

Differential Diagnosis of Pulmonary Fungal Infection and Lung Cancer via 18F-FDG PET/CT: A Retrospective Study

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Abstract

Background: There is limited evidence regarding the ^{18}F -fluorodeoxyglucose positron emission tomography/computed tomography (^{18}F -FDG PET/CT) characteristics of lung fungal (LF) infections with nodules or masses, which are often misdiagnosed as lung cancer (LC) with indications for surgery. We aimed to investigate the PET/CT findings of LF infections with nodules in comparison to those of LC and clarify the diagnostic value of ^{18}F -FDG PET/CT in the differential diagnosis of LF infections.

Methods: We enrolled 21 patients who presented with pulmonary nodules or masses on CT, were diagnosed with LF infections, and underwent PET/CT as the LF group and randomly selected 42 patients with LC diagnosed by pathology as the LC group. Clinical and PET/CT imaging data were statistically analyzed.

Results: LC was the most common misdiagnosed disease in the LF group (52.38%). There were no significant differences in lung imaging features between the two groups. The levels of white blood cells, neutrophils, and IgG and the positive rates for fungal antigen test in the LF group were significantly higher than those in the LC group ($P < 0.05$). Lung masses larger than 3 cm were more common in the LC group ($P < 0.05$). Overall, 80.95% (17/21) of patients in the LF group showed increased ^{18}F -FDG uptake. There were no significant between-group differences in the maximal standardized uptake value (SUVmax, 8.20 [2.70, 12.95] vs. 8.80 [7.00, 12.38]). In the LF group, eight, five, and eight patients had cryptococcal, *Aspergillus*, and *Talaromyces marneffeii* infections, respectively, with no significant difference in SUVmax among them (5.10 [1.70, 14.40] vs. 8.20 [1.50, 8.20] vs. 8.50 [5.10, 11.30]).

Conclusions: Both LF infection and LC can present with increased ^{18}F -FDG uptake on PET/CT. Thus, it is difficult to distinguish between them according to lung PET/CT and CT manifestations. Patients presenting with pulmonary masses should also be suspected to have fungal infection, even those with an increased SUVmax and simultaneous lymph node and bone involvement; particular attention is needed for patients with abnormal inflammation indexes and fungal antigen test. We should be emphasized preoperative pathological examination and fungal etiology.

Background

Positron emission tomography/computed tomography (PET/CT) can combine function, metabolism, and anatomy together. Malignant tumors show an abnormal concentration of radioactivity due to increased uptake of ^{18}F -fluorodeoxyglucose (^{18}F -FDG); this is useful for distinguishing benign lesions from malignant lesions [1]. However, the widely used imaging agent ^{18}F -FDG is non-specific, and high ^{18}F -FDG uptake can also occur in some fungal infections, which can then be easily misdiagnosed as malignant tumors [2]. In patients without risk factors for fungal infections, who are clinically asymptomatic, or have mild symptoms, solitary nodules or masses on lung CT and high ^{18}F -FDG uptake on PET/CT are often used as indicators for surgery. At present, only case reports and few small-scale prospective or retrospective studies have explored the characteristics of fungal infections presenting with pulmonary

nodules or masses on ^{18}F -FDG PET/CT [3–5]. These infections are easily misdiagnosed as lung cancer (LC) with surgical recommendations. We aimed to compare PET/CT findings between pulmonary fungal infections with nodules or masses and LC to clarify the diagnostic value of ^{18}F -FDG PET/CT in the clinical differential diagnosis of pulmonary fungal infections.

Methods

Study design and population

This study aimed to investigate the PET/CT findings of LF infections with pulmonary nodules or mass shadows in comparison with those of LC and clarify the diagnostic value of ^{18}F -FDG PET/CT imaging in the clinical and differential diagnosis of pulmonary fungal infections. We retrospectively screened 1385 patients diagnosed with pulmonary mycosis between January 2008 and December 2017 at the First Affiliated Hospital of Guangxi Medical University. Among the 45 patients who underwent PET/CT examinations, 24 patients with malignant tumors or with insufficient etiological evidence were excluded. The remaining 21 patients with LF infection and pulmonary nodules or masses who had clear etiology were included in the LF group. Concurrently, we evaluated 7378 patients diagnosed with LC between January 2012 and December 2018. Of them, 601 patients underwent PET/CT examination. According to the sample size requirement of a 1:2 ratio, we randomly selected 42 patients with pulmonary nodules or masses diagnosed by pathology as the LC group. The clinical, high-resolution computed tomography (HRCT), and PET/CT imaging data were then collected and compared. All patients and their families provided consent for all PET/CT examinations.

Imaging Protocol

Imaging was performed using the PET/CT instrument (Siemens Biograph Sensation 16, Germany) and with ^{18}F -FDG as imaging agent produced by the PET/CT Center of the First Affiliated Hospital of Guangxi Medical University. The agent had a radiochemical purity of more than 99% and was qualified using aseptic, non-thermal, and endotoxin tests. The quality of the product met the requirements for clinical research.

^{18}F -FDG PET/CT was performed in line with established international guidelines for infection imaging [6–7]. All patients fasted for at least 6 h, and their blood glucose levels were in the range of 3.89–6.10 mmol/L before injection of ^{18}F -FDG (3.7–7.4 MBq/kg). Brain imaging was performed after 30 min, spanning the trunk from the skull base to the middle and upper femur, after emptying the bladder. The same performed range of PET examination was used for brain imaging (one bed, 8–10 min) and trunk imaging (6–7 beds, 3 min/bed). The CT parameters were as follows: pitch, 1.25; layer thickness, 5 mm; tube voltage, 120 kV; and tube current, 140 mA. The collection mode was 3D. The data were uploaded to the workstation, and coronal, sagittal, and cross-sectional fusion images acquired by CT, PET, and PET/CT were obtained.

Image Analysis

PET/CT and CT images obtained from the same machine were evaluated via visual analysis and semi-quantitative maximal standardized uptake value (SUVmax) assessment. Visual analysis was performed by at least two experienced PET/CT physicians. Disagreements were resolved by consulting a radiologist. Semi-quantitative analysis was conducted based on the concentration of ^{18}F -FDG in the SUV focus, and the SUVmax was automatically calculated using a computer according to the SUV focus shape.

Statistical analysis

Normally distributed measurement data were expressed as the mean \pm standard deviation (SD), while non-normally distributed data were expressed as the median and interquartile range (IQR). Categorical variables were expressed as the number and percentage, and between-group differences were evaluated using the independent sample t-test, Kruskal-Wallis test, and Mann-Whitney U test. Meanwhile, between-group differences in categorical variables were evaluated using the chi-squared test or Fisher exact test. All statistical analyses were performed using the Statistical Package for the Social Sciences (Windows version 25.0; SPSS Inc., Chicago, IL, USA). A two-tailed P value of < 0.05 was considered significant.

Results

Patient characteristics

There were no significant differences in sex, age, and underlying diseases between the two groups. In the LF group, two patients had diabetes; two, long-term corticosteroid use; and one, acquired immunodeficiency syndrome (AIDS). In the LC group, two patients had diabetes. Overall, 52.38% (11/21) of patients in the LF group were misdiagnosed with LC; 38.09% (8/21), tuberculosis; and 4.76% (1/21), a mediastinal tumor (Table 1).

Table 1
Baseline patient characteristics

Characteristic	LF group (n = 21)	LC group (n = 42)	P value
Male	10/21 (47.62)	30/42 (71.43)	0.064
Age (years)	60 (41, 72)	59 (53, 64)	0.855
Underlying diseases ^a	5/21 (23.81)	3/42 (7.14)	0.141
Misdiagnosed diseases			-
Lung cancer	11/21 (52.38)	0/42 (0)	-
Tuberculosis	8/21 (38.09)	0/42 (0)	-
Mediastinal tumor	1/21 (4.76)	0/42 (0)	-
Data are expressed as the number and percentage, median (IQR).			
The Mann-Whitney U test, chi-squared test, or Fisher exact test was used to compare the two groups.			
^a : Long-term corticosteroid use and having AIDS.			

Clinical Features And Pathological / Etiological Sources

There was no significant difference in systemic symptoms (including fever, emaciation, debilitation, bone pain, and neck mass) and respiratory symptoms (cough, expectoration, anhelation, chest pain, and chest distress) between the two groups ($P = 0.484$). For the classification of fungal pathogens, eight, eight, and five patients in the LF group had *Talaromyces marneffeii*, cryptococcal, and *Aspergillus* infections, respectively. For pathological types, 29, 6, and 7 patients in the LC group had adenocarcinoma, squamous cell carcinoma, and small cell LC, respectively. Overall, 54.54% (6/11) of patients in the LF group were misdiagnosed to have LC and underwent surgery. Of them, five patients underwent thoracoscopic wedge pneumonectomy and one underwent right upper lobectomy plus right middle lobectomy. Diagnosis was confirmed via surgery, biopsy, and culture in 6/21 (28.57%), 7/21 (33.33%), and 8/21 (38.10%) patients in the LF group, respectively. Meanwhile, in the LC group, diagnosis was confirmed via surgery in 24/42 (57.14%) patients; biopsy in 14/42 (33.33%) patients; and fine-needle aspiration cytology in 4/42 (9.52%) patients.

Laboratory Findings

The levels of white blood cells (WBC), neutrophils, and IgG and positive rates for fungal antigen tests (G test, GM test, and cryptococcal latex agglutination test) were significantly higher in the LF group than in the LC group ($P < 0.05$). However, there was no significant difference in the level of lymphocytes, CD4⁺T cells, CD8⁺T cells, IgA, and IgM between the two groups (Table 2).

Table 2
Laboratory findings by group

Variable	LF group (n = 21)	LC group (n = 42)	P value
WBC (10 ⁹ /L)	12.39 (7.43, 19.38)	7.91 (6.31, 8.91)	0.003*
Neutrophils (10 ⁹ /L)	9.05 (4.17, 16.16)	5.39 (3.92, 6.06)	0.009*
Lymphocytes (10 ⁹ /L)	1.82 (1.23, 2.48)	1.51 (1.27, 1.85)	0.294
CD4 ⁺ T cell (cells/ μ L)	484.0 (372.5, 808.5)	602.0 (491.0, 886.3)	0.444
CD8 ⁺ T cell (cells/ μ L)	357.0 (275.5, 725.0)	374.5 (288.7, 525.7)	0.893
IgG (g/L)	15.21 (11.09, 23.59)	11.79 (9.40, 13.24)	0.033*
IgA (g/L)	1.94 (1.14, 2.80)	2.23 (1.17, 2.75)	0.730
IgM (g/L)	1.09 (0.84, 1.39)	1.08 (0.76, 1.32)	0.650
Positive results for fungal antigen tests ^a	10/21 (47.62)	3/42 (7.14) ^b	0.001*
Data are expressed as the median (IQR).			
The Mann-Whitney U test was used for between-group comparisons.			
*P < 0.05 was considered statistically significant.			
^a : One of the three tests: G test, GM test, or <i>Cryptococcus neoformans</i> latex agglutination test.			
^b : Three patients in the lung cancer group showed positive G test findings.			

Reference range: WBC: 3.5–9.5*10⁹/L; N: 1.8–6.3*10⁹/L; L: 1.1–3.2*10⁹/L; CD4⁺T cells: 410–1590 cells/uL; CD8⁺T cells: 190–1140 cells/uL; IgG: 8–18 g/L; IgA: 0.9-4 g/L; IgM: 0.84–1.32 g/L.

WBC, white blood cell; Ig, serum immunoglobulin

High-resolution Computed Tomography Features Of The Chest

There was no significant difference in the distribution of localized pulmonary lesions, disseminated lesions, and pulmonary imaging features (e.g., spiculation sign, necrotic cavity, pleural traction sign, and pleural effusion) between the LF and LC groups. Both lymph node and bone involvement were observed in the two groups. Lung masses larger than 3 cm were more common in the LC group (P < 0. 05) (Table 3).

Table 3
HRCT features of the chest in the LF and LC groups

Variable	LF group (n = 21)	LC group (n = 42)	P value
Lung involvement site			0.449
Upper lobe	5/21 (23.81)	13/42 (30.95)	-
Lower lobe	9/21 (42.85)	21/42 (50.00)	-
Bilateral lung lesions	7/21 (33.33)	8/42 (19.05)	-
Distant involvement			
Lymph node	13/21 (61.90)	34/42 (80.95)	0.102
Bone	4/21 (19.05)	13/42 (30.95)	0.316
Size			0.029*
Nodule diameter < 1 cm	1/21 (4.76)	0/42 (0)	0.333
Nodule diameter 1–3 cm	12/21 (57.14)	14/42 (33.33)	0.070
Mass diameter > 3 cm	8/21 (38.10)	28/42 (66.67)	0.031*
CT findings			0.125
Burr, lobulation	7/21 (33.33)	28/42 (66.67)	-
Halo sign	0/21 (0)	0/42 (0)	-
Necrosis, cavitary	1/21 (4.76)	2/42 (4.76)	-
Pleural traction sign	4/21 (19.05)	5/42 (11.90)	-
Obstructive pneumonia	0/21 (0)	13/42 (30.95)	-
Pleural effusion	4/21 (19.05)	9/42 (21.43)	-
Data are expressed as the number and percentage.			
Between-groups comparisons were conducted using the chi-squared test or Fisher exact test.			
*P < 0.05 was considered statistically significant.			

SUVmax of pulmonary lesions on ¹⁸F-FDG PET/CT in the two groups

In the LF group, 80.95% of patients showed increased ¹⁸F-FDG uptake in the pulmonary lesions, and the SUVmax was 7.90 (2.70,12.95). Overall, 61.90% (13/21) of patients had an SUVmax > 2.5, while 19.05% (4/21) showed no ¹⁸F-FDG uptake. In the LC group, all patients showed ¹⁸F-FDG uptake, and the SUVmax was 8.70 (6.95, 12.38). In total, 97.62% (41/42) of patients had an SUVmax > 2.5. There was no significant difference in SUVmax between the two groups (P > 0.05) (Table 4, Figs. 1–5).

Table 4
SUVmax of pulmonary lesions in the two groups

Variable	LF group (n = 21)	LC group (n = 42)	P value
No ¹⁸ F-FDG uptake	4/21 (19.05)	0/42 (0)	-
SUVmax > 0	17/21 (80.95)	42/42 (100)	-
SUVmax > 0 median	8.20 (2.70, 12.95)	8.80 (7.00, 12.38)	0.251
SUVmax > 2.5	13/21 (61.90)	41/42 (97.62)	-
SUVmax > 2.5 median	9.90 (6.50, 14.40)	8.90 (7.25, 12.75)	0.895
Data are expressed as the number and percentage or median (IQR).			

The Mann-Whitney U test, chi-squared test, or Fisher exact test was used to compare the two groups.

Lung Fungal Infection Group

In the LF group, 12 cases showed lymph node enlargement and ¹⁸F-FDG accumulation. The SUVmax was 5.90 (3.0, 10.15), and a high SUVmax was significantly more frequent in patients with a *T. marneffe* infection ($P < 0.05$). Four patients had skeletal involvement. There was no significant difference in lung CT features and SUVmax of pulmonary lesions according to the type of fungal infection (*Aspergillus*, *T. marneffe*, and *Cryptococcus*) in the LF group (Table 5).

Table 5

Comparison of distribution and SUVmax value of pulmonary lesions in the lung fungal infection group

Variable	Aspergillus group (n = 5)	Cryptococcus group (n = 8)	TM group (n = 8)	P value
Lung involvement site				0.005*
Upper lobe	1/5 (20.00)	1/8 (12.50)	3/8 (37.50)	0.807
Lower lobe	0/5 (0)	7/8 (87.50)	2/8 (25.00)	0.003*
Bilateral lung lesions	4/5 (80.00)	0/8 (0)	3/8 (37.50)	0.012*
Distant involvement				
Lymph node	3/5 (60.00)	1/8 (12.50)	8/8 (100)	0.001*
Bone	1/5 (20.00)	0/8 (0)	3/8 (37.50)	0.238
Size				0.300
Nodule diameter < 1 cm	0/5 (0)	1/8 (12.50)	0/8 (0)	
Nodule diameter 1–3 cm	0/5 (0)	4/8 (50.00)	2/8 (25.00)	
Mass diameter > 3 cm	2/5 (40.00)	1/8 (12.50)	4/8 (50.00)	
CT findings				0.820
Burr, lobulation	2/5 (40.00)	2/8 (25.00)	3/8 (37.50)	
Halo sign	0/5 (0)	0/8 (0)	0/8 (0)	
Necrosis, Cavitory	0/5 (0)	1/8 (12.50)	0/8 (0)	
Pleural traction sign	2/5 (40.00)	1/8 (12.50)	1/8 (12.50)	
Obstructive pneumonia	0/5 (0)	0/8 (0)	0/8 (0)	
Pleural effusion	0/5 (0)	2/8 (25.00)	2/8 (25.00)	
SUVmax	8.2 (1.5, 8.2)	5.10 (1.70,14.40)	8.50 (5.10, 11.30)	0.926
Data are expressed as the number and percentage or median (IQR).				
The Kruskal-Wallis test, chi-squared test, or Fisher exact test was used to compare the two groups.				
*P < 0.05 was considered statistically significant.				
TM, <i>Talaromyces marneffe</i>				

Discussion

The diagnostic value of PET/CT in malignant tumors is recognized. Tumors with increased ^{18}F -FDG uptake and high SUVmax are considered malignant and recommended for early surgical resection. However, high ^{18}F -FDG uptake is non-specific and can occur in other conditions. In this study, 52.38% of patients with lung fungi were misdiagnosed with malignant tumors, and 54.54% of these patients underwent surgical treatment and were eventually pathologically diagnosed with fungal infection. This indicates that LF infection is easily misdiagnosed as LC. This not only increases the economic burden of patients, but also the related complications and sequelae of lobectomy, which have a negative impact on the patients' quality of life.

Case reports have shown that patients who clinically presented with LC were eventually confirmed to have fungal infections such as Cryptococcal infection, invasive *Aspergillus* infection, or tuberculosis and granulomatous lesions [8-14]. Aside from malignant tumors, other benign lesions or certain infections can show increased glucose metabolism and present with similar manifestations. Patients with pulmonary fungal infection without underlying disease and normal immune function often show isolated nodules or masses with mild or no clinical symptoms. As such, it is difficult to distinguish these masses from LC lesions using routine CT examinations. These lesions that present with increased SUVmax on PET/CT are often misdiagnosed as LC and recommend for surgical treatment. This leads to the spread of the fungal infection, such as cryptococcal meningitis caused by the deterioration of lung cryptococci [15]. Therefore, it is important to compare and analyze common clinical fungal infections with the PET/CT manifestations of LC to improve the accuracy of diagnosis.

The risk factors for LF infections include immunodeficiency, agranulocytosis, diabetes, long-term corticosteroid use, and immunosuppression. The host factor is a key factor in the hierarchical diagnosis of invasive LF infection [16-17]. However, increasing evidence indicates that in hosts without any underlying disease and with normal immune function, LF infection often presents as a solitary nodule or masse, and the clinical symptoms are mild. In this study, 5 of the 21 patients in the LF group were immunocompromised (one had AIDS; two, diabetes; and two, long-term corticosteroid use). With respect to clinical symptoms and HRCT findings, there was no significant difference in the location of the lesion between the LF and LC groups. However, LF infection was accompanied by high WBC counts and positivity for fungal antigen tests. Nonetheless, it was difficult to distinguish between LF infection and LC based on host factors and clinical and HRCT manifestations. This can cause a high rate of misdiagnosis and incorrect treatment.

We found no significant difference in the SUVmax between the LF and LC groups, clarifying the value of PET/CT in the differential diagnosis of malignant tumors and LF infections with pulmonary lesions. After entering the lungs, fungal spores that cannot be eliminated by the body are swallowed by macrophages. The fungi form lesions with histiocytic proliferation, accompanied by necrosis, inflammatory cell infiltration or granuloma in the lungs. The macrophages that engulf pathogens invade the body's mononuclear-macrophage system along with the lymphatic system and blood system organs (e.g., lymph nodes, bone marrow, blood, liver, and spleen). During granuloma formation or inflammatory activity, the

levels of glycolytic enzymes in inflammatory cells (e.g., neutrophils and macrophages) and fibroblasts are increased, and glucose transporters (glucose transport protein, Glut) are overexpressed. Further, increased FDG penetrates the cell membrane, manifested by an increased ^{18}F -FDG uptake in the primary lung lesions and other involved organs such as the lymph nodes and bone marrow ^[18–19]. SUV is currently the most used semi-quantitative index to evaluate the degree of glucose uptake of lesions, and most researchers consider an early phase SUVmax of ≥ 2.5 to be one of the criteria for distinguishing between benign and malignant lesions ^[20]. However, 13 patients in our LF group had a SUVmax > 2.5 , indicating that assessments based on glucose metabolism alone cannot distinguish LF infections from LC. In the LF group, 16 12 patients showed a localized increase in SUVmax (lymph nodes, n = 12; bones, n = 4), similar to LC. Therefore, whether only the primary lung lesion, or the involvement of lymph nodes and bone concurrently, cannot be used as a basis for distinguishing between benign and malignant lesions. In addition, we also found it is difficult to distinguish the different fungal infections in PET/CT examination of pulmonary lesions.

This study has some limitations. First, the number of cases was limited; thus large, multi-center research is needed for further investigating the PET/CT findings of pulmonary fungal infections with nodules or masses. Secondly, this was a retrospective study, more studies are needed to address key questions regarding the use of prospective surveillance and optimal treatment strategies.

Conclusions

Lung lesions presenting with characteristics highly similar to those of malignant tumors on PET/CT should be carefully evaluated to rule out other conditions. A combination of inflammatory indices such as WBC counts, erythrocyte sedimentation rate, and C-reactive protein, should be included in the assessment. Concurrently, a possible etiological basis for fungal culture, B-ultrasound, or CT-guided puncture biopsy and fiberoptic bronchoscopy before surgery should be established to reduce misdiagnosis and unnecessary surgeries. A lung mass larger than 3 cm, increased ^{18}F -FDG uptake on PET/CT, absence of clinical infection, and negative fungal antigen test results are highly indicative of a malignant lung tumor.

Abbreviations

^{18}F -FDG PET/CT, ^{18}F -fluorodeoxyglucose positron emission tomography/computed tomography; PET/CT, positron emission computed tomography; ^{18}F -FDG, ^{18}F -fluorodeoxyglucose; CT, computed tomography; LF, lung fungal infection; LC, lung cancer; SUVmax, maximal standardized uptake value; SD, Standard deviations; IQR, interquartile range, AIDS, acquired immunodeficiency syndrome; WBC, white blood cell; Ig, immunoglobulin; HRCT, high-resolution computed tomography

Declarations

- **Ethics approval and consent to participate:** This study was approved by the Ethics Committee of the First Affiliated Hospital of Guangxi Medical University. All patients and their families provided consent for all PET/CT examinations.
- **Consent for publication:** Not applicable.
- **Availability of data and materials:** All data generated or analyzed in this study are included in this published article
- **Competing interests:** The authors declare that they have no competing interests.
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- **Authors' contributions:** XF, CD, XL, JD, YQ participated in the patients' clinical management and wrote the draft of the manuscript. SH collated the images for analysis. JZ was responsible for critical revision of the manuscript. All authors have reviewed and approved the final version of the manuscript.
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Figures

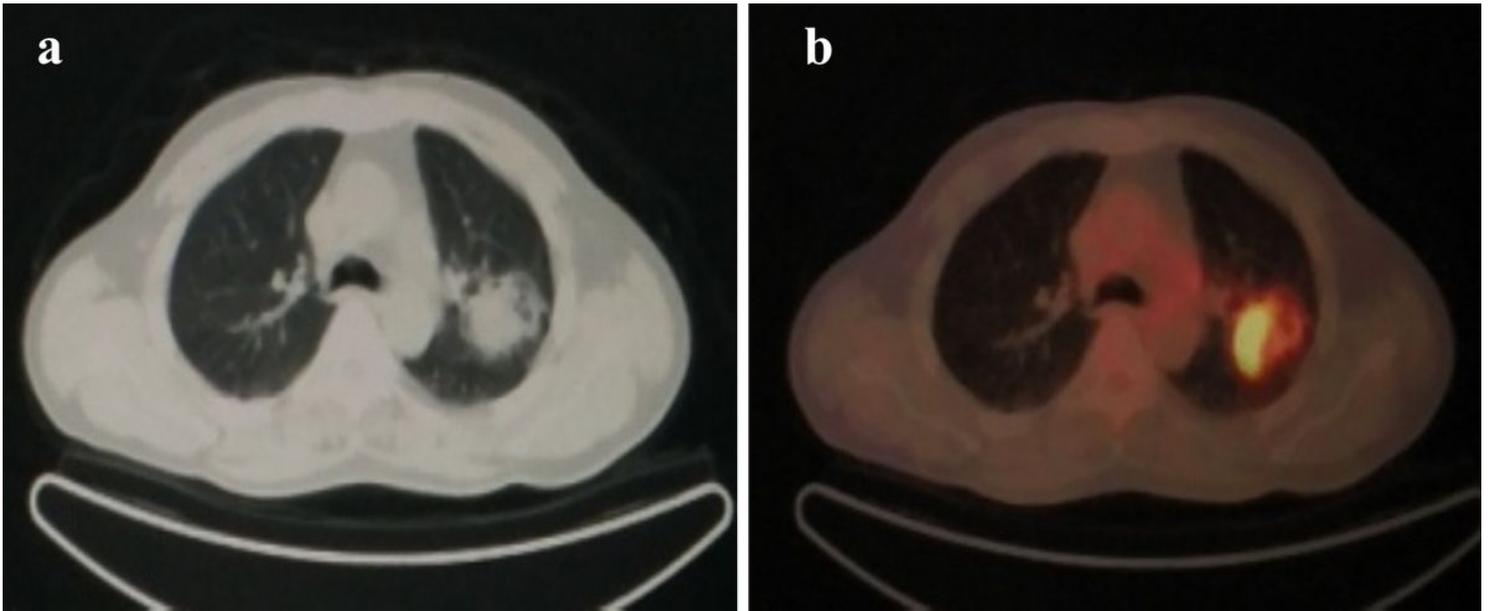


Figure 1

PET/CT image of the lung in a 54-year-old man. PET/CT showing a 3.3×4.6×4.3 cm mass in the posterior segment of the upper lobe apex of the left lung (SUVmax=8.3), with lobulation, burr, and pleural traction sign at the edge, vacuole, and necrosis. Multiple patchy clouds and flocculent density are seen around the mass, with no increase in glucose metabolism. Postoperative pathology suggested poorly differentiated lung adenocarcinoma.

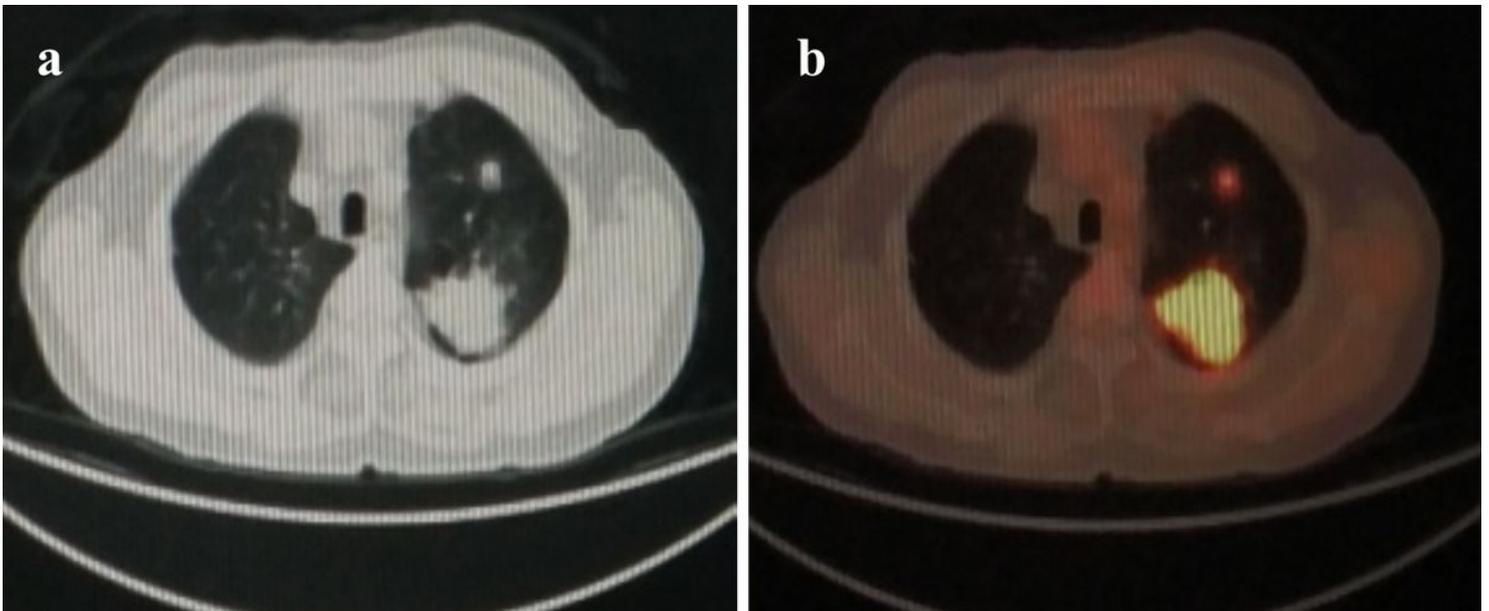


Figure 2

PET/CT image of the lung in a 77-year-old man. PET/CT showing an irregularly shaped mass measuring 4.0×3.5×5.3 cm in the posterior apex of the left upper lobe (SUVmax=16.5) with clear boundaries, lobes, and burrs on the edges and high metabolism in the anterior segment nodule. Bronchoalveolar lavage fluid culture showed pulmonary aspergillosis.

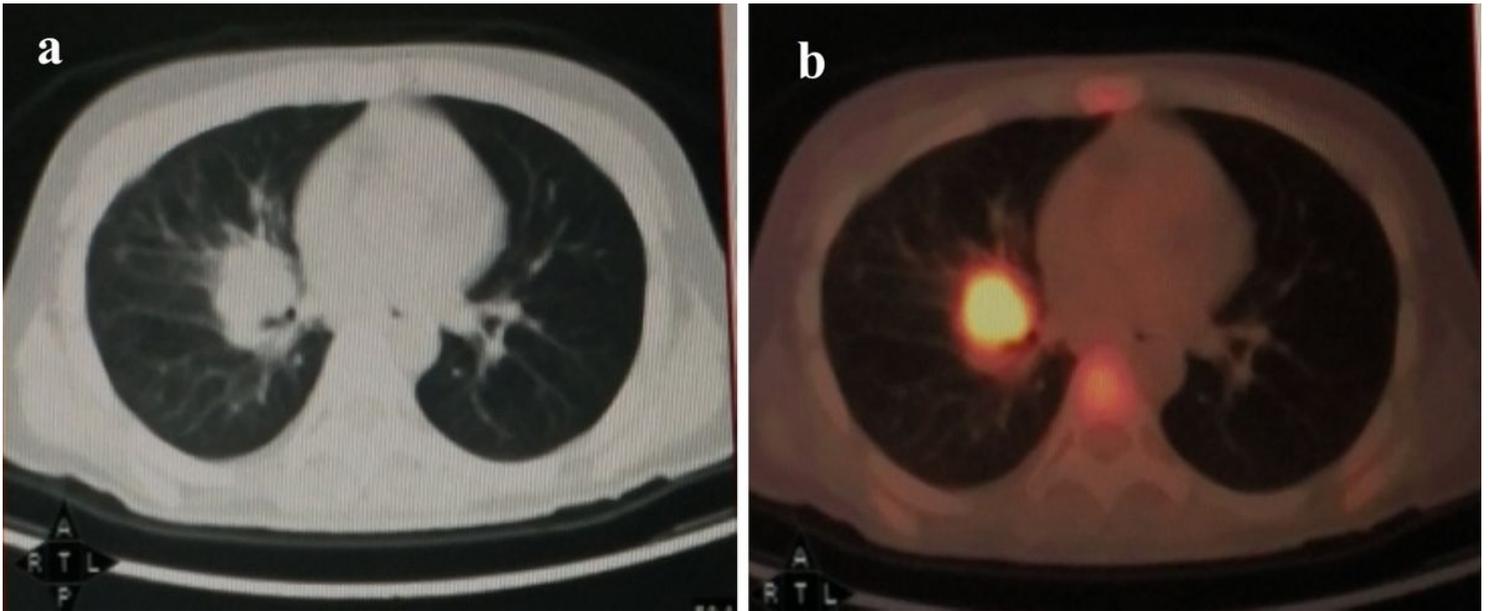


Figure 3

PET-CT image of the lung in a 25-year-old woman. PET/CT showing a 4.7×3.4×5.2 cm high-density foci with increased glucose metabolism in the mediastinum of the apical segment of the right upper lobe, unclearly separated from the mediastinal pleura, and fused with mediastinal lymph nodes into a mass (SUVmax=11.3). Bronchoalveolar lavage fluid culture showed *Talaromyces marneffeii* infection.

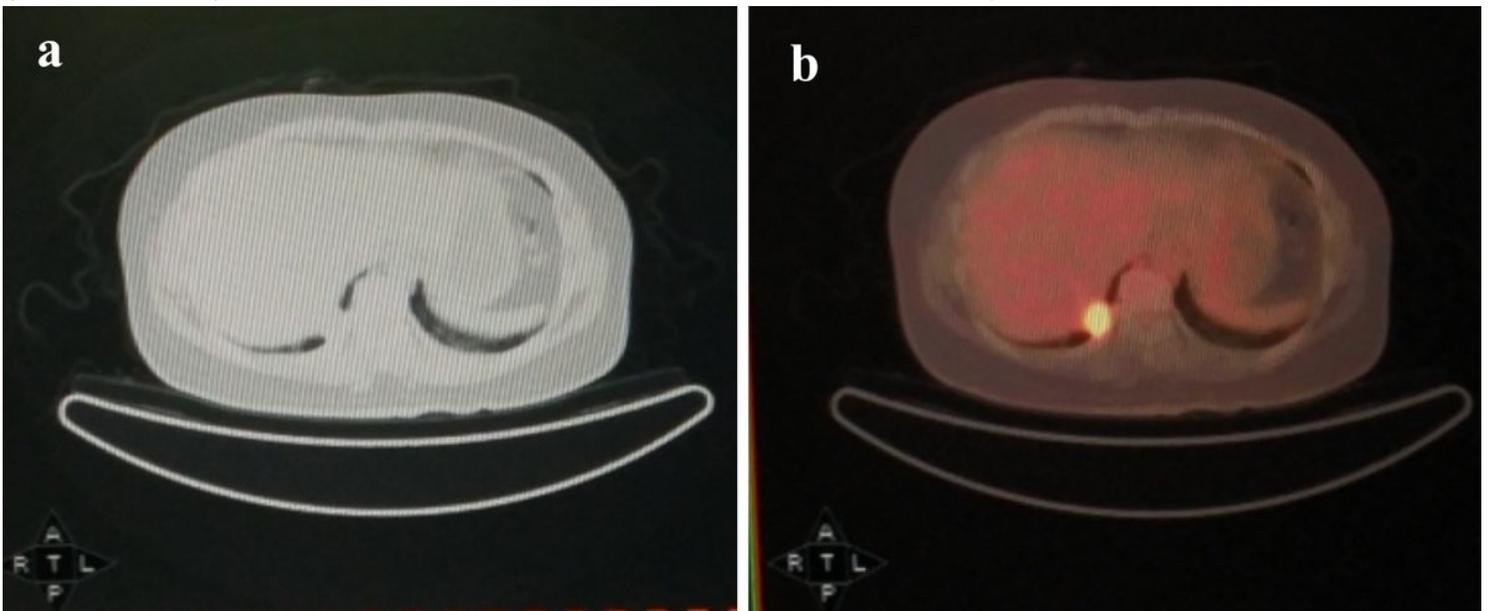


Figure 4

PET/CT image of the lung in a 39-year-old woman. PET/CT showing a 16×19 mm nodule with increased glucose metabolism in the posterior basal segment of the right lower lobe (SUVmax=11.5), with clear boundaries, burrs, and lobes on the edges, closely connected to the pleura and liver. Postoperative pathological examination showed cryptococcal infection.

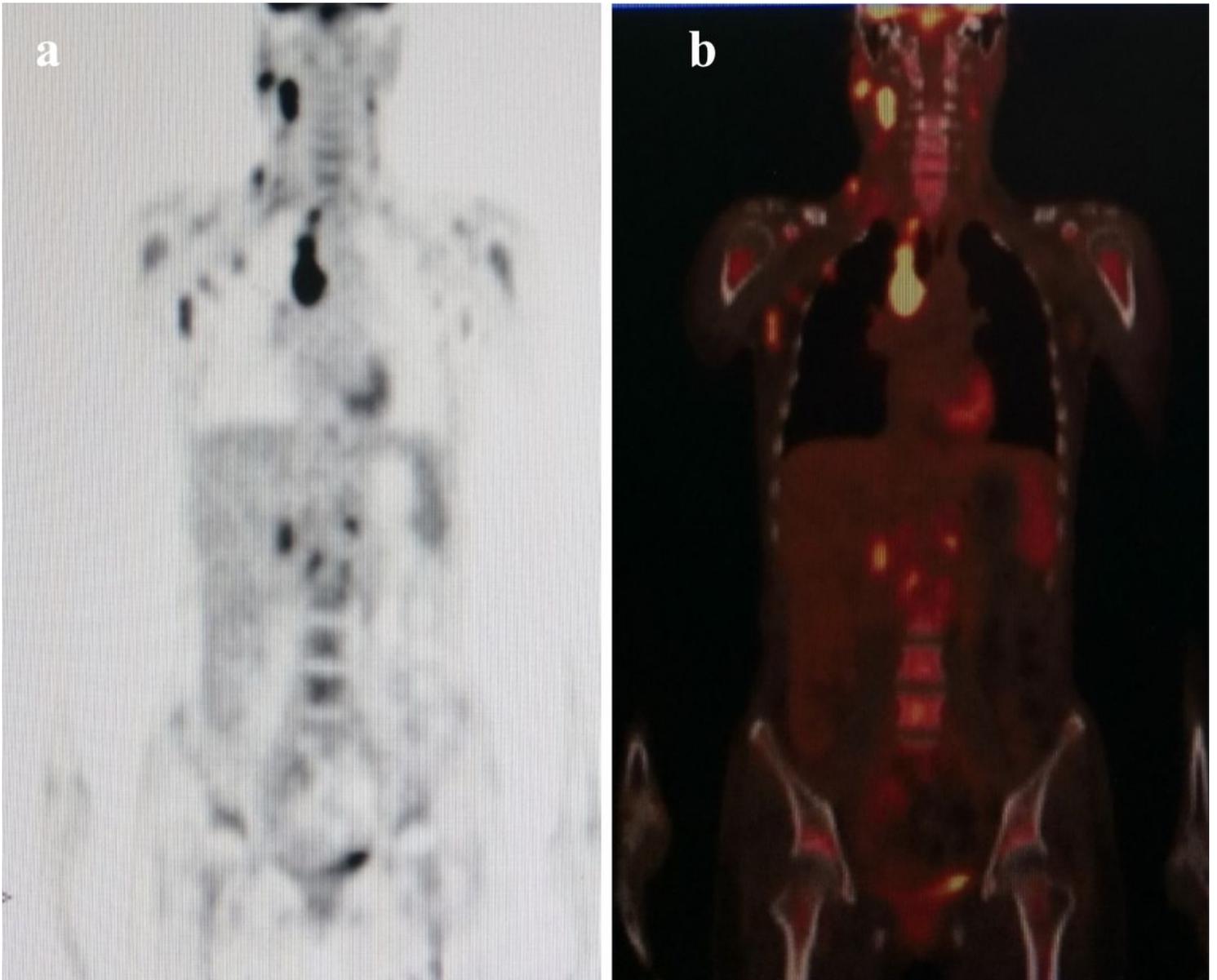


Figure 5

PET/CT image of the body in a 39-year-old woman. PET/CT showing multiple lymph nodes such as at the right lateral pharyngeal space, throat wall, and bilateral neck, axilla, and mediastinum. The abdominal aorta is enlarged and metabolically active. Many bones were also metabolically active.

Histopathologically, the neck lymph node puncture biopsy showed *Talaromyces marneffe* infection.