DOI: 10.4274/anatoljmed.2026.20092
Anatol J Gen Med Res 2026;36(2):222-9

CLINICAL RESEARCH / KLİNİK ARAŞTIRMA

ANATOLIAN JOURNAL of GENERAL MEDICAL RESEARCH

Predictive Role of Tumor Location and Baseline PET-CT Metabolic Parameters in Rectal Cancer Patients Undergoing Neoadjuvant Treatment

Rektum Kanserli Olgularda Primer Tümör Yerleşim Yeri ve Tedavi Öncesi PET-CT Metabolik Parametrelerinin Neoadjuvan Tedavi Sonrası Prognostik Değeri

Murtaza Parvizi[1], Feray Aras[2], Engin Kut[3], Olcay Ak Nalbant[4]

[1]İzmir Tınaztepe University Private Galen Hospital, Department of Radiation Oncology, İzmir, Türkiye
[2]Manisa Celal Bayar University Faculty of Medicine, Department of Nuclear Medicine, Manisa, Türkiye
[3]Manisa City Hospital, Clinic of Medical Oncology, Manisa, Türkiye
[4]Manisa City Hospital, Clinic of Medical Pathology, Manisa, Türkiye

Cite as: Parvizi M, Aras F, Kut E, Ak Nalbant O. Predictive role of tumor location and baseline PET-CT metabolic parameters in rectal cancer patients undergoing neoadjuvant treatment. Anatol J Gen Med Res. 2026;36(2):222-9

Abstract

Objective: This study evaluated the prognostic significance of primary tumor location and baseline ^{18}F-fluorodeoxyglucose positron emission tomography-computed tomography (PET-CT) metabolic parameters in patients with locally advanced rectal cancer treated with neoadjuvant chemoradiotherapy/radiotherapy.

Methods: A total of 168 patients treated between October 2010 and November 2023 were retrospectively analyzed. Baseline maximum standardized uptake value (SUV_{max}), metabolic tumor volume (MTV), total lesion glycolysis (TLG), and tumor location were evaluated for associations with overall survival (OS) and disease-free survival (DFS).

Results: The median age was 61.5 years and the median follow-up was 72.4 months. The 5-year OS and DFS rates were 72.5% and 57.4%, respectively. Tumor location did not correlate significantly with SUV_{max}, MTV, or TLG (p>0.05). Local recurrence occurred in 11 patients (6.5%), predominantly among patients with lower rectal tumors. Tumor location (r=0.161, p=0.042) and SUV_{max} (r=0.289, p=0.025) were significantly associated with local recurrence. In univariate analyses, SUV_{max}, MTV, and TLG were significant prognostic factors for OS and DFS. In multivariate analyses, MTV was an independent prognostic factor for OS [hazard ratio (HR)=1.040, p=0.03], while both SUV_{max} (HR=1.033, p=0.035) and MTV (HR=1.031, p=0.012) were independent prognostic factors for DFS.

Conclusion: Baseline PET-CT parameters, particularly SUV_{max} and MTV, provide significant prognostic information in locally advanced rectal cancer. The higher local recurrence rate in lower rectal tumors indicates a need for closer surveillance.

Keywords: Rectal cancer, neoadjuvant chemoradiotherapy, neoadjuvant radiotherapy, PET-CT

Address for Correspondence/Yazışma Adresi: Asst. Prof., Murtaza Parvizi, İzmir Tınaztepe University Private Galen Hospital, Department of Radiation Oncology, İzmir, Türkiye
E-mail: drparvizi@yahoo.com
ORCID ID: orcid.org/0000-0002-0280-7321

Received/Geliş tarihi: 22.06.2026
Accepted/Kabul tarihi: 30.07.2026
Published date/Yayınlanma tarihi: 31.08.2026

Öz

Amaç: Bu çalışma, neoadjuvan kemoradyoterapi/radyoterapi ile tedavi edilen lokal ileri evre rektum kanserli hastalarda primer tümör yerleşiminin ve başlangıç flor-18 florodeoksiglukoz pozitron emisyon tomografisi-bilgisayarlı tomografi (PET-CT) metabolik parametrelerinin prognostik önemini değerlendirmiştir.

Yöntem: Ekim 2010 ile Kasım 2023 tarihleri arasında tedavi edilen toplam 168 hasta retrospektif olarak analiz edildi. Başlangıç maksimum standartlaştırılmış tutulum değeri (SUV_{max}), metabolik tümör hacmi (MTV), toplam lezyon glikolizi (TLG) ve tümör yerleşiminin genel sağkalım (OS) ve hastalıksız sağkalım (DFS) ile olan ilişkileri değerlendirildi.

Bulgular: Ortanca yaş 61,5; ortanca takip süresi 72,4 ay olarak saptandı. 5 yıllık OS ve DFS oranları sırasıyla %72,5 ve %57,4 idi. Tümör yerleşimi ile SUV_{max}, MTV veya TLG arasında anlamlı bir ilişki bulunmadı (p>0,05). Çoğunluğu alt rektum tümörlerinde olmak üzere 11 hastada (%6,5) lokal (bölgesel) nüks gelişti. Tümör yerleşimi (r=0,161, p=0,042) ve SUV_{max} (r=0,289, p=0,025) lokal nüks ile anlamlı derecede ilişkiliydi. Tek değişkenli analizlerde SUV_{max}, MTV ve TLG; OS ve DFS için anlamlı prognostik faktörler olarak bulundu. Çok değişkenli analizlerde ise MTV, OS için bağımsız bir prognostik faktör iken [tehlike oranı (HR)=1,040, p=0,03]; hem SUV_{max} (HR=1,033, p=0,035) hem de MTV (HR=1,031, p=0,012) hastalıksız sağkalım için bağımsız prognostik faktörler olarak belirlendi.

Sonuç: Başlangıç PET-CT parametreleri, özellikle de SUV_{max} ve MTV, lokal ileri evre rektum kanserinde önemli prognostik bilgiler sağlamaktadır. Alt rektum tümörlerinde daha yüksek lokal nüks oranı, bu hastaların daha yakın takip edilmesi gerektiğini göstermektedir.

Anahtar Kelimeler: Rektum kanseri, neoadjuvan kemoradyoterapi, neoadjuvan radyoterapi, PET-CT

Introduction

Colorectal cancer (CRC) continues to represent one of the major public health challenges worldwide and remains one of the leading causes of cancer-related morbidity and mortality. According to the most recent GLOBOCAN estimates, CRC is the third most common malignancy and the second leading cause of cancer-related death globally, with nearly 1.9 million newly diagnosed cases annually[1]. Ongoing changes in lifestyle patterns, including increasing rates of obesity, sedentary behavior, alcohol consumption, and dietary habits characterized by a high intake of processed foods, are expected to further increase the incidence of CRC in the coming decades[2]. Rectal cancer accounts for approximately one-third of all CRC malignancies and exhibits distinct biological and clinical characteristics compared with colon cancer. Despite significant improvements in multidisciplinary treatment approaches, a considerable proportion of patients are metastatic at diagnosis, whereas others subsequently develop distant metastases following curative-intent treatment[3]. Consequently, identification of prognostic factors that may predict treatment outcomes remains an important area of clinical research.

Several patient-related and tumor-related variables have been associated with prognosis in rectal cancer. Age, sex, comorbid conditions, tumor stage, pathological characteristics, primary tumor location, and treatment modality have all been reported to influence survival and disease control[4-6]. Therefore, comprehensive pretreatment evaluation is essential for appropriate therapeutic decision-making and individualized risk assessment. Current staging algorithms generally rely on a combination of imaging modalities, including contrast-enhanced computed tomography (CT), pelvic magnetic resonance imaging (MRI), and in selected cases, positron emission tomography-CT (PET-CT)[7-9].

Among contemporary techniques, ^{18}F-fluorodeoxyglucose (^{18}F-FDG) PET-CT provides functional information regarding tumor metabolism in addition to anatomical assessment. PET-CT demonstrates high sensitivity for the detection of the primary tumor location. Previous studies have demonstrated excellent performance in identifying primary colorectal tumors and distant metastatic lesions, although its performance in evaluating regional lymph node involvement remains limited compared with MRI-based assessment[10-12]. Beyond its diagnostic utility, PET-CT enables quantification of several metabolic parameters, including maximum standardized uptake value (SUV_{max}), metabolic tumor volume (MTV), and total lesion glycolysis (TLG)[9]. These parameters have attracted considerable interest because they may reflect tumor aggressiveness and biological behavior. Previous studies have suggested that high metabolic activity at diagnosis may be associated with worse oncological outcomes in patients undergoing treatment for rectal cancer[13].

Primary tumor location has also emerged as a clinically relevant prognostic factor in rectal cancer. Anatomically, the rectum is commonly subdivided into upper, middle and lower segments based on the distance from the anal

verge[14]. Variations in pelvic anatomy, lymphatic drainage pathways, vascular supply, and surgical accessibility may result in different treatment responses and clinical outcomes for tumors arising from these regions. In particular, tumors located in the lower rectum have frequently been associated with higher local recurrence rates and greater technical challenges during surgical management compared with tumors arising in more proximal rectal segments[6,7,14].

The current standard of care for locally advanced rectal cancer (LARC) consists of neoadjuvant chemoradiotherapy/radiotherapy (nCRT/nRT) followed by total mesorectal excision, an approach that has been shown to enhance local tumor control and improve resectability[5]. Although several investigations have reported the prognostic relevance of PET-CT metabolic parameters and tumor location separately, studies assessing the interplay between these variables and their influence on treatment outcomes remain limited. In this study, we investigated the association of baseline ^{18}-FDG PET-CT metabolic parameters and primary tumor localization with survival and treatment outcomes in patients with LARC treated with nCRT/nRT.

Materials and Methods

Study Type and Ethics

Patients diagnosed with LARC who underwent nCRT/nRT at the Radiation Oncology Clinic of Manisa City Hospital between October 2010 and November 2023 were included in this retrospective cohort study. The research protocol underwent ethical review and was approved by the Ethics Committee of Manisa Celal Bayar University (approval no: 20.478.486/3338, date: 30.07.2025), and by the administration of Manisa City Hospital under approval number E-67427165-605-279739188.

Patient Selection

The medical records of 194 consecutive patients who underwent treatment for LARC during the study period were retrospectively reviewed. All patients were treatment-naïve at the time of initial evaluation and had been referred for neoadjuvant treatment as part of a multidisciplinary management strategy.

The inclusion criteria included age ≥18 years, histopathological confirmation of rectal adenocarcinoma, availability of complete clinical, radiological, pathological, treatment-related data, and a minimum follow-up duration of 12 months.

The exclusion criteria included: age <18 years, presence of another primary malignancy, unavailability of complete clinical and treatment data, non-adenocarcinoma histology, or follow-up duration less than 12 months.

Data Collection

Patient information was obtained from the institutional electronic database and the archived medical records. Demographic characteristics, presenting symptoms, comorbid diseases, smoking and alcohol history, family history of cancer, colonoscopy findings, histopathological reports, radiological imaging results, treatment details, and follow-up data were collected. Tumor localization was determined from colonoscopy findings and categorized, based on distance from the anal verge, as lower rectum (0-5 cm), middle rectum (5.1-10 cm), or upper rectum (>10 cm). Baseline staging investigations, surgical reports, pathological findings, recurrence patterns, metastatic progression, survival status, and dates of follow-up were also recorded for analysis.

PET-CT Image Analysis

Baseline PET-CT images were retrospectively reviewed using the GE Advantage Workstation. Metabolic parameters, including SUV_{max}, MTV, and TLG, were recorded. Tumor segmentation was performed automatically using a standardized threshold of 42% of SUV_{max}, and MTV and TLG were calculated based on this segmentation method.

Statistical Analysis

Statistical evaluation was performed using specialized software. Continuous data were summarized according to their distribution characteristics and reported as mean ± standard deviation or median (range), while categorical variables were expressed as frequencies and percentages. Relationships between clinical variables and PET-CT metabolic parameters were assessed using Pearson or Spearman correlation analyses, depending on the distribution of the variables. Variables identified as statistically significant in univariate analyses were subsequently included in multivariate Cox proportional hazards regression models to determine independent prognostic factors. A two-sided p-value of less than 0.05 was considered statistically significant. Survival outcomes were estimated using the Kaplan-Meier method, and 5-year survival probabilities were calculated with life-table analyses.

Results

Based on the study's inclusion and exclusion criteria, the medical records and clinical data of 194 patients were reviewed, of whom 26 were excluded from the analysis. Consequently, data from a total of 168 patients were included in the final evaluation. Among these patients, 68 (40.5%) were women and 100 (59.5%) were men, with a median age of 61.5 years (range, 28-85 years).

As shown in Table 1, the most common presenting symptom was rectal bleeding, observed in 64.3% of patients. Evaluation of comorbidities revealed that diabetes mellitus and cardiovascular diseases were the most frequent accompanying conditions, while 38.1% of the patients were smokers and 8.3% reported alcohol consumption. A family history of cancer was present in 11.4% of patients, with gastrointestinal system malignancies being the most common cancer type (5.4%, n=9). Following diagnostic colonoscopy, tumor localization was identified as lower rectum (0-≤5 cm, 50%, n=84), middle rectum (5.1-≤10 cm, 39.9%, n=67), and upper rectum (≥10 cm, 10.1%, n=17), respectively. Histopathological examination of all colonoscopic biopsy specimens revealed adenocarcinoma. Most of the patients (125 patients, 73.5%) had a primary tumor size ≥50 mm at diagnosis. Pre-treatment clinical stages were determined according to initial clinical and radiological staging as follows: stage IIIB in 109 patients (64.9%), stage IIIC in 30 patients (17.9%), stage IIA in 26 patients (15.4%), stage IIC in 2 patients (1.2%), and stage IIB in 1 patient (0.6%).

nCRT/nRT was delivered according to the treatment technique as follows: 35 patients (20.8%) received three-dimensional conformal radiotherapy (45 Gy to the primary tumor and regional lymphatics in 25 fractions), whereas 133 patients (78.2%) underwent intensity-modulated radiotherapy, consisting of 45 Gy to the primary tumor and regional lymphatics with a simultaneous integrated boost to the primary tumor up to 50 Gy in 25 fractions. Concurrent chemotherapy was not administered to 8 patients because of advanced age or comorbidities. Among the 160 patients who received concurrent chemotherapy, 38 patients (29.4%) were treated with 5-fluorouracil/leucovorin (Mayo regimen), whereas 122 patients (65.8%) received oral capecitabine. Of the 143 patients (85.1%) who subsequently underwent surgery following nCRT/nRT, 98 (58.3%) underwent low anterior resection and 45 (26.8%) underwent abdominoperitoneal resection. In the postoperative period, a total of 124 patients received adjuvant chemotherapy, including 13 patients (7.6%) with 5-fluorouracil/leucovorin (Mayo regimen), 13 patients (7.6%) with oral capecitabine, 84 patients (50%) with capecitabine plus oxaliplatin, and 14 patients (8.3%) with FOLFOX regimen.

Correlation analyses of baseline ^{18}F-FDG PET-CT findings related to primary tumor characteristics demonstrated weak negative correlations between primary tumor localization

Table 1. Demographic and clinical characteristics of the patients (n=168)

Parameters		
Age, years [median (min-max)]		61.5 (28-85)
		n (%)
Gender	Female	68 (40.5)
	Male	100 (59.5)
Smoking history	No	104 (61.9)
	<20 pack-years	42 (25)
	≥20 pack-years	22 (13.1)
Alcohol-drinking history	No	154 (91.7)
	Yes	14 (8.3)
First symptom	Rectal bleeding	108 (64.3)
	Constipation	22 (13.1)
	Multiple	17 (10.1)
	Pelvic pain and rectal bleeding	11 (6.5)
	Diarrhea	10 (6)

Table 1. Continued

Parameters		
Additional diseases	No	109 (64.9)
	Multiple	19 (11.3)
	Diabetes mellitus	14 (8.3)
	Cardiovascular disease	12 (7.1)
	Hypertension	9 (5.4)
	Chronic obstructive pulmonary disease	3 (1.8)
	Ulcerative colitis	2 (1.2)
Family history	No	149 (88.6)
	Gastrointestinal cancer	9 (5.4)
	Genitourinary cancer	2 (1.2)
	Breast cancer	2 (1.2)
	Other	6 (3.6)
Tumor location	Lower rectum (1-5≥ cm)	84 (50)
	Mid rectum (5.1-10≥ cm)	67 (39.9)
	Upper rectum (>10 cm)	17 (10.1)
Tumor size	<50 mm	43 (26.5)
	≥50 mm	125 (73.5)
Clinical stage	IIA	26 (15.4)
	IIB	1 (0.6)
	IIC	2 (1.2)
	IIIB	109 (64.9)
	IIIC	30 (17.9)
Type of neoadjuvant treatment	Radiotherapy	8 (4.8)
	Chemoradiotherapy	160 (95.2)
Concurrent chemotherapy	No	8 (4.8)
	5-flourouracil	38 (29.4)
	Oral capecitabine	122 (65.8)
Type of operation	No	25 (14.9)
	LAR	98 (58.3)
	APR	45 (26.8)

LAR: Low anterior resection, APR: Abdominoperineal resection

and SUV_{max} (r=0.147, p=0.249), MTV (r=0.043, p=0.798), and TLG (r=0.033, p=0.685). However, none of these correlation coefficients reached statistical significance (p>0.05).

The median follow-up duration for the patients was 72.4 months (range, 12.0-176.5 months). Local recurrences developed in 11 patients (6.5%) during follow-up, with a median time to recurrence of 23.75 months (range, 12.5-45.5 months). Additionally, distant metastases developed in 42 patients (24%); of these, 19 patients (11.3%) had liver metastases, with a median time from diagnosis to metastasis of 23.5 months (range, 13.5-45.5 months). Overall survival (OS) was 122 months (71.5-176.5 months), and the 5-year OS rate was 72.5%. Disease-free survival (DFS) was 75.0 months (range, 42.5-176.5 months), and the 5-year DFS rate was 57.4%.

Evaluation of the 11 patients who developed local recurrence following therapy demonstrated that recurrences predominantly occurred in the lower rectum (7 patients). A weak but statistically significant positive correlation was observed between tumor localization and local recurrence

(r=0.161, p=0.042). Regarding diagnostic ^{18}F-FDG PET-CT parameters in patients with local recurrence, SUV_{max} showed a statistically significant association (r=0.289, p=0.025), whereas no significant correlation was observed for the MTV and TLG parameters (r=0.043, p=0.07 and r=0.064, p=0.63, respectively).

We evaluated the surgical margins in patients who developed local recurrence. The median closest distal/proximal surgical margin was 38 mm (range, 24-50 mm), and the median radial surgical margin was 7 mm (range, 1.0-10 mm). In patients without recurrence, the median closest distal or proximal surgical margin was 35 mm (range, 20-80 mm), and the median radial margin was 9 mm (range, 1.0-16 mm). No statistically significant correlation was identified between surgical margins and local recurrence.

The prognostic significance of baseline staging ^{18}F-FDG PET-CT parameters in rectal cancer patients treated with nCRT/nRT was evaluated and presented in Table 2. In univariate analysis, SUV_{max} [hazard ratio (HR): 1.018, 95% confidence interval (CI): 1.010-1.040, p=0.032], MTV (HR: 1.032, 95% CI: 1.007-1.057, p=0.011), and TLG (HR: 1.025, 95% CI: 1.015-1.030, p=0.041) were identified as significant prognostic factors for OS. However, in multivariate analysis, only MTV remained an independent prognostic factor (HR: 1.040, 95% CI: 1.004-1.078, p=0.03). Similarly, DFS, SUV_{max}, MTV, and TLG parameters were statistically significant in univariate analysis (p=0.002, p=0.001, and p=0.003). In multivariate analysis, SUV_{max} (HR: 1.033, 95% CI: 1.002-1.064, p=0.035) and MTV (HR: 1.031, 95% CI: 1.007-1.057, p=0.012) remained independent prognostic factors, whereas TLG was no longer statistically significant (p=0.33).

Discussion

Accurate prognostic assessment following nCRT/nRT remains a critical component of contemporary management strategies for patients with LARC. Although numerous clinicopathological factors have been associated with treatment outcomes, increasing interest has focused on the prognostic role of metabolic parameters obtained from baseline ^{18}F-FDG PET-CT imaging[13,15]. In the present study, we evaluated the association of primary tumor location and baseline PET-derived metabolic parameters with oncological outcomes following nCRT/nRT. This study demonstrated that lower rectal tumors were associated with a higher risk of local recurrence and that baseline SUV_{max}, MTV, and TLG values showed prognostic relevance. Notably, no significant association was identified between primary tumor location and PET-derived metabolic parameters.

The prognostic implications of primary tumor location in rectal cancer have been investigated extensively. Tumor arising in the lower rectum are often associated with increased surgical complexity because of anatomical constraints within the pelvis, challenges in achieving adequate circumferential resection margins, and limitations related to sphincter-preserving procedures[16]. Consistent with previous reports, patients with lower rectal tumors in our cohort experienced a higher incidence of local recurrence. Surgical margin status was not significantly associated with local recurrence. This finding may reflect the relatively limited number of recurrence events in our study population and may suggest that factors beyond surgical technique alone, including tumor biology and treatment response, may contribute to disease relapse. Another important observation in our study was the absence of a significant relationship between primary tumor location and baseline metabolic activity, measured by PET-CT. Although tumor located in different rectal segments exhibit distinct anatomical characteristics and clinical outcomes, these differences were not accompanied by measurable variations in SUV_{max}, MTV, or TLG values[6,7,14]. This finding suggests that the poorer outcomes observed in lower rectal tumors may be driven primarily by anatomical and treatment-related factors rather than differences in intrinsic metabolic aggressiveness. Consequently, primary

Table 2. Overall survival (OS) and disease-free survival (DFS) of patients according primer PET-CT finding

	OS				DFS			
PET-CT finding	**Univariate analysis (HR, 95% CI)**	**p-value**	**Multivariate analysis (HR, 95% CI)**	**p-value**	**Univariate analysis (HR, 95% CI)**	**p-value**	**Multivariate analysis (HR, 95% CI)**	**p-value**
SUV_{max}	1.018 (1.010-1.040)	**0.032**	1.002 (0.999-1.004)	0.47	1.019 (1.010-1.043)	**0.002**	1.033 (1.002-1.064)	**0.035**
MTV	1.032 (1.007-1.057)	**0.011**	1.040 (1.004-1.078)	**0.03**	1.046 (1.019-1.0739	**0.001**	1.031 (1.007-1.057)	**0.012**
TLG	1.025 (1.015-1.030)	**0.041**	1.027 (0.966-1.070)	0.53	1.007 (1.002-1.012)	**0.003**	1.027 (1.003-1.046)	0.33

PET-CT: Positron emission tomography-computed tomography, SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycolysis, CI: Confidence interval, HR: Hazard ratio

tumor location and PET-derived metabolic parameters may provide complementary prognostic information rather than reflecting the same biological processes.

Among the evaluated metabolic parameters, SUV_{max} was significantly associated with local recurrence. High FDG uptake has been linked to enhanced glucose metabolism, accelerated cellular proliferation, tumor hypoxia, and resistance to anticancer therapies, all of which may contribute to more aggressive tumor behavior[15,17]. Therefore, evaluated baseline SUV_{max} may identify tumors that are more likely to recur despite multimodality treatment. However, the prognostic significance of SUV_{max} remains controversial. Deantonio et al.[18] reported that baseline SUV_{max} was not independently associated with DFS or OS, whereas MTV showed stronger correlation with treatment response. Similarly, Fernando et al.[19] demonstrated that serial PET-CT assessments performed during and after neoadjuvant treatment provided valuable prognostic information, while baseline SUV_{max} alone showed limited predictive value for long-term outcomes. In contrast, other studies have demonstrated significant associations between elevated pre-treatment SUV_{max} values and unfavorable oncological outcomes[13]. Variability in patient characteristics, imaging acquisition protocols, segmentation techniques, and cut-off definitions may explain these inconsistent findings across studies.

One of the most clinically relevant findings of the present study was the identification of MTV as an independent prognostic factor for both OS and DFS. Unlike SUV_{max}, which reflects the highest metabolic activity within a single tumor region, MTV quantifies the total volume of metabolically active tumor tissue and may therefore better represent overall tumor burden. This broader assessment of tumor biology may explain its superior prognostic performance. Similar findings have been reported previously by Choi et al.[15], who demonstrated that MTV independently predicted both survival outcomes in patients with rectal adenocarcinoma. These results support the potential utility of MTV as a clinically important imaging biomarker for pre-treatment risk stratification in LARC.

Although TLG was significantly associated with OS and DFS in univariate analyses, it failed to maintain its independent significance in multivariate models. Since TLG includes both metabolic activity and metabolically active tumor volume, strong correlations with MTV may reduce its independent prognostic contribution when both parameters are evaluated. Similar observations have been reported in previous PET-CT studies investigating rectal cancer outcomes[13,15,18].

Recent advances in radiomics and artificial intelligence have expanded the potential applications of metabolic imaging beyond conventional SUV-based metrics. Texture features extracted from FDG PET-CT images may provide additional information regarding intratumoral heterogeneity and biological behavior, potentially improving prediction of treatment response and survival outcomes[20]. As these technologies continue to evolve, the integration of advanced imaging biomarkers into prognostic models may further enhance personalized treatment approaches for patients with rectal cancer.

Study Limitations

The strengths of our study include a relatively long follow-up duration, a homogeneous patient population, the use of modern radiotherapy techniques, and the combined evaluation of other metabolic parameters, primary tumor localization, and SUV_{max} values using FDG PET-CT. However, several limitations should be acknowledged. First, the retrospective, single-center design of the study represents a major limitation. Additionally, the lack of standardization in the segmentation methods we use to measure FDG PET-CT metabolic parameters may limit the external validity of these methods. The absence of molecular biomarkers and radiomic analyses in the present study should be considered an important limitation. Therefore, further multicenter studies are needed to confirm these findings.

Conclusion

These findings highlight the prognostic relevance of pretreatment ^{18}F-FDG PET-CT metabolic parameters in patients with LARC undergoing nCRT/nRT. Among these parameters, MTV emerged as an independent predictor of OS and DFS, highlighting the potential importance of metabolic tumor burden in pre-treatment risk assessment. Additionally, the increased risk of local recurrence observed in lower rectal tumors supports the need for individualized surveillance strategies in this subgroup. The lack of correlation between the location of the primary tumor and metabolic PET-CT parameters further suggests that anatomical and metabolic tumor characteristics may represent different prognostic domains. Prospective multicenter studies are warranted to validate these findings and clarify their potential role in personalized treatment planning.

Ethics

Ethics Committee Approval: The research protocol underwent ethical review and was approved by the Ethics Committee of Manisa Celal Bayar University (approval no: 20.478.486/3338, date: 30.07.2025), and by the administration of Manisa City Hospital under approval number E-67427165-605-279739188.

Informed Consent: Retrospective design.

Footnotes

Authorship Contributions

Concept: M.P., F.A., E.K., O.A.N., Design: M.P., F.A., E.K., O.A.N., Data Collection or Processing: M.P., E.K., O.A.N., Analysis or Interpretation: M.P., F.A., E.K., Literature Search: M.P., F.A., Writing: M.P., F.A., E.K., O.A.N.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024;74:229-63.
2. Xi Y, Xu P. Global colorectal cancer burden in 2020 and projections to 2040. Transl Oncol. 2021;14:101174.
3. Cervantes A, Adam R, Roselló S, et al. Electronic address: clinicalguidelines@esmo.org. Metastatic colorectal cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. Ann Oncol. 2023;34:10-32.
4. Khalfallah M, Dougaz W, Jerraya H, Nouira R, Bouasker I, Dziri C. Prognostic factors in rectal cancer: where is the evidence? Tunis Med. 2017;95:79-86.
5. Li Y, Wang J, Ma X, et al. A review of neoadjuvant chemoradiotherapy for locally advanced rectal cancer. Int J Biol Sci. 2016;12:1022-31.
6. Wang CB, Shahjehan F, Merchea A, et al. Impact of tumor location and variables associated with overall survival in patients with colorectal cancer: a mayo clinic colon and rectal cancer registry study. Front Oncol. 2019;9:76.
7. Lee MH, Kim DH. Low rectal cancers at initial staging MRI. Radiographics. 2023;43:e230080.
8. Azin A, Wood T, Hirpara D, et al. Diagnostic utility of staging abdominal computerized tomography and repeat endoscopy in detecting localization errors at initial endoscopy in colorectal cancer. Surg Endosc. 2018;32:3303-10.
9. Heo SH, Kim JW, Shin SS, Jeong YY, Kang HK. Multimodal imaging evaluation in staging of rectal cancer. World J Gastroenterol. 2014;20:4244-55.
10. Ye Y, Liu T, Lu L, et al. Pre-operative TNM staging of primary colorectal cancer by (18)F-FDG PET-CT or PET: a meta-analysis including 2283 patients. Int J Clin Exp Med. 2015;8:21773-85.
11. Lu YY, Chen JH, Ding HJ, Chien CR, Lin WY, Kao CH. A systematic review and meta-analysis of pretherapeutic lymph node staging of colorectal cancer by 18F-FDG PET or PET/CT. Nucl Med Commun. 2012;33:1127-33.
12. Kwak JY, Kim JS, Kim HJ, Ha HK, Yu CS, Kim JC. Diagnostic value of FDG-PET/CT for lymph node metastasis of colorectal cancer. World J Surg. 2012;36:1898-905.
13. Li J, Zhou Y, Liu L, Pang H. Diagnostic and prognostic value of quantitative ^{18}F-FDG PET/CT metabolic parameters combined with clinical indicators in patients with locally recurrent rectal cancer. Abdom Radiol (NY). 2025;50:5135-47.
14. Wang YHW, Wiseman J. Anatomy, abdomen and pelvis, rectum. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026.
15. Choi BW, Kang S, Bae SU, et al. Prognostic value of metabolic parameters on ^{18}F-fluorodeoxyglucose positron tomography/computed tomography in classical rectal adenocarcinoma. Sci Rep. 2021;11:12947.
16. Dijkstra EA, Hospers GAP, Kranenbarg EM, et al. Quality of life and late toxicity after short-course radiotherapy followed by chemotherapy or chemoradiotherapy for locally advanced rectal cancer - the RAPIDO trial. Radiother Oncol. 2022;171:69-76.
17. Hanahan D. Hallmarks of cancer: new dimensions. Cancer Discov. 2022;12:31-46.
18. Deantonio L, Caroli A, Puta E, et al. Does baseline [18F] FDG-PET/CT correlate with tumor staging, response after neoadjuvant chemoradiotherapy, and prognosis in patients with rectal cancer? Radiat Oncol. 2018;13:211.
19. Fernando S, Lin M, Pham TT, et al. Prognostic utility of serial ^{18}F-FDG-PET/CT in patients with locally advanced rectal cancer who underwent tri-modality treatment. Br J Radiol. 2020;93:20190455.
20. Ju HM, Yang J, Park JM, et al. Prediction of neoadjuvant chemoradiotherapy response in rectal cancer patients using harmonized radiomics of multcenter ^{18}F-FDG-PET image. Cancers (Basel). 2023;15:5662.