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Evaluation of Lesions with Increased Fluorine-18 Fluorodeoxyglucose Uptake in the Stomach and Colon Incidental Detected by Positron Emission Tomography/ Computed Tomography

Pozitron Emisyon Tomografi/Bilgisayarlı Tomografi ile Rastlantısal Olarak Mide ve Kolonda Artmış Flor-18 Florodeoksiglikoz Tutulumu Tespit Edilen Lezyonların Değerlendirilmesi

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Abstract

Objective: One of the most common incidental increased uptake areas with fluorine-18 fluorodeoxyglucose (^{18}F-FDG) positron emission tomography/computed tomography (PET/CT) is the gastrointestinal tract. In this study, we retrospectively evaluated patients with gastric and colonic incidental increased ^{18}F-FDG uptake on PET/CT.

Methods: Patients who underwent ^{18}F-FDG PET/CT imaging and had incidental increased gastric and colonic uptake between June 2017 and June 2020 were evaluated.

Results: Of the 10,551 evaluated patients, 306 (2.9%) had colonic and 195 (1.8%) had gastric incidental ^{18}F-FDG uptake on PET/CT. Within 120 days after imaging, 173 patients (56%) with increased colonic uptake (250 different uptake area) and 95 patients with increased gastric uptake (48.7%) who underwent endoscopic evaluation in our center were included in the study. Increased focal uptake pattern was seen in 86.4% of colonic uptake areas and 67.4% of gastric uptake areas. Malignant/premalignant diseases were identified in 80% of cases with colonic uptake, and in 21% of patients with gastric uptake areas. While maximum standardized uptake value (SUV_{max}) >5.9 in the colon differentiates inflammatory and malignant/premalignant diseases from benign diseases with 80% sensitivity and 97% specificity, SUV_{max} >5.0 in the stomach differentiates malignant/premalignant lesions from inflammatory benign diseases with 75% sensitivity and 72% specificity.

Conclusion: Focal incidental increased ^{18}F-FDG uptake especially in the colon is associated with malignant/premalignant events, however, focal gastric uptake is not effective in differentiating malignant/premalignant lesions from benign lesions. Studies are needed for effective SUV_{max} values distinguish benign and malignant gastric lesions.

Keywords: Fluorine-18 fluorodeoxyglucose, positron emission tomography/computed tomography, incidental uptake, gastrointestinal tract

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Öz

Amaç: Flor-18 florodeoksiglukoz (^{18}F-FDG) pozitron emisyon tomografi/bilgisayarlı tomografi (PET/BT) görüntüleme yöntemi ile sıklıkla karşılaşılan sonuçlardan birisi de rastlantısal tutulum alanlarıdır. Bu rastlantısal tutulum alanlarından birisi de gastrointestinal sistemdir. Biz bu çalışmamızda merkezimizde PET/BT'de mide ve kolonda rastlantısal ^{18}F-FDG tutulumu izlenen hastaları değerlendirdik.

Yöntem: Ocak 2017-Haziran 2020 tarihleri arasında merkezimizde ^{18}F-FDG PET/BT görüntüleme yapılan, mide ve kolonda ^{18}F-FDG rastlantısal tutulumu olan hastalar retrospektif olarak değerlendirmeye alındı.

Bulgular: Değerlendirmeye alınan 10,551 hastanın 306'sında kolonda (%2,9), 195'inde mide de (%1,8) rastlantısal ^{18}F-FDG tutulumu olduğu görüldü. Görüntüleme sonrası 120 gün içinde merkezimizde endoskopik değerlendirmesi yapılan kolon tutulumu olan 173 hasta (%56), mide tutulumu olan 95 hasta (%48,7) çalışmaya dahil edildi. Kolonda toplam 250 ayrı alanda rastlantısal tutulum izlenmiş olup 216'sı (%86,4) fokal, 34'ü (%13,6) fokal olmayan tutulum iken, midede 64 hastada (%67,4) fokal, 31'inde (%32,6) fokal olmayan tutulum tespit edilmiştir. Kolonda tutulumu olan olguların %80'inde malign/premalign lezyon tespit edilirken, midede tutulumu olan hastaların %21'inde malign/premalign lezyon izlendiği görülmüştür. Alıcı işletim karakteristik analizinde kolonda bulunan SUV_{maks} >5,9 değeri %80 sensivite ve %97 spesifite ile kolondaki enflamatuvar ve malign/premalign lezyonları, benign lezyonlardan ayırt ederken, midede SUV_{maks} >5,0 değeri %75 sensitivite ve %72 spesifite ile midedeki malign/premalign lezyonları enflamatuvar benign hadiselerden ayırdığı görülmüştür.

Sonuç: Özellikle kolonda fokal rastlantısal ^{18}F-FDG tutulumu malign/premalign hadiseler ile ilişkili iken, midede fokal tutulum olması malign/premalign lezyonları benign lezyonlardan ayırt etmede etkin değildir. Midede benign ve malign lezyonları ayırt edecek etkin SUV_{maks} değerleri için yani çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Flor-18 florodeoksiglikoz, pozitron emisyon tomografi/bilgisayarlı tomografi, rastlantısal tutulum, gastrointestinal sistem

Introduction

Towards the end of 1990, a hybrid imaging method formed by combining positron emission tomography (PET) and computed tomography (CT) devices, has been introduced and approved to be used in first stage of solitary pulmonary nodules and lung cancer, and today, it becomes a method to diagnose and staging different cancer types including breast, lung, colorectal, esophageal, head and neck, lymphoma, and melanoma and to evaluate the treatment response[1,2].

Fluorine-18 fluorodeoxyglucose (^{18}F-FDG) is the most common radio-labelled tracker in PET scans. ^{18}F-FDG is taken into several tissue cells and accumulates during glucose metabolism, relatively higher in cancer cells. However, increased ^{18}F-FDG uptake may occur in benign, inflammatory, or granulomatous processes and normal, physiological distribution regions as well as malignant lesions[3,4].

PET/CT imaging method is increasingly being used in the oncology, therefore, incidental increased ^{18}F-FDG uptake may be identified in different organs and systems including the prostate, thyroid, breast, bladder and gastrointestinal tract (GIT) as well as the primary or metastatic tumor area[5]. Unfortunately, increased ^{18}F-FDG uptake is not specific to cancerous cells[6-9]. Specificity of ^{18}F-FDG PET/CT is low. ^{18}F-FDG accumulates in several inflammatory cells such as lymphocytes, neutrophils and macrophages due to the increased glucose metabolism[10]. The studies reported that the prevalence of incidental increased ^{18}F-FDG uptake in GIT is 0.5% to 5%[11]. Increased ^{18}F-FDG uptake in GIT is highly variable and may vary from mild to severe with focal, diffuse or segmental distribution.

In this study, we planned to evaluate the frequency, clinical features, and patterns of lesions with gastric and colonic incidental increased ^{18}F-FDG uptake on PET/CT imaging retrospectively.

Materials and Methods

Patients

Electronic records of patients over 18 years of age who underwent ^{18}F-FDG PET/CT imaging at our center between June 2017 and June 2020 were retrospectively evaluated. All patients gave written informed consent for the PET/CT study and for evaluation of their clinical records for follow-up. Patients with incidental increased gastric and colonic ^{18}F-FDG uptake were included in the study. Patients with previously known primary gastrointestinal system (GIS) malignancies, history of radiotherapy and chemotherapy for other malignancies within 4 weeks, and who had endoscopic evaluation after 120 days were excluded.

The study approved by the Local Ethical Committee of University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital (no: 2019/18-23).

PET/CT Imaging

A Philips Gemini TF-16 slice combined PET/CT device (Philips Medical Systems, Eindhoven, the Netherlands) was used for imaging. The same scanner was used in all patients. After at least 6 hours fasting, 18-15 mCi ^{18}F FDG injection was administrated intravenously (2.5 MBq/kg body weight), then, the time to imaging was 60±5 minutes. Intravenous contrast medium was not used. Firstly, CT images (140 kV, 100 mAs, 5 mm section), then PET images were obtained. The emission scan was obtained in 1.5 minutes per bed position for body area from skull vertex to proximal thigh in 9 or 10 bed positions.

^{18}F-FDG PET/CT data hybrid images were analyzed independently by nuclear medicine specialist. The pattern and degree of colonic uptake were evaluated and localized (cecum, right colon, transverse colon, left colon, rectum and anus). The lesion with incidental colonic and gastric uptake was automatically plotted in trans axial sections of the 3D isocontour relevant area (ROI). The maximum standardized uptake value (SUV_{max}), median SUV (SUV_{mean}) and metabolic tumor volume (MTV) in ROI were calculated automatically with 40% cut-off value for the relevant area. Total lesion glycolysis (TLG) was calculated by multiplying MTV and SUV_{mean} value.

Endoscopic Procedure

Endoscopic evaluations were performed by specialist physicians having more than 2000 endoscopy experiences by conventional endoscopes. All gastric and colorectal lesions were evaluated by the results of forceps biopsy, endoscopic mucosal resection, endoscopic submucosal dissection, or surgical resection. After evaluating the pooled endoscopy and pathology results, the lesions were grouped to be evaluated as malignant, premalignant, inflammatory benign and other benign events.

Statistical Analysis

SPSS 25.0 (IBM Statistical Package for Social Sciences software version 25) was used for statistical analysis. Kolmogorov-Smirnov test was used to evaluate whether the numerical data was distributed normally or not by the obtained number. Normally distributed numerical data were reported as mean and standard deviation, and data not showing normal distribution were expressed as median and interquartile range. ANOVA or Kruskal-Wallis test was performed by normality in comparisons of three or more groups. In dual group comparison, independent Student's t-test was used to compare normally distributed data, and Mann-Whitney U test was used to compare data which did not show normal distribution. Chi-square test and Fisher's Exact test were used to compare categorical variables. Receiver operating characteristic (ROC) for SUV_{max} analyses was used to obtain a cut-off value in order to distinguish malignant/premalignant lesions in the stomach from chronic gastritis, and to distinguish malignant/premalignant and inflammatory benign lesions in the colon from benign/normal lesions. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for these values. $P<0.05$ was considered statistically significant.

Results

The retrospective evaluation of 10.551 patients without chemotherapy and radiotherapy history, without previously known primary GIS malignity, who underwent PET/CT imaging in our center between January 2017 and June 2020 showed that; 306 had incidental increased ^{18}F-FDG uptake in colon (2.9%), 195 had incidental increased ^{18}F-FDG uptake in stomach (1.8%). Among 306 patients with increased colonic ^{18}F-FDG uptake, 173 patients who had undergone colonoscopy within 120 days in our center (56.5%), and among 195 patients with increased gastric ^{18}F-FDG uptake, 95 patients who had undergone upper GIS endoscopy in 120 days in our center (48.7%) were included the study.

Demographic Data of Patients with Colonic ^{18}F-FDG Uptake

Of the 173 patients with incidental increased colonic ^{18}F-FDG uptake, 127 were male (73.4%) and 46 were female (26.6%). The mean age of the patients was 63.47±8.78 (43-85). We found that PET/CT imaging was performed in 131 patients (75.7%) for solid tumors, 3 patients (1.7%) for hematological malignancies, and 39 patients (22.5%) for unknown primary malignancies. Colonic incidental ^{18}F-FDG uptake was found in 250 different areas of these 173 patients.

Correlation of Colonic ^{18}F-FDG Uptake with Colonoscopy and Pathology Results

The correlation between the colonoscopy and pathology results of 250 involved areas in the colon identified by PET/CT with increased ^{18}F-FDG uptake showed that; malignant diseases were found in 36 areas (14.4%), premalignant diseases in 165 areas (66%), inflammatory benign diseases in 22 areas (8.8%), other benign diseases in 12 areas (4.8%) and normal findings in 15 patients (6%). Focal uptake was

identified in 216 (86.4%) involved areas on PET/CT, and diffuse or segmental uptake in 34 (13.6%). Of 34 patients with diffuse/segmental uptake, 22 had colitis, 11 had diverticulosis, and 1 had normal colonoscopic findings. Of the areas with focal uptake, 36 had malignant diseases, 165 had premalignant diseases, 1 had diverticulosis, and 14 had normal colonoscopic findings. Focal increased uptake was identified in all malignant and premalignant diseases, however, 33 of 34 extensive lesions such as colitis and diverticulosis had diffuse/segmental uptake, and 1 had focal uptake. According to the results of colonoscopy, the accuracy rate of PET/CT in detecting the area of involvement and lesion was 76.4%.

Table 1 summarizes the diagnoses, numbers, mean SUV_{max}, MTV and TLG values of the lesions with colonic incidental increased ^{18}F-FDG uptake by the colonoscopy and pathology results.

Table 2 summarizes the statistical difference rates between the groups in terms of mean SUV_{max}, MTV, TLG values

Table 1. Diagnosis, numbers, mean SUV_{max}, MTV and TLG values of colonic incidental increased 18F-FDG on PET/CT

Colonoscopy/pathology results	n (%)	SUV_{max}	MTV	TLG
Malignant diseases	36 (14.4%)	14.42±7.73	16.29±10.74	124.12±98.26
Adenocarcinoma	30 (12%)	14.63±8.05	18.36±10.56	139.07±100.46
Squamous cell carcinoma	2 (0.8%)	11.20±2.97	7.52±0.96	45.84±16.19
Intraepithelial carcinoma	2 (0.8%)	19.60±4.38	6.7±1.13	76.20±33.50
Malign melanoma	1 (0.4%)	4.20	0.9	2.97
Metastasis	1 (0.4%)	14.20	6.3	49.14
Premalignant diseases	165 (66%)	10.45±5.77	8.41±15.09	43.43±80.25
Tubulovillous adenoma	70 (28%)	10.84±5.83	7.09±13.03	41.49±76.33
Tubular adenoma	66 (26.4%)	10.24±5.81	9.69±17.90	43.63±85.85
Hyperplastic polyp	13 (5.2%)	5.86±2.64	4.77±3.00	14.81±7.95
Villous adenoma	11 (4.4%)	14.45±5.31	15.76±18.99	99.38±112.06
Serrated adenoma	5 (2%)	10.98±4.70	3.22±0.78	19.50±11.56
Inflammatory benign diseases	22 (8.8%)	12.61±8.95	39.22±26.23	270.22±317.77
Non-specific colitis	16 (6.4%)	12.88±10.35	45.64±27.44	314±361.31
Ulcerative colitis	5 (2%)	12.85±3.34	25.57±9.78	180.69±83.21
Radiation colitis	1 (0.4%)	7.07	4.9	17.2
Other benign diseases				
Diverticulosis	12 (4.8%)	4.80±4.42	3.52±1.63	9.61±10.25
Normal	15 (6%)	2.61±0.48		

SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycolysis, PET/CT: Positron emission tomography/computed tomography, 18F-FDG: Fluorine-18 fluorodeoxyglucose

Table 2. Statistical differences in SUV_{max}, MTV and TLG values between lesion groups detected with colonic incidental increased 18F-FDG on PET/CT

	SUV_{max} p	MTV p	TLG p
Malignant-premalignant diseases	**0.013**	**<0.001**	**<0.001**
Malignant-inflammatory diseases	>0.05	0.161	0.682
Malignant-other benign diseases	**0.001**	**0.008**	**<0.001**
Premalignant-inflammatory benign diseases	>0.05	**<0.001**	**<0.001**
Premalign-other benign diseases	**0.001**	>0.05	**0.014**
Inflammatory benign-other benign diseases	**<0.001**	**<0.001**	**<0.001**

SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycolysis, 18F-FDG: Fluorine-18 fluorodeoxyglucose, PET/CT: Positron emission tomography/computed tomography

of the lesions with colonic incidental increased ^{18}F-FDG uptake. While mean SUV_{max}, MTV, TLG values of malignant diseases from premalignant and other benign diseases were statistically significantly higher but no statistically significant difference was observed between inflammatory benign diseases.

It is observed that SUV_{max}>5.9 value found by ROC analysis differentiated malignant/premalignant and inflammatory benign diseases from benign diseases and normal colonoscopy with 80% sensitivity and 97% specificity (PPV: 0.98%, NPV: 0.36%) in colonic incidental increased ^{18}F-FDG uptake on PET/CT.

Demographic Data of Patients with Gastric ^{18}F-FDG Uptake

Of the 95 patients with incidental increased gastric ^{18}F-FDG uptake, 58 were male (61.1%) and 37 were female (38.9%). The mean age of the patients was 61.82±10.97 (36-85). It was observed that PET/CT imaging was performed in 63 patients (66.3%) for solid tumors, 3 (3.2%) for hematological malignancies, 29 for (30.5%) unknown primary cancer.

Correlation of Gastric ^{18}F-FDG Uptake with Endoscopy and Pathology Results

The correlation between the endoscopy and pathology results of 95 patients with gastric uptake identified by PET/CT showed that; malignant diseases were detected in 8 patients (8.4%), premalignant diseases in 12 patients (12.6%), and inflammatory benign diseases in 75 patients (78.9%). Incidental focal uptake was identified in 64 (67.4%) and incidental diffuse/segmental uptake in 31 (32.6%) of 95 patients with gastric uptake identified by PET/CT. The correlation between endoscopy and pathology results in 31 cases with diffuse/segmental uptake were found to be consistent with chronic gastritis.

Table 3 summarizes the diagnoses, numbers, mean SUV_{max}, MTV and TLG values of the lesions with gastric incidental increased ^{18}F-FDG uptake by the endoscopy and pathology results.

Table 4 summarizes the statistical difference rates between the groups in terms of mean SUV_{max}, MTV, TLG values of the lesions with gastric incidental increased ^{18}F-FDG uptake. Accordingly, no statistically significant difference was

Table 3. Diagnosis, numbers, mean SUV_{max}, MTV and TLG values of gastric incidental increased 18F-FDG on PET/CT

Endoscopy/pathology results	n (%)	SUV_{max}	MTV	TLG
Malignant diseases	8 (8.4%)	9.55±2.42	13.05±4.63	63.17±17.25
Adenocarcinoma	5 (5.3%)	8.49±1.79	13.45±6.02	58.88±24.10
Malign epithelial tumor	2 (2.1%)	12.58±1.94	12.35±1.62	75.17±11.50
Lymphoma	1 (1.1%)	8.76	12.45	60.63
Premalignant diseases	12 (12.6%)	5.98±3.33	15.42±28.13	95.98±180.85
Hyperplastic polyp	8 (8.4%)	4.76±2.07	2.67±0.58	8.63±2.52
Adenomatous polyp	3 (3.1%)	7.78±5.09	21.77±14.41	114.59±118.84
Leiomyoma	1 (1.1%)	10.32	98.30	564.24
Inflammatory benign diseases (chronic gastritis)	75 (78.9%)	4.40±1.94	33.97±42.28	138.71±218.94

SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycolysis, 18F-FDG: Fluorine-18 fluorodeoxyglucose, PET/CT: Positron emission tomography/computed tomography

Table 4. Statistical differences in SUV_{max}, MTV and TLG values between lesion groups detected with gastric incidental increased 18F-FDG on PET/CT

	SUV_{max} p	MTV p	TLG p
Malignant-premalignant disease	0.051	0.184	0.067
Malignant-inflammatory disease	**<0.001**	>0.05	>0.05
Premalignant-inflammatory disease	0.405	**0.024**	>0.05

SUV_{max}: Maximum standardized uptake value, MTV: Metabolic tumor volume, TLG: Total lesion glycolysis, 18F-FDG: Fluorine-18 fluorodeoxyglucose, PET/CT: Positron emission tomography/computed tomography

observed between malignant diseases and premalignant diseases in terms of mean SUV_{max}, MTV, TLG values. Mean SUV_{max}value of malignant diseases was found to be statistically significantly higher than the mean SUV_{max}value of inflammatory benign diseases.

It is observed that SUV_{max}>5.0 value found by ROC analysis differentiated malignant/premalignant diseases from inflammatory benign diseases with 75% sensitivity and 72% specificity (PPV: 0.41%, NPV: 0.91%) in gastric incidental increased ^{18}F-FDG on PET/CT.

Discussion

PET/CT imaging method is commonly used in the oncology, therefore, incidental increased ^{18}F-FDG uptake is identified frequently in different organs and systems as well as primary and metastatic lesions due to the non-specific nature of ^{18}F-FDG[5]. The literature reported that incidental increased ^{18}F-FDG uptake on PET/BT is 6.7-12%[12,13]. It may be due to a secondary malignancy as well as benign or premalignant several events (granulomatous disease, inflammatory and precancerous diseases etc.). Incidental increased ^{18}F-FDG uptake leads to question marks in the minds of the clinician and radiologist, and GIT is also one of the systems in which it occurs.

A meta-analysis consisting of 89.061 patients in 32 studies compiled by Treglia et al.[11] reported that incidental focal increased ^{18}F-FDG uptake in the colon is approximately 3.6%. In this meta-analysis, the number of patients whose histopathological correlation was evaluated by colonoscopy only due to focal increased ^{18}F-FDG uptake is between 4-125. In the literature, the highest rate of incidental increased ^{18}F-FDG uptake in colon was reported by van Hoeij et al.[14] (5%). This study evaluated 242 different areas in 203 patients having focal uptake only in the colon. In our study, the patients with both focal and diffuse/segmental increased uptake in colon were evaluated together. And also, our study is the study in which the most uptake areas (250 different areas) were evaluated in the literature. We found 2.9% incidental increased ^{18}F-FDG uptake similar with the literature. Especially unlike other studies, the patients who had received radiotherapy and chemotherapy were excluded in our study, and possible low ^{18}F-FDG uptake rates were ruled out.

PET/CT imaging of GIT shows incidental increased ^{18}F-FDG uptake as focal or non-focal patterns. In the literature, non-focal uptakes (diffuse and segmental) are generally associated with physiological uptake by the smooth muscles of GIT, FDG excretion, intraluminal concentration or inflammatory events, however, focal uptake is associated with endoscopically detectable malignant or premalignant diseases[1,15-17]. In the studies, non-focal uptakes are commonly associated with benign events, therefore they are generally excluded from the evaluations[1,11,14-18]. In our study, we aimed to determine the uptake pattern and involvement rates in benign and inflammatory benign events by evaluating all focal and non-focal involvement patterns together, and to find their SUV_{max}, MTV, TLG values that differentiate them from malignant and premalignant diseases. Incidental increased focal uptake was observed in 216 (86.4%) of 250 separate areas in the colon, and according to the results of colonoscopy and pathology, malignant or premalignant diseases were detected in 201 (80%) of these areas. While normal colonoscopic findings were observed in 14 of the other 15 patients, no pathology was observed except for diverticulosis in 1. In the literature, among the patients with incidental increased ^{18}F-FDG uptake in colon, the incidence of malignant or premalignant diseases is 44% to 65%[1,11,14-18]. Unlike the literature, the incidence of malignant or premalignant diseases is higher in the cases included in our study (80%). This may be due to the fact that patients with diffuse/segmental uptake, which is currently highly associated with benign events, are less referred to colonoscopic evaluation by clinicians. Given the conventional colonoscopic evaluation may misses 15-20% of polyps below 1 cm, 6% of polyps greater than 1 cm, we suggest that PET/CT may highly indicate malignant or premalignant diseases in the events characterized by focal uptake, and colonoscopy examination should not be delayed in these patients[19]. Therefore, we predict that individuals with incidentally increased ^{18}F-FDG uptake in the colon will require re-evaluation by colonoscopy even if normal colonoscopy is performed.

Of course, in addition to the focal and non-focal uptake pattern, SUV_{max}, MTV, TLG values provide information about the activity of the lesion. Among the studies on incidental increased ^{18}F-FDG uptake in GIT, several studies showed that SUV_{max} value may differentiate malignant, premalignant, inflammatory events, and several studies showed that SUV_{max} value cannot differentiate these events[1,11,14-18,20,21]. In our study, while the mean SUV_{max} value in malignant diseases was statistically significantly higher than premalignant diseases, but there was no statistically significant difference between with the inflammatory benign diseases (respectively;

p=0.013, p>0.05). The differentiating feature among these groups is that high SUV_{max} values are accompanied by high TLG and MTV values due to diffuse/segmental uptake, especially in inflammatory benign diseases. In our study, the sensitivity and specificity of SUV_{max} value above 5.9 detected by ROC analyses is respectively 80% and 97% for differentiating malignant, premalignant and inflammatory benign diseases (diverticulosis) and normal colonoscopic findings. This value is same as proof based reviews of Pencharz et al.[5]. In our study, there is a diffuse/segmental uptake in the colon and findings compatible with colitis were observed in the cases with high SUV_{max}, TLG, MTV values. This finding suggests whether PET/CT imaging should be useful in the diagnose and severity of an inflammatory bowel disease (IBD) leading to inflammation in GIT.

In the literature, there are no studies consisting of large number of patients with incidental gastric increased ^{18}F-FDG uptake identified by PET/CT. In Le Roux et al.'s[22] study consisting of 39 patients with incidental focal increased ^{18}F-FDG uptake in the stomach, gastric distention continued in 14 patients after hyoscine N-butylbromide administration, and malignancy was detected in 10 of these cases, but 4 had normal pathology results. In our study, among 95 patients with gastric incidental increased ^{18}F-FDG uptake on PET/CT, 64 had (67.4%) focal, 31 (32.6%) had diffuse or segmental uptake. Following the correlation of endoscopy and pathology results, malignant or premalignant diseases were found in 20 of these 95 lesions (21%). All malignant or premalignant diseases in the stomach had increased focal uptake pattern, however, other 44 increased focal uptake patterns were compatible with chronic gastritis. It was observed that most of incidental increased ^{18}F-FDG uptake in the stomach (78.9%) is compatible with chronic gastritis and 41% of these cases had diffuse/segmental uptake pattern, 59% had focal uptake pattern. Therefore, it is difficult to say that the focal uptake pattern in the stomach is associated with malignant or premalignant diseases just like in the colon.

Besides, TLG and MTV values are also not sufficient to differentiate malignant and premalignant lesions from chronic gastritis due to the diffuse uptake pattern, especially in chronic gastritis. It was observed at this point that SUV_{max} value outweighs the uptake pattern and TLG and MTV values, and according to the ROC analysis, the SUV_{max} values above 5 differentiated malignant or premalignant diseases from chronic gastritis with 75% sensitivity and 72% specificity. Especially, in societies like our country with a high prevalence of *Helicobacter pylori (H. pylori)*, we should remember that this type of incidental increased ^{18}F-FDG uptake in the stomach may be common. In a study on this issue, Kobayashi et al.[23] reported that SUV_{max} values were statistically significantly higher in individuals with *H. pylori* and chronic gastritis as compared to others. Therefore, we suggest that proton pump inhibitor (ppi) may be effective for about 10-14 days before PET/CT imaging in order to prevent incidental increased gastric uptake ^{18}F-FDG false positivity and high activity.

Study Limitations

Our study has some limitations. In addition to its retrospective design, it is one of the limitations of not evaluating all cases with incidental involvement in the GIT. In addition, the data only includes the data of single center, tertiary referral center. There is a need for more studies evaluating incidental ^{18}F-FDG uptake in the stomach with a wider number of patients, especially after the use of ppi.

Conclusion

Incidental focal increased ^{18}F-FDG uptake in colon is associated with malignant or premalignant diseases, however, gastric focal increased ^{18}F-FDG uptake may be associated with benign events as well as malignant or premalignant diseases. We suggest that if diffuse or segmental increased uptake in colon is concurrent with high SUV_{max}, MTV and TLG values, it is highly possible to be associated with inflammatory benign events (colitis), but low SUV_{max}, MTV and TLG values are associated with diverticulosis or normal colon.

In patients with incidental increased ^{18}F-FDG uptake in the colon, 5.9 SUV_{max} value is considered to be a value with good specificity indicating the patient group who need a colonoscopy. The number of premalignant and malignant patients detected especially in the stomach is low, however, we may suggest that the SUV_{max} value above 5 has an acceptable sensitivity and specificity in distinguishing malignant and premalignant lesions from benign events, with a good negative predictive value. In groups with larger number of patients, this rate should be tested.

Imaging methods such as magnetic resonance imaging or CT may be insufficient to identify disease severity and uptake pattern, especially in patients with IBD. Studies on the efficacy of PET/CT may be planned in these patients. Besides, we recommend the use of ppi 10-14 days before PET/CT imaging especially in the societies with a high prevalence of *H. pylori* to reduce the need for unnecessary endoscopy.

Ethics

Ethics Committee Approval: The study approved by the Local Ethical Committee of University of Health Sciences Turkey, İzmir Tepecik Training and Research Hospital (no: 2019/18-23).

Informed Consent: Informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: D.Ç.P., Ö.B.B., C.C., Design: D.Ç.P., C.C., Ö.B.B., Data Collection or Processing: D.Ç.P., Ö.B.B., N.A., Analysis or Interpretation: D.Ç.P., Ö.B.B., Literature Search: D.Ç.P., Ö.B.B., Writing: D.Ç.P., Ö.B.B., N.A.

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