

Case Report

Allergic bronchopulmonary mycosis due to *Schizophyllum commune* in a patient with chronic hepatitis B

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Abstract

Introduction: *Schizophyllum commune* (*S. commune*) is an opportunistic pathogenic fungus and can cause infection of the respiratory system in immunocompromised hosts. Allergic bronchopulmonary mycosis (ABPM) is the major disease caused by *S. commune*. However, identification of *S. commune* using routine mycological diagnostic methods is difficult. It is easy to make mistakes in diagnosis and treatment, resulting in deterioration of the disease. We report the first case of ABPM due to *S. commune* in a Chinese patient with chronic hepatitis B.

Case presentation: The patient presented cough, sputum and dyspnea for six months. The pathogen was missed during routine laboratory workup. We performed bronchoscopy examination and bronchoalveolar lavage. *S. commune* was identified by metagenomic next-generation sequencing (mNGS) of bronchial alveolar lavage fluid (BALF). Hence, the patient was immediately treated with 200 mg voriconazole twice daily (intravenous infusion) and 20 mg prednisone once a day (oral therapy), along with oral entecavir for hepatitis B. There was no recurrence of infection after the medication was discontinued.

Conclusions: *S. commune* infection should be considered in the diagnosis of patients with refractory cough, sputum and dyspnea, especially in immunocompromised individuals. The mNGS technique is an effective supplementary technique for the diagnosis of *S. commune* infection, enabling precise clinical decision-making and appropriate treatment. Most patients have good prognosis with a combination of proper antifungal therapy and hormonal therapy.

Key words: *Schizophyllum commune*; allergic bronchopulmonary mycosis; mNGS; diagnosis; treatment; prognosis.

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Introduction

Schizophyllum commune (*S. commune*) is a type of filamentous basidiomycete fungus and is widely distributed in nature. It belongs to the Schizophyllaceae family, phylum Basidiomycota, class Agaricomycetes, and order Agaricales. *S. commune* is rarely involved in human disease because of its weak pathogenicity. Infections by *S. commune* in immunologically normal hosts is mostly manifested as colonization. However, in patients with immune insufficiency, local fungal colonization can lead to local organ destruction and cause hypersensitivity reactions or even systemic dissemination. The main target of *S. commune* infection is the respiratory tract [1]. Sinusitis and allergic bronchopulmonary mycosis (ABPM) are the two major diseases caused by *S. commune*.

ABPM is an immunologic disorder caused by hyperimmune response to the endobronchial growth of certain fungi. The most common pathogenic fungus is *Aspergillus* sp. ; *S. commune* (11%) is the third most

important non-*Aspergillus* species causing ABPM [2,3]. ABPM caused by *S. commune* was first reported by Kamei *et al.* in 1994 [4]. *S. commune* is characterized by clamp connections, hyphal spicules, and formation of basidiocarps. Nevertheless, it often appears as a monokaryotic isolate in clinical samples and is unable to form the characteristic clamp connections [5]. Therefore, *S. commune* cannot be identified with routine mycological diagnostic methods. Diagnosis is difficult and this can lead to treatment errors.

We experienced the first case of allergic bronchopulmonary mycosis due to *S. commune* in a patient with chronic hepatitis B. *S. commune* was missed during routine laboratory workup, but identified by metagenomic next-generation sequencing (mNGS) technique. Herein, we describe the successful treatment of the patient, and also review previous cases of ABPM caused by *S. commune*.

Case presentation

A 49-year-old woman with chronic hepatitis B presented to our hospital for chronic cough, sputum and dyspnea on November 30, 2021. She had chronic cough since April 2021. She presented to the local physician who prescribed a cough mixture which was ineffective. Then in August 2021 she went to a tertiary hospital where chest computed tomography (CT) showed an abnormal shadow with a gloved finger sign in the middle lobe of the right lung (Figure 1A, B). The results of laboratory tests showed that whole blood eosinophils and serum IgE levels were $0.81 \times 10^9/L$ and 913 IU/mL, respectively. A bronchoscopy was performed but the cause was not found. She was treated with cephalosporins and azithromycin for two weeks and the symptoms improved. However, her cough recurred one month later with right chest pain and shortness of breath.

The patient was therefore referred to our hospital and re-evaluated. Chest CT showed consolidation in the right middle lung field (Figure 1C, D) and mucoid impaction of the bronchus (Figure 1E, F). She was then admitted to our hospital in November 2021 for further

treatment. Her medical history revealed that she had a history of chronic hepatitis B and was not treated with anti-hepatitis B virus therapy. She denied any other chronic illnesses or surgical history. There was no history of dust or tuberculosis exposure, nor any family history, any pets, or any history of gardening or mountain hiking.

On examination, the patient appeared well. Her temperature was 36.8 °C, heart rate was 96 bpm and regular, blood pressure was 102/64 mmHg, and oxygen saturation was 98% in room air. Her breathing rate was 17 per minute. The sound of the right lung was lower than the left one, and no rales or wheezes were detected in both lungs. Laboratory investigations revealed the whole blood eosinophils count of $0.85 \times 10^9/L$ and serum IgE value had increased to 1280 IU/mL. Pulmonary function testing showed that the ratio of expiratory volume in the first second to forced lung capacity (FEV1/FVC) was 95.13%, and the level of fractional exhaled nitric oxide (FeNO) was 14 ppb. Chest contrast-enhanced CT showed no strengthening of lesions after enhancement. A bronchoscopy examination was performed again and several mucous

Figure 1. A to F and I to L: chest CT images; G and H: bronchoscopic images. **A, B:** red arrow shows a gloved finger sign in the middle lobe of the right lung; **C, D:** red arrow shows consolidation in the right middle lung field and mucoid impaction of the bronchus; **E, F:** red arrow shows mucous plugs in the right middle bronchus and blocking the lumen; **G:** white arrow shows mucous plugs in the right middle bronchus; **H:** white arrow indicates that mucous plugs were completely removed after bronchoscopic cryotherapy; **I, J:** red arrow shows a little infiltration in the right middle lung and central bronchiectasis; **K, L:** red arrow shows that no new lesions can be seen on CT images.

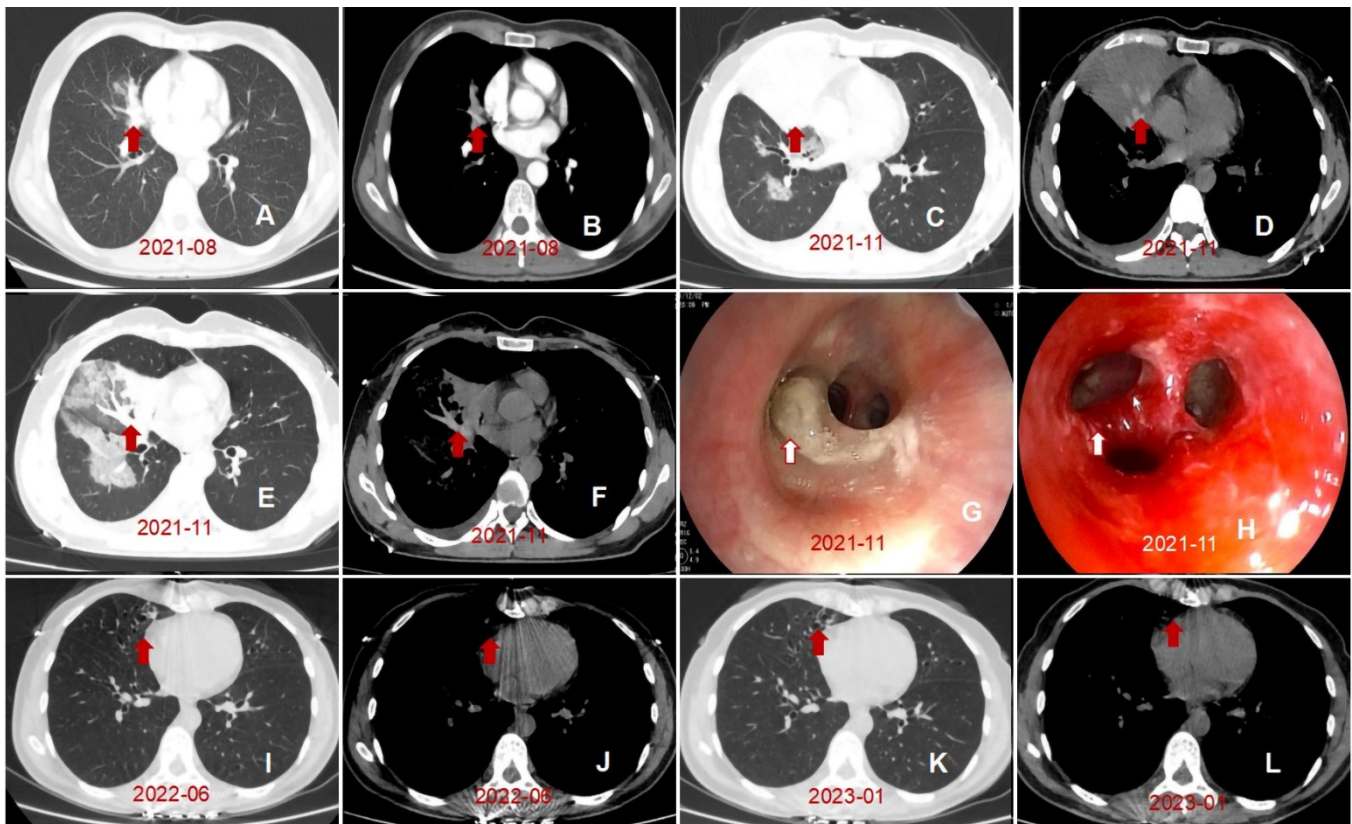
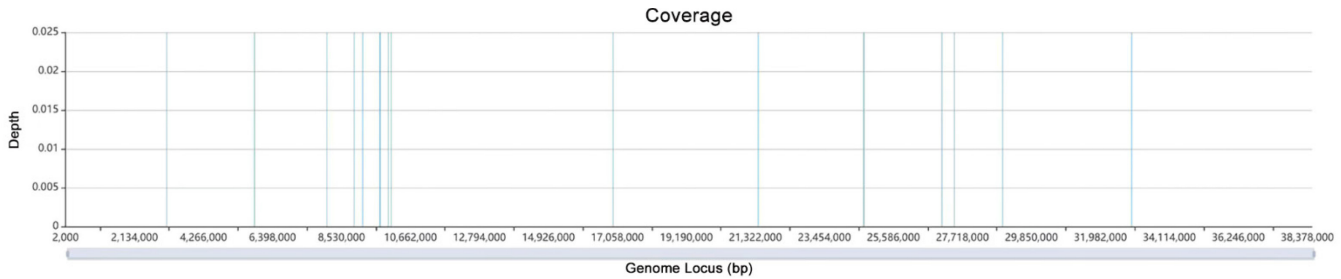


Figure 2. Gene coverage figure of *Schizophyllum commune* in the BALF sample. Twenty-nine unique nucleotide sequences corresponded to the sequences of *S. commune* in the genome locus.



plugs were found in the right middle bronchus (Figure 1G). We performed bronchoalveolar lavage in the right mid-lobe bronchus and completely removed the mucous plugs after bronchoscopic cryotherapy (Figure 1H). However, culture of sputum, bronchial alveolar lavage fluid (BALF) and mucous plugs was negative. The patient was further investigated because mucous plug is a feature of ABPM. Direct analysis of BALF samples using a next-generation sequencer revealed fungal DNA and *S. commune* was dominant. The gene coverage figure showed that 29 unique nucleotide sequences corresponded to the sequences of *S. commune* in the genome locus (Figure 2), and the relative abundance was 17.37%. Therefore, the patient was diagnosed with ABPM caused by *S. commune* based on the new diagnostic criteria proposed by Asano *K et al.* [19] and started intravenous 200 mg voriconazole twice a day and oral 20 mg prednisone once a day (0.5 mg/kg/d) from December 3, 2021. Meanwhile, the patient had a history of chronic hepatitis B. Despite normal liver function, the patient had elevated levels of HBV DNA at 2.16×10^6 IU/mL. Considering voriconazole's possible liver damage, the doctors of the infectious disease department suggested moving the anti-hepatitis B threshold forward; so entecavir was prescribed as an anti-hepatitis B virus drug in combination with a hepatoprotective drug.

Two weeks later, the patient's symptoms significantly relieved. She continued taking voriconazole (400 mg/day) and prednisone (10 mg/day) orally at discharge, tapering the dose of prednisone gradually. She was followed up on an outpatient basis

and alanine aminotransferase and creatinine were reviewed once a month. The patient developed a rash on her hands with itching during the follow-up, which is considered as a side effect of voriconazole. So, we reduced the dose of voriconazole to 200 mg/day. A chest CT scan obtained in June 2022 showed only a little infiltration in the right middle lung and central bronchiectasis (Figure 1I, J). The treatment was evaluated as effective, and she stopped taking the pills. The patient's total course of treatment was six months. Her symptoms have not recurred through the most recent follow-up in January 2023 and chest CT showed no new lesions (Figure 1K, L). Laboratory results and treatment of the patient are listed in Table 1.

Discussion

S. commune is an opportunistic pathogenic fungus. The development of *S. commune* infection is closely related to age of the host, host immunity and the number of fungal agents. As the number of patients with hematopathy, diabetes, acquired immune deficiency syndrome (AIDS), chemotherapy, dialysis, organ transplantation, and other diseases is increasing, the incidence of rare fungal infections is on the rise. *S. commune* infection can be categorized into allergic, saprophytic, chronic, and invasive forms. ABPM is one of the major diseases caused by *S. commune*.

However, data on clinical features, diagnostic methods and treatment options of ABPM caused by *S. commune* are currently not sufficient, especially in patients with immune insufficiency. We reported the first case of ABPM due to *S. commune* in a patient with

Table 1. Laboratory results and treatment of the patient.

Time	WBC	E	E%	IgE	CRP	Treatment
2021/08/20	7.9	0.81	10.2%	913	3.9	cephalosporins and azithromycin for 2 weeks
2021/12/01	10.16	0.85	8.4%	1280	103.38	
2021/12/03	<i>Schizophyllum commune</i> confirmed by mNGS					voriconazole (400 mg/d) and prednisone (20 mg/d)
2021/12/17	12.93	0.14	1.1%	1730	8.6	voriconazole (400 mg/d) and prednisone (10 mg/d)
2022/01/12	11.69	0.08	0.7%	243	7.4	voriconazole (400 mg/d) and prednisone (7.5 mg/d)
2022/02/17	6.99	0.07	1.0%	210		voriconazole (200 mg/d) and prednisone (5 mg/d)
2022/06/06	8.67	0.10	1.2%	121		stopped taking pills
2023/01/16	6.27	0.19	3.0%	96.4	3.01	-

WBC: white blood cell count; E: eosinophils; E%: eosinophils/white blood cell count; CRP: C-reactive protein.

chronic hepatitis B. We also reviewed global literature focused on ABPM caused by *S. commune*. Our literature search through PubMed and Web of Science covered the period up to December 2022. We used the search words ‘allergic’, ‘bronchopulmonary’, ‘mycosis’, ‘mycoses’, and ‘*Schizophyllum commune*’. Altogether 13 cases were compiled and analyzed in detail.

We summarized 13 cases of ABPM caused by *S. commune* that were reported globally (Table 2). Out of these, 11 cases were from Japan (84%), which may be related to the high awareness of the disease among Japanese clinicians and microbiologists. The age of onset ranged from 35 to 80 years, and females made up the majority (84%, n = 11).

Among the 13 reported cases (Table 2), four patients had underlying diseases, including pulmonary tuberculosis (n = 3) and diabetes mellitus (n = 1). However, there have been no previous cases of ABPM due to *S. commune*, secondary to chronic hepatitis B. Hepatitis B virus infection is the major cause of hepatic failure in China, and hepatic failure is considered to be one possible cause of immune insufficiency.

Visvanathan *et al.* [15] pointed out that patients with chronic hepatitis B are characterized by down-regulation of a number of Toll-like receptor 2, Kuff’s cells, dendritic cells, and natural killer cells. We suspect that the patient in our case had a history of chronic hepatitis B and elevated levels of HBV DNA, resulting in impaired innate and acquired immunity. The pathogenic process may be inhalation of spores from the environment. The spores colonize the lungs and germinate to form hyphae. The hyphae have protease antigens that stimulate the body to release cytokines to initiate an immune response, including elevated IgE and increased eosinophils [16]. A persistent inflammatory response leads to disruption of the bronchial wall, mucus obstruction, and characteristic bronchiectasis.

Correct pathogenic diagnosis is the prerequisite for treatment. The identification of *S. commune* mostly uses traditional microbial methods including sputum, BALF and mucous plugs culture (n = 9). But *S. commune* may be missed by routine laboratory workup because it generally does not form spores and grows woolly, whitish, and sterile colonies. The analysis of the internal transcriptional interval regional sequence (ITS)

Table 2. Literature review of case reports on ABPM due to *Schizophyllum commune*.

Case No/Reference	Age/Gender	Underlying condition	Clinical symptoms	Disease duration	Imaging	Diagnosis method	Treatment	Treatment duration	Effect
1/[1]	35/F	TB	Cough, sputum, dyspnea	3 yrs.	Gloved-finger sign, MIB, ectatic bronchi	Sputum culture	ICS+LABA+oral PSL	Unknown	Effective
2/[4]	53/F	-	Cough	1 yr.	Lingular infiltrate, ectatic bronchi	BALF culture, antibody	ITCZ	10 mos.	Ineffective
3/[6]	67/F	TB	Cough dyspnea	2 yrs.	MIB	Mucous plugs culture	bronchial toile	Unknown	Ineffective
4/[7]	51/F	-	Cough hemoptysis	3 mos.	Atelectasis	BALF culture	AMB	1 mo.	Effective
5/[8]	71/F	DM	Cough, dyspnea	1 mo.	Normal	BCT positive, antibody	ITCZ+ICS+L ABA+LAMA	Unknown	Effective
6/[8]	69/M	-	Cough dyspnea	5 yrs.	Normal	BCT positive, antibody	ITCZ+ICS+L ABA+LAMA	Unknown	Effective
7/[9]	58/F	-	Cough, sputum	1 mo.	MIB, ectatic bronchi	BALF culture, sputum, NGS	bronchial toile	Unknown	Effective
8/[9]	70/F	-	Cough, sputum, fever	2 mos.	MIB	BALF culture, sputum, NGS	ITCZ	3 mos.	Effective
9/[10]	61/F	-	Cough, sputum, dyspnea	5 yrs.	Ectatic bronchi	Mucous plugs culture, sputum, NGS	ITCZ+oral PSL	Unknown	Effective
10/[11]	80/F	TB	Cough, dyspnea	Unknown	Atelectasis, MIB	Mucous plugs culture	bromhexine	3 wks.	Effective
11/[12]	63/F	-	Cough, sputum	1 mo.	MIB	Mucousplugs culture	ITCZ to VRCZ	1 yr.	Effective
12/[13]	42/M	-	Cough, sputum	5 mos.	Atelectasis, MIB	Mucous plugs culture, antibody	ITCZ+oral PSL	Unknown	Effective
13/[14]	59/F	-	Cough, sputum	2 mos.	Gloved-finger sign, MIB, consolidation	BALF culture, nucleotide sequence	VRCZ+ICS	Unknown	Effective

TB: pulmonary tuberculosis; DM: diabetes mellitus; MIB: mucoid impaction of bronchus; BALF: bronchoalveolar fluid; NGS: next-generation sequencing; BCT: bronchial challenge test; ITCZ: itraconazole; VRCZ: voriconazole; AMB: amphotericin B; PSL: prednisolone; ICS: inhaled corticosteroid; LABA: Long-acting β2 receptor agonist; LAMA: Long-acting M receptor agonist.

and D1/D2 large subunit (LSU) region sequencing of ribosomal DNA (rDNA) is the most accurate method for identifying haploid *S. commune* [17]. In our case, sputum and BALF culture did not yield any significant pathogen. *S. commune* was identified via analysis of BALF samples using a next-generation sequencer, and the gene coverage figure revealed 29 unique nucleotide sequences corresponding to the sequences of *S. commune* in the genome locus (Figure 2). The mNGS technique can quickly and accurately target the nucleic acid in samples to unbiasedly detect pathogens. It is increasingly being used for the clinical diagnosis of bacterial or fungal infection in infectious diseases, due to its higher sensitivity and faster identification of the pathogen and is less affected by antibiotics.

Diagnosis of allergic bronchopulmonary mycosis is a complex process that requires a combination of clinical presentation, mycology, and imaging features. The criteria proposed by Rosenberg and Patterson *et al.* [18] are classical diagnostic criteria. However, the criteria are highly specific, and less sensitive. In 2021, Asano *et al.* developed new diagnostic criteria for ABPM in patients who do not have cystic fibrosis [19]. The new diagnostic criteria have higher sensitivity and reasonable specificity. The female patient of our case had asthma symptoms, elevated peripheral blood eosinophils and total IgE, lung infiltrates and atelectasis, central bronchiectasis, and tracheoscopic mucus plugs. The pathogen was identified as *S. commune* and antifungal therapy combined with corticosteroids was effective. She met seven components of the new diagnostic criteria, and was diagnosed as ABPM due to *S. commune*.

The clinical symptoms of allergic bronchopulmonary mycosis due to *S. commune* are nonspecific and can be manifested as cough, sputum, dyspnea, fever and hemoptysis. The most common manifestation is cough. Some patients present with an elevated peripheral eosinophil count and total IgE, mildly elevated or normal peripheral leukocytes, as well as normal erythrocyte sedimentation Rate (ESR) and C-reactive protein (CRP). Evaluation of serum specific IgE/IgG against *S. commune* has certain diagnostic value. Lung imaging can be presented as bronchial mucus plugs, atelectasis, central bronchiectasis, infiltrates, gloved finger signs, etc. It is worth noting that bronchial mucus plugs and central bronchiectasis are the most common manifestations and have important value in the diagnosis of ABPM. The bronchoscopic manifestations are mostly white or yellow jelly-like mucus plugs that can be seen in the bronchial lumen, and in severe cases, completely block

the lumen, resulting in local or total atelectasis. *S. commune* infections should be considered in the diagnosis of patients with chronic cough, sputum and dyspnea, especially in immunocompromised hosts. But the final pathogen diagnosis still depends on the identification of *S. commune*.

There are currently no guidelines for the treatment of ABPM caused by *S. commune*, but guidelines for treatment of allergic bronchopulmonary mycosis due to *Aspergillus sp* (ABPA) recommends a combination of antifungal therapy and hormonal therapy [20]. Among the previous 13 patients with ABPM due to *S. commune* (Table 2), six patients were treated with combination therapies of antifungal agents with systemic and/or inhaled hormone, four patients were treated with only antifungal therapy, and one patient was treated with bromhexine. The efficacy of antifungal therapy combined with hormonal therapy reached 100%. In terms of the choice of antifungal drugs, Chowdhary *et al.* reported *in vitro* susceptibility tests of 30 strains of common *S. commune* to different antifungal drugs, and the low minimum inhibitory concentration (MIC) group with better clinical efficacy was: itraconazole 0.20 mg/mL, voriconazole 0.24 mg/mL, and amphotericin B 0.29 mg/mL [21]. Ishiguro *et al.* reported a patient with ABPM due to *S. commune* who did not improve when treated with itraconazole for 16 weeks and then the treatment was changed to oral voriconazole effectively for two years without recurrence [12]. In our case, although drug susceptibility testing was not performed, the patient was treated with combination of voriconazole and prednisone. Her symptoms and the lung CT lesion were improved and there was no recurrence six months after stopping medication. As a result, we recommend a combination of antifungal and hormonal therapy in patients with ABPM caused by *S. commune*. Besides medication therapy, we can remove the mucus plug in the bronchi by repeated lavage or freeze-thaw under bronchoscopy. Amitani *et al.* [6] and Ogawa *et al.* [9] reported cases of tracheoscopic removal of mucus plug alone, and the patients recovered, but the follow-up data were not available. Surgical operation is limited to pulmonary fungal ball and colonization status, and video-assisted thoracoscopic surgery is available in patients with empyema [22].

Conclusions

In conclusion, clinicians should consider *S. commune* as a possible causative microorganism in cases of refractory pulmonary tract infections, particularly in patients with immune insufficiency. We report the first case of ABPM due to *S. commune* associated with chronic hepatitis B. The patient underwent a combination treatment of voriconazole and corticosteroids, as well as anti-hepatitis B virus treatment, with no sign of recurrent infection six months after stopping medication. mNGS technique has advantages in the clinical diagnosis of bacterial or fungal infectious diseases. Most patients have a good prognosis through timely and accurate diagnosis and active treatment.

Patient consent

The patient was asked for consent for this publication and did not declare any opposition.

Authors' contributions

RX, JFZ: literature review, planning the study, and writing the manuscript; JNZ: data analysis and proofreading of the manuscript; QZW: design of study, supervision, and finalizing the manuscript. All authors read and approved the final manuscript.

References

- Chowdhary A, Randhawa HS, Gaur SN, Agarwal K, Kathuria S, Roy P, Klaassen CH, Meis JF. (2013) *Schizophyllum commune* as an emerging fungal pathogen: a review and report of two cases. *Mycoses* 56: 1-10. doi: 10.1111/j.1439-0507.2012.02190.x.
- Chowdhary A, Agarwal K, Kathuria S, Gaur SN, Randhawa HS, Meis JF (2014) Allergic bronchopulmonary mycosis due to fungi other than *Aspergillus*: a global overview. *Crit Rev Microbiol* 40: 30-48. doi: 10.3109/1040841X.2012.754401.
- Deepak D, Singh Rajput M, Sharma B, Chowdhary A (2019) Allergic bronchopulmonary mycosis due to fungi other than *Aspergillus*. *Eur Ann Allergy Clin Immunol* 51: 75-79. doi: 10.23822/EurAnnACI.1764-1489.87.
- Kamei K, Unno H, Nagao K, Kuriyama T, Nishimura K, Miyaji M (1994) Allergic bronchopulmonary mycosis caused by the basidiomycetous fungus *Schizophyllum commune*. *Clin Infect Dis* 18: 305-309. doi: 10.1093/clinids/18.3.305.
- Sigler L, de la Maza LM, Tan G, Egger KN, Sherburne RK (1995) Diagnostic difficulties caused by a nonclamped *Schizophyllum commune* isolate in a case of fungus ball of the lung. *J Clin Microbiol* 33: 1979-1983. doi: 10.1128/jcm.33.8.1979-1983.1995.
- Amitani R, Nishimura K, Niimi A, Kobayashi H, Nawada R, Murayama T, Taguchi H, Kuze F. (1996) Bronchial mucoid impaction due to the monokaryotic mycelium of *Schizophyllum commune*. *Clin Infect Dis* 22: 146-148. doi: 10.1093/clinids/22.1.146.
- Miyazaki Y, Sakashita H, Tanaka T, Kamei K, Nishimura K, Yoshizawa Y (2000) Mucoid impaction caused by monokaryotic mycelium of *Schizophyllum commune* in association with bronchiectasis. *Intern Med* 39: 160-162. doi: 10.2169/internalmedicine.39.160.
- Ogawa H, Fujimura M, Takeuchi Y, Makimura K (2011) Two cases of *Schizophyllum asthma*: is this a new clinical entity or a precursor of ABPM? *Pulm Pharmacol Ther* 24: 559-562. doi: 10.1016/j.pupt.2011.04.030.
- Ogawa H, Fujimura M, Takeuchi Y, Makimura K, Satoh K (2012) The definitive diagnostic process and successful treatment for ABPM caused by *Schizophyllum commune*: a report of two cases. *Allergol Int* 61: 163-169. doi: 10.2332/allergolint.11-CR-0325.
- Seki M, Ohno H, Gotoh K, Motooka D, Nakamura S, Iida T, Miyazaki Y, Tomono K (2014) Allergic bronchopulmonary mycosis due to co-infection with *Aspergillus fumigatus* and *Schizophyllum commune*. *ID Cases* 1: 5-8. doi: 10.1016/j.idcr.2014.01.001.
- Kobayashi H, Taira T, Wakuda K, Takahashi T, Endo M (2016) A favorable clinical effect of an expectorant in allergic bronchopulmonary mycosis caused by *Schizophyllum commune*. *Respir Med Case Rep* 19: 54-57. doi: 10.1016/j.rmcr.2016.07.006.
- Ishiguro T, Kagiya N, Kojima A, Yamada M, Nakamoto Y, Takaku Y (2018) Allergic bronchopulmonary mycosis due to *Schizophyllum commune* treated effectively with voriconazole. *Intern Med* 57: 2553-2557. doi: 10.2169/internalmedicine.0668-17.
- Ito A, Ishiguro T, Takaku Y, Kagiya N, Kamei K, Takayanagi N (2019) Allergic bronchopulmonary mycosis caused by *Schizophyllum commune*: a special interest in positive culture of other basidiomycetes fungi. *Intern Med* 58: 3569-3572. doi: 10.2169/internalmedicine.2694-19.
- Shen Q, Yao YK, Yang Q, Zhou JY (2016) *Schizophyllum commune*-induced pulmonary mycosis. *Chin Med J (Engl)* 129: 2141-2142. doi: 10.4103/0366-6999.189062.
- Visvanathan K, Skinner NA, Thompson AJ, Riordan SM, Sozzi V, Edwards R (2007) Regulation of Toll-like receptor-2 expression in chronic hepatitis B by the precore protein. *Hepatology* 45: 102-110. doi: 10.1002/hep.21482.
- Hamilos DL, Lund VJ (2004) Etiology of chronic rhinosinusitis: the role of fungus. *Ann Otol Rhinol Laryngol Suppl* 193: 27-31. doi: 10.1177/00034894041130S508.
- Buzina W, Lang-Loidolt D, Braun H, Freudenschuss K, Stammberger H (2001) Development of molecular methods for identification of *Schizophyllum commune* from clinical samples. *J Clin Microbiol* 39: 2391-2396. doi: 10.1128/JCM.39.7.2391-2396.2001.
- Rosenberg M, Patterson R, Mintzer R, Cooper BJ, Roberts M, Harris KE (1977) Clinical and immunologic criteria for the diagnosis of allergic bronchopulmonary aspergillosis. *Ann Intern Med* 86: 405-414. doi: 10.7326/0003-4819-86-4-405.
- Asano K, Hebisawa A, Ishiguro T, Takayanagi N, Nakamura Y, Suzuki J (2021) New clinical diagnostic criteria for allergic bronchopulmonary aspergillosis/ mycosis and its validation. *J Allergy Clin. Immunol* 147: 1261-1268. doi: 10.1016/j.jaci.2020.08.029.
- Walsh TJ, Anaissie EJ, Denning DW, Herbrecht R, Kontoyiannis DP, Marr KA (2008) Treatment of aspergillosis: clinical practice guidelines of the Infectious Diseases Society of America. *Clin Infect Dis* 46: 327-360. doi: 10.1086/525258.
- Chowdhary A, Kathuria S, Singh PK, Agarwal K, Gaur SN, Roy P (2013) Molecular characterization and in vitro antifungal susceptibility profile of *Schizophyllum commune*, an emerging basidiomycete in bronchopulmonary mycoses.

- Antimicrob Agents Chemother 57: 2845-2848. doi: 10.1128/AAC.02619-12.
22. Zhu A, An KR, Chen Y, Rowsell C, Goode L, Ko M (2021) A case of primary pulmonary *Schizophyllum commune* empyema treated with video-assisted thoracoscopic decortication. *Gen Thorac Cardiovasc Surg* 69: 584-587. doi: 10.1007/s11748-020-01522-z.

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