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CASE REPORT

Lung Abscess Caused by *Tannerella forsythia* Infection: A Case Report

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Background: *Tannerella forsythia* is a gram-negative anaerobic bacterium commonly found in the oral cavity. It is among the common pathogenic bacteria associated with gingivitis, chronic periodontitis, and aggressive periodontitis. However, there is currently no literature discussing lung abscesses primarily caused by *T. forsythia* infection.

Presentation: This article presents the case of a 55-year-old male with a massive lung abscess. The patient underwent ultrasound-guided percutaneous drainage, and the sample was sent for pathogen metagenomic next-generation sequencing (mNGS) testing. The test indicated that the lung abscess was primarily caused by *T. forsythia* infection. A literature review was conducted to understand the characteristics of this pathogen as well as its clinical features and suitable treatment approaches.

Conclusion: Currently, there is no literature specifically mentioning *T. forsythia* as a primary pathogen causing lung abscesses. This anaerobic bacterium is commonly found in the oral cavity and is difficult to cultivate using routine culture methods. mNGS emerges as a value diagnostic method for identifying this pathogen. Treatment recommendations include drainage and antibiotic selection encompassing common periodontal pathogens such as red complex bacteria and *Actinomyces*.

Keywords: *Tannerella forsythia*, lung abscess, metagenomic next-generation sequencing, drainage

Background

Tannerella forsythia is a gram-negative anaerobic bacterium commonly found in the oral cavity. Together with *Porphyromonas gingivalis* and *Treponema denticola*, they are referred to as the "red complex" residing in dental plaques. This bacterium is commonly bacteria associated with gingivitis, chronic periodontitis, and aggressive periodontitis.[1] Additionally, it is a frequent pathogen in peri-implantitis, an inflammatory condition around dental implants.[2] In individuals with periodontal infection and a risk of aspiration, anaerobic bacteria from the gingival crevice can enter the lower respiratory tract and cause lung abscess formation.[3] Cases of lung abscesses caused by common periodontal pathogens, such as *P. gingivalis*,[4] have been reported in the literature. However, there is currently no literature regarding lung abscesses primarily caused by *T. forsythia* infection. This article presents a case in which *T. forsythia* was identified as the main pathogen in a lung abscess following dental implantation. The characteristics of this pathogen, its clinical features, and its treatment are discussed in the following literature review.

Case Report

Medical History

A 55-year-old male with type 2 diabetes was hospitalized for an investigation of a persistent cough and purulent sputum for 1 month. His medications included repaglinide, metformin, and acarbose for glycemic control and amlodipine for a history of hypertension. He has been a heavy alcohol consumer for over 30 years, averaging half a liter of spirits, and is an ex-smoker with an over 140-pack-year history, although he has been smoke-free for the past 10 years.

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The cough and production of yellow purulent sputum started 12 days after a dental implantation. The patient denied chest tightness, shortness of breath, nasal congestion, rhinorrhea, and sore throat. There was no history of night sweats or hemoptysis. He did not experience abdominal distension or diarrhea. A chest CT scan performed at an external hospital revealed a large cystic lesion in the left lung (with a fluid level suggestive of abscess formation and local extension), thickening of the left lower pleura, and a small amount of fluid in the left pleural cavity. A diagnosis of a lung abscess was made, and the patient commenced a course of levofloxacin without symptom improvement. Subsequently, he sought medical attention at our hospital.

Physical Examination

The observations made on patient examination during presentation were unremarkable. The patient was alert and oriented. No jaundice was observed in the skin or mucous membranes. On dental examination, there were porcelain bridges on the upper right area involving the first premolar, second premolar, first molar, and second molar, with grade 1 mobility and tenderness. No redness, swelling, or purulent discharge was observed in the teeth, and there were no fistulas or sinuses. There was no palpable superficial lymph node enlargement. Decreased breath sounds were noted on the left side, while coarse breath sounds were heard on the right side. No significant dry or wet rales were auscultated. The cardiac borders were normal, and without enlargement. The abdomen was soft and flat, and the liver and spleen were not palpable below the rib cage. Neurological examination was unremarkable.

Investigations

Complete blood count: White blood cell count was 9.8×10^{-9}/L, neutrophils were 7.31×10^{-9}/L, and procalcitonin was 0.097 ng/mL. Pus analysis: White blood cell count was $242{,}368 \times 10^{-6}$/L. The white blood cells in the pus increased significantly, and were positive for the Lee–White test (++). The total protein in the pus was 59.2 g/L. Oxygen and anaerobic cultures of the pleural fluid for 5 days showed no bacterial growth. Chest CT scan (Figure 1): There was a large

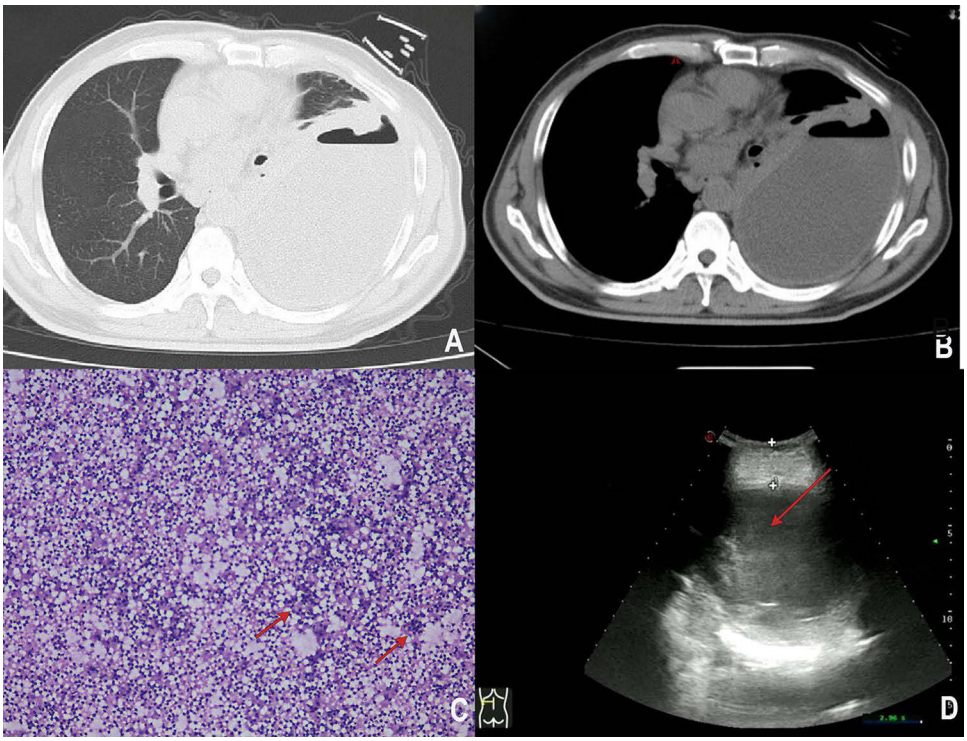

Figure 1 (**A** and **B**) Chest CT image before treatment. (**C**) Pathological examination showed numerous neutrophils (as shown by the red arrow), few mesothelial cells, and lymphocytes in the smears and sediment. (**D**) Chest ultrasound indicates massive effusion (as shown by the red arrow).

cystic lesion in the left lung (with fluid level suggestive of abscess formation, and localized lung involvement), thickening of the left diaphragmatic pleura, and minimal pleural effusion on the left side.

Treatment and Prognosis

Based on the chest CT findings, empiric antibiotic treatment was commenced (meropenem at 8 hourly). Ultrasound-guided percutaneous chest tube (8 French) placement was performed to drain the abscess fluid (Figure 1). Pus mNGS (Table 1) revealed predominant *T. forsythia* (sequence count: 52,577; relative abundance: 85.48%), *P. gingivalis* (sequence count: 3985; relative abundance: 6.48%), *Streptococcus milleri* (sequence count: 1258; relative abundance: 2.05%), *Schaalia cardiffensis* (sequence count: 631; relative abundance: 1.03%), and *Treponema socranskii* (sequence count: 437; relative abundance: 0.71%). Pathological examination showed numerous neutrophils, few mesothelial cells, and lymphocytes in the smears and sediment (Figure 1). In the context of recent dental implantation, a diagnosis of a primary odontogenic lung abscess predominantly caused by *T. forsythia* was made. The patient's cough and sputum improved after 1 week of continuous drainage and treatment with meropenem. A follow-up chest CT showed reduced fluid and the formation of empyema (Figure 2). The patient was provided with a 2-week course of moxifloxacin on discharge. During a telephone follow-up 2 weeks later, the patient reported no symptom recurrence. After 4 weeks, the patient's chest ultrasound revealed a small amount of pleural effusion (Figure 3). The patient's clinical symptoms did not worsen after 2 weeks of discontinuation of medication.

Discussion

The current literature suggests that *T. forsythia* is a common agent of periodontal abscess,[5] but available literature regarding abscesses caused by *T. forsythia* at other anatomical sites is limited. Animal experiments have demonstrated the ability of *T. forsythia* to induce skin abscesses.[6–8] There are no reported cases in the literature describing lung abscesses caused primarily by *T. forsythia*. In this article, we present a case of lung abscess that developed after dental implantation. Following aspiration and drainage, high-throughput gene testing of the purulent fluid revealed *T. forsythia* as the predominant pathogen, along with coinfection by *P. gingivalis, S. milleri, S. cardiffensis*, and *T. socranskii*. The microbial profile of this infection is similar to the common pathogens associated with peri-implantitis,[2] suggesting the lung abscess in this case was caused by an infection originating from the teeth.

T. forsythia has been challenging to detect using conventional culture techniques and is often overlooked.[9] Research has shown that the culture detection rate of *T. forsythia* is low compared to PCR detection, suggesting that PCR techniques can be useful for epidemiological studies and clinical diagnosis of periodontal diseases.[10] The low culture detection rate may be because the pathogen requires certain bacteria to provide nutrition or N-acetylmuramic acid to support its growth.[11,12] In this case, pathogenic bacteria were not cultured from the purulent fluid, highlighting the importance of conducting high-throughput gene testing to determine the presence of dental-origin infection in patients with concomitant periodontal disease and lung abscess. This information can guide antibiotic selection.

Currently, mNGS is a very effective broad-spectrum pathogen screening method for cases where pathogen identification proves challenging. Several case reports have demonstrated that mNGS can assist in the clinical diagnosis of various

Table 1 The Result of mNGS

Name of Pathogen	Reads Accum	Relative Abundance (%)	Genus Name
Tannerella forsythia	52,577	85.48	*Tannerella*
Porphyromonas gingivalis	3985	6.48	*Porphyromonas*
Streptococcus milleri	1258	2.05	*Streptococcus*
Schaalia cardiffensis	631	1.03	*Schaalia*
Treponema socranskii	437	0.71	*Treponema*

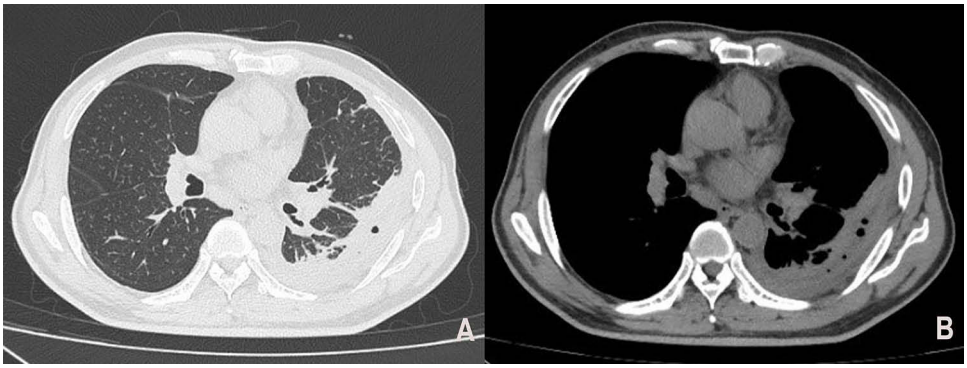

Figure 2 Follow-up chest CT after thoracic drainage and 1 week of meropenem anti-infective treatment. (**A**) Lung windows (**B**) Mediastinal windows.

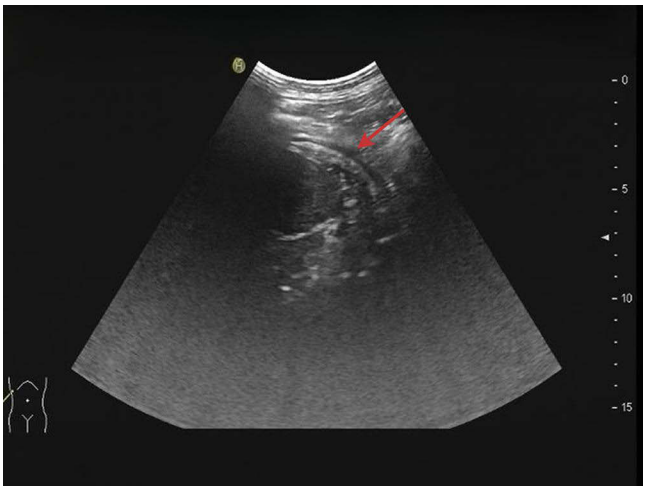

Figure 3 Follow-up chest ultrasound indicated a small pleural effusion (as shown by the red arrow) after 4 weeks.

infections, including leptospirosis,[13] *Scedosporium apiospermum*,[14] and Chlamydia psittaci;[15] additionally, it contributes to clinical treatment by facilitating modifications to treatment protocols. In a large sample study on the diagnostic performance of mNGS in infectious diseases, it was concluded that mNGS outperformed traditional culture methods, especially in cases involving *Mycobacterium tuberculosis*, anaerobic bacteria, and fungi, and was less affected by prior antibacterial drug exposure;[16] however, it also has some limitations. Given its unbiased and ultra-sensitive characteristics, an mNGS assay could produce a large number of sequences that match multiple microorganisms, which can be confusing. Moreover, it can produce false negative and false positive results and is expensive.[17] In this case, we used antibiotics that covered the pathogens identified using mNGS, and we achieved good results. For patients whose pus cannot be cultured to detect pathogens, we recommend using the mNGS test.

T. forsythia may have an increased infection rate in immunocompromised individuals. A systematic review of 965 patients with HIV-associated periodontitis showed a high *T. forsythia* infection rate, reaching 51%, which was significantly higher than the rate of other common periodontal pathogens such as *P. gingivalis* and *T. denticola*.[18] A study by Montevecchi et al showed that patients with diabetes and periodontal disease had a higher prevalence of *T. forsythia* than that of patients with periodontal disease without diabetes.[19] Another study focusing on the salivary microbiota in type 2 diabetes found *T. forsythia* was enriched in type 2 diabetes.[20] Therefore, it is suggested that *T. forsythia* may have a higher infection rate, increased virulence, and a greater tendency to act as a primary pathogen in immunocompromised individuals. However, further research is needed to confirm these observations.

The formation of abscesses in *T. forsythia* infections requires synergistic interactions with other oral pathogens. The growth of *T. forsythia* may be dependent on the nutritional support provided by other pathogens.[11,12] Animal experiments have shown that when *T. forsythia* is co-inoculated with *Fusobacterium nucleatum* or *P. gingivalis*, significant abscess formation occurs, whereas single inoculation of *F. nucleatum, P. gingivalis*, or *T. forsythia* strains do not lead to significant abscess formation.[7] Research by Yoneda et al has demonstrated a pathogenic synergistic effect between *T. forsythia* and *P. gingivalis* strains.[8] Studies have also found a frequent co-detection of *T. forsythia* and *P. gingivalis*, and when cultured together, it was observed that the virulence and invasiveness of *T. forsythia* were enhanced. This may be attributed to the tissue-degrading enzymes produced by *P. gingivalis*, which exposes the extracellular matrix surface, allowing *T. forsythia* to adhere through its BspA protein, thus promoting the occurrence and progression of the disease.[21]

T. forsythia infection has also been implicated in the development of other diseases. Research has shown that *T. forsythia* and *P. gingivalis* can cause damage and destruction to host cells and tissues by producing various enzymes and toxins, thereby promoting the development of esophageal cancer.[22] It has also been reported to be associated with the formation of atherosclerotic cardiovascular disease in relation to periodontal infections caused by *T. forsythia* and other oral pathogens.[23]

Currently, there is limited information on the antibiotic susceptibility of *T. forsythia*.[24] An in vitro study showed that *T. forsythia* is highly sensitive (100%) to moxifloxacin, while the resistance rates to amoxicillin, azithromycin, and metronidazole were 25.6%, 21.1%, and 25.6%, respectively. Furthermore, the study demonstrated that other periodontal pathogens, such as *P. gingivalis* and *Actinomyces*, exhibited complete sensitivity to moxifloxacin.[25] Some studies have reported resistance of *T. forsythia* to tetracycline and macrolide antibiotics.[22,26,27] Previous research has indicated that the common pathogens in periodontitis and peri-implantitis are red complex bacteria and *Actinomyces* species.[2,28] A study on antibiotic resistance in peri-implantitis revealed high resistance of periodontal pathogens, such as *P. gingivalis, Aggregatibacter actinomycetemcomitans, T. forsythia*, and *Prevotella intermedia*, to tetracycline, clindamycin, metronidazole, erythromycin, and azithromycin.[29] In the present case of lung abscess following dental implantation, the main pathogen identified was *T. forsythia*, along with mixed infection of *P. gingivalis, Actinomyces*, and other bacteria. The pathogen profile was similar to that commonly observed in periodontal diseases and peri-implantitis. Therefore, antibiotic selection should primarily target the common pathogens associated with periodontitis. In this case, the patient was treated with meropenem and moxifloxacin, with significant improvement in symptoms observed after drainage of the purulent fluid, and radiological improvement on follow-up chest CT scans. The duration of treatment for lung abscesses caused by anaerobic bacteria is not clear at present, but the reported duration of treatment varies from 21 to 48 days, depending on the patient's clinical symptoms and radiological response, with longer duration required for lung abscesses caused by *Actinomyces* and *Nocardia*.[30,31] After percutaneous transthoracic catheter drainage for lung abscess, the patient's symptoms improved significantly. We continued intravenous and oral anti-infective treatment for a total of 21 days. No new discomfort was reported during the follow-up. We think early puncture drainage is more important than a long course of anti-infection treatment for the mass lung abscess. This may shorten the duration of anti-infective treatment and protect the lungs from the constant attack of bacteria.

Most patients with lung abscesses can be treated with antibiotics. When antibiotic treatment proves ineffective, drainage or surgical treatment is required.[32] Siraj O. Wali[33] believed that percutaneous catheter drainage is a safe and effective method for treating lung abscesses, especially in cases where antibiotic treatment has failed. A meta-analysis[34] of 194 patients with lung abscesses revealed that 166 (86.5%) patients showed improvement after percutaneous catheter drainage and 17 (8.8%) patients developed catheter-related complications, including pneumothorax, empyema, bronchopleural fistula, and hemothorax. These complications were associated with the use of large-bore catheters sized > 14 French. The authors of the study believe that percutaneous catheter drainage is an effective method for the treatment of lung abscesses with a low complication rate. In this case, the patient's symptoms did not improve after anti-infective therapy, and a CT indicated a massive lung abscess. After consulting with a thoracic surgeon, we used ultrasound to guide tube drainage treatment with an 8-French caliber tube combined with systemic anti-infective treatment, and the patient's symptoms improved significantly. When there was no more pus drainage, we pulled out the thoracic drainage tube and conducted a follow-up chest CT 2 days later, which revealed the formation of empyema. This is inconsistent with the results of the meta-analysis by Lee Jong Hyuk et al.[34] The puncture drainage may form a fistula in the lung, and

while it may cause complications, timely removal of pus is crucial because it helps protect the unaffected lung tissue. As the patient did not report further discomfort, we changed to moxifloxacin anti-infection treatment and discharged the patient for follow-up.

There are some limitations in this medical record study. We did not obtain the chest CT that was reviewed after the long treatment because the patient was concerned about radiation. In addition, because mNGS testing for periodontitis pathogens was not performed during treatment, it was not possible to confirm the presence of the same pathogens around the implanted teeth as in the lung.

Conclusion

To the best of our knowledge, this case report is the first report of a lung abscess primarily caused by *T. forsythia* infection. The limited previous reports about *T. forsythia* may be attributed to the fastidious nature of this anaerobic bacterium and its demanding cultivation requirements. *T. forsythia* is more likely to become pathogenic in immunocompromised people, and PCR or mNGS is an effective method to prove its infection. There is a lack of information regarding the antibiotic susceptibility of *T. forsythia*. When it causes a huge lung abscess, we advise early percutaneous catheter drainage and anti-infective treatment, which covers common periodontal pathogens such as red complex bacteria and *Actinomyces*. Moxifloxacin may be a favorable option to treat these pathogens.[25]

Ethics Approval and Informed Consent

The study was performed in accordance with the principles stated in the declaration of Helsinki and approved by the Second Affiliated Hospital of Fujian Medical University Ethics Committee (number:【2023】 (325)).

Consent for Publication

The patient provided informed consent for publication of the case. We have obtained the consent of the institution (the Second Affiliated Hospital of Fujian Medical University) to publish the case details.

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Disclosure

The authors report no conflicts of interest in this work.

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