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ORIGINAL ARTICLE – OPEN ACCESS

Nonmalignant Lung Pathologies Showing ^{18}F-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography Positivity

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ABSTRACT

Objective: ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography (^{18}F-FDG PET/CT) not only gives information about anatomical features of lung lesions but also about their metabolic activity. This study aimed to determine the mediastinal and parenchymal pathologies of the lung with false-positive FDG involvement and characteristics that could benefit differential diagnosis.

Materials and Methods: This study retrospectively analyzed 1,924 subjects that underwent ^{18}F-FDG PET/CT from December 2010 to January 2015. Subjects with a maximum standardized uptake value (SUV_{max}) value of ≥2.5 in the lung tissue, mediastinal lymph nodes with no primary lung malignancy, and a benign pathology result were included.

Results: The mean age of the 143 subjects was 61.7±11.0 years. The pathologies anthracosis, granulomatous inflammatory events, and organized pneumonia (OP) were 64 (45%), 36 (25%), and 18 (13%) cases, respectively, in order of frequency. The median SUV_{max} value of all lesions was 5.2 (min–max, 2.5–37.6). Moreover, mediastinal lymph node involvement was frequent (59%). The median SUV_{max} value of anthracotic lesions was significantly lower than the median SUV_{max} value of granulomatous and OP lesions ($p<0.001$ and $p=0.007$, respectively). No significant difference in the median SUV_{max} value was noted between granulomatous and OP lesions.

Conclusion: Anthracosis and tuberculosis should be considered as benign causes of mediastinal lymph node positivity in developing countries. ^{18}F-FDG PET/BT is an unreliable method for the differential diagnosis of benign diseases characterized by inflammation. Thus, metabolic activity evaluation is more suitable.

Keywords: ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG PET), anthracosis, maximum standardized uptake value (SUV), organizing pneumonia, sarcoidosis, tuberculosis

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INTRODUCTION

Today, lung cancer is the most common type of cancer with the highest mortality regardless of gender (1). Early diagnosis and accurate staging of lung cancer are very important for treatment as in all types of cancer. For lesions suspected of malignancy in thoracic computed tomography (CT), the use of an ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG PET) and CT combination helps clinicians eliminate question marks and decide on advanced diagnostic procedures. Moreover, ^{18}F-FDG PET/CT not only evaluates the anatomical characteristics of the lesion but also its metabolic activity. It is used to distinguish between malignant and benign lesions, determine biopsy location, stage the disease, and evaluate treatment response. Many studies report that malignant lesions show higher levels of FDG uptake in PET scans due to their metabolic activity than benign lesions. Thus, the threshold value of the maximum standardized uptake value (SUV_{max}) has been determined as 2.5 with a sensitivity and specificity of 80%–96% and 65%–92%, respectively, in the differentiation of malignant–benign lesions (2, 3). However, a tumor with slow metabolic activity can cause a false-negative, and acute or chronic inflammation can cause a false-positive in PET uptake (4).

This study evaluated nonmalignant mediastinal and parenchymal lung pathologies together with positive ^{18}F-FDG PET/CT imaging and analyzed the predictive features of these pathologies to reduce the frequency of diagnostic surgical procedures.

MATERIALS and METHODS

Subjects

This study was approved by the Erciyes University Faculty of Medicine Ethics Committee (Ethics Committee no: 2015/384).

This study retrospectively analyzed 1,924 subjects who underwent an ^{18}F-FDG PET/CT requested by the Departments of Chest Diseases and Thoracic Surgery of Erciyes University Medical Faculty Hospital between January 2010

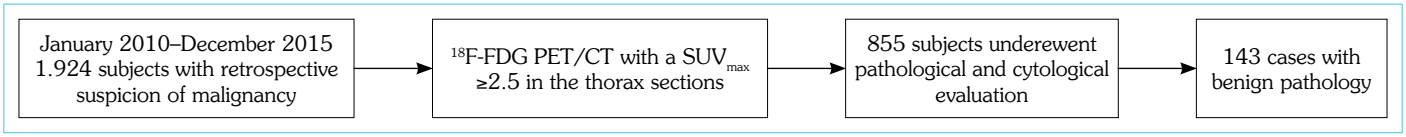

Figure 1. Establishment of the study group

and December 2015. Of the subjects, 855 with an FDG involvement of ≥2.5 in the thorax sections were further examined. According to the anatomic location of the lesion, subjects were evaluated with bronchoscopic biopsy, imaging-guided transthoracic biopsy, video-associated thoracoscopy (VATS), mediastinoscopy, and thoracotomy. Subjects diagnosed with benign pathology (e.g., anthracosis, granulomatosis, organized pneumonia (OP), chronic inflammatory event, interstitial pneumonia, fibrosis, and infectious diseases) were included. In addition, subjects diagnosed with active primary lung cancer and pathology results consistent with malignancy were excluded. Finally, 143 (7.4%) cases with benign histological and cytological results were included (Fig. 1). Information about the included subjects (e.g., age, smoking history, biomass exposure, and comorbid conditions such as accompanying extrapulmonary malignancy, hypertension, diabetes mellitus, coronary artery disease, and chronic renal failure) were retrieved from the hospital data records system.

^{18}F-FDG PET/CT

A whole-body scan was carried out with a Gemini TF (Philips Medical Systems, Eindhoven, Netherlands) time-of-flight capable, fully three-dimensional PET scanner in combination with a 16-slice Brilliance CT device. The subjects fasted for at least 6 h before the scan, and blood glucose levels were maintained below 180 mg/dL. Intravenous bolus fluorodeoxyglucose injection with a dosage ranging from 370 to 555 MBq (10–15 mCi) was administered. Images of six to eight bed positions starting from the base of the skull up to the thigh were obtained 1 h later. The whole-body PET scan was followed by an enhanced whole-body CT, which was used for attenuation correction. The subjects did not receive an intravenous contrast agent. In the semiquantitative evaluation, those images with increased focal uptake and higher intensity than the surrounding tissues and not corresponding to the physiological contribution of the ^{18}F-FDG were evaluated as positive (SUV_{max} ≥2.5)

Diagnostic Procedure

Subjects with tissue diagnosis and positive uptake (≥2.5) in the lung tissue and mediastinal lymph nodes during the ^{18}F-FDG PET/CT were evaluated. Thus, 143 subjects with no known primary lung cancer and benign pathology were included in the study. Diagnostic procedures were performed by the Chest Diseases, Thoracic Surgery, and Interventional Radiology Departments of the university. Of the 143 subjects, 79 were diagnosed with mediastinoscopy, 24 with imaging-guided transthoracic biopsy, 21 with transbronchial biopsy with bronchoscopy, 13 with thoracotomy, five with fine needle aspiration biopsy with bronchoscopy, and one with VATS.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS software, version 15.0; SSPS Inc, Chicago, IL, USA) was used for statistical analysis of the obtained data. The distribution of continuous variables was tested with the one-sample Kolmogorov–Smirnov test and the data were shown as mean±standard deviation or median and minimum–maximum ranges. Categorical variables were reported as frequency and group percentages. The Mann–Whitney U test was used for the comparison of two nonparametric groups. The Kruskal–Wallis analysis was used for comparisons with more than two groups. If a difference was detected in the Kruskal–Wall analysis, the Dunn–Bonferroni test was used as a multiple comparison test. The relationship between categorical variables was analyzed with the exact method of the chi-square test. All P values were bilateral and a P value <0.05 was considered significant.

Table 1. Demographic data of cases with false ^{18}F-FDG PET/CT positivity

	n_{total}=143
Gender female/male, n (%:%)	91/52 (64/36)
Age (years), Mean±SD	61.7±11.0
Comorbidity, n (%:%)	
Yes/no	65/78 (45/55)
Chronic diseases (n=65), n (%)	
Extrapulmonary malignancy	47 (72)
Hypertension	5 (8)
Diabetes mellitus	6 (9)
Coronary artery disease	5 (8)
Chronic renal failure	2 (3)
History of smoking, n (%)	
Yes	76 (53)
No	43 (30)
Not known	24 (17)

^{18}F-FDG PET/CT: ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography; SD: Standard deviation

RESULTS

This study included 143 subjects with benign pathology results, and 91 (63.6%) of them were males. The mean age of the subjects was 61.7±11.0 years. Of the subjects, 65 (45%) had at least one known chronic disease and the most common accompanying disease was extrapulmonary malignancy in 47 (72%) subjects. Of the cases, 53% had a smoking history (Table 1).

After examining the pathology of the 143 subjects with false ^{18}F-FDG PET/CT positivity, anthracosis, granulomatous inflammatory events, and organized pneumonia (OP) was observed in 64 (45%), 36 (25%), and 18 (13%) cases, respectively (Table 2). The median PET/CT SUV_{max} value was 5.2 (min–max, 2.5–37.6) of the examined 143 benign cases. The median SUV_{max} was 3.8 (min–max, 2.5–37.3), 7.9 (min–max, 2.6–37.6), and 6.8 (min–max, 2.5–13.3) for lesions with anthracosis, granulomatous lesions, and lesions with OP, respectively.

Table 2. Lesion distribution and median SUV_{max} value according to pathology results

Pathological diagnosis	n	%	Median SUV_{max} (Min–Max)
Overall lesions	143	100	5.2 (2.5–37.6)
Anthracotic	64	45	3.8 (2.5–37.3)
Granulomatous inflammatory event	36	25	7.9 (2.6–37.6)
Organized pneumonia	18	13	6.8 (2.5–13.3)
Chronic inflammatory event	13	9	5.3 (2.7–11.1)
Fungal infection	4	3	5.1 (2.6–8.8)
Interstitial pneumonia	3	2	9.3 (6.7–13.9)
Abscess	2	1	9.5 (5.5–13.6)
Fibrosis	1	1	3.0 (3.0–3.0)
Inflammatory pseudotumor	1	1	3.4 (3.4–3.4)
Hydatid cyst	1	1	2.5 (2.5–2.5)

SUV_{max} The maximum standardized uptake values. Min: Minimum; Max: Maximum

Table 3. Distribution of lesions and characteristics according to anatomic location

Characteristics	Lymph node (mediastinal/hilar) (n=85)	Lung tissue (n=57)	p
Male/female, n (%)	56:29 (66:34)	35:22 (61:39)	0.357
Age (years)	63.0±10.3	59.9±11.9	0.121
Median SUV_{max} value (min–max)	4.8 (2.5–37.6)	6.5 (2.5–25.4)	0.040
Interventional procedure	85	57	N/A
FOB-Bronchial biopsy	0	0	
FOB-Transbronchial biopsy	0	19	
FOB-LN FNABx	4	0	
CT-TTBx	0	23	
VATS	0	0	
Mediastinoscopy	75	0	
Thoracotomy	6	15	
Pathology result			N/A
Anthracosis	62	2	
Granulomatous	23	13	
OP	–	18	

SUV_{max} the maximum standardized uptake values. FOB: Fiberoptic bronchoscopy; FOB-LN NABx: Fiberoptic bronchoscopy-guided lymph node fine needle aspiration biopsy; CT-TTBx: Computed tomography-guided transthoracic biopsy; VATS: Video-associated thoracoscopy; OP: Organized pneumonia; N/A: Not available

Of the cases with a SUV_{max} value of ≥2.5 in the thorax sections of the ^{18}F-FDG PET/CT imaging, 85 (59%), 57, and one were located in the lymph nodes, lung tissue, and the pleura, respectively. When the lesions were evaluated in the two groups according to their anatomical location, mediastinal/hilar lymph node and lung tissue, the median SUV_{max} value of the parenchymal lesions and the lymph nodes was 6.5 and 4.8, respectively. The statistical difference was significant (p=0.040). No significant age difference was found between both groups (p=0.121). Three-quarters of the cases with lung parenchymal involvement were diagnosed with bronchoscopic or transthoracic needle biopsy and the most common pathology 18/57 (32%) was OP. Of the 85 cases with mediastinal/hilar lymph nodes, 75 were diagnosed with mediastinoscopy, and the pathology of 62 (73%) cases was evaluated in favor of anthracosis (Table 3). Moreover, one case had pleural involvement. The subject was a 54-year-old female, the chronic inflammation diagnosis used VATS, and the SUV_{max} value was 5.4.

The mean age of the 64 cases with anthracosis was 65.3±7.7 years and 46 (72%) were males. Of the cases, 39 (61%) had a smoking history and seven female cases (8%) had biomass exposure history.

The oldest group consisted of anthracosis subjects when the age distribution of the subjects was examined, and the difference between granulomatous subjects was significant (p=0.026). No significant age difference was noted between subjects with OP and anthracosis and granulomatous subjects (p=0.310 and p=0.563, respectively).

A comorbidity accompanying two-thirds of the subjects with anthracosis was noted. The most common accompanying disease was extrapulmonary malignancy for 63% (40/64). In terms of comorbidity, a statistically significant difference was observed among granulomatous and tuberculosis with anthracosis (p=0.011 and p=0.029, respectively). The PET/CT imaging of the subjects with malignancy showed that 43 of the 47 subjects had FDG involvement in the lymph nodes (four granulomatous inflammatory events and 39 anthracosis). The pathologies of the parenchymal lesions of four cases were evaluated as fungal infection, granulomatous inflammatory event, abscess, and anthracosis. The mean age of the subjects with malignancy was 66.2±7.4 years, and 40 of 47 subjects had false-positive PET/CT results due to anthracosis. The age of the subjects with accompanying malignancy was higher than those without (59.5±11.9; p=0.005). In addition, mediastinoscopy was performed in 90% of the subjects with malignant diagnosis and anthracosis pathology, and thoracotomy was performed in 10% (Table 4).

Upon examining the follow-up files of the subjects with granulomatous lesions, 11 of 36 subjects were clinically considered to have tuberculosis (nine had a positive Mycobacterium tuberculosis culture). The mean age of the tuberculosis cases was 65.2±13.0 years and the median SUV_{max} value of the lesions imaged in the PET/CT was 9.1 (min–max, 3–23). When the SUV_{max} value of the cases with tuberculosis and with the pathology of anthracosis was compared, the SUV_{max} value was found to be significantly higher (p=0.007). Moreover, no significant difference in median SUV_{max} values between the cases with tuberculosis and cases with OP and sarcoidosis (p=0.256 and p=0.880, respectively). The tuberculosis lesions were located in the mediastinum (six), left upper lobe (three), right lower lobe (one), and lingula (one). Twelve subjects were diagnosed with sarcoidosis according to clinical, radiological, and laboratory results. The mean age of the

Table 4. Comparison of cases with anthracosis, granulomatous, and organized pneumonia

Characteristics (n=64)	Anthracosis (n=36)	Granulomatous (n=11)	Tuberculosis (n=12)	Sarcoidosis (n=18)	Organized pneumonia	p
Male/female, n (%)	46:18 (72:28)	21:15 (58:42)	5:6 (45:55)	1:11 (8:92)	13:5 (72:28)	0.008
Place of involvement						<0.001
Lymph node, n (%)	62 (97)	23 (64)	6 (55)	8 (67)	–	
Lung tissue, n (%)	2 (3)	13 (36)	5 (45)	4 (33)	18 (100)	
Age (mean±SD)	65.3±7.7	58.4±13.8	65.2±13.0	54.2±13.4	62.1±9.9	0.020
Lymph node	65.5±7.7	56.1±13.2	66.7±6.5	53.5±14.7	–	0.003
Lung tissue	59.5±9.2	62.5±14.2	63.4±19.0	55.5±12.4	62.1±9.9	0.721
Median SUV_{max}	3.8 (2.5–37.3)	7.9 (2.6–37.6)	9.1 (3–23)	7.1 (4–38)	6.9 (2.5–13.3)	<0.001
Lymph node	3.8 (2.5–37.3)	8.6 (3–38)	12.7 (3–21)	7.1 (4–38)	–	<0.001
Lung tissue	15.3 (5.2–25.4)	7.5 (3–23)	8.3 (3–23)	7.4 (6–18)	6.9 (2.5–13.3)	0.917
Comorbidity	46	10	4	3	6	>0.05*
Malignancy	40	5	3	1	0	
Hypertension	2	1	–	–	1	
Diabetes mellitus	1	3	–	2	2	
CAD	3	1	1	–	1	
Chronic renal failure	–	–	–	–	2	

CAD: Coronary artery disease; SD: Standard deviation; *: In terms of comorbidity, a statistically significant difference was observed among granulomatous and tuberculosis with anthracosis when analyzed in pairs with the chi-square method (p=0.011 and p=0.029, respectively)

sarcoidosis cases was 54.2±13.4 years, and the median SUV_{max} value of the lesions imaged in the PET/CT was 7.1 (min–max, 4–38). The sarcoidosis lesions were located in the mediastinum (eight), right upper lobe (two), right middle lobe (one), and right lower lobe (one). However, 13 cases with granulomatous pathology could not be clinically classified.

According to the radiological characteristics of the 18 cases with OP, six subjects had multinodular consolidation, five subjects had air bronchogram consolidation, five subjects had cavitary lesions, and five subjects had mass lesions. No significant difference was noted in SUV_{max} values and radiological lesion subtypes (p=0.684). The OP lesions were located in the right lower lobe (six), right upper lobe (four), right middle lobe (three), left lower lobe (three), and left upper lobe (two). One-third of the OP subjects had accompanying diseases. Moreover, the pathology of two subjects with chronic renal failure was consistent with OP (Table 4).

The radiology of five (4%) cases with false PET positivity showed solitary pulmonary nodules. The pathology of one and four of these cases were evaluated as OP and chronic inflammatory events, respectively.

The median SUV_{max} value of anthracotic lesions was significantly lower than the median SUV_{max} value of granulomatous and OP lesions (p<0.001 and p=0.007, respectively). No significant difference in median SUV_{max} value was noted between granulomatous and OP lesions (p=0.166). Similarly, the separate evaluation of the sarcoidosis and tuberculosis cases to the pneumonia cases showed no significant difference in FDG involvement (p=0.305 and p=0.256, respectively).

DISCUSSION

This study aimed to investigate the predictive features of benign pathologies with false-positive involvement in ^{18}F-FDG PET/CT imaging carried out with the diagnosis of malignancy to reduce the frequency of diagnostic surgical procedures. According to the study's results, the most common pathologies with FDG involvement are anthracosis (45%), granulomatous inflammatory event (25%), and OP (13%). The literature shows that benign diseases (e.g., granulomatous diseases, autoimmune diseases, and infections) in the endemic areas of tuberculosis cause false PET/CT positivity (5–7).

PET/CT is used routinely in lung cancer staging, and benign causes (e.g., infection, tuberculosis, sarcoidosis, anthracosis, and pneumoconiosis) can cause false-positive involvement in the mediastinal lymph node (8–10). The current study evaluated lesions with FDG involvement in the lymph nodes and lung parenchyma. Moreover, lymph node involvement (60%) was higher than parenchymal involvement (40%). In the literature, no comparative evaluation of mediastinum and lung parenchyma was found. The median SUV_{max} value of all lesions in the current study was 5.2. The value was 4.8 and 6.5 for lymph nodes and parenchymal lesions (p=0.040), respectively. The main pathology causing lymph node positivity was anthracosis (73%) and the median SUV_{max} of these cases was 3.8. Studies have reported that anthracotic lymph nodes imitate tuberculosis and malignancy, which causes PET/CT involvement (10, 11). The relationship between biomass fuel exposure, indoor air pollution, smoking, and anthracosis is known, especially for underdeveloped/developing countries (12, 13). The current study determined the significant difference between FDG uptake and pathology of anthracotic cases, granulomatous, and OP lesions (p<0.001 and p=0.007, respectively).

The clinician first aims to exclude malignancy in suspicious radiological PET-CT findings. Accordingly, he/she first applies less invasive bronchoscopy and biopsy methods. Surgical diagnostic methods are used if clinical doubt exists and no diagnosis is possible (14). The false-positive rate increases and the diagnostic algorithm is applied when the infection status of the subjects cannot be ruled out. An example is the study of Zhao et al. (7), where the most common false PET/CT positivity was caused by neutrophilic inflammation and the most common clinical diagnosis (59%) was pneumonia. The time of PET/CT is also important in the evaluation of false positivity. The imaging should be carried out after the infection is under control if the subject has an active infection. In infection diagnosis, microbiological evaluation and bronchoscopy-guided study of infection agents from bronchial lavage may also contribute to a differential diagnosis.

Intermittent PET/CT follow-up may also be an option in the diagnosis of false-positive PET/CT. Beatty et al. (15) evaluated 272 subjects with primary organ malignancy and incidental second primary suspicion in PET/CT. Of these subjects, 133 underwent a diagnostic procedure and the remaining 139 were followed. Of the 133 subjects that underwent a surgical procedure, 62 showed benign results. The lesions disappeared in 54 of the 139 followed-up subjects. Thus, the reason for PET positivity was benign and false-positive in 43% (116/272) of the subjects with primary malignancy. Moreover, the most common comorbidity in the current study was also extrapulmonary malignancy. Furthermore, the pathology of 40 of the 47 cases was anthracosis.

Özgül et al. (16) evaluated subjects with extrathoracic primary malignancy accompanied by positive PET involvement in intrathoracic lymph nodes. This study emphasized the necessity of histopathological confirmation and that benign causes (e.g., tuberculosis, sarcoidosis, and anthracosis) should be kept in mind. Similarly, ^{18}F-FDG PET/CT involvement in the current study was most seen in mediastinal and hilar lymph nodes (43/47) in subjects with extrapulmonary malignancy. Of these subjects, 90% were diagnosed with mediastinoscopy and the pathology was evaluated in favor of anthracosis (40/43). The age of subjects with malignancy was higher than in those without (p=0.005). According to the results of the current study, the probability of benign and pathological anthracosis is 85% in ^{18}F-FDG PET/CT imaging with isolated lymph node involvement in subjects with advanced age (≥65 years) and extrapulmonary malignancy. The study of Lee et al. (9) also showed that advanced age (>65 years) is a risk factor for false-positive lymph node involvement. The decreased immune response of the respiratory system with age and increased susceptibility to infections, the pulmonary cumulation of previous infections, and inflammatory pathologies may lead to increased false-positive lymph node tendency in elderly subjects (9, 17).

Clinical follow-up of cases with granulomatous pathology was evaluated and specific diagnoses were obtained. One-third of these cases received a tuberculosis diagnosis. Active tuberculosis disease was considered and treatment was started in eight cases with positive tuberculosis culture. The increase in SUV_{max} value in tuberculosis subjects (median, 9.1; min–max, 3–23) may be due to the high rate of active disease (18). In addition, pulmonary tuberculosis is the cause of 57%–92% of false PET/CT positivity in regions with high prevalence due to its epidemic and radiographic features and is the leading cause of ^{18}F-FDG PET/CT positivity in primary lung cancer (4, 5). One-third of the granulomatous cases received a sarcoidosis diagnosis during follow-up. Zhao et al. (7) reported that FDG uptake in PET/CT of sarcoidosis cases was significantly higher than other benign pathologies and they suggested that the maximum SUV value could be used for differential diagnosis between sarcoidosis and other benign lesions. However, the current study did not observe any significant differences between the SUV_{max} values of sarcoidosis, OP, and tuberculosis cases. Previous studies show a significant correlation between FDG uptake on PET/CT and the activation of these inflammatory diseases (19–22). Thus, PET/CT is not reliable for the differential diagnosis of these benign diseases but can contribute to the evaluation of the activity status and treatment response of the disease.

The most common pathology in parenchymal lesions was OP (32%) in the current study. Moreover, examples were noted in the literature that OP can cause false PET/CT positivity by imitating malignancy (20, 22, 23). Tateishi et al. (20) reported a significant difference in FDG uptake between radiological subtypes in their study. However, the results of this study showed that the difference in radiological findings and FDG involvement did not significantly change, which is similar to the study of Erdoğan et al. (22). OP cases could not be etiologically classified but it was demonstrated, as reported by Erdoğan et al., because the current study was carried out retrospectively. Moreover, no significant difference in SUV_{max} value between cryptogenic and secondary OP was noted.

The primary limitation of the current study was that it was retrospective and the sample size was small. Another limitation was that a less invasive method such as endobronchial ultrasound (EBUS) was not used, especially in lymph node sampling. However, no EBUS device exists in the hospital during the study period.

Distinguishing between benign and malignant lesions in the lung with radiological methods is still not possible today. The definitive diagnosis is made using a biopsy or surgical procedure if the biopsy fails. In recent years, data show that the delayed ^{18}F-FDG PET/CT method reduces misinterpretation and comparison of early and late SUV_{max} values, or the new calculation method, the relative activity distribution method, can increase the differentiation between malignant and benign in PET/CT imaging (24, 25). Moreover, studies that use different radionuclide agents such as 11C-1-methionine and ^{18}F-fluoro-alpha-methyl-tyrosine exists (26, 27). Dual time-point imaging of FDG PET/CT can be used to differentiate active infectious diseases (e.g., tuberculosis) from other benign pathologies (28). However, further and broader studies are needed with these new techniques and agents.

Thus, anthracosis and tuberculosis should be kept in mind as causes for false PET/CT positivity, especially in developing countries. Therefore, this study recommended that the clinician obtains anamnesis correctly and adequately by avoiding unnecessary invasive methods, making a differential diagnosis considering laboratory and radiological data, and using a minimally invasive method (e.g., bronchoscopy) in the first step. Today, misleading situations exist where benign lesions can create false-positive results in FDG PET/CT imaging. However, the contrary can happen as well, where malignant lesions create a false-negative result. Therefore, nuclear medicine physicians and clinicians need to improve themselves to understand the difference between inflammation, infection, and malignancy.

Ethics Committee Approval: The Erciyes University Clinical Research Ethics Committee granted approval for this study (number: 2015/384).

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

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – FSO, İG, NT, STY, BBK; Design – FSO, İG, NT, STY, BBK; Supervision – FSO, İG, NT, STY, BBK; Materials – NT, STY, BBK; Data Collection and/or Processing – STY, BBK; Analysis and/or Interpretation – NT, STY, BBK; Literature Search – FSO, NT, STY, BBK; Writing – STY, BBK; Critical Reviews – FSO, İG, NT, STY, BBK.

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