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CASE REPORT

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Pulmonary cavity with black sputum in COVID-19-Pneumoconiosis: a case report

Wen-qin Jiang[1], Yu-hong Li[2*] and Wen-Ming Wang[3]

Abstract

Background Black sputum is scarce in clinical work. Pulmonary cavities with black sputum are more common in fungal infections and inhalation of a large amount of dust rarely.

Case report A 58-year-old young man went to the hospital several times because of Black sputum after being infected with COVID-19 and was diagnosed with pulmonary tuberculosis. The chest computerized tomography (CT) showed multiple high-density mass shadows in both lungs, accompanied by cavity formation. Bronchoscopy showed carbon foam was deposited in bilateral bronchial mucosa without new organisms, and the bronchial lavage fluid is medium black mucus, which gene X-PERT/rifampicin resistance test, fungal and pathological examination were negative. According to medical history, the patient has been engaged in underground work in coal mines three times, without any preventive measures. The final diagnosis was pneumoconiosis. The symptoms were relieved after two alveolar lavage treatments within 1 month, and the black sputum disappeared. Chest CT showed lung cavity lesions are stable 3 months later.

Conclusion Occupational dust exposure should not be ignored when treating patients with hollow lungs and black sputum. Pneumoconiosis is always diagnosed at an advanced stage, either as a milia nodular disease in chest imaging, or it progresses to PMF (progressive bulk fibrotic), with or without cavitation. There are currently no reported cases of pneumoconiosis combined with COVID-19 infection. Patients with pneumoconiosis have become susceptible to COVID-19 infection due to pulmonary interstitial fibrosis and low immunity. PMF cases of COVID-19 are atypical, and their clinical symptoms, laboratory examinations, and imaging manifestations are allIt exhibits atypical properties, and because the fungal test is negative, infection with COVID-19 may accelerate the production of unexplained tracheal mucus and black sputum in microbiological examinations.

Keywords Lung cavity, Black sputum, Pneumoconiosis

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Background

Pulmonary cavities are air-filled spaces within lung consolidation, masses, or nodules that form after the necrotic part is drained or drained through the bronchial tree. Many lung diseases are associated with cavitary-like lesions, such as lung cancer, tuberculosis, lung abscesses, and fungal infections [1]. However, tuberculosis is the most common cause of cavitary lung lesions [2]. Black sputum is rare in clinical practice. Cavities with black sputum are more common in fungal infections. In addition, there are rare causes such as inhalation of large amounts of dust, long-term smoking, and special working environments. Severe damage to the lungs and respiratory tract may also lead to the formation of black sputum [3]. Diffuse fibrosis of the lungs of patients with pneumoconiosis causes lung tissue damage, decreased ventilation function, and significantly reduces the ability to defend against pathogens due to changes in lung tissue structure and immune dysfunction. It is known that after COVID-19 infection, inflammatory cells invade the respiratory tract and release inflammatory mediators in lung tissue, accelerating the congestion and edema of the airway mucosa. COVID-19 infection in patients with pneumoconiosis may result in increased mucus secretion and large sputum production with increased black sputum [4, 5]. However, to date, the secretion of large amounts of black sputum following COVID-19 infection has not been reported.

Case report

A 58-year-old middle-aged man went to the hospital several times because of black sputum after being infected with COVID-19 and was diagnosed with pulmonary tuberculosis. He developed a fever and cough, and excessive sputum secretion with black tar-like (Fig. 1). After infection with COVID-19 coughed up a lot of black phlegm every day, the amount is about 300 ml, accompanied by shortness of breath, no hemoptysis, and chest pain. He underwent multiple anti-infection and expectoration treatments, but the effects were not good. The chest CT showed multiple high-density mass shadows and enlarged mediastinal and hilar lymph nodes without cavity lesions in both lungs at the early stages of COVID-19 infection (Fig. 2). Coughing up a large amount of black phlegm for a week, an empty cavity appears in the shadow of a high-density mass (Fig. 3). The results of relevant tests on admission were as follows: procalcitonin 0.057 ng/ml (0-0.02), interleukin-6: 1.50 pg./ml (0–7), high-sensitivity C-reactive protein: 5.259 (0–3), erythrocyte sedimentation rate: 40(mm/H), leukocyte, neutrophil count and lymphocyte count were within normal range. Bronchoscopy showed carbon foam was deposited in bilateral bronchial mucosa without new organisms, and the bronchial lavage fluid is medium black mucus (Figs. 4 and 5), which gene X-PERT /rifampicin resistance test, fungal and pathological examination were negative. There was no evidence of tuberculosis. Follow-up medical history, the patient has been engaged in underground work in coal mines three times: the patient worked in a coal mine for 4 years as a coal miner at the age of 15; he worked as a driller in a lead and galena mine for 2 years at the age of 20; he worked in a small coal mine as a coal miner for 11 years at the age of 31. During three periods, no preventive measures were taken. The final diagnosis was pneumoconiosis. The symptoms were relieved after two alveolar lavage treatments within 1 month, and the black sputum had mostly disappeared. Chest CT

Fig. 1 Black tar-like sputum

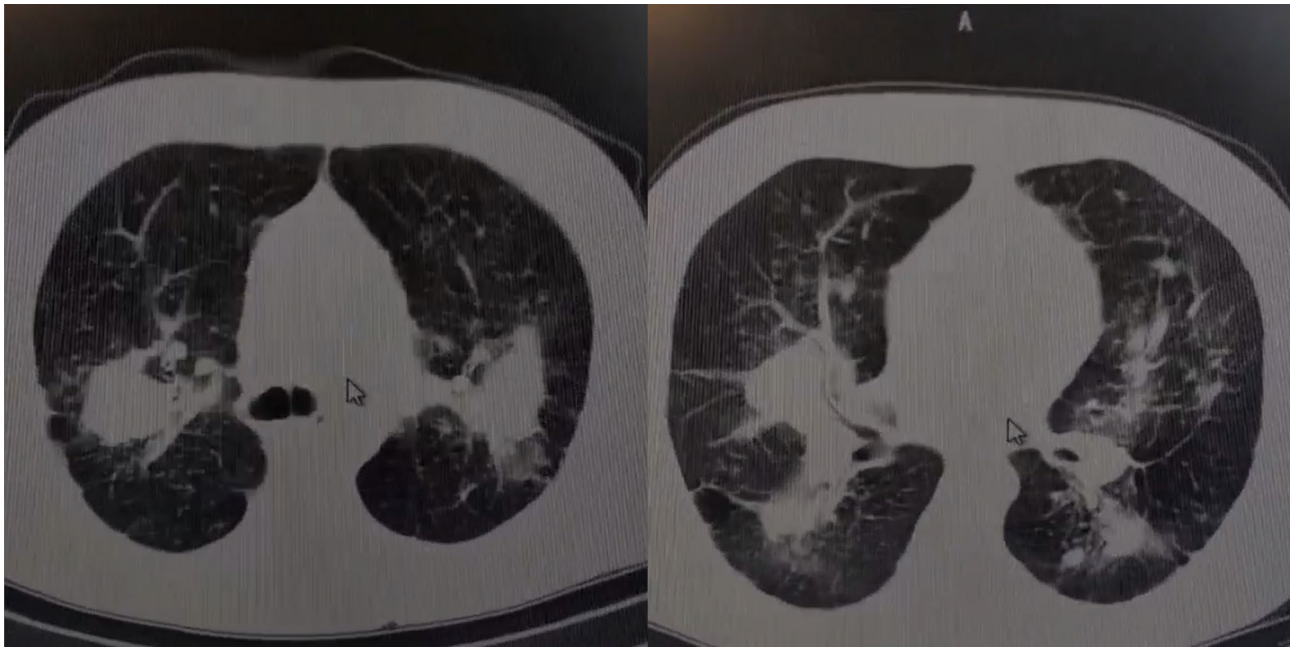

Fig. 2 In Lung windows as alveolar opacities presenting like progressive massive fibrosis (PMF). In the mediastinal window it is mentioned as a calcified lymph node presenting like mass compressing the bronchial lumen. 2023.1 Local County Hospital

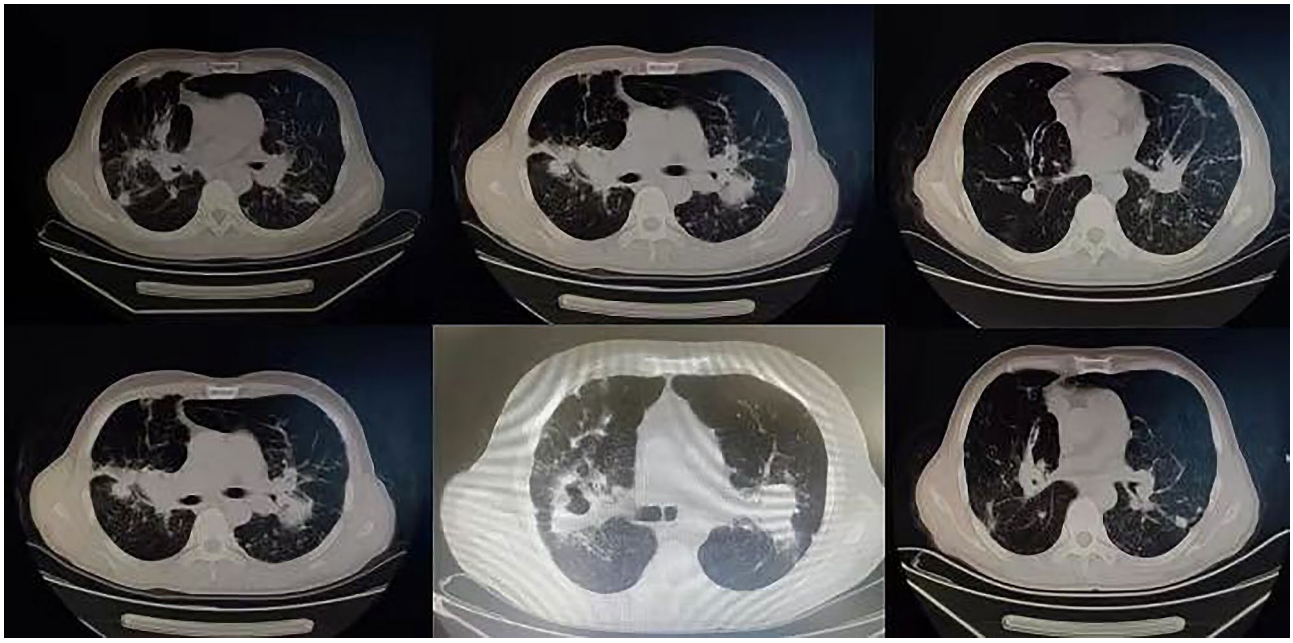

Fig. 3 A cavity appears in high-density mass shadows. 2023.2 Provincial Fourth People's Hospital

showed lung cavity lesions are stable 3 months later (Fig. 6). He is now in regular outpatient follow-up and is in stable condition.

Discussion and conclusions

Cavitation in the lungs is a common pattern of lung disease, often found in conditions such as lung cancer, lung abscess, tuberculosis, fungal lung infections, fibrosing pneumonia, and occasionally in pulmonary infarction granulomatous vasculitis, sarcoidosis, and inflammatory pseudotumors [1]. Pulmonary tuberculosis is the most common cause of cavitary lesions in the lungs [6]. However, prolonged inhalation of silica dust and retention in the lungs in patients with pneumoconiosis can impair macrophage function and lead to diffuse fibrotic lesions in lung tissue, which provides

Fig. 4 Bronchial lavage fluid is medium black mucus. 2023.2 Provincial Fourth People's Hospital

favorable conditions for the reproduction of tuberculosis bacteria in the lungs [7]. There are mainly the following reasons: (1) The dust irritates and damages the respiratory mucosa for a long time, and the defense ability is reduced, which is conducive to the invasion of Mycobacterium tuberculosis. (2) Dust enters the lungs to damage or activate effector cells such as lymphocytes, secrete a variety of cytokines and other activated molecules, and eventually lead to pulmonary fibrosis. (3) Pulmonary fibrosis leads to ischemia and hypoxia of local lung tissue, which reduces the lung defense function and makes it easy to be infected with Mycobacterium tuberculosis. (4) Pneumoconiosis has the effect of enhancing the vitality of tuberculosis bacteria, has certain toxicity to macrophages, weakens the phagocytosis and sterilization ability of macrophages, and makes Mycobacterium tuberculosis spread in tissues. (5) Patients with pneumoconiosis have a long medical history, mostly accompanied by emphysema, chronic cor pulmonale, bronchiectasis, and other diseases, with varying degrees of malnutrition, low immunity, and are easily infected with Mycobacterium tuberculosis and disseminate to lead to respiratory failure. It plays an important role in the formation of pulmonary cavities by inducing the gradual establishment of cellular immunity at the site of the lesion and activating phagocytes to form caseous necrosis [8, 9]. Once the two diseases are comorbid, they will promote each other, accelerate the progression and deterioration of the disease, and affect the prognosis, which is one of the important causes of death in silicosis patients [10]. In addition, pneumoconiosis is diffuse fibrosis of lung tissue caused by long-term inhalation of pathogenic dust and retention in the lungs. Patients with pneumoconiosis not only have their respiratory tract clearance and defense mechanisms compromised, but their immune function is also significantly impaired [4]. Moreover, the transmission routes of COVID-19 infection are mainly direct transmission and contact transmission. The population is generally susceptible. Patients with pneumoconiosis, as a special type of population, are due to long-term exposure to productive dust. Large inhalation of dust in the lungs damages macrophages and causes inflammation, which in turn interacts with the cell surface angiotensin-converting enzyme. The combination of 2 leads to a series of respiratory tract injuries, including damage to airway epithelial cells [11–13]. Airway epithelial cells play an indispensable and important role in barrier defense, clearance, and blocking of pathogens [8]. Inflammation and oxidative stress cause pulmonary fibrosis. Because of diffuse fibrosis in the lungs, the lung tissue is damaged, the ventilation function is reduced, the bronchioles are distorted, deformed, stenosis, and drainage are blocked, which ultimately leads to damage to the mucous membranes of the respiratory tract and the function of clearing and purifying is reduced. Prone to pulmonary infection. Moreover, the dust cells accumulated in the body of patients with pneumoconiosis activate T lymphocytes and B lymphocytes as antigens, promoting the body's immune response and producing a variety of autoantibody, resulting in immune dysfunction, resulting in a decrease in the body's resistance, which is more likely to cause infection [14]. Therefore, patients with pneumoconiosis have a stronger susceptibility to COVID-19 infection, and the clinical manifestations may be heavier after infection. On the one hand, due to severe damage to the airway, on the other hand, due to diffuse fibrotic lesions of lung tissue due to ischemia and necrosis, it is also caused by pneumoconiosis. Infection with COVID-19 accelerates the bronchial tubes. The reason for the production of mucus and the increase of black phlegm.

Pneumoconiosis is a systemic disease mainly caused by diffuse fibrosis of lung tissue caused by long-term inhalation of productive dust and is the most serious occupational disease in China. According to a study, the risk of coal workers' pneumoconiosis at the current respirable coal dust concentration is 10^5 ~ 10^6 at 5 and 10 years, and the risk of coal workers' pneumoconiosis at 20 years and 30 years after exposure is

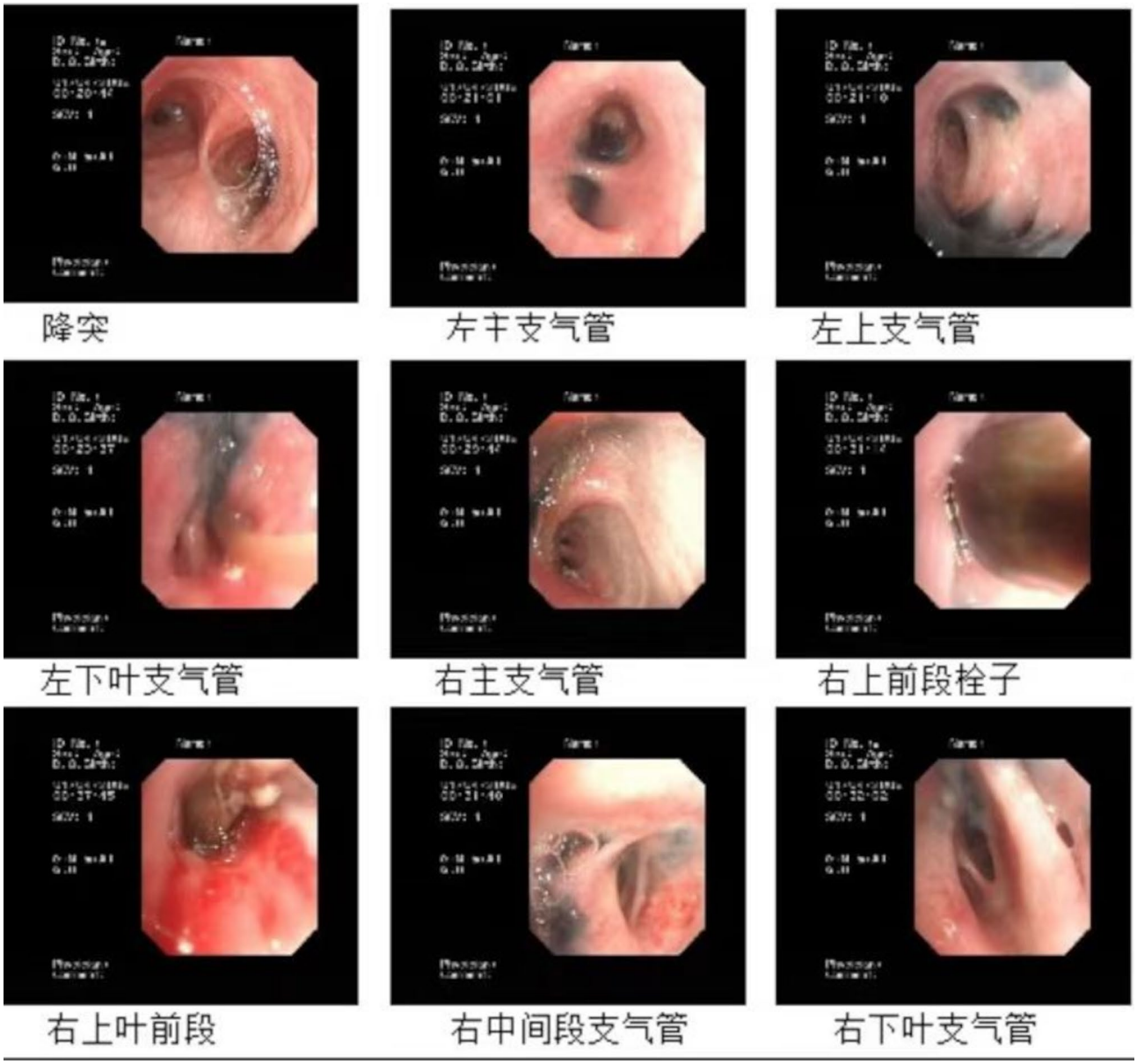

Fig. 5 Bronchoscopy showed carbon foam was deposited in bilateral bronchial mucosa.2023.2 Provincial Fourth People's

10^3～10^2. The risk of coal workers' pneumoconiosis will be higher than the acceptable risk level as they gain muscle with age, and protective measures need to be taken to reduce the risk of disease [15]. During the pathogenesis of pneumoconiosis, dust-phagophing macrophages accumulate in the respiratory bronchioles or alveoli, interlobular septums, trachea, and perivascular areas of the lungs, stimulating tissue proliferation to form pneumoconiosis or granuloma nodosa [16]. Pneumoconiosis is often asymptomatic in the early stages, but as pulmonary fibrosis increases, pneumoconiosis may develop restrictive ventilatory dysfunction and develop different complications such as emphysema, pneumothorax, pulmonary hypertension, and respiratory failure [17]. In addition, the basic imaging features of pneumoconiosis: early pulmonary fibrosis changes to linear irregular shadows in the lungs, which increase with the level of pneumoconiosis, and bronchial distortion, dilation, or occlusion are seen in the lesions, and cavities are seen in the lesions when tuberculosis is combined [18]. In addition, the bronchoalvage fluid of patients with pneumoconiosis is black mucus, and the detection rate of pathogenic bacteria in bronchoalveolar lavage fluid is higher [19]. Therefore, the evaluation of patients with pneumoconiosis should be based on the type, stage, symptoms, pulmonary function, blood gas analysis, and complications of pneumoconiosis [20]. Studies

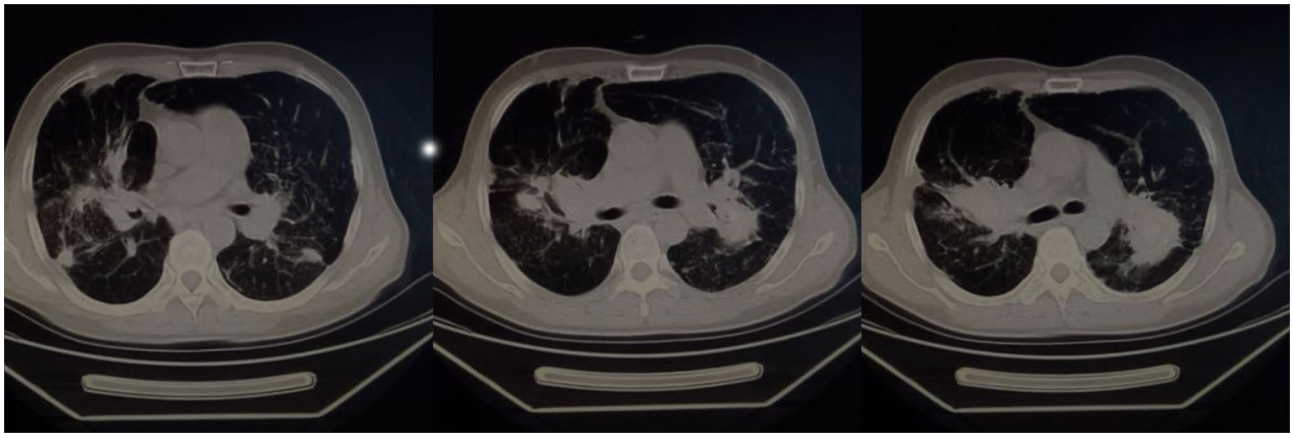

Fig. 6 Lung cavity lesions are stable 3 months later. 2023.6 Provincial Fourth People's Hospital

have found that the drug contains ingredients such as powder-proxylline, which can play a role in degrading silicosis collagen fibers, and traditional Chinese medicine studies have found that the drug can inhibit the production of hydrogen peroxide and superoxide anions, and then exert antioxidant, antiphagocytic, and anti-inflammatory effects [21]. Treatment with Han Fang Hexamethyl can quickly alleviate symptoms such as poor breathing, effectively improve lung function and blood gas indexes, significantly improve patient's quality of life, and have a high safety profile [22].

In short, occupational dust exposure should not be ignored when we treat patients with lung cavities and black sputum. Pneumoconiosis is always diagnosed at an advanced stage, either as a milia nodular disease in chest imaging, or it progresses to PMF (progressive bulk fibrotic), with or without cavitation. Patients with pneumoconiosis have become susceptible to COVID-19 infection due to pulmonary interstitial fibrosis, low immunity, etc. PMF cases of COVID-19 are atypical, and their clinical symptoms, laboratory examinations, and imaging manifestations are all atypical, and due to the negative test for fungi, Infection with COVID-19 may accelerate the production of unexplained tracheal mucus and black phlegm in microbiological examinations.

Abbreviations

CT	Computerized tomography
COVID-19	Coronavirus Disease 2019

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to provide information.

Author contributions

Write the paper and literature search: WQJ; guide and help literature search: YHL; diagnosis and treatment of patients: WMW. All authors read and approved the final manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Affiliated Hospital of Qinghai University.

Consent for publication

Written informed consent was obtained from the patient for the publication of this case report and any accompanying figures.

Competing interests

The authors declare no competing interests.

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