# X-ray Manifestations of Pneumoconiosis Patients and Differential Analysis with Pulmonary Tuberculosis

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**Abstract** [**Objectives**] This study was conducted to explore the X-ray manifestations of pneumoconiosis patients and differentiation from pulmonary tuberculosis. [**Methods**] Retrospective analysis was conducted on 103 patients who underwent lung examinations, including 47 cases of pneumoconiosis and 56 cases of pulmonary tuberculosis. The differences in nodule characteristics and accompanying cavity sign between pneumoconiosis and pulmonary tuberculosis were compared. [**Results**] The X-ray manifestations of pneumoconiosis patients mainly included various forms of lung images, which were uneven in density, and had blurry edges, and sometimes thickening of lung markings and reduction of lung volume could be observed. The acinar nodules observed in X-ray films of patients with hematogenous disseminated pulmonary tuberculosis appeared petal like. The uniformity of nodule appearance such as nodule distribution, nodule density, and nodule size was significantly lower in pneumoconiosis than in hematogenous disseminated pulmonary tuberculosis, showing a statistical significance ($P<0.05$). The diameter of cavities in patients with pneumoconiosis accompanied by cavity sign [(0.64 ± 0.13 vs 3.37 ± 0.95) cm] was lower than that in patients with secondary pulmonary tuberculosis accompanied by cavity sign. There was a significant difference in the thickness of the cavity wall between the two diseases, and patients with pneumoconiosis accompanied by cavity sign had a higher rate of thick wall cavities (>3 mm). The X-ray manifestations of pneumoconiosis and tuberculosis were relatively similar, but the distribution, density and size of nodules in pneumoconiosis were relatively uneven, and the patients accompanied by cavity sign had smaller cavity diameter and higher rate of thick-walled cavities. [**Conclusions**] This study provides a reference for the clinical differential diagnosis of pneumoconiosis and pulmonary tuberculosis.

**Key words** Pneumoconiosis; Pulmonary tuberculosis; X-ray; Cavity sign; Differential analysis

Pneumoconiosis and tuberculosis are two common lung diseases, both of which pose an undeniable threat to human health. Pneumoconiosis is an occupational disease caused by long-term inhalation of dust, mainly occurring in occupational populations such as coal miners, asbestos workers, and construction workers[1]. Pulmonary tuberculosis is a disease caused by *Mycobacterium tuberculosis* infection, commonly found in people with malnutrition, weakened immunity, or long-term exposure to infection sources[2]. The symptoms and signs of these two diseases have many similarities, such as coughing, chest pain, and phlegm, so it is often difficult to distinguish in clinical practice. X-ray examination, as a commonly used diagnostic method, has important significance in distinguishing pneumoconiosis from pulmonary tuberculosis[3]. There are also some similarities in X-ray manifestations between pneumoconiosis and pulmonary tuberculosis, such as pulmonary infiltration and spotted shadows. However, there are also some differences in X-ray manifestations between pneumoconiosis and tuberculosis, which are of great help in differential diagnosis[4]. The X-ray manifestations of pneumoconiosis are mainly diffuse ground glass shadows, thickened interlobular septa, and spotted shadows in the lungs, while the X-ray manifestations of pulmonary tuberculosis are pulmonary nodules, cavities, bronchiectasis, and so on. Therefore, these two diseases can be effectively distinguished by analyzing the X-ray manifestations of pneumoconiosis and pulmonary tuberculosis, providing important references for clinical diagnosis and treatment. In this study, a detailed analysis and comparison of the X-ray manifestations of pneumoconiosis and tuberculosis was conducted to explore the differential diagnosis method of the two diseases, aiming to provide reference for clinical doctors, help deepen the understanding of pneumoconiosis and tuberculosis, and improve the prevention and treatment level of these two diseases.

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## Information and Methods

### General information

Retrospective analysis was conducted on 103 patients who underwent lung examinations at the Third People's Hospital of Guizhou Province and the Public Health Treatment Center of Guiyang City from January 2021 to September 2022, including 47 cases of pneumoconiosis and 56 cases of tuberculosis. Among patients with pneumoconiosis, there were 27 males and 20 females; their ages ranged from 34 to 61 years old, with an average age of (50.64 ± 6.85) years; in terms of disease staging, there were 12 cases in stage I, 19 cases in stage II, and 15 cases in stage III; and 12 cases were accompanied by cavity sign. Among patients with pulmonary tuberculosis, there were 31 males and 25 females; their ages ranged from 35 to 64 years old, with an average age of (51.05 ± 6.67) years; there were 21 cases of hematogenous disseminated type; and 33 cases were accompanied by cavity sign.

### Selection standards

**Diagnostic standards** Diagnosis of pneumoconiosis: Referring to

relevant standards in *Diagnostic Standards for Pneumoconiosis*[5] (WS/T 210-2017), ① there is a clear history of occupational exposure or evidence of long-term exposure to dust; ② there are symptoms such as cough, expectoration, chest tightness, and shortness of breath; ③ it is accompanied by lung rales and acropachia; ④ pulmonary function examination show restrictive ventilatory disorder or restrictive ventilatory disorder accompanied by obstructive ventilatory disorder; and ⑤ images shows pulmonary interstitial fibrosis, ground glass opacity, small nodules, and bronchial wall thickening. Combining occupational history and clinical manifestations, pneumoconiosis could be diagnosed.

Diagnosis of pulmonary tuberculosis: Referring to the relevant diagnostic standards in *Diagnosis of Pulmonary Tuberculosis*[6] (WS 288-2017): ① the patients have symptoms such as cough, blood in sputum, and expectoration; ② pulmonary nodules, spots, cavities and other lesions are found through X-ray, CT and other imaging examinations; and ③ *Mycobacterium tuberculosis* is found through the cultivation and testing of sputum, pleural effusion, bronchoalveolar lavage fluid, and other samples. According to above standards, combined with patients' previous tuberculosis history and exposure history, pulmonary tuberculosis could be diagnosed while excluding lung diseases such as pneumonia and lung cancer.

**Inclusion criteria** ① Diagnosed according to the above diagnostic criteria; ② complete clinical data; ③ aged 18 and above.

**Exclusion criteria** ① Other lung diseases; ② accompanied by malignant tumors; ③ severe dysfunction of organs such as liver and kidney in combination; ④ under 18 years old; ⑤ accompanied by mental illness or consciousness disorder; ⑥ partial missing and incomplete clinical data.

**Inspection methods**

All patients underwent high kV X-ray examination, with relevant parameters such as exposure time ranging from 0.02 to 0.08 s, an exposure amount ranging from 2 to 10 mAs, a focal length of 1.8 m, and a small focal point. Specific operation steps: ① Patient preparation: The patient needed to take off their top and wear medical shorts, and remove metal items such as watches, earrings and necklaces from their body. If a patient had a bra, she needed to take it off or wear a metal-free bra. ② Position: The patient needed to stand or sit in front of an X-ray machine, facing the machine, and maintaining stable breathing. Doctors would guide patients on how to stand or sit for easy photography. ③ Shooting location: High kV X-ray examination required shooting multiple locations, including the anteroposterior and lateral positions. Two photos needed to be taken in the anteroposterior position, one showing the entire chest and the other showing partial magnification. A side view needed to be taken to observe lung lesions and pleural thickening. The photography selected a blue film base and adopted an automatic image washing function. After obtaining the X-ray film, three senior physicians professional in lung diseases jointly reviewed the films and ultimately determined the examination results.

**Observation indexes**

(1) The X-ray imaging manifestations of patients with pneumoconiosis and pulmonary tuberculosis were analyzed. The imaging differences and similarities between pneumoconiosis and tuberculosis were evaluated and compared.

(2) The differences in nodules between pneumoconiosis and hematogenous disseminated pulmonary tuberculosis were analyzed.

(3) The conditions of pneumoconiosis and secondary pulmonary tuberculosis with cavity sign were observed and compared.

**Statistical processing**

SPSS 26.0 was applied to analyze data. The counting data were expressed as n (%) and compared using $\chi^2$ test. The measurement data were represented by ($\bar{x} \pm s$) and subjected to *t*-test. The test level was both sides $\alpha = 0.05$.

## Results and Analysis

**X-ray film manifestations of pneumoconiosis and pulmonary tuberculosis**

The X-ray manifestations of pneumoconiosis patients mainly included various forms of lung images such as spotted, nodular, shaded, and patchy, usually appearing in the upper and middle lobes of the lungs. The images were uneven in density, and had blurry edges, sometimes thickening of lung markings and reduction of lung volume could be observed. As the condition worsened, the X-ray manifestations would also correspondingly worsen, leading to pulmonary infiltration and fibrosis. The acinar nodules observed in X-ray films of patients with hematogenous disseminated pulmonary tuberculosis appeared petal like. The main X-ray manifestations of acute cases were diffuse lesions in both lungs, with blurred edges and varying sizes, and it might be accompanied by the symptoms of pleurisy. The main X-ray manifestations of chronic patients were multiple nodular lesions of varying sizes, distributed in the upper and lower fields of both lungs. Mild and blurry infiltration shadows could be seen around the lesions, and there might be cavities formed within the lesions, fibrosis in the lesion areas, reduced lung volume, and enlarged hilar lymph nodes.

**Comparison of X-ray nodule appearances between patients with pneumoconiosis and pulmonary tuberculosis**

The uniformity of nodule appearance, such as nodule distribution, nodule density, and nodule size, was significantly lower in pneumoconiosis than in hematogenous disseminated pulmonary tuberculosis, and the differences were statistically significant ($P < 0.05$), as shown in Table 1.

**Comparison of X-ray cavity sign between pneumoconiosis and pulmonary tuberculosis**

The diameter of cavities in patients with pneumoconiosis accompanied by cavity sign [(0.64 ± 0.13 vs 3.37 ± 0.95) cm] was lower than that in patients with secondary pulmonary tuberculosis accompanied by cavity sign ($P < 0.05$). There was a significant difference in the thickness of the cavity wall between the two diseases, and patients with pneumoconiosis accompanied by cavity sign had a higher rate of thick-wall cavities (>3 mm) ($P < 0.05$),

as shown in Table 2.

**Table 1 Comparison of X-ray nodule appearances between patients with pneumoconiosis and pulmonary tuberculosis**

| Nodule appearance | Type | Pneumoconiosis ($n$=47) | Pulmonary tuberculosis ($n$=21) | $\chi^2$ | $P$ |
|---|---|---|---|---|---|
| Nodule distribution | Uniform | 4 | 13 | 22.070 | 0.000 |
| | Nonuniform | 43 | 8 | | |
| Nodule density | Uniform | 8 | 14 | 16.346 | 0.000 |
| | Nonuniform | 39 | 7 | | |
| Nodule size | Uniform | 13 | 12 | 5.427 | 0.020 |
| | Nonuniform | 34 | 9 | | |

**Table 2 Comparison of X-ray cavity sign between pneumoconiosis and pulmonary tuberculosis**

| Type | $n$ | Cavity diameter//cm | Thickness of cavity wall//mm | |
|---|---|---|---|---|
| | | | ≤3 | >3 |
| Pneumoconiosis | 12 | 0.64±0.13 | 3 | 9 |
| Pulmonary tuberculosis | 33 | 3.37±0.95 | 28 | 5 |
| $t/\chi^2$ | – | 9.850 | 12.047 | |
| $P$ | – | 0.000 | 0.001 | |

## Conclusions and Discussion

Pneumoconiosis is an occupational lung disease, and long-term inhalation of dust can cause pathological changes such as lung tissue inflammation, fibrosis, and pulmonary dysfunction. The main clinical manifestations include respiratory symptoms, chronic obstructive pulmonary disease, and severe respiratory failure[7]. The pathological characteristics of pneumoconiosis mainly manifest as dust deposition in the lung tissue, and the pathological changes caused by different types of dust also vary. For example, coal dust-induced pneumoconiosis is mainly characterized by melanin deposition and fibrosis, while silica dust-induced pneumoconiosis is mainly characterized by pulmonary interstitial fibrosis[8]. Pulmonary tuberculosis is a chronic infectious disease caused by *Mycobacterium tuberculosis*. After infection, *M. tuberculosis* can reproduce and form tuberculosis nodules in the alveoli, which often include necrotic centers, extracellular nuclei, and peripheral lymphocyte infiltration. The necrosis center inside the tuberculosis nodule forms caseous necrotic tissue, and the surrounding tissue undergoes reactions such as epithelioid transformation, cell infiltration, and fibroblast proliferation, forming fibrotic changes similar to honeycombs[9]. During the further development of the lesions, caseous necrotic substances can penetrate the alveolar wall and form cavities, causing symptoms such as hemoptysis. Both of these diseases can have adverse effects on the respiratory system of the human body. If not treated promptly and effectively, it is likely to induce serious complications such as pneumothorax and bronchiectasis. Especially for patients with pneumoconiosis, as the condition progresses, the immune system of the body will suffer severe damage, and functions will continue to weaken, which not only reduces patients' quality of daily life, but may also endanger their lives.

X-ray is one of the important tools in the differential diagnosis of pneumoconiosis and pulmonary tuberculosis. In X-ray images, the pathological manifestations of pneumoconiosis and tuberculosis are different, and can be distinguished through imaging features. Pneumoconiosis mainly manifests as thickened lung markings, increased lung field density, and enlarged hilar lymph nodes, while pulmonary tuberculosis manifests as pulmonary nodules, cavities, and fibrosis. Important references can be provided for the differential diagnosis of pneumoconiosis and pulmonary tuberculosis by observing and analyzing X-ray images. In this study, retrospective analysis was conducted to compare the clinical characteristics and X-ray manifestations of two diseases. The results showed that the uniformity of nodule appearance such as nodule distribution, nodule density, and nodule size was significantly lower in pneumoconiosis than in hematogenous disseminated pulmonary tuberculosis; the diameter of cavities in patients with pneumoconiosis accompanied by cavity sign [(0.64±0.13 vs 3.37±0.95) cm] was lower than that in patients with secondary pulmonary tuberculosis accompanied by cavity sign; and there was a significant difference in the thickness of the cavity wall between the two diseases, and patients with pneumoconiosis accompanied by cavity sign had a higher rate of thick wall cavities (>3 mm). The differences between the two diseases were as follows: First, the distribution of pneumoconiosis and tuberculosis was different from the location of the disease. Pneumoconiosis often occurs in the middle and lower parts of the lungs, especially near the hilar and subpleural areas, while tuberculosis often occurs in the apical and upper lobes of the lungs. Therefore, it is necessary to pay attention to the location of lesions during X-ray examination, and the localization of the lesion site is helpful for differential diagnosis. Secondly, from the perspective of pathological features, the pathological features of pneumoconiosis and tuberculosis are also different. The main pathological changes of pneumoconiosis are pulmonary interstitial fibrosis and thickening of alveolar walls, usually manifested as spotted, grid like, or nodular images. The lesions of pulmonary tuberculosis are manifested in various forms of images, such as nodular, infiltrative, and cavernous. Therefore, the morphological features of X-ray images can preliminarily determine the type of lesions, which is beneficial for differential diagnosis. In addition, the nodules in pneumoconiosis and tuberculosis are also different in appearance. The nodular appearance of pneumoconiosis usually presents as small nodules with bilateral, symmetrical, uniform size, and clear edges, while the nodular appearance of pulmonary tuberculosis usually presents as irregularly shaped, unevenly sized, and blurry edges of nodules[10]. Therefore, the type of lesions can be further determined by observing the morphological characteristics of the nodule appearance. Finally, the accompanying cavity sign also has important significance in the differential diagnosis of pneumoconiosis and pulmonary tuberculosis. Pneumoconiosis is usually not accompanied by a cavity sign, while tuberculosis is often accompanied by a cavity sign. The cavity sign is caused by necrosis and liquefaction of lung tissue and air ingress. It is one of the characteristic manifestations of pulmonary tuberculosis, and the cavity wall often presents thin wall or irregular wall thickness. Therefore, the type of lesions can be further determined by observing the occurrence of the accompanying cavity sign.

In summary, X-ray has important application value in the differential diagnosis of pneumoconiosis and pulmonary tuberculosis. The type of lesions can be preliminarily determined by observing imaging features including the location of lesions, characteristics of lesions, nodule appearance, and accompanying cavity sign, providing important reference for clinical differential diagnosis. However, it should be noted that X-ray imaging examination has certain limitations, and for the diagnosis of some lesions, a comprehensive analysis should be conducted based on patients' condition, medical history, and other imaging examination methods and clinical manifestations.

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