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Prognostic Importance of Volumetric Data from Pretreatment Fluorine-18-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography in Gastric Adenocarcinoma: Retrospective Observational Study

Mide Adenokarsinom Tanılı Hastalarda Tedavi Öncesi Flor-18-Florodeoksiglukoz Pozitron Emisyon Tomografisi/Bilgisayarlı Tomografi Volümetrik Parametrelerinin Prognostik Değeri: Retrospektif Gözlemsel Araştırma

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ABSTRACT Objective: Fluorine-18-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) volumetric parameters have been established to quantify the metabolic activity and 3-dimensional volumetric burden of the entire tumor. However, data on their application in gastric cancer remain limited. This study aimed to evaluate the prognostic significance of 18F-FDG PET/CT volumetric parameters in patients with primary gastric adenocarcinoma (GAC). **Material and Methods:** Maximum and mean standardized uptake values (SUV_{max} and SUV_{mean}, respectively), metabolic tumor volume (MTV), and total lesion glycolysis (TLG) of the primary gastric lesion were calculated in 52 GAC patients. The prognostic impact of these parameters and the presence of distant or lymph node metastasis was explored using Kaplan-Meier and Cox regression analyses. **Results:** No correlation was found between SUV_{max} (p=0.99), MTV (p=0.92), TLG (p=0.32), and overall survival (OS). OS was significantly influenced by distant metastasis (p=0.003); however, no statistically significant correlation was identified despite patients with distant metastasis demonstrating elevated volumetric values. No relationship was found with the presence of metastatic lymph nodes (hazard ratio 0.507, 95% confidence interval 0.24-1.05, p=0.70). Operable patients exhibited reduced MTV and TLG values of the primary tumor compared to non-operable patients (p=0.071 and 0.046, respectively). Patients eligible for surgery had longer survival periods. **Conclusion:** The analysis did not reveal any significant volumetric prognostic variables. The presence of distant metastases had a significant impact on OS. However, positive FDG PET-CT lymph node status did not reduce survival. The significant relationship between the TLG value and operability suggests that the TLG value may reflect tumor behavior.

Keywords: Gastric cancer; positron emission tomography/computed tomography; prognosis; standardized uptake value; volumetric

ÖZET Amaç: Flor-18-florodeoksiglukoz pozitron emisyon tomografisi/bilgisayarlı tomografi (18F-FDG PET/BT) volümetrik parametreleri, metabolik aktiviteyi ve tümörün 3 boyutlu hacimsel yükünü ölçmek için belirlenmiştir. Ancak mide kanserinde kullanımlarına ilişkin veriler sınırlıdır. Bu çalışma, primer gastrik adenokarsinomlu (GAK) hastalarda 18F-FDG PET/BT hacimsel parametrelerinin prognostik önemini değerlendirmeyi amaçlamaktadır. **Gereç ve Yöntemler:** Elli iki GAK hastasında primer gastrik lezyonun maksimum ve ortalama standardize tutulum değeri [standardized uptake value (SUV)] (SUV_{maks}, SUV_{ort}), metabolik tümör hacmi [metabolic tumor volume (MTV)] ve toplam lezyon glikoliz (TLG) değerleri hesaplandı. Bu parametrelerin ve uzak metastaz veya lenf nodu metastazının varlığının prognoz üzerindeki etkisi, Kaplan-Meier ve Cox regresyon analizleri kullanılarak araştırıldı. **Bulgular:** SUV_{maks} (p=0,99), MTV (p=0,92), TLG (p=0,32) değerleri ile genel sağkalım [overall survival (OS)] arasında ilişki bulunamadı. Uzak metastaz varlığı, OS'u önemli ölçüde etkiledi (p=0,003). Uzak metastazlı hastalarda yüksek volümetrik değerler gösterilmesine rağmen istatistiksel olarak anlamlı bir korelasyon saptanmadı. Metastatik lenf nodlarının varlığı ile sağkalım arasında bir ilişki bulunamadı (tehlike oranı 0,507; %95 güven aralığı 0,24-1,05; p=0,70). Ameliyat edilebilir hastalarda primer tümörün MTV ve TLG değerleri, ameliyat edilemeyen hastalara kıyasla düşüktü (sırasıyla p=0,071 ve 0,046). Ameliyata uygun hastaların daha uzun sağkalım süreleri vardı. **Sonuç:** Çalışmamızda, anlamlı prognostik bir volümetrik değişken ortaya koymamıştır. Uzak metastazların varlığı, OS üzerinde anlamlı bir etkiye sahip iken; pozitif FDG PET/BT lenf nodu durumu sağkalımı azaltmamıştır. TLG değeri ile operabilite arasındaki anlamlı ilişki, TLG değerinin tümör davranışını yansıtabileceğini düşündürmektedir.

Anahtar Kelimeler: Mide kanseri; pozitron emisyon tomografisi/bilgisayarlı tomografi; prognoz; standardize uptake değeri; volümetrik

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Gastric carcinoma is one of the most prevalent neoplasms globally and is the 4th most common cause of cancer-related death. The 5-year survival rate for individuals diagnosed with stomach cancer is approximately 20%.[1] A crucial factor influencing gastric cancer mortality is the postponement of diagnosis. Moreover, surgical morbidity associated with gastrectomy is significant. Identifying patients with poor prognoses is crucial for optimizing therapeutic outcomes and developing a personalized treatment approach. Therefore, effective methods for predictive forecasting are essential. Fluorine-18-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) is widely employed for the evaluation of many malignancies, including gastric cancer.[2,3] Furthermore, recent studies have demonstrated that assessing the glycolytic properties of a tumor using 18F-FDG PET enhances the evaluation of therapy responses and prognostic predictions across diverse tumors.[4-6] Despite substantial research on the prognostic relevance of maximum standardized uptake value (SUV_{max}), it represents a singular voxel measurement of 18F-FDG concentration. Volumetric metrics, such as metabolic tumor volume (MTV) and tumor lesion glycolysis (TLG), have been established to quantify the metabolic activity and 3D volumetric burden of the total mass. The expectation that these parameters represent the whole volume and severity of the disease has led researchers to undertake numerous studies evaluating their prognostic significance across diverse malignancies.[7] However, data regarding their application in stomach cancer and studies assessing volumetric measures as prognostic indicators in patients with gastric adenocarcinoma (GAC) are limited.[8,9] These studies mostly include a restricted patient population, and the results of the investigations are inconsistent.[3,10] This study aimed to determine how the simultaneous assessment of several volumetric PET measures could affect the predictions of survival in patients with GAC. Additionally, there is limited information on the importance of standardized measurements, such as the ratios of SUV of the lesion to the liver (SUVTLR) and to the blood pool (SUVTBR), in predicting outcomes in gastric cancers. The prognostic value of these standardized factors was also evaluated in our cohort.

MATERIAL AND METHODS

PATIENTS

We retrospectively reviewed the medical records of patients with gastric cancer who underwent FDG PET/CT at Eskişehir Osmangazi University, Department of Nuclear Medicine between January 2011-December 2021. Of these, 52 patients with biopsy-proven GAC who underwent preoperative [18F] FDG PET/CT for disease staging, had no prior antitumor therapy, and had no other malignancies, were enrolled in this study. Patients who had received treatment or undergone surgery before PET/CT and those who had PET/CT scans performed at another center were excluded. After PET/CT, 21 patients had surgery. The remaining patients received chemotherapy with or without radiotherapy. All demographic and clinical information about the patients was gathered from the Hospital Information Management System. The recorded clinicopathological information included sex, age at diagnosis, location and differentiation of the tumor, and baseline blood levels of carcinoembryonic antigen (CEA) and carbohydrate antigen 19-9 (CA 19-9). Lesions in the body, antrum, or pylorus were classified as distal, whereas those in the cardia or fundus were classified as proximal lesions. We acquired the patients' survival time from the hospital system throughout the data collection phase of this investigation. Overall survival (OS) was evaluated as the length of time from the initial pathological diagnosis to death. Patients were followed up with imaging (contrast-enhanced abdominopelvic CT) and blood tests (serum CEA and CA 19-9). According to the data in the hospital system, there were no patients in whom recurrence was detected. Since there were no data in the hospital data indicating that our deceased patients died from a cause other than primary gastric malignancy, it was accepted that our patients died due to gastric malignancy. Eskişehir Osmangazi University Non-Interventional Clinical Research Ethics Committee approved this study on May 28, 2025 (approval number: 13). The study was conducted according to the principles of the Declaration of Helsinki.

FDG PET/CT Imaging

All PET/CT scans were performed according to a standardized protocol; each patient observed a mini-

mum fasting duration of 6 h, and blood glucose levels were kept below 180 mg/dL before the intravenous infusion of FDG. No oral or intravenous contrast was used. One-hour post-administration of 18F-FDG, low-dose whole-body CT and PET images were obtained using a Siemens Biograph 6 HI-REZ integrated PET/CT scanner (Siemens Medical Solutions, Knoxville, TN, USA). Researchers employed an iterative reconstruction method to reconstruct PET images using CT scans for attenuation correction.

FDG PET/CT Interpretation

Two skilled nuclear medicine professionals evaluated PET/CT images visually. A volume of interest (VOI) was manually drawn on the axial PET/CT fusion image around the edge of the primary tumor, and axial, coronal and sagittal images from fused PET/CT were assessed. A threshold of 40% was established to obtain the MTV and TLG data. As the cut-off is frequently applied, a VOI based on SUV_{max} (40%) was automatically defined (Figure 1 shows an illustration of the VOI). For the semi-quantitative analysis of FDG, the VOI's SUV_{max}, TLG, and MTV were measured and recorded. Ratios for the SUV, such as TLR and TBR, were also acquired. TLR was defined as the SUV_{max} ratio of the tumor to that of the liver. TBR was defined as the SUV_{max} ratio of the tumor to that of the blood pool. To achieve the ideal SUV for the blood pool and liver, VOIs were delineated from the aortic arch and parenchyma of the right hepatic lobe on PET/CT images. PET/CT detected the presence of distant metastases, defined as metastasis to any distant organ and/or distant lymph nodes. The existence of lymph nodes was verified through histological diagnosis in operated patients or via PET/CT imaging. In FDG PET/CT studies, lymph nodes demonstrating FDG absorption surpassing the liver parenchyma were classified as positive for metastasis.

STATISTICAL ANALYSIS

The study results were analyzed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistical techniques (count, percentage, mean, and median) were used to analyze the study data. In survival analyses, researchers designated the length of time from the ini-

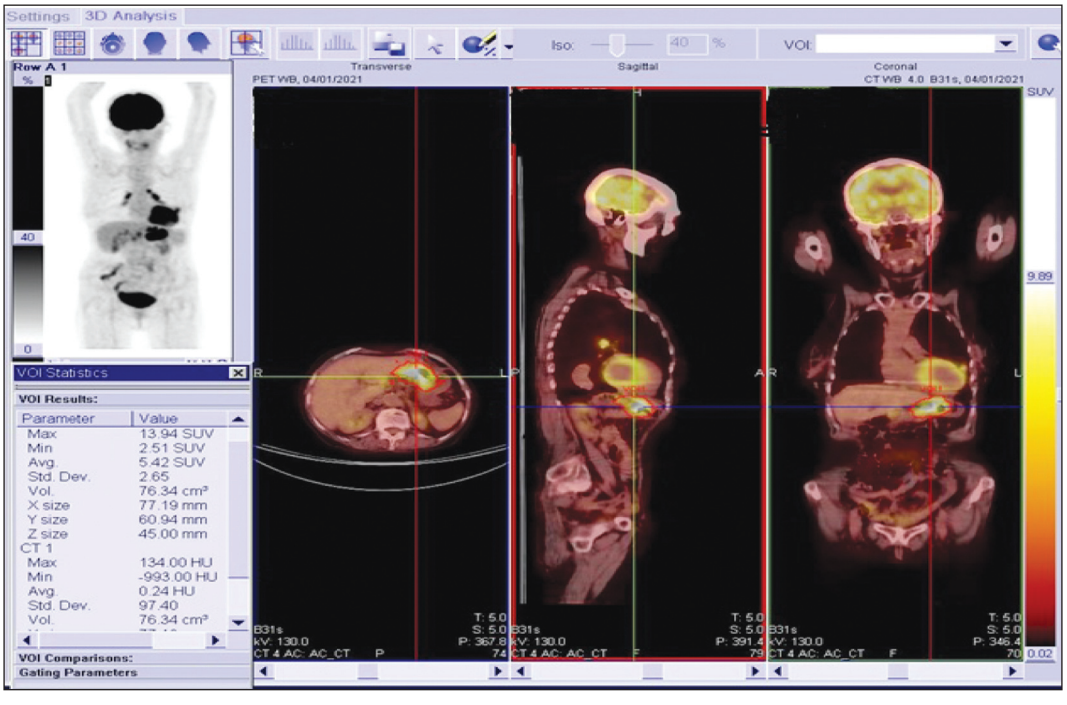


FIGURE 1: Fused coronal, sagittal and transaxial FDG PET/CT images in an 82 year-old female

The crosshairs localize an FDG-avid gastric cancer. The VOI, which is based on SUV_{max} 40%, is displayed in red. SUV_{max}, SUV_{mean}, and MTV were measured respectively. FDG PET/CT: Fluorodeoxyglucose positron emission tomography/computed tomography; VOI: Volume of interest; SUVmax: Maximum standardized uptake value; MTV: Metabolic tumor volume

tial pathological diagnosis to death as the OS period. The Kaplan-Meier method was used to analyze survival. Log-rank univariate analysis was employed to evaluate the impact of diverse prognostic factors associated with tumor and patient features on OS. We used multivariate analyses to assess the impact of various prognostic variables on OS using the Cox regression approach. A 95% confidence interval was used to evaluate the data, and a p value below 0.05 was considered statistically significant.

RESULTS

A total of 52 patients with GAC who underwent pretreatment PET/CT imaging were included in this study, comprising 35 (67%) males and 17 (33%) females, with a median age of 66 (range: 59-72 years) years. Most of the tumors were in the distal stomach (37, 72%), then in the proximal stomach (12, 23%), and finally diffuse (3, 5%). According to the initial tumor pathology, moderately and poorly differentiated tumors represented the majority of histologic grades at 29%, while well-differentiated tumors comprised 10% and were absent in the remaining cases. Six (11%) patients exhibited signet-ring cell carcinoma, 3 (5%) presented with mixed adenoneuroendocrine carcinoma, 1 (2%) was diagnosed with poorly cohesive carcinoma, and 1 (2%) had papillary adenocarcinoma of the stomach. In the remaining cases, histology was identified as adenocarcinoma (80%). Of the 52 patients, 21 (40%) received surgical treatment. Seven patients underwent partial gastrectomy, whereas 14 patients underwent total gastrectomy. During the follow-up period, 41 (78%) of the 52 patients died, with a median OS duration of 11 months (range 3-29 months) (Table 1). No patient exhibited disease progression during follow-up. The median values for the primary tumor SUV_{max}, SUV_{mean}, TLG, MTV, TBR, and TLR were 10.66 (range, 7.51-16.11), 5.94 (range, 4.05-9.02), 182.21 (range, 98.09-319.07), 30.74 (range, 14.48-49.06), 3.59 (range, 2.32-5.47), and 2.63 (range, 1.80-4.20), respectively. Twenty-two (42%) patients had distant metastases. The majority of these metastases were in the liver, lungs, and bones, with infrequent occurrences in the peritoneum and in distant lymph nodes. At baseline, 54% of the patients (28 out of 52) exhibited lymph node metastases. The abdominal region exhibited the highest incidence of lymph node metastases (93%), whereas the cervical region displayed the lowest (7%). Twenty-five (48%) patients had high levels of CA 19-9 (≥37 U/mL), while 29 (56%) patients had high levels of CEA (≥2.9 ng/mL) (Table 1). Sex, serum CA 19-9 and CEA levels, positive lymph nodes, and distant metastasis SUV_{max}, MTV, TLG, TBR, and TLR were assessed as metabolic and clinical variables in the survival analysis. Figure 2 depicts the cumulative survival of patients with GAC, determined using Kaplan-Meier analysis of metabolic data. Among these characteristics, only distant metas-

TABLE 1: Patient characteristics

Variables	n (%)
Gender	
Male	35 (67)
Female	17 (33)
Median age (year) (range)	66 (59-72)
Tumor location	
Proximal	12 (23)
Distal	37 (72)
Diffuse	3 (5)
Operation	
No	31 (60)
Yes	21 (40)
Differentiation	
Moderately differentiated	15 (29)
Poorly differentiated	15 (29)
Unknown	17 (32)
PET/CT findings	
Distant metastasis	
Yes	22 (42)
No	30 (58)
Lymph nodes	
Positive	28 (54)
Negative	24 (46)
CEA (ng/mL)	
Normal	23 (44)
Elevated	29 (56)
CA 19-9 (U/mL)	
Normal	27 (52)
Elevated	25 (48)
Surviving status of patients	
Non-surviving	41 (78)
Surviving	11 (22)
OS (month) (range)	11 months (3-29)

PET/CT: Positron emission tomography/computed tomography; CEA: Carcinoembryonic antigen; CA: Carbohydrate antigen; OS: Overall survival

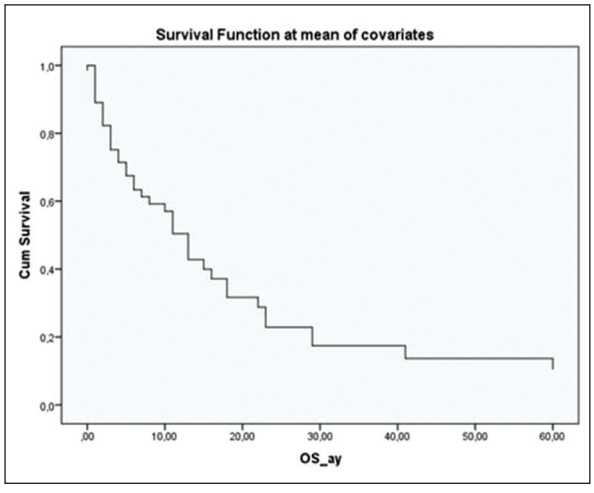


FIGURE 2: Cumulative OS curves based on volumetric parameters
OS: Overall survival

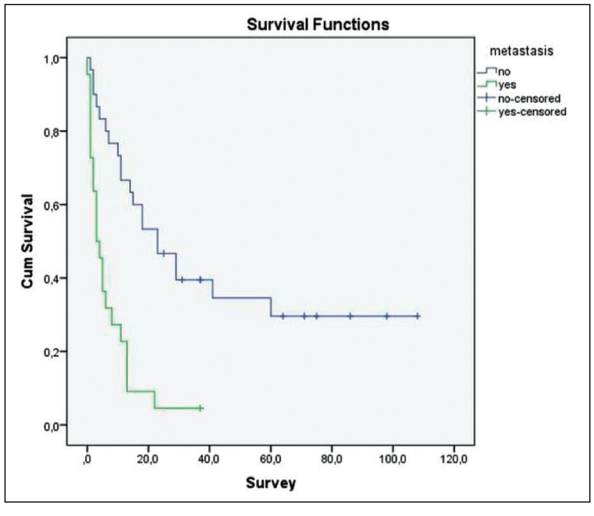


FIGURE 3: Kaplan-Meier curve of OS in patients with and without distant metastasis
OS: Overall survival

tasis correlated with OS in the univariate analysis ($p<0.05$). Concerning the correlation between distant metastasis and survival, 1 (9%) patient who survived presented with distant metastases. Distant metastases were evident in 21 (51%) deceased patients, significantly affecting survival ($p=0.003$). Patients without distant metastatic disease on FDG PET/CT demonstrated a significant association with improved survival outcomes (Figure 3). Despite patients with distant tumors demonstrating elevated metabolic parameter values, no statistically significant correlation was observed (Table 2). In patients with distant metastases identified on FDG-PET, the multivariate analysis continued to show a statistically significant effect on OS, as noted in the univariate analysis (median survival 3.5 versus 23 months, hazard ratio 0.335, 95% confidence interval 0.162-0.691, $p=0.03$). However, in patients with positive lymph nodes on FDG-PET, there was no significant impact on OS in either the univariate or multivariate analyses (hazard ratio 0.507, 95% confidence interval 0.24-1.05, $p=0.70$). Although not statistically significant ($p>0.005$), patients who died had higher mean values of SUV_{max}, SUV_{mean}, MTV, TLG, TBR, and TLR of the original tumor. Among the PET measurements, SUV_{max}, SUV_{mean}, MTV, TLG, TBR, and TLR showed no link with survival outcomes and did not serve as independent prognostic indicators for OS ($p>0.05$) (Table 3). Moreover, OS did not differ significantly between patients categorized by sex ($p=0.762$) and those with increased vs. normal serum CEA ($p=0.847$) and CA 19-9 ($p=0.135$) levels. In operated patients, the mean SUV_{max} was 10.05 (range: 7.79-15.34), the mean MTV was 35.49 (range: 17.79-57.46), and the mean TLG was 126.38 (range: 84.42-216.08). Only one of the surviving patients did not undergo surgery. Operable patients ex-

TABLE 2: Comparison of average 18-fluorodeoxyglucose metabolism quantifiers between metastatic and local tumours

Metabolic quantifier	Overall (n=52)	Nonmetastatic (n=30)	Metastatic (n=22)	p value
SUV_{max}	10.66 (7.51-16.11)	8.9 (6.2-15.9)	11.4 (8.9-16.2)	0.158
SUV_{mean}	5.94 (4.05-9.02)	5.1 (3.4-8.9)	5.9 (4.7-9.07)	0.215
TLG	182.21 (98.09-319.07)	139.01 (74.7-266.1)	275.1 (135.4380.02)	0.152
MTV	30.74 (14.48-49.06)	25.48 (11.7-51.9)	35.53 (20.7-50.3)	0.309
TBR	3.59 (2.32-5.47)	2.91 (2.1-5.1)	4.02 (2.4-6.2)	0.215
TLR	2.63 (1.80-4.20)	2.55 (1.7-4.3)	2.63 (1.8-3.3)	0.968
OS (months)	21 (14-28)	23 (9-45)	3.5 (1-11.5)	**0.00***

*Statistically important; SUV_{max}: Maximum standardized uptake value; SUV_{mean}: Mean standardized uptake value; TLG: Total lesion glycolysis; MTV: Metabolic tumor volume; TBR: Tumor to blood ratio; TLR: Tumor to liver ratio; OS: Overall survival

TABLE 3: Estimated adjusted hazard ratios for OS for each imaging parameter

Parameter	p value	HR	%95 CI
SUV_{max}	0.992	0.999	0.841-1.187
TLG	0.326	1.002	0.998-1.005
MTV	0.924	0.999	0.973-1.025
TBR_{max}	0.512	1.155	0.443-1.500
TLR_{max}	0.706	0.816	0.547-2.435

OS: Overall survival; SUV_{max}: Maximum standardized uptake value; TLG: Total lesion glycolysis; MTV: Metabolic tumor volume; TBR: Tumor to blood ratio; TLR: Tumor to liver ratio; HR: Hazard ratio; CI: Confidence interval

TABLE 4: Comparison of average 18-fluorodeoxyglucose metabolism quantifiers between operated and non-operated patients

Metabolic quantifier	Non-operated (n=31)	Operated (n=21)	p value
SUV_{max}	10.04 (7.7-15.3)	9.30 (6.1-18.3)	0.438
SUV_{mean}	5.76 (4.0-8.8)	5.08 (3.4-9.7)	0.438
TLG	226.28 (91.9-384.6)	126.38 (86.4-216.07)	**0.046***
MTV	35.49 (17.7-50.4)	24.26 (11.6-38.9)	0.071
TBR	3.54 (2.2-4.6)	2.67 (2.0-5.5)	0.241
TLR	2.71 (1.9-3.9)	2.33 (1.5-4.6)	0.534
OS (months)	5 (2-11)	31 (18-64)	**0.00***

*Statistically important; SUV_{max}: Maximum standardized uptake value; SUV_{mean}: Mean standardized uptake value; TLG: Total lesion glycolysis; MTV: Metabolic tumor volume; TBR: Tumor to blood ratio; TLR: Tumor to liver ratio; OS: Overall survival

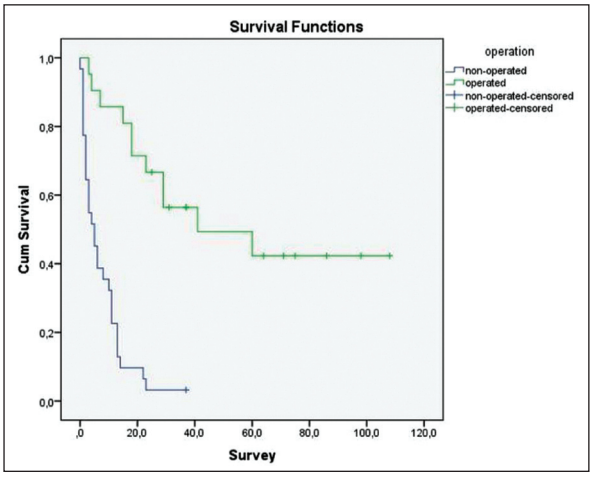


FIGURE 4: Kaplan-Meier curve of OS in patients with operated/non-operated patients
OS: Overall survival

hibited reduced values for MTV and TLG in the primary tumor tissue compared to non-operable patients, with p values of 0.071 and 0.046, respectively (Table 4). Patients eligible for surgery exhibited longer survival periods than those who were not (p=0.00) (Figure 4). Sixty-eight percent of the 22 patients who underwent surgery (15/22) exhibited histopathologically confirmed lymph node metastases. Ninety-one percent of the 11 patients (10/11) who died post-surgery exhibited lymph node metastases (p=0.022).

DISCUSSION

This study examined the efficacy of volumetric indicators from 18F-FDG PET/CT in predicting outcomes in GAC. The results indicated that OS was not correlated with volumetric markers. Distant metastases found on FDG PET/CT were a strong and separate sign that could predict the OS of patients with GAC. In oncology, FDG PET/CT has been used extensively as a marker of glucose metabolism in tumors. The predictive significance of FDG PET/CT characteristics has been extensively studied in many cancer types.[11] 18F-FDG PET/CT offers biological observations prior to surgery. Additionally, it is non-invasive and can be easily performed.[12,13] This imaging technique may serve as an effective tool for preoperative prognostic assessment of patients with hepatocellular carcinoma. According to some studies, the quantity of 18F-FDG uptake in the gastric tumor on 18F-FDG PET/CT may be a predictor of survival.[14-19] Recent studies on gastric cancer have predominantly focused on the SUV_{max} value. Mochiki et al. demonstrated that people with FDG-avid gastric tumors have a lower survival rate than those with FDG-negative tumors. Additionally, patients with a high tumor SUV_{max} had a lower OS rate than those with a low tumor SUV_{max} among those who underwent successful surgery to remove the cancer.[13] Chung et al. established that in patients with metastatic gastric cancer, an increased tumor SUV_{max} is associated with a reduced OS rate.[17] Similarly, SUV_{max} was identified as the most accurate independent predictive factor for advanced-stage patients receiving palliative therapy, as documented by Park et al.[16] A study including 271 post-gastrectomy patients indicated that an SUV_{max} >8.2 serves as a negative prognostic indicator for disease recurrence.[20] While prior research predominantly suggests a relationship between elevated SUV_{max} and adverse clinical outcomes as well as tumor aggressiveness, our findings revealed no association between SUV_{max} and OS. In

accordance with our findings, another study revealed no significant differences in patient survival when evaluating the SUV_{max} of the primary tumor.[21] Grabinska et al. also did not identify any SUV_{max} value that significantly indicated tumor dissemination.[22] SUV_{max} is significant for prognostication; it has established these limitations.[23,24] Supplementary metrics, including MTV, TLG, and SUV ratios, are essential for precise tumor prognostic estimates. Volume-based measurements may more accurately represent metabolic activity. Although a solid consensus in the literature is lacking, multiple studies have revealed a notable association between OS and volumetric PET measures (MTV and TLG) in diverse malignancies.[7] To predict progression-free survival in patients with gastric cancer, Kim et al. found that MTV, as measured using pretreatment 18F-FDG PET/CT, is a significant prognostic factor.[10] Kwon et al. argued that increased SUV_{max} and MTV of the main tumor signify an enhanced probability of recurrence in patients with advanced gastric cancer.[25] Although multiple studies suggest that MTV acts as an independent prognostic factor in various malignancies, our research revealed that MTV and TLG levels were not statistically different in metastatic and nonmetastatic patients. The liver and blood pools are frequently used as reference backdrops.[26] Recent studies have highlighted the prognostic value of TLR in many cancers.[27-31] These studies demonstrated that SUVTLR serves as a predictive indicator of both disease-free survival and recurrence. Furthermore, numerous studies have demonstrated the predictive validity of the SUV_{max} ratio between the primary tumor and blood pool. The researchers found that patients with lower SUVTBR had prolonged progression-free survival and OS compared with those with higher SUVTBR. These studies suggest that the metabolic features measured by 18F-FDG PET and SUV ratios could be useful indicators of survival in patients with GAC.[32,33] However, our study did not demonstrate the impact of these metabolic features on survival. These results may stem from the limited sample size of our study and the diverse characteristics of the patient population regarding clinical stages (both early and advanced). The various SUV thresholds suggested in previous studies may also affect the results. Although PET measurements did not significantly influence OS, the presence of distant metastases emerged as the sole predictive factor in our investigation. In agreement with our study's findings, Mütevelizade et al. also found that metastasis at diagnosis was strongly related to lower survival in soft tissue sarcoma.[34] Our research demonstrated that while metabolic parameter values were higher in individuals with distant metastases, no statistically significant correlation was identified. Stage, tumor invasion, and lymph node involvement influence survival in gastric cancer.[10] Coupe et al. initially showed that FDG-PET-positive lymphadenopathy is an independent and substantial prognostic factor for gastric cancer. Additionally, they discovered that the presence of FDG-avid lymph nodes was a significantly better predictor of death in a subset of patients who were operated on.[18] Consistent with this information, we also found that the mortality rate was higher in patients with lymph node metastasis who underwent surgery. Conversely, our study found that pathological FDG-avid lymphadenopathy on PET-CT did not predict survival. The constraints of our investigation include its retrospective design, execution at a single location, inability to monitor patients over an extended duration, and limited sample size. Patients were neither standardized nor classified by clinical stage because most patients did not undergo surgery and received diverse therapeutic regimens. Pathological assessment of lymph nodes was not performed in all patients because some patients were managed without surgery due to distant organ metastases and advanced-stage disease, and the study's retrospective design precluded further pathological assessment.

CONCLUSION

In conclusion, our study results indicate that the detection of distant metastases using 18F-FDG PET/CT at diagnosis is the main factor affecting OS. Nonetheless, a positive FDG PET-CT lymph node status and higher CEA and CA 19-9 levels were not linked to reduced survival, and our analysis failed to identify any substantial volumetric prognostic variables. However, the statistically significant difference in TLG values, which show the tumor's vol-

umetric and glycolytic activity, between operated and non-operated patients, suggests that TLG values may also reflect tumor biology and behavior in GAC. Multicenter, prospective, and randomized studies with more patients are crucial to determine the influence of baseline 18F-FDG PET/CT imaging and volumetric factors on survival outcomes. Early prognostic predictions can improve patient management and guide therapeutic decisions in patients with GAC.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

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REFERENCES

1. GBD 2017 Stomach Cancer Collaborators. The global, regional, and national burden of stomach cancer in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease study 2017. Lancet Gastroenterol Hepatol. 2020;5(1):42-54. Erratum in: Lancet Gastroenterol Hepatol. 2020;5(3):e2. [Crossref] [PubMed] [PMC]
2. Gallamini A, Zwarthoed C, Borra A. Positron emission tomography (PET) in oncology. Cancers (Basel). 2014;6(4):1821-89. [PubMed] [PMC]
3. Foley KG, Coomer W, Coles B, Bradley KM. The impact of baseline 18F-FDG PET-CT on the management and outcome of patients with gastric cancer: a systematic review. Br J Radiol. 2022;95(1139):20220437. [Crossref] [PubMed] [PMC]
4. Vesselle H, Schmidt RA, Pugsley JM, Li M, Kohlmyer SG, Vallires E, et al. Lung cancer proliferation correlates with [F-18]fluorodeoxyglucose uptake by positron emission tomography. Clin Cancer Res. 2000;6(10):3837-44. [PubMed]
5. Ikenaga N, Otomo N, Toyofuku A, Ueda Y, Toyoda K, Hayashi T, et al. Standardized uptake values for breast carcinomas assessed by fluorodeoxyglucose-positron emission tomography correlate with prognostic factors. Am Surg. 2007;73(11):1151-7. [PubMed]
6. Allal AS, Slosman DO, Kebdani T, Allaoua M, Lehmann W, Dulguerov P. Prediction of outcome in head-and-neck cancer patients using the standardized uptake value of 2-[18F]fluoro-2-deoxy-D-glucose. Int J Radiat Oncol Biol Phys. 2004;59(5):1295-300. [Crossref] [PubMed]
7. Moon SH, Hyun SH, Choi JY. Prognostic significance of volume-based PET parameters in cancer patients. Korean J Radiol. 2013;14(1):1-12. [PubMed] [PMC]
8. Ott K, Fink U, Becker K, Stahl A, Dittler HJ, Busch R, et al. Prediction of response to preoperative chemotherapy in gastric carcinoma by metabolic imaging: results of a prospective trial. J Clin Oncol. 2003;21(24):4604-10. [PubMed]
9. Ott K, Herrmann K, Lordick F, Wieder H, Weber WA, Becker K, et al. Early metabolic response evaluation by fluorine-18 fluorodeoxyglucose positron emission tomography allows in vivo testing of chemosensitivity in gastric cancer: long-term results of a prospective study. Clin Cancer Res. 2008;14(7):2012-8. [PubMed]
10. Kim J, Lim ST, Na CJ, Han YH, Kim CY, Jeong HJ, et al. Pretreatment F-18 FDG PET/CT parameters to evaluate progression-free survival in gastric cancer. Nucl Med Mol Imaging. 2014;48(1):33-40. [PubMed] [PMC]
11. Hirata K, Tamaki N. Quantitative FDG PET assessment for oncology therapy. Cancers (Basel). 2021;13(4):869. [PubMed] [PMC]
12. Yun M. Imaging of gastric cancer metabolism using 18 F-FDG PET/CT. J Gastric Cancer. 2014;14(1):1-6. [Crossref] [PubMed] [PMC]
13. Mochiki E, Kuwano H, Katoh H, Asao T, Oriuchi N, Endo K. Evaluation of 18F-2-deoxy-2-fluoro-D-glucose positron emission tomography for gastric cancer. World J Surg. 2004;28(3):247-53. [PubMed]
14. Yaprak G, Tataroglu D, Dogan B, Pekyurek M. Prognostic factors for survival in patients with gastric cancer: Single-centre experience. North Clin Istanb. 2019;7(2):146-52. [PubMed] [PMC]
15. Ha TK, Choi YY, Song SY, Kwon SJ. F18-fluorodeoxyglucose-positron emission tomography and computed tomography is not accurate in preoperative staging of gastric cancer. J Korean Surg Soc. 2011;81(2):104-10. [PubMed] [PMC]
16. Park JC, Lee JH, Cheoi K, Chung H, Yun MJ, Lee H, et al. Predictive value of pretreatment metabolic activity measured by fluorodeoxyglucose positron emission tomography in patients with metastatic advanced gastric cancer: the maximal SUV of the stomach is a prognostic factor. Eur J Nucl Med Mol Imaging. 2012;39(7):1107-16. [PubMed]

17. Chung HW, Lee EJ, Cho YH, Yoon SY, So Y, Kim SY, et al. High FDG uptake in PET/CT predicts worse prognosis in patients with metastatic gastric adenocarcinoma. J Cancer Res Clin Oncol. 2010;136(12):1929-35. [Crossref] [PubMed] [PMC]
18. Coupe NA, Karikios D, Chong S, Yap J, Ng W, Merrett N, et al. Metabolic information on staging FDG-PET-CT as a prognostic tool in the evaluation of 97 patients with gastric cancer. Ann Nucl Med. 2014;28(2):128-35. [PubMed]
19. Na SJ, o JH, Park JM, Lee HH, Lee SH, Song KY, et al. Prognostic value of metabolic parameters on preoperative 18F-fluorodeoxyglucose positron emission tomography/ computed tomography in patients with stage III gastric cancer. Oncotarget. 2016;7(39):63968-80. [Crossref] [PubMed] [PMC]
20. Lee JW, Lee SM, Lee MS, Shin HC. Role of ^{18}F-FDG PET/CT in the prediction of gastric cancer recurrence after curative surgical resection. Eur J Nucl Med Mol Imaging. 2012;39(9):1425-34. [PubMed]
21. Stahl A, Ott K, Weber WA, Becker K, Link T, Siewert JR, et al. FDG PET imaging of locally advanced gastric carcinomas: correlation with endoscopic and histopathological findings. Eur J Nucl Med Mol Imaging. 2003;30(2):288-95. [Crossref] [PubMed]
22. Grabinska K, Pelak M, Wydmanski J, Tukiendorf A, d'Amico A. Prognostic value and clinical correlations of 18-fluorodeoxyglucose metabolism quantifiers in gastric cancer. World J Gastroenterol. 2015;21(19):5901-9. [PubMed] [PMC]
23. Adams MC, Turkington TG, Wilson JM, Wong TZ. A systematic review of the factors affecting accuracy of SUV measurements. AJR Am J Roentgenol. 2010;195(2):310-20. Erratum in: AJR Am J Roentgenol. 2010;195(4):1043. [PubMed]
24. Boellaard R, Krak NC, Hoekstra OS, Lammertsma AA. Effects of noise, image resolution, and ROI definition on the accuracy of standard uptake values: a simulation study. J Nucl Med. 2004;45(9):1519-27. [PubMed]
25. Kwon HR, Pahk K, Park S, Kwon HW, Kim S. Prognostic value of metabolic information in advanced gastric cancer using preoperative 18F-FDG PET/CT. Nucl Med Mol Imaging. 2019;53(6):386-95. [Crossref] [PubMed] [PMC]
26. Boktor RR, Walker G, Stacey R, Gledhill S, Pitman AG. Reference range for intrapatient variability in blood-pool and liver SUV for 18F-FDG PET. J Nucl Med. 2013;54(5):677-82. [PubMed]
27. Park HL, Yoo IR, Boo SH, Park SY, Park JK, Sung SW, et al. Does FDG PET/CT have a role in determining adjuvant chemotherapy in surgical margin-negative stage IA non-small cell lung cancer patients? J Cancer Res Clin Oncol. 2019;145(4):1021-6. [Crossref] [PubMed] [PMC]
28. Na SJ, Oh JK, Hyun SH, Lee JW, Hong IK, Song BI, et al. 18F-FDG PET/CT can predict survival of advanced hepatocellular carcinoma patients: a multicenter retrospective cohort study. J Nucl Med. 2017;58(5):730-6. [PubMed]
29. Lee JW, Oh JK, Chung YA, Na SJ, Hyun SH, Hong IK, et al. Prognostic significance of ^{18}F-FDG uptake in hepatocellular carcinoma treated with transarterial chemoembolization or concurrent chemoradiotherapy: a multicenter retrospective cohort study. J Nucl Med. 2016;57(4):509-16. [PubMed]
30. McAteer D, Wallis F, Couper G, Norton M, Welch A, Bruce D, et al. Evaluation of 18F-FDG positron emission tomography in gastric and oesophageal carcinoma. Br J Radiol. 1999;72(858):525-9. [PubMed]
31. Huang J, Huang L, Zhou J, Duan Y, Zhang Z, Wang X, et al. Elevated tumor-to-liver uptake ratio (TLR) from 18F-FDG-PET/CT predicts poor prognosis in stage IIA colorectal cancer following curative resection. Eur J Nucl Med Mol Imaging. 2017;44(12):1958-68. [PubMed] [PMC]
32. Bütof R, Hofheinz F, Zöphel K, Stadelmann T, Schmollack J, Jentsch C, et al. Prognostic value of pretherapeutic tumor-to-blood standardized uptake ratio in patients with esophageal carcinoma. J Nucl Med. 2015;56(8):1150-6. [PubMed]
33. Utsunomiya T, Ogawa K, Funamizu N, Sakamoto K, Watanabe J, Otani H, et al. The tumor-to-liver ratio of the standardized uptake value is a useful FDG-PET/CT parameter for predicting malignant intraductal papillary mucinous neoplasm of the pancreas. Ann Gastroenterol Surg. 2022;6(5):695-703. [PubMed] [PMC]
34. Mütevelizade G, Tosyalı HK, Aydın N, Gümüşer G, Sayıt Bilgin E. Yumuşak doku sarkomu tanılı hastalarda F-18 FDG PET/BT evreleme parametrelerinin sağkalıma etkisi [The impact of F-18 FDG PET/CT staging parameters on surviival in patients diagnosed with soft tissue sarcoma]. Medical Journal of İzmir Hospital. 2025;29(1):41-7. [Link]