

Association Between Preoperative Primary Tumor SUVmax on FDG PET/CT and High-Risk Pathological Features for the Prediction of Lymph Node Metastasis in Endometrial Cancer

 Serhan Can İşcan^{1*},  Fatih Akkuş²,  Çağlayan Biçer³,  Selçuk Erkinç⁴

¹ Department of Gynecologic Oncology, Faculty of Medicine, Kütahya Health Sciences University, Kütahya, Türkiye

² Department of Obstetrics and Gynecology, Faculty of Medicine, Kütahya Health Sciences University, Kütahya, Türkiye

³ Department of Obstetrics and Gynecology, Isparta City Hospital, Isparta, Türkiye

⁴ Department of Gynecologic Oncology, Faculty of Medicine, İzmir Democracy University, İzmir, Türkiye

*Correspondence: Serhan Can İşcan; serhancaniscan@gmail.com

Cite as: İşcan SC, Akkuş F, Biçer Ç, Erkinç S. Association between preoperative primary tumor SUVmax on FDG PET/CT and high-risk pathological features for the prediction of lymph node metastasis in endometrial cancer. *J Cukurova Anesth Surg.* 2026;9(3):1063-1073.
doi: 10.36516/jocass.2015278

Received: 10.08.2026, **Accepted:** 25.09.2026, **Published:** 30.09.2026, CC BY-NC 4.0

Abstract

Aim: To evaluate the association between preoperative primary tumor SUVmax on 18F-FDG PET/CT and lymph node metastasis, and to assess its relationship with high-risk pathological features in surgically staged endometrial cancer patients. **Materials and Methods:** In this retrospective cohort study, 134 patients with histologically confirmed endometrial cancer who underwent preoperative 18F-FDG PET/CT and primary surgical staging were included. Primary tumor SUVmax, clinical, imaging, and histopathological parameters were compared between patients with and without lymph node metastasis. ROC curve analysis and univariable/multivariable logistic regression were performed to identify predictors of nodal metastasis. **Results:** Lymph node metastasis was present in 16 patients (11.9%). Median SUVmax was significantly higher in the lymph-node-positive group (22.60 vs. 14.56; $p = 0.003$). SUVmax showed moderate discrimination for lymph node metastasis (AUC 0.733; optimal cutoff ≥ 21.10 ; sensitivity 62.5%, specificity 79.7%, negative predictive value 94.0%). Pathological tumor diameter showed the numerically highest AUC (0.822), though DeLong's test revealed no significant pairwise differences among ROC curves. On univariable analysis, SUVmax, tumor diameter, CA125, high grade, non-endometrioid histology, LVSI, deep myometrial invasion, and cervical involvement were significantly associated with nodal metastasis. In the exploratory multivariable model, LVSI remained independently associated (adjusted OR 14.33; $p = 0.001$), while SUVmax ($p = 0.182$) and deep myometrial invasion ($p = 0.094$) lost statistical significance. **Conclusion:** Primary tumor SUVmax is significantly associated with lymph node metastasis and correlates with high-risk pathological features in endometrial cancer. Its moderate discriminatory performance suggests that SUVmax may provide complementary, noninvasive information for preoperative risk assessment. However, SUVmax did not remain statistically significant in the exploratory multivariable model and should not be considered an independent determinant of surgical management. The high negative predictive value observed in this cohort should also be interpreted in the context of the relatively low prevalence of lymph node metastasis. Larger prospective studies are required to determine the incremental value of SUVmax when combined with established preoperative risk factors.

Keywords: Positron Emission Tomography-Computed Tomography, Endometrial Neoplasms, Lymphatic Metastasis, Risk factors, SUVmax.

1. Introduction

Endometrial cancer is the most common malignancy of the female genital tract in Türkiye and other developed countries^{1,2}. Endometrial cancer is frequently identified in the early stages of the disease and has a favorable overall prognosis. The five-year survival rate for localized tumor is 96 percent³. The staging of endometrial cancer is determined by the outcomes of total abdominal hysterectomy, bilateral salpingo-oophorectomy, pelvic and paraaortic lymphadenectomy, and omentectomy. The prognosis is contingent upon age, tumor grade and histology, extent of myometrial invasion, cervical involvement, lymph node metastasis, Lymphovascular space invasion (LVSI)^{4,5}. Nodal involvement is a particularly important prognostic factor and is associated with substantially poorer survival^{6,7}. Contrast-enhanced CT and MRI are commonly used for preoperative staging⁸, while 18F-FDG PET/CT provides complementary metabolic information and may detect metastatic disease in morphologically normal-sized lymph nodes or small metastatic foci⁹. PET/CT scans also help in planning the extent of the operation. Differentiating between early and late stages can prevent complications that may occur after lymph node dissection or can prevent recurrence that may occur due to inappropriate treatment^{7,10,11}. Lymph node dissection increases the duration of surgery and has been associated with longer hospital stays and higher treatment costs. Furthermore, patients with endometrial cancer often have additional morbidities such as morbid obesity, metabolic syndrome, hypertension, and diabetes, defining them high-risk patients for surgery. Additionally, lymphadenectomy has not been shown to contribute to survival in early-stage cancers¹². The maximum standardized uptake value (SUVmax) is the most widely used semiquantitative PET parameter and has been associated with aggressive tumor characteristics, including myometrial invasion (MI), cervical involvement (CI), lymph node metastasis (LNM), and high-risk malignancies in endometrial carcinoma (EC)¹³.

This study aimed to evaluate the association between preoperative primary tumor SUVmax measured on 18F-FDG PET/CT and histopathologically confirmed lymph node metastasis in surgically staged endometrial cancer. A secondary aim was to assess the relationship between primary tumor SUVmax and established high-risk pathological features.

2. Materials and Methods

This retrospective, cohort study was conducted at the Department of Gynecological Oncology, Isparta City Hospital and Buca Seyfi Demirsoy Research and Training Hospital. The study was approved by the Non-invasive Clinical Research Ethics Committee of Izmir Democracy University (2023/11-23) and was conducted in accordance with the Declaration of Helsinki. Four hundred two patients who underwent surgery from January 2017 to March 2026 with histologically verified endometrial cancer, were evaluated for eligibility. Of these, 134 met all inclusion criteria and were included in the final analysis. The remaining 268 patients were excluded because they did not meet one or more pre-specified eligibility criteria, including absence of preoperative whole-body 18F-FDG PET/CT, incomplete PET/CT or histopathological data, absence of the required surgical staging or nodal assessment, receipt of neoadjuvant chemotherapy or radiotherapy, a synchronous or recent malignancy that could confound FDG uptake, uncontrolled diabetes mellitus at the time of PET/CT, or a primary tumor that was not sufficiently FDG-avid or measurable for reliable SUVmax assessment. Eligible patients had undergone primary surgical staging comprising at least total hysterectomy with bilateral salpingo-oophorectomy and pelvic and para-aortic nodal assessment, with omentectomy when clinically indicated, and had complete histopathological reporting of tumor grade, histologic subtype, LVSI, depth of myometrial invasion, cervical stromal involvement, and nodal status.

All patients fasted for a minimum of 6 hours before the examination, and blood glucose was confirmed to be below 200 mg/dL (11.1 mmol/L) prior to tracer injection, in accordance with EANM procedural guidelines for tumor imaging¹⁴. 18F-FDG was administered intravenously at a weight-adjusted dose of 5 MBq/kg, and whole-body PET/CT acquisition (skull base to mid-thigh) was performed 60 ± 10 minutes after injection using a Siemens Biograph 16 PET/CT system. For anatomical localization and attenuation correction, low-dose, non-contrast CT was obtained. Four nuclear medicine specialists evaluated PET images both visually and quantitatively. Due to the requirement of a pathological diagnosis prior to conducting a PET/CT scan, the specialists analyzing the PET/CT scans were informed of the patients' diagnoses. For quantitative assessment, a volume of interest was placed over the primary endometrial tumor at the region demonstrating the highest FDG uptake, and the body-weight-normalized maximum standardized uptake value (SUVmax) was recorded for each patient. Histologic subtype was classified as endometrioid or non-endometrioid (serous, clear-cell, carcinosarcoma, and mixed carcinoma). Tumor grade was assigned according to the FIGO grading system for endometrioid carcinoma, and grade 3 tumors, together with non-endometrioid histology, were considered high-grade/high-risk histology. Depth of myometrial invasion was categorized as absent/superficial (<50% of myometrial thickness) or deep ($\geq 50\%$). Cervical stromal involvement was recorded as present or absent. Lymph node metastasis was defined as histopathologically confirmed tumor deposits in any dissected pelvic or paraaortic lymph node. Pathological tumor diameter was measured as the largest dimension of the tumor on the surgical specimen. Surgical-pathological staging was assigned according to the 2009 FIGO staging system.

Preoperative clinical data were extracted from institutional electronic records, including age, body mass index (BMI, kg/m²), serum CA125 level before surgery, preoperative tumor diameter assessed by PET/CT.

2.1. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA), JASP version 0.98.1 (JASP Team, University of Amsterdam, Amsterdam, the Netherlands), and jamovi version 2.7 (The jamovi project, 2025, Available from: <https://www.jamovi.org>). Continuous variables were assessed for normality using the Shapiro–Wilk test. Normally distributed variables are presented as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables are presented as median and interquartile range (IQR). Comparisons between patients with and without histopathologically confirmed lymph node metastasis were performed using the independent-samples Student's t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Welch's correction was applied when the assumption of homogeneity of variances was violated. Categorical variables are presented as counts and percentages and were compared using the chi-square test or Fisher's exact test, as appropriate.

The discriminatory performance of continuous parameters for predicting lymph node metastasis was evaluated using receiver operating characteristic (ROC) curve analysis. The parameters assessed included primary tumor SUVmax, pathological tumor diameter, preoperative tumor size on imaging, and serum CA125. Areas under the ROC curve (AUCs) were reported with corresponding 95% confidence intervals (CIs). Optimal cutoff values were determined by maximizing the Youden index (sensitivity + specificity – 1), and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated at the optimal cutoff for each parameter. Pairwise comparisons between ROC curves were performed using DeLong's test in jamovi version 2.7.

Univariable binary logistic regression analyses were performed to identify potential predictors of lymph node metastasis. Candidate variables included primary tumor SUVmax, pathological tumor diameter, serum CA125, BMI, age, high tumor grade (Grade 3 vs Grades 1–2), non-endometrioid histology, lymphovascular space invasion (LVSI), deep myometrial invasion ($\geq 50\%$), and cervical stromal involvement. Because of its markedly skewed distribution, CA125 was log-transformed before inclusion in the regression analyses. Results are reported as odds ratios (ORs) with corresponding 95% CIs. Given the limited number of lymph node metastasis events ($n = 16$), the multivariable logistic regression model was deliberately restricted to three clinically relevant variables—primary tumor SUVmax, LVSI, and deep myometrial invasion—to reduce the risk of model overfitting. This corresponded to approximately five events per variable; therefore, the multivariable findings were considered exploratory. Model explanatory performance was summarized using pseudo- R^2 . All statistical tests were two-sided, and a p value < 0.05 was considered statistically significant.

3. Results

3.1. Patient Characteristics

A total of 134 patients were included in the final analysis. The mean age was 61.65 ± 10.62 years, and the median primary tumor SUVmax was 15.48 (IQR, 8.65–21.27). Histopathologically confirmed lymph node metastasis was present in 16 patients (11.9%). Endometrioid histology was seen in 79.1% of the tumors and Grade 3 in 32.8%. LVSI and deep myometrial invasion were present in 18.7% and 53.7% of patients, respectively. Baseline demographic, imaging, and pathological characteristics are summarized in Table 1.

Table 1. Demographic, clinical, imaging, and pathological characteristics of the study population ($n = 134$)

Variable	Value ($n = 134$)
Age (years)	61.65 ± 10.62
BMI (kg/m^2)	32.13 (28.89–36.41)
CA125 (U/mL)	12.70 (7.30–30.20)
Primary tumor SUVmax	15.48 (8.65–21.27)
Preoperative tumor size (imaging) (cm)	3.80 (2.42–5.47)
Pathological tumor diameter (cm)	4.00 (2.70–6.00)
FIGO stage	
IA	57 (42.5%)
IB	24 (17.9%)
II	21 (15.7%)
IIIA	2 (1.5%)
IIIC1	4 (3.0%)
IIIC2	12 (9.0%)
IVA	4 (3.0%)
IVB	10 (7.5%)
Tumor grade	
Grade 1	64 (47.8%)
Grade 2	26 (19.4%)
Grade 3	44 (32.8%)
Histologic type	
Endometrioid	106 (79.1%)

Variable	Value (n = 134)
Non-endometrioid	28 (20.9%)
Serous carcinoma	17 (12.7%)
Clear cell carcinoma	4 (3.0%)
Carcinosarcoma	2 (1.5%)
Mixed serous-endometrioid carcinoma	2 (1.5%)
Mixed mucinous carcinoma	1 (0.7%)
Poorly differentiated malignant epithelial tumor	1 (0.7%)
Neuroendocrine carcinoma (small cell)	1 (0.7%)
Lymphovascular space invasion (LVSI)	25 (18.7%)
Deep myometrial invasion ($\geq 50\%$)	72 (53.7%)
Cervical stromal involvement	38 (28.4%)
Positive peritoneal cytology	8 (6.0%)
Omentectomy performed	125 (93.3%)
Preoperative PET/CT-suspicious lymph node	44 (32.8%)
Preoperative PET/CT-suspected deep invasion	62 (46.3%)
Pathological lymph node metastasis	16 (11.9%)

Continuous variables are presented as mean $\pm$ SD or median (IQR) according to distribution; categorical variables as n (%). SUVmax: maximum standardized uptake value; CA125: cancer antigen 125; FIGO: International Federation of Gynecology and Obstetrics (2009 staging).

3.2. Comparison According to Lymph Node Metastasis Status

Patients with lymph node metastasis had significantly higher primary tumor SUVmax values than those without metastasis (22.60 [IQR, 16.75–24.52] vs. 14.56 [IQR, 7.90–19.97]; $p = 0.003$; Figure 1). CA125 levels and both preoperative and pathological tumor diameters were also significantly higher in the lymph-node-positive group, whereas BMI was lower. High tumor grade, non-endometrioid histology, LVSI, deep myometrial invasion, and cervical stromal involvement were significantly more frequent among lymph-node-positive patients. Age, peritoneal cytology, and omentectomy rates did not differ significantly between groups (Table 2).

Table 2. Comparison of clinical, PET/CT, and pathological parameters according to lymph node metastasis status

Variable	Total (n=134)	LN negative (n=118)	LN positive (n=16)	p
Age (years)	61.65 $\pm$ 10.62	61.07 $\pm$ 10.55	65.94 $\pm$ 10.45	0.096
BMI (kg/m ²)	32.13 (28.89–36.41)	32.55 (29.13–36.66)	28.37 (26.27–31.61)	0.026
CA125 (U/mL)	12.70 (7.30–30.20)	12.20 (6.40–21.70)	42.90 (15.58–72.75)	0.002
Primary tumor SUVmax	15.48 (8.65–21.27)	14.56 (7.90–19.97)	22.60 (16.75–24.52)	0.003
Preoperative tumor size (imaging) (cm)	3.80 (2.42–5.47)	3.20 (2.23–5.00)	6.10 (4.57–7.12)	0.001
Pathological tumor diameter (cm)	4.00 (2.70–6.00)	4.00 (2.50–5.50)	6.90 (5.88–8.62)	0.001
Tumor grade	Grade 1 64 (47.8%)	61 (51.7%)	3 (18.8%)	0.001
	Grade 2 26 (19.4%)	25 (21.2%)	1 (6.2%)	
	Grade 3 44 (32.8%)	32 (27.1%)	12 (75.0%)	

Variable	Total (n=134)	LN negative (n=118)	LN positive (n=16)	p
Histologic type				
Non-endometrioid	28 (20.9%)	20 (16.9%)	8 (50.0%)	0.006
LVSI positive	25 (18.7%)	13 (11.0%)	12 (75.0%)	0.001
Deep myometrial invasion (≥50%)	72 (53.7%)	57 (48.3%)	15 (93.8%)	0.002
Cervical stromal involvement	38 (28.4%)	29 (24.6%)	9 (56.2%)	0.015
Positive peritoneal cytology	8 (6.0%)	7 (6.0%)	1 (6.2%)	1.000
Omentectomy performed	125 (93.3%)	109 (92.4%)	16 (100.0%)	0.599

LN: lymph node. *p*-values from independent-samples *t*-test/Mann-Whitney *U* test (continuous variables, per normality) or chi-square/Fisher's exact test (categorical variables).

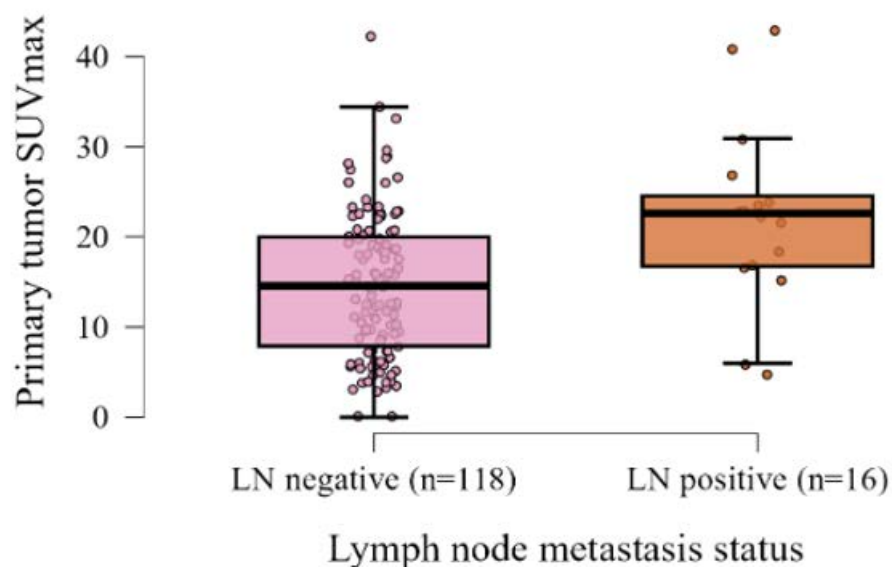


Figure 1. Comparison of primary tumor SUVmax values between patients with and without lymph node metastasis

3.3. ROC and Diagnostic Performance Analyses

Primary tumor SUVmax showed moderate discrimination for lymph node metastasis (AUC 0.733, 95% CI 0.592–0.873; $p = 0.001$), with an optimal cutoff of ≥ 21.10 , yielding 62.5% sensitivity, 79.7% specificity, and 94.0% NPV. Pathological tumor diameter showed the highest numerical AUC (0.822, 95% CI 0.729–0.914), followed by preoperative tumor size (AUC 0.762) and CA125 (AUC 0.735). However, DeLong's test showed no significant pairwise differences between the ROC curves (all $p > 0.05$; Table 3 and Figure 2).

Table 3. ROC curve analysis of continuous parameters for the prediction of lymph node metastasis

Parameter	AUC (95% CI)	p	Cutoff	Sens. (%)	Spec. (%)	PPV (%)	NPV (%)	Acc. (%)
Primary tumor SUVmax	0.733 (0.592–0.873)	0.001	21.10	62.5	79.7	29.4	94.0	77.6
Pathological tumor diameter (cm)	0.822 (0.729–0.914)	0.001	5.35	81.3	72.9	28.9	96.6	73.9

Parameter	AUC (95% CI)	p	Cutoff	Sens. (%)	Spec. (%)	PPV (%)	NPV (%)	Acc. (%)
Preoperative tumor size, imaging (cm)	0.762 (0.653–0.872)	0.001	4.45	87.5	66.1	25.9	97.5	68.7
CA125 (U/mL)	0.735 (0.608–0.862)	0.001	22.65	68.8	75.2	27.5	94.6	74.4

AUC: area under the curve. Cutoff values were determined by the Youden index. Sens.: sensitivity; Spec.: specificity; PPV: positive predictive value; NPV: negative predictive value; Acc.: accuracy. CA125: cancer antigen.

DeLong's test showed no significant pairwise differences between the ROC curves of primary tumor SUVmax, pathological tumor diameter, preoperative tumor size, and CA125 (all $p > 0.05$). Although pathological tumor diameter yielded the highest AUC (0.822), its discriminatory performance was not significantly superior to that of the other parameters.

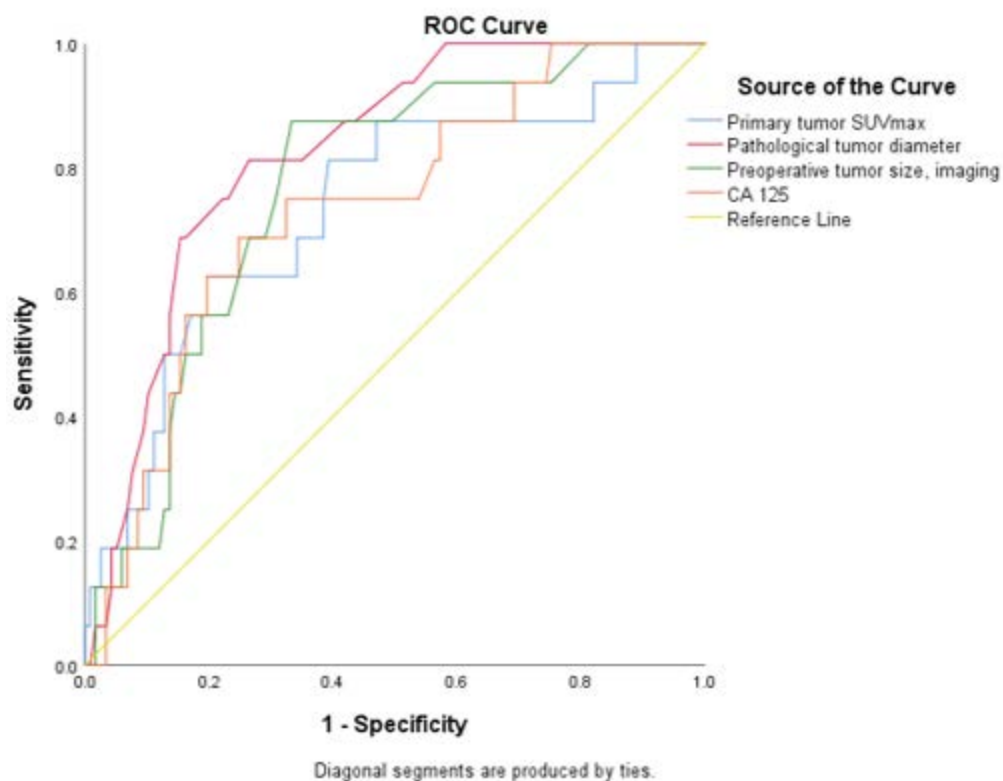


Figure 2. Receiver operating characteristic (ROC) curves of continuous parameters for predicting lymph node metastasis

3.4. Predictors of Lymph Node Metastasis

In univariable logistic regression, primary tumor SUVmax, pathological tumor diameter, CA125, high tumor grade, non-endometrioid histology, LVSI, deep myometrial invasion, and cervical stromal involvement were significantly associated with lymph node metastasis. LVSI showed the strongest association (OR 24.23, 95% CI 6.81–86.27; $p = 0.001$). In the exploratory multivariable model, LVSI remained independently associated with lymph node metastasis (adjusted OR 14.33, 95% CI 3.77–54.40; $p = 0.001$), whereas deep myometrial invasion ($p = 0.094$) and primary tumor SUVmax ($p = 0.182$) were no longer statistically significant (Table 4).

Table 4. Univariable and multivariable logistic regression analyses for predictors of lymph node metastasis

Variable	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Primary tumor SUVmax	1.10 (1.04–1.17)	0.002	1.05 (0.98–1.14)	0.182
Pathological tumor diameter	1.33 (1.13–1.56)	0.001	—	—
CA125	1.59 (1.10–2.30)	0.015	—	—
BMI	0.93 (0.84–1.03)	0.145	—	—
Age	1.05 (0.99–1.10)	0.089	—	—
High grade (Grade 3 vs Grade 1–2)	8.06 (2.42–26.83)	0.001	—	—
Non-endometrioid histology	4.90 (1.64–14.60)	0.004	—	—
LVSI positive	24.23 (6.81–86.27)	0.001	14.33(3.77–54.40)	0.001
Deep myometrial invasion (≥50%)	16.05 (2.05–125.47)	0.008	6.43(0.73–56.81)	0.094
Cervical stromal involvement	3.95 (1.35–11.54)	0.012	—	—

OR, odds ratio; CI, confidence interval; BMI, body mass index; LVSI, lymphovascular space invasion. High grade was defined as Grade 3 versus Grades 1–2. CA125 was log-transformed before analysis because of its markedly skewed distribution. The multivariable model included primary tumor SUVmax, LVSI, and deep myometrial invasion (≥50%); $n = 134$, with 16 lymph node metastasis events. The model pseudo- R^2 was 0.37.

4. Discussion

In this retrospective cohort of 134 surgically staged endometrial cancer patients, preoperative primary tumor SUVmax on 18F-FDG PET/CT was significantly associated with histopathologically confirmed lymph node metastasis, and higher SUVmax values correlated with several established high-risk pathological features, including high tumor grade, non-endometrioid histology, LVSI, deep myometrial invasion, and cervical stromal involvement. These findings are consistent with the biological rationale that SUVmax reflects tumor glucose metabolism, which parallels proliferative activity, cellular density, and aggressive tumor phenotype^{13,15}.

The AUC of 0.733 for primary tumor SUVmax indicates moderate discrimination for lymph node metastasis and is comparable to previously reported PET-based estimates in endometrial cancer^{3,6}. At the optimal cutoff of 21.10, sensitivity was 62.5% and specificity was 79.7%, broadly consistent with the moderate diagnostic performance reported in prior studies and meta-analyses^{7,10}. The NPV was high (94.0%); however, this estimate must be interpreted in the context of the relatively low prevalence of lymph node metastasis in our cohort (11.9%), which inherently increases NPV. Therefore, a low primary tumor SUVmax should not be used in isolation to omit sentinel lymph node mapping or other indicated nodal assessment. Rather, SUVmax may contribute complementary information when interpreted together with established clinical, imaging, and pathological risk factors.

Our finding that pathological tumor diameter yielded the numerically highest AUC (0.822), although not statistically superior to SUVmax, preoperative imaging size, or CA125 on DeLong's test, underscores that tumor burden—whether assessed metabolically or morphologically—carries comparable prognostic weight for nodal spread. This is in agreement with Dağ et al., who reported that combined metabolic and volumetric PET parameters improved risk stratification beyond SUVmax alone in patients undergoing postoperative radiotherapy for endometrial cancer¹³. Similarly, Shibuya et al. demonstrated that SUVmax retained independent prognostic value for outcome prediction, although its performance varied according to histologic and molecular subgroup, suggesting

that metabolic imaging parameters may perform differently depending on underlying tumor biology¹⁶.

An important observation in our study was that although SUVmax was significantly associated with lymph node metastasis in univariable analysis (OR 1.10, 95% CI 1.04–1.17), it lost statistical significance in the exploratory multivariable model (adjusted OR 1.05, 95% CI 0.98–1.14; $p = 0.182$) after adjustment for LVSI and deep myometrial invasion, whereas LVSI remained the strongest independent predictor (adjusted OR 14.33, 95% CI 3.77–54.40). These findings indicate that SUVmax should not be interpreted as an independent determinant of nodal metastasis or surgical management. The attenuation of its association may partly reflect overlap between metabolic tumor activity and adverse pathological features such as LVSI and deep myometrial invasion¹⁵. Given the limited number of lymph node metastasis events in our cohort ($n = 16$), the multivariable model was restricted to three variables to maintain an acceptable events-per-variable ratio; therefore, these findings should be interpreted as exploratory rather than confirmatory, and larger prospective series are needed to clarify whether SUVmax provides independent predictive value once LVSI status is known. This pattern is consistent with prior literature indicating that while SUVmax correlates strongly with individual high-risk features, LVSI and deep myometrial invasion often subsume much of this predictive information in multivariable models^{4,15}.

Although LVSI emerged as the strongest independent predictor of lymph node metastasis in our multivariable model, this finding carries an important practical caveat: LVSI status is, by definition, established only through histopathological examination of the surgical specimen and is therefore unavailable to the clinician at the time of preoperative decision-making. In this respect, LVSI and primary tumor SUVmax occupy fundamentally different roles in the clinical pathway—the former is a postoperative prognostic descriptor, whereas the latter is a preoperative, noninvasive parameter that can inform surgical planning before any tissue is obtained. From a purely predictive standpoint, LVSI outperformed SUVmax in our cohort; however, from a clinically actionable standpoint, SUVmax remains the more relevant parameter, since it is the only high-risk indicator among those studied that is available prior to hysterectomy and lymphadenectomy. Its documented association with LVSI, deep myometrial invasion, high tumor grade, and non-endometrioid histology (Table 2) suggests that an elevated primary tumor SUVmax may serve as a preoperative surrogate marker, flagging patients who are more likely to harbor these adverse histopathological features—including LVSI itself—before this information becomes available. This distinction reinforces the rationale for incorporating SUVmax into preoperative risk-stratification algorithms, not as a replacement for postoperative pathological assessment, but as an imaging-based tool that can help guide the extent of primary surgical staging, including the decision to perform systematic lymphadenectomy or sentinel lymph node biopsy, at a time point when histopathological information is not yet accessible^{9,12,13}.

Several limitations warrant consideration. First, the retrospective design and two-center setting may limit generalizability, although a standardized PET/CT acquisition protocol was applied across both institutions. Second, the relatively small number of lymph node metastasis events restricted the complexity of multivariable modeling and may have limited statistical power to detect independent associations. Third, SUVmax measurements can be influenced by scanner calibration, reconstruction algorithms, and blood glucose levels. Fourth, as this study focused on primary tumor SUVmax rather than nodal SUVmax or PET-based nodal assessment, direct comparisons with studies emphasizing nodal metabolic characteristics should be made cautiously^{9,11}. Finally, the absence of central pathology review and the retrospective assignment of FIGO 2009 staging, rather than

the most recent 2023 FIGO or ESGO-ESTRO-ESP risk classification, may limit direct comparability with more contemporary risk-stratification frameworks⁵.

5. Conclusion

Preoperative primary tumor SUVmax on 18F-FDG PET/CT was significantly associated with lymph node metastasis and with established high-risk pathological features in endometrial cancer. Its moderate discriminatory performance supports its potential role as a noninvasive adjunct to established preoperative risk assessment, rather than as an independent determinant of surgical management. Although the observed NPV was high, this finding should be interpreted in the context of the low prevalence of lymph node metastasis and does not support using SUVmax alone to omit nodal assessment. LVSI was the strongest predictor in the exploratory multivariable model but is a postoperative pathological parameter, whereas SUVmax is available before surgery. Larger prospective multicenter studies are needed to determine whether SUVmax provides incremental value when integrated with contemporary clinical and imaging-based risk models.

Author Contributions (CRediT): Conceptualization: Serhan Can İşcan; Methodology: Serhan Can İşcan; Formal Analysis: Serhan Can İşcan, Fatih Akkuş; Investigation: Serhan Can İşcan, Çağlayan Biçer, Selçuk Erkılnç; Data Curation: Çağlayan Biçer, Serhan Can İşcan; Writing – Original Draft: Serhan Can İşcan; Writing – Review & Editing: All authors; Supervision: Selçuk Erkılnç.

Acknowledgements: The authors thank all healthcare professionals who contributed to the surgical procedures and data collection.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest: The authors declare that they have no competing interests.

Ethical Approval: This study was approved by The Non-invasive Clinical Research Ethics Committee of Izmir Democracy University (approval no. 2023/11-23, dated December 27, 2023) and was conducted in accordance with the principles of the Declaration of Helsinki.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Republic of Türkiye Ministry of Health, General Directorate of Public Health. Türkiye Cancer Statistics 2020. Accessed April 13, 2026. Available from: https://hsqm.saglik.gov.tr/depo/birimler/kanser-db/Dokumanlar/Istatistikler/Turkiye_Kanser_Istatistikleri_2020.pdf
2. Yanarates A, Budak E. Prognostic role of PET/CT in endometrial cancer. *Ginekol Pol.* 2019;90(9):491-495. doi:10.5603/GP.2019.0085
3. Antonsen SL, Jensen LN, Loft A, Berthelsen AK, Costa J, Tabor A, et al. MRI, PET/CT and ultrasound in the preoperative staging of endometrial cancer: a multicenter prospective comparative study. *Gynecol Oncol.* 2013;128(2):300-308. doi:10.1016/j.ygyno.2012.11.025
4. Kitajima K, Murakami K, Yamasaki E, Fukasawa I, Inaba N, Kaji Y, et al. Accuracy of 18F-FDG PET/CT in detecting pelvic and paraaortic lymph node metastasis in patients with endometrial cancer. *AJR Am J Roentgenol.* 2008;190(6):1652-1658. doi:10.2214/AJR.07.3372
5. Concin N, Matias-Guiu X, Cibula D, Colombo N, Creutzberg CL, Ledermann J, et al. ESGO-ESTRO-ESP guidelines for the management of patients with endometrial carcinoma: update 2025. *Lancet Oncol.* 2025;26(8):e423-e435. doi:10.1016/S1473-2045(25)00167-6.
6. Kim HJ, Cho A, Yun M, Kim YT, Kang WJ. Comparison of FDG PET/CT and MRI in lymph node staging of endometrial cancer. *Ann Nucl Med.* 2016;30(2):104-113. doi:10.1007/s12149-015-1037-8.

7. Chang MC, Chen JH, Liang JA, Yang KT, Cheng KY, Kao CH. 18F-FDG PET or PET/CT for detection of metastatic lymph nodes in patients with endometrial cancer: a systematic review and meta-analysis. *Eur J Radiol.* 2012;81(11):3511-3517. doi:10.1016/j.ejrad.2012.01.024.
8. Chung HH, Kang WJ, Kim JW, Park NH, Song YS, Chung JK, et al. The clinical impact of [18F]FDG PET/CT for the management of recurrent endometrial cancer: correlation with clinical and histological findings. *Eur J Nucl Med Mol Imaging.* 2008;35(6):1081-1088. doi:10.1007/s00259-007-0687-8.
9. Bollineni VR, Ytre-Hauge S, Bollineni-Balabay O, Salvesen HB, Haldorsen IS. High diagnostic value of 18F-FDG PET/CT in endometrial cancer: systematic review and meta-analysis of the literature. *J Nucl Med.* 2016;57(6):879-885. doi:10.2967/jnumed.115.170597.
10. Hu J, Zhang K, Yan Y, Zang Y, Wang Y, Xue F. Diagnostic accuracy of preoperative 18F-FDG PET or PET/CT in detecting pelvic and para-aortic lymph node metastasis in patients with endometrial cancer: a systematic review and meta-analysis. *Arch Gynecol Obstet.* 2019;300(3):519-529. doi:10.1007/s00404-019-05207-8.
11. Seon KE, Shin Y, Lee JY, Nam EJ, Kim S, Kim YT, et al. Is presumed clinical stage I endometrial cancer using PET-CT and MRI accurate in predicting surgical staging? *J Gynecol Oncol.* 2025;36(2):e25. doi:10.3802/jgo.2025.36.e25.
12. Taş M, Yavuz A, Dolanbay M, Kaya E, Öner G, Özçelik B. Preoperative detection of lymph node metastasis in endometrial cancer: the role of 18-FDG PET/CT. *J Surg Med.* 2019;3(9):681-684. doi:10.28982/josam.619609.
13. Dağ S, Doğan AK, Canaz E, Arslan ND, Yılmaz B. Diagnostic accuracy of preoperative metabolic 18F-FDG PET/CT parameters for patients with endometrial cancer treated with postoperative radiation therapy. *Cam Sakura Med J.* 2021;1(1):14-23. doi:10.4274/csmedj.galenos.2021.2021-8-9.
14. Boellaard R, Delgado-Bolton R, Oyen WJG, et al. FDG PET/CT: EANM procedure guidelines for tumour imaging: version 2.0. *Eur J Nucl Med Mol Imaging.* 2015;42(2):328-354. doi:10.1007/s00259-014-2961
15. Antonsen SL, Loft A, Fisker RV, Nielsen AL, Andersen ES, Høgdall E, et al. SUVmax of 18FDG PET/CT as a predictor of high-risk endometrial cancer patients. *Gynecol Oncol.* 2013;129(2):298-303. doi:10.1016/j.ygyno.2013.01.019.
16. Shibuya H, Kobayashi Y, Watanabe M, Momomura M, Matsumoto H, Morisada T. The prognostic value of maximum standardized uptake value (SUVmax) of 18F-FDG PET/CT for risk stratification and outcome prediction in endometrial cancer: a retrospective analysis. *Cureus.* 2025;17(3):e80109. doi:10.7759/cureus.80109.