Case report

Lung abscess caused by *Streptococcus pneumoniae* serotype 6B

Yuhei Ito[a],[*], Hirokazu Toyoshima[b], Takehiro Suzuki[c], Keisuke Iwamoto[a], Hajime Sasano[a], Hidetoshi Itani[a], Shigeto Kondo[a], Motoaki Tanigawa[a]

[a] Department of Respiratory Medicine, Ise Red Cross Hospital, Ise, Japan
[b] Infectious Diseases Department of Internal Medicine, Ise Red Cross Hospital, Ise, Japan
[c] Medical Intern, Ise Red Cross Hospital, Ise, Japan

ABSTRACT

Lung abscess has been considered to be a rare complication of pneumococcal infection, and most cases are reported to be *Streptococcus pneumoniae* serotype 3. A 67-year-old man presented with fever and was diagnosed to have lung abscess caused by *S. pneumoniae* serotype 6B. The minimal inhibitory concentration (MIC) of penicillin for the isolate was 1 μg/mL. He was treated with high-dose intravenous sulbactam/ampicillin as definitive therapy based on susceptibility testing for *S. pneumoniae* and recovered successfully without surgical intervention. *S. pneumoniae* serotype 6B can cause lung abscess.

1. Introduction

In the pre-antibiotic era, approximately one third of patients who developed a lung abscess died [1]. Use of antimicrobial agents has improved the prognosis, but mortality estimates in reports published for the period of 1969–2010 have ranged from 1.0% to 38.2%, and lung abscess remains an important respiratory disease [2–12]. *Streptococcus pneumoniae* is the most frequent bacterial cause of community-acquired pneumonia. However, lung abscess has generally been considered to be a rare complication of pneumococcal infection [13]. Further, most of the cases of lung abscess caused by *S. pneumoniae* are reported to be serotype 3 [14,15]. Lung abscess caused by *S. pneumoniae* serotype 6B is rare [14,15]. Here we report the case of a lung abscess caused by *S. pneumoniae* serotype 6B in a 67-year-old-man.

2. Case

A 67-year-old man presented to our hospital with a 9-day history of fever. He denied cough, dyspnea, or any respiratory disease except for a past medical history of pneumonia 40 years earlier. He was not taking any medications. He had a smoking history of 20 cigarettes per day for 45 years. At presentation, his vital status was as follows: height 163 cm; weight 50 kg; body mass index 18.8; blood pressure 119/62 mmHg; body temperature 38.4 °C; heart rate 110 beats per min; respiratory rate 18 breaths per min; and percutaneous oxygen saturation 93% on room air. Auscultation of the lungs revealed coarse crackles in the right lower lung field. Laboratory findings were as follows: total protein 7.3 g/dL;

albumin 3.1 g/dL; alanine aminotransferase 18 IU/L; aspartate aminotransferase 17 IU/L; lactate dehydrogenase 125 IU/L; blood urea nitrogen 14 mg/dL; creatinine 0.48 mg/dL; C-reactive protein 11.84 mg/dL; white blood cell count 14,300/μL with 71.3% neutrophils and 19.1% lymphocytes; red blood cell count 4.66×10^6/μL; hemoglobin 13.9 g/dL; hematocrit 40.7%; and platelet count 35.6×10^4/μL. A chest radiograph revealed a mass in the right lower lung field. Chest computed tomography revealed a gas-containing abscess in the right lower lobe (Fig. 1). A sputum Gram stain showed numerous polymorphonuclear leukocytes and predominant Gram-positive cocci in pairs (Geckler's group 5). He was diagnosed as having a lung abscess and treated empirically with intravenous sulbactam/ampicillin 3 g every 6 hours. On day 6, *S. pneumoniae* serotype 6B was grown from sputum cultures. The minimal inhibitory concentration (MIC) of penicillin for the isolate was 1 μg/mL. Two sets of blood cultures were negative. Treatment with sulbactam/ampicillin 3 g every 6 hours was continued according to antimicrobial susceptibility testing. On day 19, chest computed tomography revealed marked improvement of the lung abscess. On day 23, antimicrobial therapy was switched to oral amoxicillin/clavulanate 500/250mg forth daily and continued for 14 days. The patient's lung abscess resolved without need for surgical intervention.

3. Discussion

S. pneumoniae serotype 6B can cause lung abscess, which tends to be severe and has a high mortality rate. However, we have encountered a

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* Corresponding author. Department of Respiratory Medicine, Ise Red Cross Hospital, 2-471 Funae, Ise, Mie 516-8512, Japan.
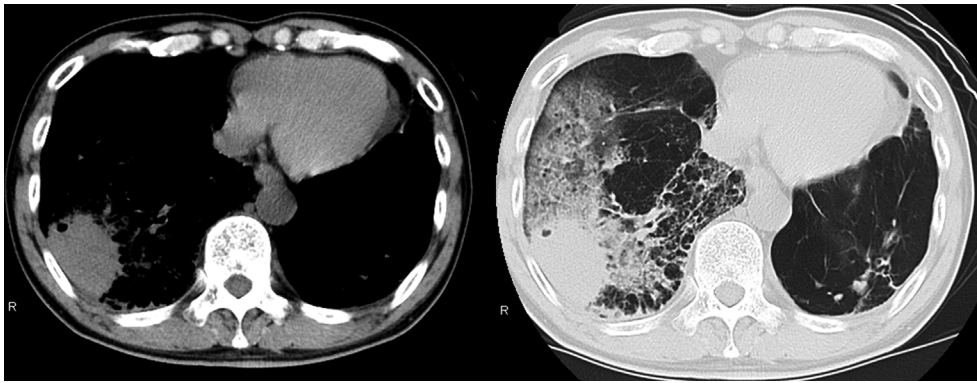 *E-mail address:* yi14402@ise.jrc.or.jp (Y. Ito).

Fig. 1. Chest computed tomographic image showed a gas-containing lung abscess in the right lower lobe.

patient whom we treated successfully using high-dose intravenous sulbactam/ampicillin as definitive therapy based on susceptibility testing for *S. pneumoniae* and who recovered without surgery.

Lung abscess caused by *S. pneumoniae* is rare. Bender et al. reported that 33 (27%) of 124 children with bacteremic pneumococcal pneumonia had necrotizing pneumonia [14] and, in a study by Pande et al., 23 (6.6%) of 351 adults with pneumococcal pneumonia had necrotizing pneumonia [15]. Previous studies describing the bacterial etiology of lung abscess for the 1993–2012 period reported an incidence of lung abscess caused by *S. pneumoniae* in the range of 0%–5% [8–12]. *S. pneumoniae* type 3 is the major pathogen of lung abscess caused by *S. pneumoniae* and accounts for about one third of cases. Bender et al. reported that 11 of 33 children with lung abscess caused by *S. pneumoniae* had serotype 3 [14] and Pande et al. reported that 5 of 16 adults with lung abscess caused by *S. pneumoniae* had this serotype [15]. In contrast, *S. pneumoniae* serotype 6B rarely causes lung abscess. In previous reports, only two children and one adult have been reported to have lung abscess caused by *S. pneumoniae* serotype 6B [14,15]. The pathogenesis of the lung abscess caused by *S. pneumoniae* serotype 6B in our immunocompetent 67-year-old man, who had no bronchial obstruction, may have involved the thick polysaccharide capsule of *S. pneumoniae*. The polysaccharide capsule is one of the important virulence factors associated with *S. pneumoniae*, and plays a central role in preventing phagocytosis by polymorphonuclear leukocytes and macrophages. Possible mechanisms include the absence of receptors on phagocytic cells that recognize capsular polysaccharide, the presence of electrochemical forces that repel phagocytic cells, masking of antibodies to cell wall constituents and C3b that may have fixed to the cell but beneath the capsule, and inactivation of complement [16]. Weinberg et al. reported that more heavily encapsulated serotypes of *S. pneumoniae* are more resistant to neutrophil-mediated killing and are associated with a higher prevalence of nasopharyngeal carriage [17]. Another study by Weinberg et al. reported higher mortality in patients with bacteremic pneumococcal pneumonia who had serotypes 3, 6A, 6B, 9N, or 19F, which tend to be heavily encapsulated [18].

Our patient was successfully treated by high-dose intravenous sulbactam/ampicillin as a definitive therapy based on *S. pneumoniae* susceptibility testing and recovered without the need for surgery. In previous reports for 1969–2010, the mortality rate of lung abscess has been reported to range from 1.0% to 38.2% [2–12]. Further, lung abscess sometimes requires surgical intervention. Takayanagi et al. reported that 8 (3.9%) of 205 patients with lung abscess required surgical intervention (three for drainage of lung empyema, four for pulmonary resection, and one for drainage of a brain abscess) [12]. Further, Wang et al. reported that 14 (15.6%) of 90 patients with lung abscess required surgery [11]. Bender et al. also reported that patients with necrotizing pneumococcal pneumonia are more severely ill and require significantly longer hospital stays than those with pneumococcal pneumonia without necrotic change [14]. In contrast, Pande et al. reported that necrotic change in patients with pneumococcal necrotizing pneumonia is not associated with higher mortality [15].

The emergence of drug-resistant *S. pneumoniae* has been reported recently, but the clinical relevance of this strain is uncertain [19]. One report suggested that the clinically relevant level of penicillin resistance for pneumonia is an MIC of 4 μg/mL [20]. The MIC of penicillin for *S. pneumoniae* serotype 6B in our patient was 1 μg/mL. The effectiveness of β-lactam antibiotics is correlated with the amount of time the local antibiotic concentration is above the MIC of the infecting organism [21,22]. Antibiotic concentrations in cerebrospinal fluid and middle ear fluid are lower than the concentration found at the same time in serum [23,24]. In contrast, drug concentrations in lung interstitial tissues are much more similar to those found in serum [23]. Based on pharmacokinetic and/or pharmacodynamic data from potential penicillin simulations, increasing the dose of β-lactam antibiotics may produce adequate outcomes for pneumococcal infection outside the central nervous system [25]. High-dose amoxicillin (3 g/day) is recommended as an alternative therapy in the American Thoracic Society/Infectious Diseases Society of America guideline for community-acquired pneumonia caused by *S. pneumoniae* with a penicillin MIC of 2–4 μg/mL [19]. Further, since many factors attenuate the effect of antibiotics in the treatment of lung abscess, it is reasonable to treat with high-dose parenteral antibiotics for a longer period. It has been reported that factors challenging the antibiotic treatment of suppurative lesions include difficulties in penetration of the fibrous capsule of the abscess, degeneration of the antibiotics by bacteria, and adverse physicochemical conditions, such as high protein binding, an anaerobic environment, and a low pH [26–30]. The duration of antibiotic therapy depends on the clinical and radiographic response of the patient, and antibiotics therapy should last at least until fever, purulent sputum, and the abscess fluid level have resolved, which usually takes 25–48 days [12,31]. The penicillin MIC for *S. pneumoniae* in this case was 1 μg/mL, so the patient was administered high-dose intravenous sulbactam/ampicillin 3 g every 6 hours for a sufficient length of time before switching to oral therapy to achieve drug concentrations that exceeded the MIC in the interstitial tissues of the lung for an adequate period. Resistance to penicillin has been shown to be uncommon for serotype 3 but is very common for several other serotypes (6B, 9V, 14, 19A, 19F, and 23F). Further, serotype 6B strains of *S. pneumoniae* were 2.7-fold more likely to be resistant to at least one of several drugs or drug classes (penicillin, macrolides, a combination of trimethoprim and sulfamethoxazole, and chloramphenicol) than were other strains [32].

In conclusion, *Streptococcus pneumoniae* serotype 6B can cause lung abscess. Even though lung abscess tends to be severe and has a high mortality rate, the patient described here was treated with high-dose intravenous sulbactam/ampicillin as a definitive therapy based on susceptibility testing for *S. pneumoniae*, and recovered successfully without any surgical intervention.

Declaration of interests

Acknowledgments

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