with previous or concurrent diagnosis of any other primary malignancy, patients with follow-up duration <6 months, patients without pretreatment ^{18}F-FDG PET/CT, and patients without adequate surgical staging (total abdominal hysterectomy and bilateral salpingoopherectomy, pelvic- para-aortic LN dissection) were excluded from the study.

Patients with EC were surgically staged according to the 2009 International Federation of Gynecology and Obstetrics (FIGO) (9). Tumor histopathologic types were classified as endometrioid endometrial carcinoma (grades 1, 2 and 3), serous carcinoma, mixed-type endometrial carcinoma, and carcinosarcoma. The estimated 3-year NFS, DFS, and overall survival rates were 84.2%, 86.1%, and 87.5%, respectively.

^{18}F-FDG PET/CT Image Acquisition and Analysis

All ^{18}F-FDG PET/CT records were retrospectively analyzed by the investigators without knowledge of patients' clinical and histopathological information. Imaging of patients who fasted for at least 6 h before intravenous administration of 5-6 MBq/kg ^{18}F-FDG and whose blood glucose concentrations were <180 mg/dL was perfromed using an integrated PET/CT system. Combined image acquisition began approximately 60

min after [18]F-FDG injection from the vertex to the mid-thigh. Sagittal, coronal, and transaxial images and fused images were analyzed on workstation (Syngo.via Siemens Molecular Imaging).

Qualitative and quantitative (or semi-quantitative) image analyses were performed by an experienced nuclear medicine physician (B.Y.) with significant experience in reading [18]F-FDG PET/CT scans (average 140 reads/month individually). Pretreatment FDG uptake in both local tumor and LNs was quantitatively assessed using SUV_{max}. For each FDG PET/CT study, SUV_{max} values of the most FDG-avid pelvic and/or para-aortic and inter-aortocaval LNs were measured.

The volume of interest (VOI) was defined over the primary tumoral lesion. The tumor contours were semi-automatically delineated by using thresholds of 30% and 40% of the SUV_{max} within the lesion to calculate MTV (7,8). MTV values were used to calculate TLG by multiplying the mean SUV within the VOI both for 30% and 40% thresholds. In the pretreatment PET/CT for the primary tumor area, SUV_{max}-of the tumor (T), MTV-30, MTV-40, TLG-30, and TLG-40; for pelvic LNs SUV_{max}-P, for para-aortic LNs SUV_{max}-PA, for interaortocaval LNs, SUV_{max}-invasive adenocarcinoma (IAC) were recorded (Figure 1). In addition, any suspicious distant metastatic site was noted and verified by other imaging modalities.

Treatment and Follow-up

3D HDR ICRT was delivered once a week in three or five fractions, and D90 ≥5.5 Gy or 7 Gy was prescribed for the planning target volume (PTV) in all patients. The PTV was defined as the upper 1/3 and 5 mm deep of the vagina using a cylinder applicator on the same-day CT scan and a new plan in each brachytherapy fraction. Twelve (46.2%) patients received pelvic intensity modulated radiation therapy (IMRT) technique with Rapid Arc in 1.8 Gy daily fractions, five times a week, for a median total dose of 45 Gy (range, 45-50.4). Para-aortic radiation was delivered to cases with para-aortic LN histopathological involvement (n=3), with a dose up to 45 Gy with one isocenter field in field IMRT. Adjuvant chemotherapy (cisplatin and paxlitaxel, 4-6 cycles) was only administered to patients with high-risk EC (30.8%; n=8).

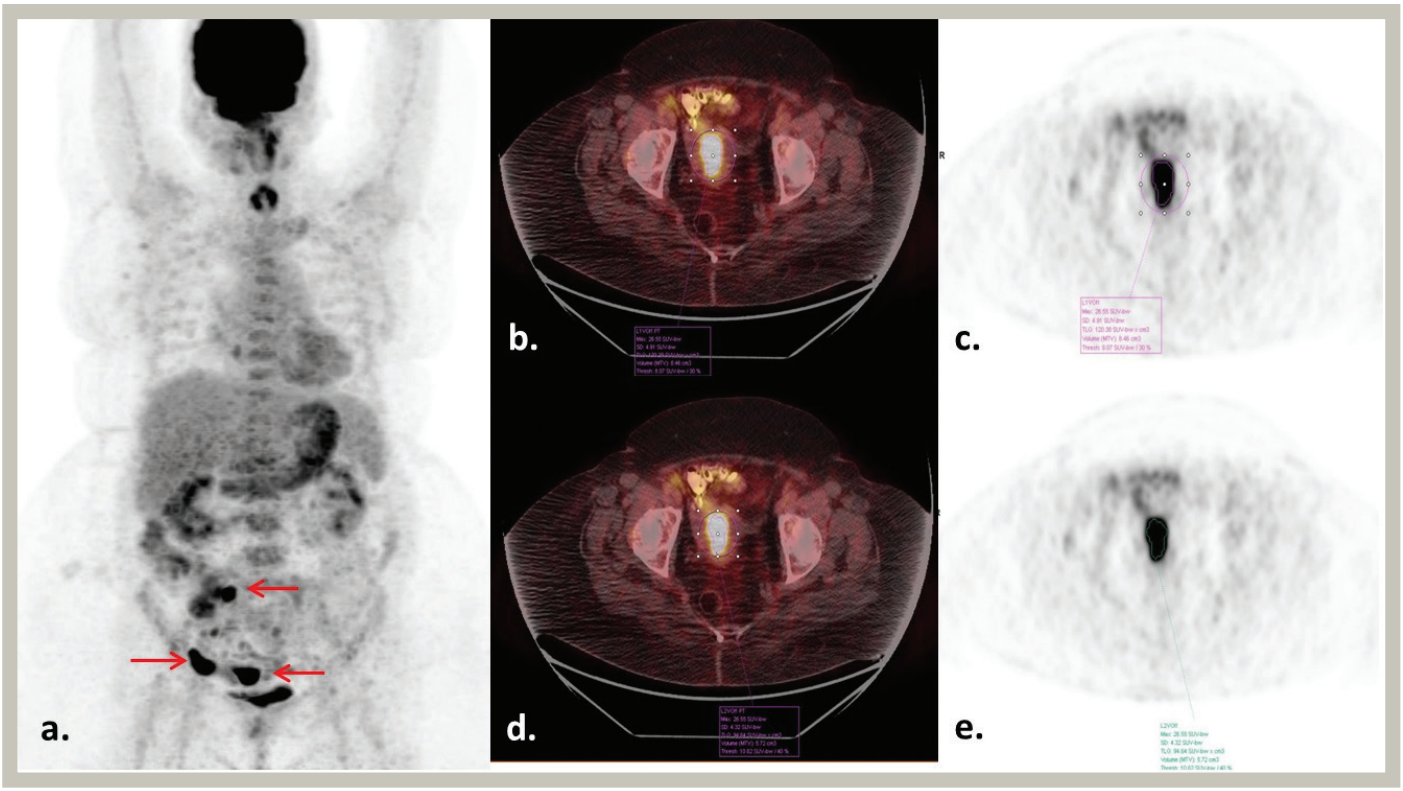

Figure 1. Pretreatment [18]F-FDG PET/CT images of a 52-year-old patient with high-risk EC. a) MIP image with primary tumor and lymph node metastases (arrows). b, d) Axial fused pretreatment PET/CT image of the pelvis with endometrial tumor demonstrating high FDG uptake and different threshold values of MTV and TLG. c, e) Axial PET images with different threshold levels of MTV and TLG

[18]F-FDG:[18]F-fluoro-deoxy-glucose, PET/CT: Positron emission tomography/computed tomography, MIP: Maximum ıntensity projection, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, EC: Endometrial cancer

During follow-up patients underwent bimanual pelvic examination and speculum examination. Serum CA-125 levels were measured and imaging studies were performed every 3 months for 2 years, every 6 months from 2 to 5 years, and annually thereafter.

Statistical Analysis

All statistical analyses were performed using SPSS software (version 15.0; SPSS Inc.), with $p<0.05$ considered significant. Descriptive data are expressed as mean ± standard deviation and percentages. Student's t-test was used to compare the mean values between two independent groups, and the chi-square test was used to compare nominal values between two groups. The metabolic parameters among the groups were compared using the Mann-Whitney U test. Correlations among the PET parameters were analyzed using Spearman rank correlation analysis. With respect to SUV_{max}, MTV, and TLG, receiver-operating characteristic (ROC) curve analysis was performed to determine the cut-off values for predicting LNM and clinicopathologic characteristics. The optimal cut-off values of SUV_{max}, MTV, and TLG were those giving the highest sensitivity and specificity.

The sensitivity, specificity, and area under the curve (AUC) values of the ^{18}F-FDG PET/CT were also calculated. Multivariate logistic regression analysis was performed to determine the independent variables associated with LNM and clinicopathologic characteristics by including all significant factors ($p<0.25$) from the univariate analysis.

Results

Patient Characteristics

Patient's clinicopathological findings were summarized according to risk stratification (Table 1). The median age was 63 (range, 45-84) years, and the median follow-up time was 22 (range, 9-36) months. Sixteen patients had FIGO stage I disease, and 22 patients were found to have endometrioid histology. While 14 patients had intermediate-risk EC, 12 patients had high-risk features. Moreover, 26 patients had pelvic LN dissection, and 15 patients underwent further para-aortic LN dissection, of which 888 LNs were retrieved. Six (23.1%) patients had LNM on pathologic examination (Figure 2).

Correlation of Preoperative ^{18}F-FDG PET/CT Metabolic Parameters with Clinicopathological Factors

According to the presence of LNM, metabolic parameters of PET and clinicopathological findings are shown in Table 2. The mean TLG-30, TLG-40, and SUV_{max}-T were significantly higher in patients with tumor diameter ≥2.5 cm ($p<0.01$), and only TLG-40 was significantly related with high-grade EC ($p=0.045$). The mean TLG-30, TLG-40, MTV-30, and MTV-40 of the local tumor were significantly higher in patients with locally advanced disease ($p<0.03$) (Table 3). Meanwhile, the mean SUV_{max}-P for LNM was significantly higher in the node-positive group than in the node-negative group ($p=0.009$). By contrast, SUV_{max}-T could not predict pelvic and/or para-aortic LNM. Moreover, no significant difference was found for SUV_{max}-T between endometrioid and non-endometrioid subtypes, with mean SUV_{max} of 13.02 and 13.68, respectively ($p>0.05$). Besides, the mean SUV_{max}-PA and SUV_{max}-IAC were not higher in patients with para-aortic LN metastases ($n=3$; $p<0.05$).

Cut-off Values of PET Parameters for Predicting Risk Factors

The ROC curve for SUV_{max}-P for discriminating LNM is shown in Figure 3 (AUC 0.900; 95% confidence interval (CI) 0.729-1.000; $p=0.003$). Using 2.81 as a cut-off value of SUV_{max}-P, the specificity, accuracy, sensitivity, positive predictive value, and negative predictive value of ^{18}F-FDG PET/CT in the detection of LNM in all patients ($n=26$) were 95%, 83.3%, 88.5%, 94.7%, and 71.4%, respectively (Table 3). The relationship between SUV_{max}-P and DFS and OS was not significant ($p=0.3$; $p=0.5$, respectively). The cut-off values of SUV_{max}-T, SUV_{max}-PA, and SUV_{max}-IAC were not significant to discriminate LNM, high-grade tumor, MI, or CI. For the prediction of LNM, MTV-30 and MTV-40 with cut-off values of 11.9 cm^3 and 24.8 cm^3 yielded sensitivity and specificity of 83.3-60% ($p=0.021$; AUC 0.817) and 66.7-100% ($p=0.051$; AUC 0.767), respectively.

For the prediction of CI and MI, cut-off values of metabolic PET parameters were also evaluated with ROC curve analysis (Figure 4, 5). For CI prediction, MTV-30 and MTV-40 with cut-off values of 20.7 cm^3 and 14.3 cm^3 yielded sensitivity and specificity of 75-88.9% ($p=0.006$; AUC 0.844) and 75-88.9%, respectively ($p<0.006$; AUC 0.819).

Table 1. Patient characteristics

		Intermediate risk (n=14)	High risk (n=12)
Histology n (%)	Adeno Ca	14 (100)	8 (66.7)
	Others	(-)	4 (33.3)
Tumor diameter mean ± SD (min-max)		3.07±1.3 (0.8-5.5)	3.8±2.3 (1-9)
≤2.5 cm; n (%)		7 (50)	4 (33.3)
>2.5 cm; n (%)		7 (50)	8 (66.7)
Grade, n (%)	1-2	12 (85)	5 (42)
	3	2 (15)	7 (58)
LVI n (%)	-	2 (14.3)	5 (41.7)
Myometrial invasion n (%)	<1/2	10 (71.4)	0
	>1/2	4 (28.6)	12 (100)
Cervical involvement n (%)	-	0	8 (66.7)
FIGO stage n (%)	1A	10 (71.4)	0 (0.0)
	1B	4 (28.6)	2 (16.7)
	2	-	4 (33.3)
	3c1	-	3 (25)
	3c2	-	3 (25)
Lymph node metastases; n (%)	-	0	6 (100)
Left pelvic LN mean ± SD (min-max)	-	12.1±7.4 (3-30)	13.6±7.5 (5-29)
Right pelvic LN mean ± SD (min-max)	-	10.8±4.5 (2-22)	10.6±4.75 (2-20)
Para-aortic LN mean ± SD (min-max)	-	6.9±13.3 (0-51)	12.5±7.5 (0-24)
Presacral LN mean ± SD (min-max)	-	1.05±2.64 (0-9)	0.5±1 (0-3)
SUV_{max}-T mean ± SD (min-max)	-	12.8±7.4 (0.8-5.5)	13.62±7.5 (1-9)
SUV_{max}-P mean ± SD (min-max)	-	2.11±0.45 (1.5-3.1)	2.57±0.95 (1.1-4.24)
SUV_{max}-PA mean ± SD (min-max)	-	0.57±1 (0-2.9)	0.61±0.92 (0-2.44)
SUV_{max}-IAC mean ± SD (min-max)	-	0.34±1.29 (0-4.8)	0.28±0.68 (0-2.1)
MTV-30 mean ± SD (min-max)	-	11.69±6.9 (3.67-33.1)	36.5±36.4 (2.8-120.1)
TLG-30 mean ± SD (min-max)	-	79.1±72.6 (19.2-290.3)	243.3±351.7 (17-1314)
MTV-40 mean ± SD (min-max)	-	7.9±4.6 (2.7-21.3)	23.8±24.4 (1.74-85.5)
TLG-40 mean ± SD (min-max)	-	61.5±55.3 (13.8-211)	189.5±286.6 (13.1-1067)

LVI: Lymphovasculer invasion, FIGO: International Federation of Gynecology and Obstetrics, SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, SD: Standard deviation, min: Minimum, max: Maximum, LN: Lymph node, IAC: Invasive adenocarcinoma

The area under the ROC plot for detecting LNM using TLG-30 with a cut-off value of 99.09 g/mL cm^3 was 0.792 (sensitivity 83.3%; specificity 75%; p=0.033). Additionally, the AUC of TLG-30 with a cut-off value of 82.06 g/mL cm^3 was 0.788 (sensitivity 68.8%; specificity 80%; p=0.015) and the AUC of TLG-40 with a cut-off value of 49.01 g/mL cm^3 was 0.781 (sensitivity 75%, specificity 70%, p=0.018), and they were significant predictors of MI. Furthermore, mean tumor diameter and lymphovascular invasion had significant relation with MI.

Multiple Logistic Regression Analysis

According to the regression analysis, MTV-40 [p=0.043; odds ratio (OR) 1.123; 95% CI 1.004-1.258] was an independent predictor of LNM, and the lymphovascular invasion (p=0.037; OR 64.006; 95% CI 1.291-3172.4) was the only significant predictive factor of MI. In addition, MTV-30 was a significant predictor of CI (p=0.04; OR 1.108; 95% CI 1.005-1.223; Table 4).

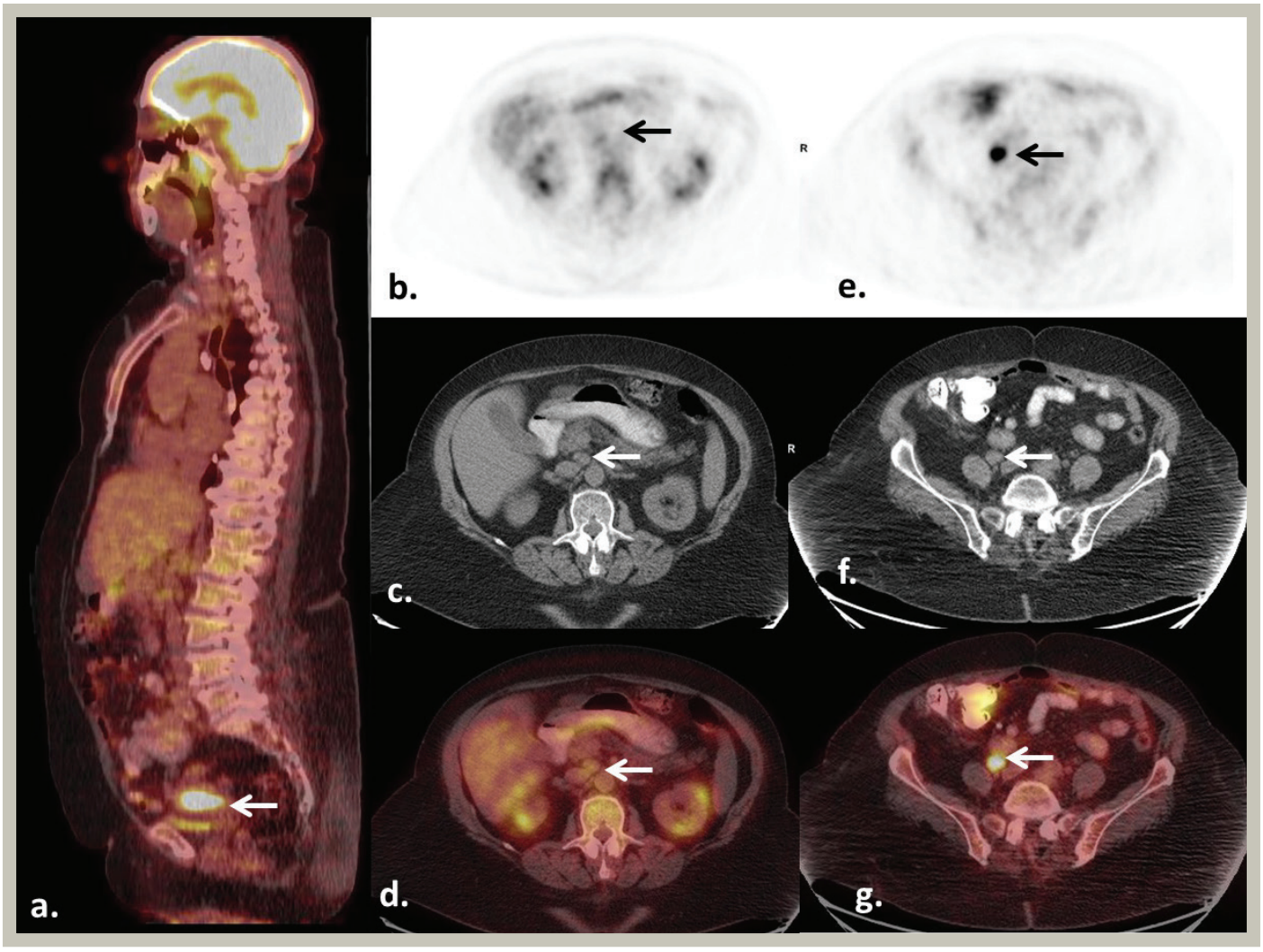

Figure 2. Pretreatment [18]F-FDG PET/CT images of a 62-year-old patient with high-risk EC. a) Sagittal fused image of pretreatment PET/CT demonstrates high FDG uptake of the primary tumor (arrow). b, c, d) Axial PET, fused, and CT images of interaortocaval lymph node metastasis (arrows). e, f, g) Axial PET, fused, and CT images of right common iliac lymph node metastasis (arrows)

[18]F-FDG:[18]F-fluoro-deoxy-glucose, PET/CT: Positron emission tomography/computed tomography, EC: Endometrial cancer

Table 2. PET parameters according to lymph node metastases

	Lymph node metastases [n=6 (23%)]	
	Yes	p
SUV_{max}-T mean ± SD (median)	13.2±5.5 (12.8)	0.972
SUV_{max}-P mean ± SD (median)	3.28±0.81 (346)	**0.009**
SUV_{max}-PA mean ± SD (median)	0.94±1.08 (0-2.44)	0.264
MTV-30 mean ± SD (median)	52.9±45.6 (39.5)	**0.021**
TLG-30 mean ± SD (median)	357.8±479.3 (179.8)	**0.033**
MTV-40 mean ± SD (median)	35.1±30.6 (29.9)	0.051
TLG-40 mean ± SD (median)	279.9±391.9 (143.4)	0.051

p<0.05 is significant. SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, PET: Positron emission tomography, SD: Standard deviation

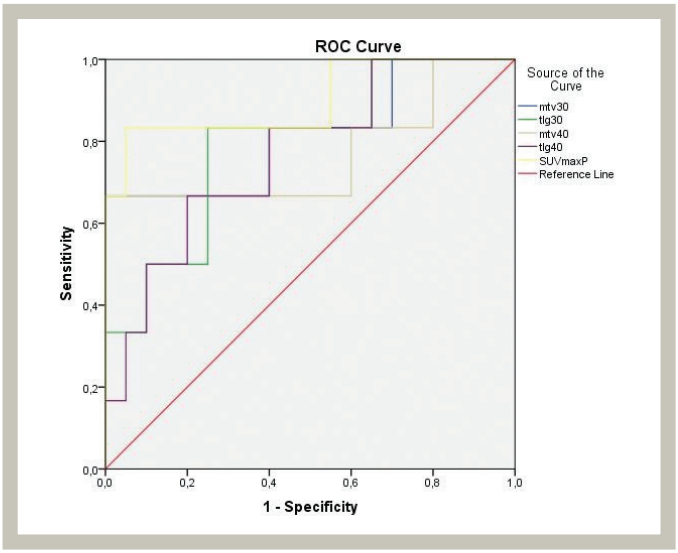

Figure 3. ROC curve associated with the metabolic parameters on ^{18}F-FDG PET/CT in predicting lymph node metastases

ROC: Receiver-operating characteristic, ^{18}F-FDG: ^{18}F-fluoro-deoxy-glucose, PET/CT: Positron emission tomography/computed tomography, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, SUV_{max}: Maximum standardized uptake value

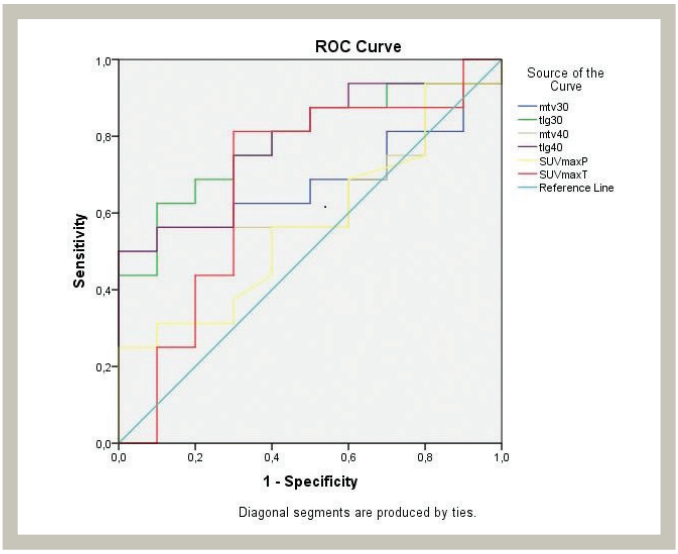

Figure 4. ROC curve analysis for the diagnostic value of maximum standardized uptake value of the primary tumor and metabolic parameters in predicting deep myometrial invasion

ROC: Receiver-operating characteristic, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, SUV_{max}: Maximum standardized uptake value

Discussion

In accordance with the literature, we found that SUV_{max}-P, MTV-30, and TLG-30 were significantly correlated with LNM in patients with EC. Moreover, we found significant correlation between these metabolic parameters and MI and CI, which are well-known prognostic factors to predict LNM in EC.

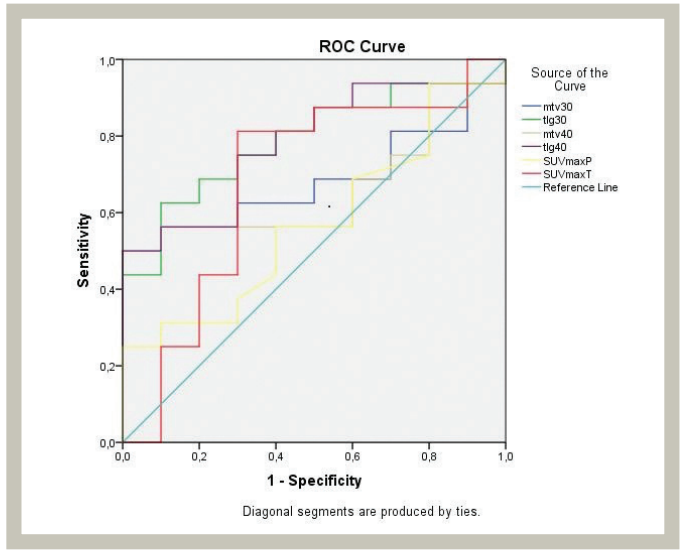

Figure 5. ROC curve analysis for the diagnostic value of maximum standardized uptake value of the primary tumor and metabolic parameters in predicting cervical invasion

ROC: Receiver-operating characteristic, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, SUV_{max}: Maximum standardized uptake value

In patients with inoperable EC, primary radiotherapy is the preferred treatment (10). By contrast, adjuvant radiotherapy is widely used, depending on the individual risk factors, including histological subtype, grading, lymphovascular-stromal invasion, MI and CI, tumor size, and LNM (9). While these prognostic factors were previously determined through surgery and pathological examination, nowadays, imaging modalities allow evaluation of tumor size, MI and CI, and LNM to some extent.

Patients with EC with early stage, grade 1, and grade 2 endometrioid histology, preoperative imaging usually does not significantly change the baseline management or prognosis. However, staging of patients with high-risk EC with ^{18}F-FDG PET/CT has become more common gradually. This is an important issue because LNM is a major factor in treatment planning and prediction of prognosis. However, few studies have examined the diagnostic accuracy of PET/CT for the detection of LNM in EC, and available results show variable accuracy (11). Studies have reported that ^{18}F-FDG PET/CT have high specificity in detecting metastatic nodes; however, its sensitivity was only modest and affected by the size of the metastatic deposit (12,13). In our study, we found high sensitivity, specificity, and accuracy of SUV_{max}-P with a specific cut-off value in the detection of LNM, and this finding was diffferent from those of previous studies.

Table 3. Sensitivity, specificity, area under the curve, and p value of metabolic parameters on ^{18}F-FDG PET/CT for detecting lymph node metastases

	Sensitivity	Specificity	AUC	95% CI	p value
SUV_{max}-P ≥2.81	83.3	95	0.900	0.729-1000	0.003
MTV-30 ≥11.89	83.3	60	0.817	0.586-1000	0.021
TLG30 ≥99.09	83.3	75	0.792	0.583-1000	0.033
MTV-40 ≥24.82	66.7	100	0.767	0.489-1000	0.051
TLG-40 ≥62.18	83.3	60,0	0.767	0.552-0.981	0.051

p<0.05 is significant. SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycosis, AUC: Area under the curve, CI: Confidence interval, ^{18}F-FDG: ^{18}F-fluoro-deoxy-glucose, PET/CT: Positron emission tomography/computed tomography

Table 4. Results of multiple logistic regression analysis

		Lymph node metastases		
	p	**OR**	**95% CI**	
MTV- 40	0.043	1.123	1.004	1.258
		Myometrial invasion		
	p	OR	95% CI	
LVI	0.037	64.006	1.291	3172.464
TLG-30	0.075	1.013	0.999	1.028
Tumor diameter	0.103	2.533	0.828	7.748
		Cervical invasion		
	p	**OR**	**95% CI**	
Histology	0.056	22.058	0.928	524.149
MTV-30	0.040	1.108	1.005	1.223

p<0.05 is significant. MTV: Metabolic tumor volume, LVI: Lymphovascular invasion, TLG: Total lesion glycosis, OR: Odds ratio, CI: Confidence interval

Previous studies have demonstrated that high SUV_{max}-T can be associated with the aggressiveness of EC (3,4), although its effect on overall survival or locoregional relapse remains controversial (5,11). Yahata et al. (13) reported that a high SUV_{max}-T was predictive of risk factors, such as deep MI, locally advanced stage, and node metastasis in EC. In contrast to these studies, the present study showed that SUV_{max}-T had significant relation only with tumor diameter in patients with EC.

In recent years, several metabolic parameters of PET/CT, besides the SUV_{max}, were reported to be useful in EC. Kitajima et al. (14) demonstrated that the MTV and TLG of local tumors were correlated with pathological features and were suggested useful for differentiating high- from low-risk EC. Consistently, Chung et al. (8) reported that MTV was an independent prognostic factor for disease recurrence in EC, and Husby et al. (15) reported that MTV was useful to classify patients with high-risk EC. Lee et al. (16) showed that preoperative TLG was related with disease recurrence in 28 patients with carcinosarcoma. Additionally, Shim et al. (17) stated that preoperative MTV and TLG could be independent prognostic factors to predict EC recurrence. In the present study, we found that MTV and/or TLG may be a new tool to assess well-established surrogate markers for poor outcome: High-grade disease, advanced FIGO stage, CI, and LNM. Therefore, we evaluated potential cut-offs to help identify patients at a higher risk of having these markers. For CI and LNM prediction, we found specific cut-off values for MTV-30 and MTV-40. Additionally, TLG-40 was a significant predictor of high-grade tumors, and TLG-30 and TLG-40 were higher in patients with EC with high FIGO stages. Our results also suggest the potential importance ofMTV and TLG for the preoperative classification of patients with high-risk status and improve the ability to tailor surgical and systemic therapies accordingly. Our results are similar with those of previous studies (15,17) that emphasize MTV and TLG as significant predictors of several clinicopathologic characteristics and superior to SUV_{max}-T in differentiating patients with high-risk status from those with low-risk status.

However, we could not achieve significant cut-off values for SUV_{max}-T, SUV_{max}-PA, and SUV_{max}-IAC to predict LNM, deep MI, CI, and high-grade EC. As SUV_{max}-T only represents the

single greatest point of metabolic activity within the tumor, it cannot evaluate the entire metabolic tumor burden (18). Meanwhile, MTV and TLG can evaluate metabolic activity throughout the tumor volume. Therefore, these parameters could reflect tumor histology, prognosis, and treatment response more precisely than SUV_{max}-T.

Study Limitations

This study has some limitations. First, it was a retrospective study. Second, the study was conducted with a relatively small number of patients. Third, the study cohort was composed of patients with intermediate- or high-risk status and these findings do not represent those with low-risk status. Prospective studies with a larger number of patients and longer follow-up periods are required to confirm our findings. The potential added value of ^{18}F-FDG PET/CT as a predictive biomarker is promising but requires further evaluation.

Conclusion

SUV_{max}-P, MTV, and TLG cut-off values on ^{18}F-FDG PET/CT for the prediction of LNM increase the diagnostic accuracy and aid pretreatment identification of patients with high-risk status. Especially, SUV_{max}-P can be useful in deciding the extent of LN dissection and radiation therapy field for patients with medically inoperable intermediate-high-risk EC or for patients with inadequate surgical staging.

Ethics

Ethics Committee Approval: The study was approved as a retrospective study by the İstanbul Training and Research Hospital Clinical Research Ethics Committee (decision no: 1447, date: 28.09.2018).

Informed Consent: The requirement to obtain informed written consent was abandoned.

Peer-review: Externally peer-reviewed.

Authorship Contributions

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