# CT Study of Pulmonary Fungal Infection Inhibition and Pulmonary Tumor

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**Abstract:** Objective: To investigate CT manifestations of pulmonary fungal infection in non-immunosuppressed population. Methods: A total of 30 cases of pulmonary fungal infection with CT imaging data were collected and sorted out. All cases were confirmed by more than 3 positive sputum cultures, and 15 cases were confirmed by surgery and pathology. CT diagnosis was made and its influential characteristics were summarized. Results: Among the 30 patients with confirmed pulmonary mycosis, 7 had bilateral lung lesions, mainly involving both lungs and the distribution of lung field zones. The lesions were lumpy in 8 cases, nodular and patchy in 4 cases and solid in 6 cases. CT manifestations of pulmonary fungal infection are usually a mixture of various types of images. Ground glass-like shadows and flaky shadows are the most common CT manifestations, accounting for 9 cases and 6 cases of nodular shadows respectively, 3 cases of “air crescent” sign and 1 case of thickening of lung texture. Conclusion: CT can effectively reflect the pathological changes of tumor-type pulmonary fungal infection, improve the accuracy of clinical diagnosis and treatment, and has definite effect, which is worthy of reference.

## 1. Introduction

In recent years, the incidence rate, diagnosis rate and clinical severity of pulmonary fungal infection have increased significantly. In addition to the significant increase in patients with immunosuppressive related diseases, such as human immunodeficiency virus infection, receiving immune agents or autoimmune diseases of patients after organ transplantation, and hematological diseases have also increased significantly. Therefore, the incidence of opportunistic fungal infection in the lung of the elderly has increased greatly. Because the clinical manifestations of pulmonary fungal infection are not specific and often coexist with other pulmonary infections, it is easy to misdiagnose and delay treatment, resulting in increased mortality. As the most susceptible organ, lung accounts for 60% of visceral fungal infection [1]. Pulmonary opportunistic fungal infection is difficult to diagnose clinically and has high mortality rate, which has become an important public health and safety problem. The imaging features of the disease are various, and it is difficult to distinguish it from inflammatory pseudotumor, tuberculoma and lung cancer, which is easy to cause missed diagnosis or misdiagnosis [2]. In this paper, the imaging manifestations and differential CT signs of 30 non-immunosuppressed people were studied, and the imaging manifestations and signs of pulmonary mycosis were discussed.

## 2. Data and Methods

### 2.1 General Information

Thirty patients with secondary fungal infection of malignant tumor with complete clinical and CT data were retrospectively investigated, including 18 males and 12 females, aged 15-74 years with an average of 46 years. Among them, 11 cases are secondary infection, i.e. conditional disease. The basic diseases include 4 cases of pulmonary infection and 1 case of malignant tumor. Among the confirmed cases, 10 cases are pulmonary aspergillosis infection, 1 case is pulmonary mucormycosis infection and 2 cases are pulmonary candida infection. The clinical data, CT imaging and laboratory microbiological examination data were recorded. The specific contents include name,

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sex, age, clinical symptoms, accompanying underlying diseases, curative effect of antifungal therapy, sputum fungus culture results, blood culture results and other pathogenic microbiological examination data of pulmonary infection.

### 2.2 Method

All patients underwent chest anteroposterior X-ray and CT examination. The CT machine is a US GE16-slice and 64-slice spiral CT machine. The chest is normally in the supine position and scanned after breath holding, ranging from the lung tip to the lung bottom. The thickness and interval of layers are all 5mm, pitch 1.375:1, tube voltage 120KV, tube current 160-250mA. Some thin-layer images are transmitted to the post-processing workstation for MPR reconstruction. The patient is assisted to take the supine position, lift the patient's double arms, scan from the lung tip to the lung bottom, and perform plain scanning after positioning phase scanning. Each case was observed with lung window and mediastinal window respectively. The morphology, quantity and changes of pulmonary lesions in patients were statistically analyzed. 6 cases were swabbed culture, 5 cases were bronchoscope swabbed, and 1 case was lung puncture biopsy. Fungal culture was positive for 3 consecutive times (and the same fungus) or confirmed by pathology. Fungal infection was diagnosed. Peripheral intravenous injection was performed with high pressure syringe at an injection rate of 2.5-3 mL/s, and scanning was performed for 28 seconds after injection. Lung window and mediastinal window were used for observation respectively.

## 3. Result

CT examination showed that multiple lesions of both lungs were common, mainly distributed in the middle, outer and subpleural areas of both lung fields. Lesions vary in size and shape. Multiple forms of lesions can be seen in the same case. All 30 patients in this group underwent sputum culture, including 12 cases of candida albicans positive, 3 cases of aspergillus positive, 7 cases of candida nameless combined with fumigant, and 8 cases of candida albicans combined with candida glabrata. The top five underlying diseases are diabetes, hypertension, chronic obstructive pulmonary disease, old tuberculosis and rheumatic diseases, and some patients may suffer from multiple underlying diseases at the same time. Ground-glass shadow, flake shadow, nodule shadow, cavity, mass, thickening of lung texture and connection with bronchial vascular bundle. 1l cases were limited to one side and 10 cases were scattered on both sides. The upper, middle and lower lung fields of both lungs are involved. The lesions are mainly distributed in the two middle and lower lung fields and can be distributed across segments and leaves. Calcification shadow: pulmonary CT value > 100HU dense lesions; Pleural effusion, unilateral and bilateral free or encapsulated effusion; Enlarged mediastinal lymph nodes: the short diameter of mediastinal lymph nodes is > 10 mm.

In this group, the lesions were located in left lung and right lung in 3 cases and bilateral lung in 14 cases respectively. Lesions were limited to one lobe in 5 cases, involving 2 lobes in 2 cases and pneumonia in 3 cases. Lesions are flaky ground glass-like or dense consolidation shadows, accompanied by air-filled bronchial images, with blurred edges, lobular or segmental pneumonia changes, most of which are near subpleural lesions. Nodular shape was found in 7 cases, presenting as round or irregular dense shadows with different sizes, all of which were mostly distributed in the lower fields of both lungs. One case of pulmonary cryptococcosis is mediastinal cryptococcosis. Histopathological specimens were obtained and confirmed by CT-guided mediastinal lymph node biopsy. Among them, 1 case was complicated with patchy shadow and nodular shadow, and only 1 case showed “air crescent” sign. Manifestations include scattered distribution of two lungs, single or multiple nodules and/or masses; Nodules vary in size, ranging from 15~45mm to 45 mm in diameter with an average of 33 mm. Satellite foci: proliferative or fibrous foci scattered around nodules or masses; Pleural depression sign: linear or curtain shadow between nodule or mass and adjacent pleura [3]. 3 cases of mould balls. Spherical dense shadow can be seen in the old purified cavity and bronchiectasis in the lung. The boundary between the lower edge and the cavity wall is unclear. Fissure-like transparent area can be seen in the upper edge. The position of the scanning sphere will change with the change of body position.

There were 3 cases of disseminated miliary nodule foci in both lungs. In 1 case, multiple round thick-walled small cavities were found in disseminated small nodule foci. The cave walls were relatively regular. No small nodule shadow and liquid-gas level were found in the cave walls. Most of them are located in the lung fields of the central and western belts. There were 8 cases of solid variant, which showed large sheet-like high density shadow, vague boundary, unilateral or bilateral, involving one lung segment or lobe, with lucent bronchial shadow in it. Mixed manifestations were found in 7 cases, such as aspergilloma, cavity, calcification, etc. Inflammatory infiltration was found in part of the lesion, bronchial inflation sign was found in it, and nodules were found in part of the lesion. One case was misdiagnosed as malignant tumor, one as tuberculosis, and one as missed diagnosis. The lesions of 3 patients with pulmonary fungal infection in this group are mostly distributed in two lungs, accounting for 11 cases, 3 cases in the right lung, 1 case in the left lung, and 3 cases only in the upper lobe of the left lung. The distribution of lesions in CT examination of 30 patients with pulmonary fungal infection is statistically analyzed, as shown in Table 1. Pulmonary lesions in this group of patients with pulmonary mycosis are mostly located in double lungs, lower leaves, subpleural area and randomly distributed.

Table 1 Distribution of Pulmonary Fungal Infection Foci in This Group

| Fungal species | Unilateral and bilateral lung | Lobes of lung | | | | Main transverse distribution area | |
|---|---|---|---|---|---|---|---|
| | One side | Bilateral | Upper lobe | Middle lobe | Inferior lobe | Hilar region | Subpleural |
| Aspergillus | 5 | 12 | 2 | 6 | 3 | 9 | 11 |
| Candida | 3 | 8 | 1 | 4 | 7 | 5 | 6 |
| Cryptococcus | 2 | 6 | 0 | 2 | 4 | 4 | 3 |
| Trichoderma | 3 | 1 | 0 | 1 | 0 | 1 | 0 |
| Pneumocystis | 2 | 3 | 1 | 0 | 2 | 0 | 0 |

## 4. Discussion

Lung is one of the most common target organs of fungal infection, and most of them are conditional pathogenic fungi, Aspergillus and Cryptococcus are the most common, and their clinical manifestations lack specificity. Fungi are various in morphology and structure, several times or even dozens of times larger than bacteria, and are generally divided into unicellular fungi and multicellular fungi. Elderly people are prone to chronic obstructive pulmonary disease, pulmonary interstitial fibrosis, pulmonary tuberculosis and lung cancer. Extrapulmonary diseases also include chronic cardiac and renal insufficiency, diabetes, cardiovascular and cerebrovascular diseases, autoimmune diseases and various tumors. The most common pathogenic bacteria in patients who use immunosuppressive agents for a long period of time is Cryptococcus sp., which has a very high incidence rate. CT manifestations of pulmonary fungal infection are complex and changeable, showing various properties and morphological changes, which can be manifested as a single lesion of the lung, or multiple lesions can coexist simultaneously or successively. Histopathology and cytopathology of puncture or biopsy specimens can be seen hyphae or black yeast-like bacteria through culture or direct microscopic examination, and there is relevant evidence of tissue damage. If we blindly pursue the so-called classic manifestations and neglect the most common non-specific manifestations, it will inevitably lead to misleading and deviation in diagnosis [4]. CT examination can show pathological changes. Even in 60% of patients, CT examination found abnormalities 5 days earlier than X-ray chest film. Therefore, foreign countries all advocate early CT examination.

Fungal infection of lung and bronchus or other related diseases is called pulmonary mycosis. The basic pathological changes in acute stage include cell infiltration, coagulative necrosis, abscess formation, and chronic pulmonary infection. The common pathogenic bacteria in China are Candida, Aspergillus, Cryptococcus, conjugated bacteria and pneumospore bacteria [5]. Their clinical manifestations are lack of specificity, which is usually difficult to distinguish from bacterial and tuberculous infections. Granulomatous inflammation is the main histologic morphology of patients. The main manifestations are tumors and nodules. The manifestations of tumors are different. Of the

30 cases, 7 cases were misdiagnosed as malignant tumors, and the misdiagnosis rate was high in the first examination. Among them, 2 cases with single mass shadow and 3 cases with multiple nodules and mass shadow were misdiagnosed as tumors before operation because their underlying diseases were not clear. In Yang's research [6], the proportion of healthy patients was 5%, and chronic obstructive pulmonary disease, systemic lupus erythematosus, leukemia and chronic kidney disease were common. The reason is: fungal endotoxin and lysozyme can cause tissue necrosis and dissolution, such as erosion of blood vessels can cause hemoptysis. In addition, there are reports that fungal balls move and rub in cavities with rich vascular networks, and their mechanical action can also cause hemoptysis [7]. Lesions are mostly pneumonia type and nodule type, and can be mixed. Pneumonia is caused by fungal invasion of airway infection. Pulmonary tissue exudes and necrosis occurs during hematogenous dissemination. CT findings are miliary and multiple patchy shadows.

By analyzing the chest CT images of 30 patients with pulmonary fungal infection, we found that the diversity of CT manifestations of pulmonary fungal infection is another characteristic of this group of patients, which almost covers all the basic lung lesions. Zhao et al [8] concluded that the main reasons are: irrational use of antibiotics causes dysbacteriosis; Fungal invasion and infection caused by destruction of normal skin mucosa; Immunodeficiency leads to dissemination and proliferation of fungi; Because the diagnostician is not clear about the imaging evolution process of fungal infection, the imaging manifestations of fungal infection are complex and changeable, and change rapidly, which does not conform to the evolution rules of common tumors. Therefore, great attention should be paid in practical application. Microscopically, caseous necrosis, abscess, cavity, fibrosis and granuloma are common, and hyphae can be seen around the focus. The characteristic change of aspergillus globulus invasive fungal pneumonia is nodular lesion in lung, and halo sign can be seen around early stage. In this study, both invasive and non-invasive pulmonary mycosis were included. Some of the original cavities or Aspergillus spheres in the lungs should be parasitized by fungi and belong to non-invasive pulmonary mycosis. Aspergilloma does not invade the tissue and will not cause the patient's systemic symptoms. It only causes irritating cough and sometimes repeated hemoptysis. Chronic obstructive pulmonary disease and old pulmonary tuberculosis cause changes in the basic anatomical structure of the lungs, and the ability to remove pathogenic bacteria decreases to susceptibility. The clinical manifestations of pulmonary mycosis are nonspecific cough, expectoration, hemoptysis, fever, etc. There is no specificity.

The imaging manifestations of tumor like pulmonary mycosis are lack of specificity, which is easy to be confused with other diseases such as tumors. However, if we see two pulmonary patchy exudative lesions on the basis of nodules or masses, we should think of the possibility of fungal infection. Aspergilloma is common in the elderly and chronic lung disease patients. It has special image and often lives in the cavity formed by chronic lung diseases such as tuberculosis, pulmonary cyst and lung cancer. There are also some clinical critical patients in internal and surgical departments, patients with serious underlying diseases, implantation of various catheters in the body, and the large use of broad-spectrum antibiotics and glucocorticoids are also risk factors for pulmonary fungal infection. There are also reports that it is related to bird droppings such as pigeons. This group of 30 patients had a history of pigeon breeding. CT examination of pulmonary cryptococcosis may have the following manifestations: solitary mass shadow, single or multiple nodule shadow. It is believed in the literature that this is related to the necrosis of some tissues in the nodule and the formation of fissured cavities [9]. Therefore, nodule shadow may be the early imaging manifestation of “air crescent sign”. CT findings in 2 cases were atelectasis of left lung, local thickening of bronchial tube wall, stenosis of lumen and soft tissue density shadow in lumen. This sign was accompanied by nodule or mass shadow in 5 cases of this group. Pleural depression can be caused by pulmonary fungal nodules and mass lesions adjacent to pleural surface, but the degree is heavier than lung cancer and accompanied by adjacent pleural thickening. A small number of patients will have bronchial inflation syndrome, and patients with general immune dysfunction will have bronchial inflation syndrome. In this study, 3 patients (10%) have bronchial inflation syndrome.

## 5. Conclusion

CT examination can well show the focus of pulmonary fungal infection. CT manifestations of pulmonary mycosis are various. Air crescent sign, halo sign, ground glass shadow, cavity sign, treetop sign and wedge-shaped solid shadow are specific signs of pulmonary mycosis, which are helpful for diagnosis and differentiation of pulmonary mycosis. The differential diagnosis of pulmonary fungal infection with tumor-like manifestations is difficult. The combination of imaging and clinical conditions is the best method to understand the infection process of pulmonary diseases. Lesion distribution, nodule size, number and presence or absence of cavitation, air crescent sign, tree bud sign, halo sign and anti-halo sign can provide help for the diagnosis and differential diagnosis of pulmonary mycosis. CT diagnosis of tumor-type pulmonary fungal infection has certain characteristics. Tumors generally form cavities or hollows. When crescent sign in tumors is obvious, the presence or absence of fungal infection in patients can be considered.

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