Original Article

Clinical characteristics of apical segment lung abscess: a 10-year retrospective study

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Background: Lung abscess in the apical segment of the lung is not rare and is often underestimated in clinical practice. However, the clinical features of apical segment lung abscess (AL) have scarcely been reported. Hence, this study aimed to determine the clinical characteristics of AL and explore moderate therapeutic strategies.

Methods: This was a retrospective, single-center cohort study. We reviewed the medical records of consecutive patients who were admitted to Shanghai Pulmonary Hospital in Shanghai, China, from January 2009 to December 2018. This study collected information on patients with lung abscess, including demographics, symptoms, clinical findings, and treatment. The statistical methods used were descriptive statistics, Chi-squared test, Fisher's exact test, *t*-tests, and logistic regression analysis.

Results: Of 824 patients, 431 with lung abscess were finally eligible after a review of medical records. The patients were divided into two groups: the AL group (n=68) and the non-apical segment lung abscess (NAL) group (n=363). Compared with patients in the NAL group, those in the AL group had lower rates of chronic obstructive pulmonary disease (COPD) (5.9% *vs.* 17.4%, P=0.02), diabetes (14.7% *vs.* 32.2%, P=0.004) and hypoprealbuminemia (10.3% *vs.* 25.3%, P=0.007). Regarding clinical symptoms, patients in the AL group exhibited lower fever (38.2% *vs.* 58.4%, P=0.002) and less purulent sputum (32.4% *vs.* 45.5%, P=0.045). Moreover, regarding radiological features, the AL group had a lower proportion of air-fluid level on chest computed tomography (CT) (7.4% *vs.* 16.8%, P=0.047). In addition, the study demonstrated that the AL group had a shorter duration of intravenous antibiotic treatment [8 (7–8) *vs.* 10 (8–12) days, P<0.001]. Surprisingly, the AL group had a high rate of surgical treatment (36.8% *vs.* 15.4%, P<0.001). In multivariate analysis, surgical treatment occurred more frequently in patients with AL [odds ratio (OR): 2.58, 95% confidence interval (CI): 1.40–4.77, P=0.002], lower in patients who had fever (OR: 0.55, 95% CI: 0.31–0.98, P=0.04), and imaging features of liquefaction necrosis (OR: 0.32, 95% CI: 0.15–0.69, P=0.004).

Conclusions: Patients with AL presented with atypical and relatively mild clinical symptoms. However, the rate of surgical treatment was significantly higher. These data should be considered when managing the AL.

Keywords: Lung abscess; diagnosis; treatment

Submitted Apr 18, 2024. Accepted for publication Jul 26, 2024. Published online Sep 21, 2024.
doi: 10.21037/jtd-24-624
View this article at: https://dx.doi.org/10.21037/jtd-24-624

Introduction

A lung abscess is a circumscribed collection of pus in the lung parenchyma due to microbial infection, which may lead to cavity lesions and an air-fluid level within the cavity (1,2). Typical clinical symptoms of lung abscess include fever, cough, purulent sputum, dyspnea, and chest pain. Severe lung abscess can spread infection throughout the body, leading to conditions such as sepsis, disseminated intravascular coagulation (DIC), and other serious complications. Formerly, the mortality rate of lung abscess was as high as 75%. The mortality of patients with lung abscess has been reduced due to effective antimicrobial therapy, drainage, and surgery (2-4). However, due to the increased prevalence of diabetes, respiratory diseases, cardiovascular diseases, and drug resistance to antibiotics, lung abscess is more common. Its impact on patients' quality of life and socioeconomic burden cannot be ignored (5,6).

In clinical practice, lung abscess management is primarily based on reviews and expert opinions (7,8). However, the standard treatment for lung abscess remains unclear (8,9). Surgical intervention is necessary in patients with lung abscess who do not respond to conservative treatment (3). Consequently, it is crucial to accurately diagnose and identify the non-surgical features of lung abscess at an early stage. This may help avoid invasive surgical treatment, reduce the socioeconomic burden, and preserve the lung function of patients with lung abscess.

The clinical diagnosis of lung abscess is based on imaging features, symptoms, laboratory findings, and microbiological cultures (2,4). Previous studies have reported that lung abscess pathogens are predominantly anaerobic (10,11). However, recent studies have revealed changes in the bacterial spectrum of lung abscess (9,12,13). In Denmark, a study demonstrated that the risk factors for lung abscess include chronic obstructive pulmonary disease (COPD), alcohol abuse, and poor dental condition (8). Meanwhile, Chiang *et al.* reported the advantages of early drainage, which decreased the length of hospital stay of patients with lung abscess (3). In addition, anemia and clinical symptoms are associated with medical expenditures in patients with lung abscess (5,14). Generally, lung abscess is more likely to be found in right lower lobe and posterior segment of upper lobe of both lungs (15). Lung abscess with location at apical segment of the lung, is not rare in clinical practice. However, few studies have revealed the clinical characteristics of apical segment lung abscess (AL).

Hence, this study aimed to explore the clinical features of AL and identify appropriate therapeutic strategies. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-624/rc).

Highlight box

Key findings

- Patients with apical segment lung abscess (AL) presented with mild clinical symptoms. However, the rate of surgical treatment was significantly higher.

What is known and what is new?

- Typical clinical symptoms of lung abscess include fever, cough, and purulent sputum. The treatment of lung abscess is still predominantly based on antibiotics, drainage, and surgery. However, the standard treatment for lung abscess remains unclear. Few studies have revealed the clinical characteristics of AL.
- The AL had atypical clinical features. It is recommended that clinicians should take AL seriously, and exercise caution regarding surgical management.

What is the implication, and what should change now?

- Regarding AL, it is essential to perform appropriate invasive investigations to make a correct differential diagnosis, when the course of anti-infection therapy is inadequate and the lesion has poor absorption. This may reduce the rate of surgery. In the meantime, multicenter study with a larger sample size and long-term follow-up is required.

Methods

Study design and patient enrollment

All patients who were hospitalized at the Shanghai Pulmonary Hospital, School of Medicine, Tongji University between January 2009 and December 2018 were retrospectively included in the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This retrospective, single-center, observational study was approved by the Research Ethics Committee of Shanghai Pulmonary Hospital, School of Medicine, Tongji University (No. K16-274). Informed consent was obtained from all individual participants. We conducted a retrospective review of the medical records of all patients diagnosed with lung abscess. Based on clinical features, radiological manifestations before and after anti-infection treatment, and pathology after surgical treatment, patients with lung abscess were included in this study, but hematogenous lung abscess was excluded. Patients were excluded if they were misdiagnosed, younger than 18 years old, older than 80 years old, had incomplete data, or were

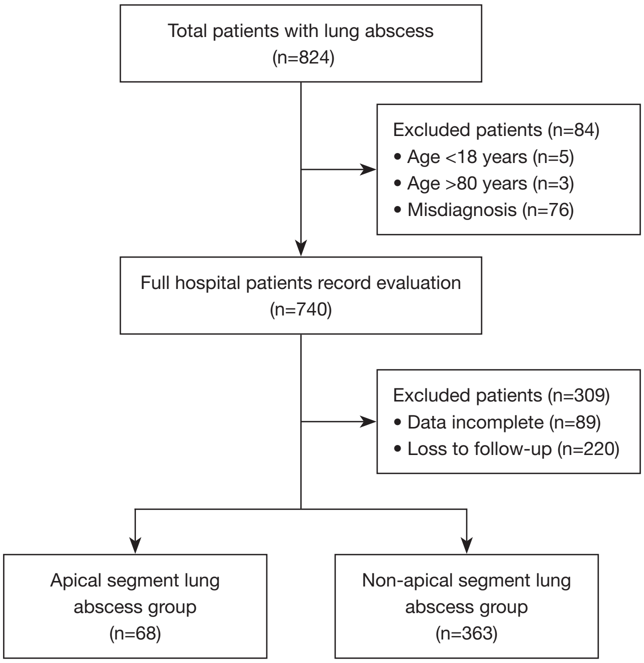


Figure 1 Flow chart of the study subjects.

lost to follow-up. The flowchart of the study is illustrated in *Figure 1*.

Data collection and definition

The general data collected included age, sex, symptoms, underlying conditions, chest computed tomography (CT) imaging features, laboratory findings, duration of intravenous antibiotic treatment, and treatment strategies after follow-up (anti-infection or surgery). Microbiological culture specimens in this study were obtained from lower respiratory tract, including only sputum, bronchoalveolar lavage fluid (BALF), or lung puncture.

The data in this study were recorded retrospectively from medical records into a standardized electronic file (Excel, Microsoft, Redmond, WA, USA). Bronchiectasis was defined as an abnormal and persistent dilatation of the bronchial, which is accompanied by clinical symptoms, such as cough, sputum and hemoptysis (16). The diagnosis of bronchiectasis was usually based on high-resolution computed tomography (HRCT) or clinical history. Diagnostic criteria for COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines (17). The definition of diabetes was based on self-reported diabetes history and/or self-reported utilization of anti-diabetic drugs. Pulmonary bullae are air cavities that develop when multiple alveoli fuse in response to increased pressure within the chest cavity (18). Chest CT imaging features of pulmonary alveoli present as a well-margined area of emphysema, 1 cm or more in diameter, with very thin walls (<1 mm) (18). Laboratory parameters included white blood cells (WBC), neutrophils (N), albumin, hemoglobin (Hb), and oxygen saturation (SpO_2). The study participants were divided into two groups based on the location of lung abscess on chest CT: the AL group and the non-apical segment lung abscess (NAL) group. During retrospective follow-up, effective medical anti-infection treatment for lung abscess was defined as the disappearance of clinical symptoms, shrinkage of the lesion on chest CT, and normalization of clinical indicators. Patients with lung abscess who underwent surgery were eventually confirmed by post-operative pathology.

Statistical analysis

Descriptive parameters were used to explore patient characteristics. The Kolmogorov-Smirnov test was employed to test the normality of the data. Continuous variables with normal distribution were presented as mean ± standard deviation (SD), and descriptive data for non-normal distribution were expressed as interquartile ranges (IQR). Categorical variables were presented as frequencies and percentages. The χ^2 test or Fisher's exact test was utilized to evaluate differences in categorical variables. The *t*-test was applied to analyze continuous variables, which were presented as the mean with SD. Univariate and multivariate analyses were performed using a logistic regression model to identify the factors associated with treatment. Odds ratio (OR) and 95% confidence interval (CI) were calculated. Statistical analysis was performed using SPSS 20.0 (SPSS Inc., Chicago, IL, USA). All tests were two-sided, and statistical significance was set at P<0.05 in all analyses.

Results

Baseline characteristics and clinical symptoms

As revealed in *Figure 1*, 824 patients were diagnosed with lung abscess at discharge during the study period. A total of 76 patients were excluded due to misdiagnosis, 5 patients younger than 18 years old, and 3 older than 80 years old were excluded from the study. Initially, 740 patients were

Table 1 Baseline characteristics and clinical symptoms of patients with lung abscess

Variables	Total (n=431)	AL (n=68)	NAL (n=363)	P value
Age, years	54.8±11.5	52.8±11.4	55.2±11.4	0.12
Gender, male	371 (86.1)	59 (86.8)	312 (86.0)	0.86
Risk factors				
History of smoking	276 (64.0)	41 (60.3)	235 (64.7)	0.48
Alcoholism	54 (12.5)	9 (13.2)	45 (12.4)	0.85
Dental decay	53 (12.3)	5 (7.4)	48 (13.2)	0.18
Underlying conditions				
Asthma	9 (2.1)	1 (1.5)	8 (2.2)	>0.99
Bronchiectasis	34 (7.9)	3 (4.4)	31 (8.5)	0.25
COPD	67 (15.5)	4 (5.9)	63 (17.4)	0.02
Diabetes	127 (29.5)	10 (14.7)	117 (32.2)	0.004
Hypertension	93 (21.6)	13 (19.1)	80 (22.0)	0.59
Hypoproteinemia	135 (31.3)	16 (23.5)	119 (32.8)	0.13
Hypoprealbuminemia	99 (23.0)	7 (10.3)	92 (25.3)	0.007
Anemia	145 (33.6)	20 (29.4)	125 (34.4)	0.42
Symptoms				
Productive cough	335 (77.7)	54 (79.4)	281 (77.4)	0.72
Fever	238 (55.2)	26 (38.2)	212 (58.4)	0.002
Bloody sputum	83 (19.3)	9 (13.2)	74 (20.4)	0.17
Chest pain	72 (16.7)	13 (19.1)	59 (16.3)	0.56
Dyspnoea	21 (4.9)	2 (2.9)	19 (5.2)	0.62
Purulent sputum	187 (43.4)	22 (32.4)	165 (45.5)	0.045
Fatigue	12 (2.8)	1 (1.5)	11 (3.0)	0.75
Night sweats	11 (2.6)	0 (0.0)	11 (3.0)	0.30
Microbiological culture	366 (84.9)	53 (77.9)	313 (86.2)	0.08
Positive culture	123 (28.5)	15 (22.1)	108 (29.8)	0.20
Time from onset to hospital, days	7 [5–9]	7 [5–7]	7 [5–9]	0.60

Data are expressed as mean ± standard deviation, n (%), or median [interquartile range]. AL, apical segment lung abscess; NAL, non-apical segment lung abscess; COPD, chronic obstructive pulmonary disease.

evaluated. Then, 89 patients were excluded because of incomplete medical data, and 220 patients were excluded due to loss of follow-up. Ultimately, 431 patients were included in this retrospective study.

The baseline characteristics and clinical symptoms of the patients with lung abscess are displayed in *Table 1*. In our study, the AL group patients were predominantly men 59 (86.8%), with a mean age of 52.8±11.4 years old, similar to NAL group patients. For risk factors associated with lung abscess in the AL group patients, smoking was observed in 41 (60.3%) patients, and 9 (13.2%) patients had a history of alcoholism. Additionally, dental decay was observed in 5 (7.4%) patients. There was no statistical difference between the AL and NAL group patients. Besides, the AL group patients presented with multiple underlying conditions. The underlying conditions more frequently

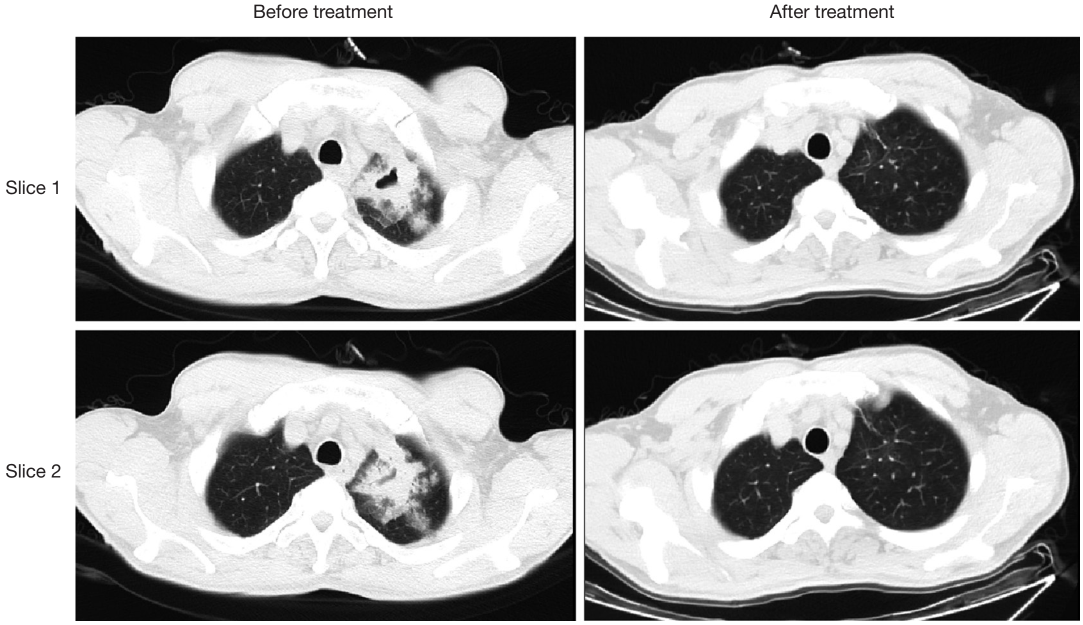


Figure 2 The chest CT pictures of lung abscess with location at apical segment of the left lung before and three months after antibiotic treatment at two different scan slices. CT, computed tomography.

were anemia in 20 (29.4%) patients, hypoproteinemia in 16 (23.5%), hypertension in 13 (19.1%).

Compared to the NAL group, there was a significantly lower percentage of patients with diabetes in the AL group (14.7% *vs.* 32.2%, P=0.004). Similarly, there were fewer patients with COPD in the AL group (5.9% *vs.*17.4%, P=0.02). In addition, the AL group had less hypoprealbuminemia (10.3% *vs.* 25.3%, P=0.007). The two groups had no statistically significant differences in the other underlying conditions. In the AL group patients, the three most common symptoms in our study were productive cough 54 (79.4%), followed by fever 26 (38.2%), and purulent sputum 22 (32.4%). The occurrence of other symptoms was less frequent. Our study demonstrated that the AL group had lower fever than the NAL group (38.2% *vs.* 58.4%, P=0.002). Besides, patients with lung abscess in the NAL group had more purulent sputum (45.5% *vs.* 32.4%, P=0.045).

Radiological presentations and laboratory findings

The lung abscess appears as a very low-density area, often surrounded by a high-density peripheral ring of enhancement. All 431 patients underwent a chest CT scan, which was read by respiratory physicians to determine the location of lung abscess. The typical radiological imaging of AL as shown in *Figure 2*. Regarding the distribution of lung abscess, right upper lobe 164 (38.1%) is the most common site, especially posterior segment of the right upper lobe 104 (24.1%), followed by right lower lobe 119 (27.6%), and left lower lobe 61 (14.2%). While bilateral lung multiple abscess was just 3 (0.7%) (*Table 2*). In this study, the median lung abscess was 4.3 (3.2–5.5) cm. The four most frequently imaging features of lung abscess were cavity 220 (51.0%), liquefaction necrosis 191 (44.3%), mediastinal lymph node enlargement (MLNE) 163 (37.8%), and air-fluid level 66 (15.3%) (*Table 3*).

Regarding AL, apical segment of the right upper lobe 55 (12.8%) is the most common site, followed by apical segment of the left lung upper lobe 13 (3.0%). In our study, the numbers of cases and percentage of lung abscess in different lung segments were determined (*Figure 3*). Moreover, this study provided further analysis of the radiological features of AL (*Table 3*). Regarding radiological characteristics, the median lung abscess was 4.1 (3.6–5.5) cm in the AL group. The study data clearly demonstrated that the three more frequently imaging features of AL included cavity 37 (54.4%), liquefaction necrosis 25 (36.8%), MLNE 22 (32.4%). However, the above characteristics had no significant differences between the two groups. In addition,

Table 2 The numbers of cases and percentage of lung abscess in different lobes and segments of both lungs (n=431)

Lung abscess location	Case (n)	Proportion
Right upper lobe	164	38.1%
Right middle lobe	35	8.1%
Right lower lobe	119	27.6%
Left upper lobe	55	12.8%
Left lower lobe	61	14.2%
Bilateral lung multiple	3	0.7%
Right lung upper lobe		
Anterior segment	8	1.9%
Apical segment	55	12.8%
Posterior segment	104	24.1%
Right lung middle lobe	36	8.4%
Right lung lower lobe		
Medial-anterior basal segment	22	5.1%
Latero basal segment	33	7.7%
Posterior basal segment	17	3.9%
Superior segment	66	15.3%
Left lung upper lobe		
Apical segment	13	3.0%
Posterior segment	20	4.6%
Anterior segment	12	2.8%
Lingular segment	11	2.6%
Left lung lower lobe		
Superior segment	36	8.4%
Medial-anterior basal segment	18	4.2%
Lateral basal segment	22	5.1%
Posterior basal segment	2	0.5%

If multiple locations, all are recorded leading to a total proportion of more than 100%.

the incidence of air-fluid level appearance in the AL group was lower than the NAL group (7.4% *vs.* 16.8%, P=0.047). The two groups had no differences in laboratory test results.

Microbiological results

Etiologic microorganisms were cultured from 366 (84.9%) patients, and 123 cases were positive. The four most frequently identified bacteria were *Klebsiella pneumoniae* (*K. pneumoniae*) (11.2%), *Pseudomonas* spp. (4.6%), *Streptococcus constellatus* (*S. constellatus*) (4.1%), and *Staphylococcus* spp. (3.6%). The microbial species and percentage of microorganisms are displayed in *Figure 4*. Pathogenic microorganisms were documented in the AL group and NAL group, including *K. pneumoniae* (9.4% *vs.* 11.5%), *Pseudomonas* spp. (3.8% *vs.* 4.8%), *S. constellatus* (3.8% *vs.* 4.2%). *Haemophilus influenzae* (*H. influenzae*) and *Serratia marcescens* (*S. marcescens*) were more commonly found in AL group. There was no statistically significant difference in the composition of the microbial populations between the two groups.

Treatment and outcome

In total, 431 patients were administered antibiotics. Of these patients, 346 (80.3%) were treated with a combination of antibiotics. Eighty-five (19.7%) patients with lung abscess were treated with a single antibiotic (*Table 4*). According to our research, the highest percentage of antibiotic use was for β-lactams (81.0%) in patients with lung abscess, followed by quinolones (42.0%), and lincosamides (31.3%). The types and proportions of antibiotics used in two groups are depicted in *Figure 5*. Moreover, the retrospective follow-up outcome data depicted that 81 (18.8%) patients finally underwent surgery, which was eventually confirmed as lung abscess by surgical pathology. In the AL group, 25 patients received surgical treatment. Whereas in the case of NAL group, 56 patients underwent surgical treatment.

More importantly, the proportion of surgical management in the AL group was significantly higher than the NAL group, with a statistically significant difference (36.8% *vs.* 15.4%, P<0.001). However, the duration of intravenous antibiotic treatment was significantly shorter in the AL group than the NAL group [8 (7–8) *vs.* 10 (8–12) days, P<0.001]. In multivariate analysis, surgical treatment occurred more frequently in patients with AL (OR: 2.58, 95% CI: 1.40–4.77, P=0.002), lower in patients who had fever (OR: 0.55, 95% CI: 0.31–0.98, P=0.04) and imaging features of liquefaction necrosis (OR: 0.32, 95% CI: 0.15–0.69, P=0.004) (*Table 5*).

Discussion

We aimed to investigate the clinical features of AL. In this study, we observed that patients with AL presented

Table 3 Image findings and laboratory tests of patients

Variables	Total (n=431)	AL (n=68)	NAL (n=363)	P value
Image findings				
Size of abscess, cm				0.24
≤3	94 (21.8)	10 (14.7)	84 (23.1)	
>3, ≤5	202 (46.9)	37 (54.4)	165 (45.5)	
>5	135 (31.3)	21 (30.9)	114 (31.4)	
Size, cm	4.3 [3.2–5.5]	4.1 [3.6–5.5]	4.3 [3.2–5.4]	>0.99
Pulmonary bullae	50 (11.6)	7 (10.3)	43 (11.8)	0.71
Liquefaction necrosis	191 (44.3)	25 (36.8)	166 (45.7)	0.17
MLNE	163 (37.8)	22 (32.4)	141 (38.8)	0.31
Cavity	220 (51.0)	37 (54.4)	183 (50.4)	0.55
Air-fluid level	66 (15.3)	5 (7.4)	61 (16.8)	0.047
Pleural effusion	115 (26.7)	12 (17.6)	103 (28.4)	0.07
Laboratory findings				
SpO_2, %	95.8±4.9	96.4±1.8	95.7±5.3	0.27
ALB, g/L	37.0±6.4	37.5±5.0	36.9±6.6	0.42
Hb, g/L	125.5±16.1	127.6±14.2	125.1±16.4	0.23
WBC, $\times 10^9$/L	8.8 [6.6–12.4]	9.0 [6.6–13.0]	8.8 [6.6–12.3]	0.82
N, %	74.0 [65.2–79.0]	70.4 [62.2–78.0]	74.6 [65.5–79.3]	0.10

Data are expressed as mean ± standard deviation, n (%), or median [interquartile range]. AL, apical segment lung abscess; NAL, non-apical segment lung abscess; MLNE, mediastinal lymph node enlargement; SpO_2, oxygen saturation; ALB, albumin; Hb, hemoglobin; WBC, white blood cell; N, neutrophils.

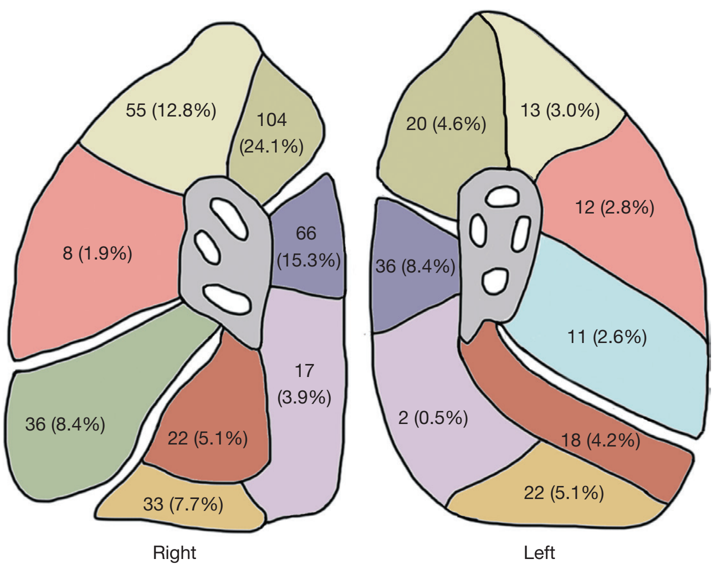
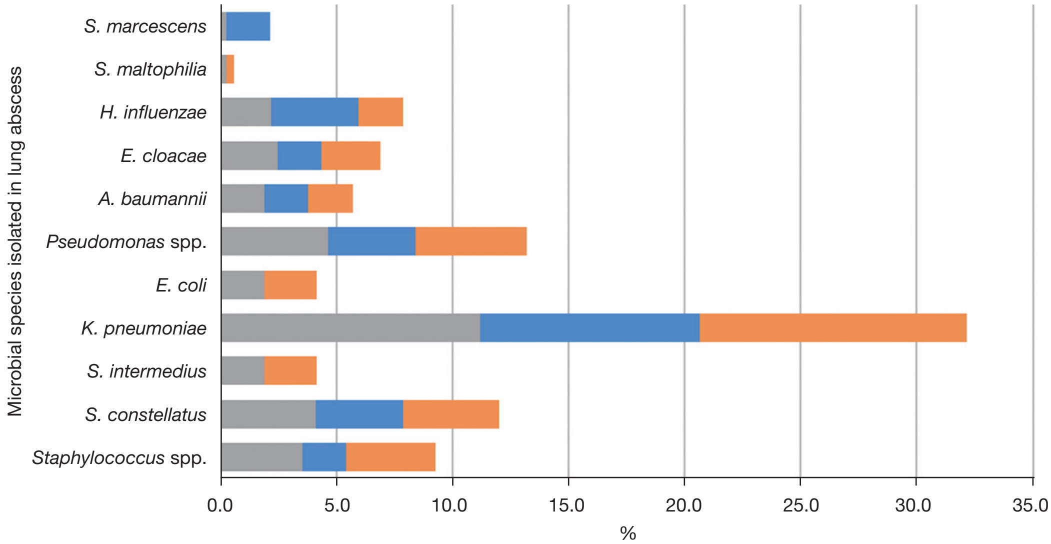


Figure 3 Distribution of lung abscess. The numbers of cases and percentage of lung abscess in different lung segments. If multiple locations, all are recorded leading to a total proportion of more than 100%.



	Staphylococcus spp.	*S. constellatus*	*S. intermedius*	*K. pneumoniae*	*E. coli*	*Pseudomonas* spp.	*A. baumannii*	*E. cloacae*	*H. influenzae*	*S. maltophilia*	*S. marcescens*
Total (n=366)	3.6	4.1	1.9	11.2	1.9	4.6	1.9	2.5	2.2	0.3	0.3
AL (n=53)	1.9	3.8	0.0	9.4	0.0	3.8	1.9	1.9	3.8	0.0	1.9
NAL (n=313)	3.8	4.2	2.2	11.5	2.2	4.8	1.9	2.6	1.9	0.3	0.0

Figure 4 Microbiological culture results of lung abscess. The X-axis represents the percentage of microorganisms isolated from lung abscess in different groups. The Y-axis represents the type of microbial species isolated from lung abscess. The values in the different groups are shown in the table below the X-axis. AL, apical segment lung abscess; NAL, non-apical segment lung abscess.

Table 4 Treatment and clinical outcomes of patients

Variables	Total (n=431)	AL (n=68)	NAL (n=363)	P value
Antibiotic treatment options				
Combination	346 (80.3)	60 (88.2)	286 (78.8)	0.07
Single	85 (19.7)	8 (11.8)	77 (21.2)	0.07
Duration of intravenous antibiotic treatment, days	9 [8–11]	8 [7–8]	10 [8–12]	<0.001
Surgical treatment	81 (18.8)	25 (36.8)	56 (15.4)	<0.001

Data are expressed as n (%) or median [interquartile range]. AL, apical segment lung abscess; NAL, non-apical segment lung abscess.

with mild clinical symptoms. Moreover, the patients with AL had a high rate of surgical treatment. Meanwhile, by multivariate analysis, our results demonstrated that surgical treatment occurred more frequently in patients with AL, lower in patients who had fever and imaging features of liquefaction necrosis.

It is well known that lung abscess is common in clinical practice, resulting in increased length of hospital stay, expensive medical expenses, and a higher rate of radiological sequelae (5,9). Currently, there are no standardized guidelines for managing patients with lung abscess, especially for AL. Recently, few studies have been conducted on patients with AL. More research is needed to explore standard treatment strategies.

In our study, patients with lung abscess were predominantly men (86.1%), with a mean age of 54.8± 11.5 years old, consistent with the findings of other literatures (9,12). Meanwhile, patients with lung abscess had a history of smoking (64.0%), alcoholism (12.5%), and dental caries (12.3%), similar to those reported in previous

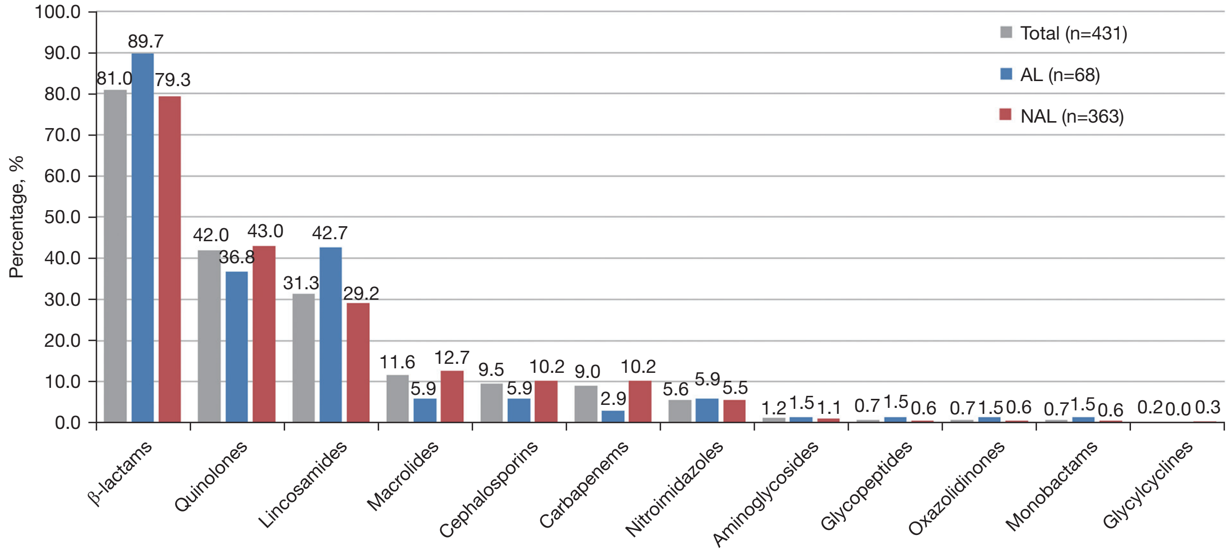


Figure 5 The types and percentage of antibiotics used to treat lung abscess. The X-axis represents the types of antibiotics used in various groups. The Y-axis represents the percentage of antibiotics used in various groups. AL, apical segment lung abscess; NAL, non-apical segment lung abscess.

Table 5 Univariate and multivariate regression analysis of risk factors for surgical treatment

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P value	OR	95% CI	P value
AL	3.19	1.80–5.63	<0.001	2.58	1.40–4.77	0.002
COPD	0.31	0.12–0.79	0.01	0.48	0.17–1.33	0.16
Diabetes	0.40	0.21–0.75	0.004	0.53	0.26–1.09	0.08
Hypoprealbuminemia	0.36	0.17–0.75	0.006	1.40	0.52–3.80	0.51
Fever	0.38	0.23–0.62	<0.001	0.55	0.31–0.98	0.04
Pulmonary bullae	0.34	0.12–0.98	0.046	0.48	0.16–1.46	0.20
Liquefaction necrosis	0.27	0.15–0.48	<0.001	0.32	0.15–0.69	0.004

OR, odds ratio; CI, confidence interval; AL, apical segment lung abscess; COPD, chronic obstructive pulmonary disease.

studies (10,19-21). Nevertheless, we observed a proportion of COPD (15.5%), hypoprealbuminemia (23.0%), anemia (33.6%), and diabetes (29.5%). These findings may differ from those of previous studies (8,9,21). This difference may be linked to differences in region, hospital admission and selection criteria for inclusion in the study. Due to its low anti-infection ability, abnormal immune response, and impairment of neutrophil function in diabetic patients, the risk of lung abscess is increased (22). Patients with COPD have difficulty in discharging sputum, leading to further microbial dysfunction, this further provides a favorable environment for microbial colonization, triggering lung abscess (17). Furthermore, patients with lung abscess often have coexisting hypoprealbuminemia and anemia, which may be linked to the fact that lung abscess affects their systemic nutritional status (23). Both groups were similar in terms of demographic characteristics and risk factors.

Besides, we found that the incidence of diabetes in AL was rare and much lower than that reported in other literatures (5,12). In addition, our study showed that COPD occurred more frequently in NAL but not in AL. Because of high mucus secretion and cilium impairment in the respiratory tract (23). Interestingly, the proportion of hypoprealbuminemia was much lower in the AL. In a previous report, patients with upper lobe infections had less underlying disease than those with lower lobe infections (24).

Typical clinical symptoms of lung abscess are productive cough, fever, and purulent sputum (14). In this study, it is worth noting that when comparing the first symptoms of patients with lung abscess between the two groups, patients with AL were not prone to fever and purulent sputum. The AL group patients had mild poisoning symptoms compared to the NAL group patients. Previous studies showed that ventilation-perfusion ratio (VA/Qc) in upper lobe of the lung is higher than lower lobe of the lung (24-26). Due to anatomy of the lung, upper lobe have a lower blood supply than lower lobe (24,25). Therefore, patients with AL may have relatively few local inflammatory factors in lesions due to the poor local blood supply, resulting in mild systemic symptoms.

For lung abscess of different etiologies, the distribution of lung abscess has its own characteristics. In clinical practice, many patients with lung abscess do not provide an accurate history to determine the etiology. Hematogenous lung abscess was excluded from this study. Prior studies have found that lung abscess was predominantly found in the lower lobe of both lungs and posterior segment of the right upper lobe (8,27). In this study, the result demonstrated that AL was not uncommon, accounting for 68 (15.8%). This should not be taken lightly by clinicians. At the same time, it has been found that patients with AL have specific clinical features. This was the main focus of our study. Regarding its distribution, lung abscess can actually be distributed in more than one lobe of both lungs. Moreover, some important factors determine the distribution of lung abscess, such as hematogenous dissemination and bronchogenic (9,27). In our study, the conditions of dental decay and alcoholism in patients with lung abscess may be contributing factors to inhalation (27). In fact, bronchogenic lung abscess is more frequently limited to one lobe than hematogenous lung abscess (9). Besides, patients with bronchogenic lung abscess often have coexisting lung diseases (9,27). However, it was not the focus of this study and was not properly investigated. Further research may be undertaken. More importantly, the final results included in the study showed that lung abscess was predominantly limited to one lobe. What's more, our study's radiological data revealed that lung abscess predominantly occurred in non-apical segment of both lungs, similar to previous reports (8,9). Furthermore, the radiological characteristics of air-fluid level were less likely to appear on chest CT in AL. This may be linked to the fact that upper lobes of both lungs drain better than lower lobes. This may also be one of the reasons for mild symptoms of AL.

Previous studies have demonstrated that anaerobic bacteria were common pathogens in patients with lung abscess in the West (2,10,11). However, recent studies such as ours have found fewer anaerobic bacteria (12,28). Numerous studies on lung abscess have reported variations in the bacterial spectrum across different regions (9,10,12). Wang *et al.* reported that *K. pneumoniae* was the most common pathogen causing community-type lung abscess in Taiwan (12). As in our study, the microbiological data also revealed that *K. pneumonia* was the main bacterium isolated from lung abscess, inconsistent with other reports (10,12,29,30). This may be because patients included in our study had community-type lung abscess, and differences in microbiological culture detection methods (31). *Pseudomonas* spp. was the second most common species reported in another study (19). Besides, *Staphylococcus* spp. was common pathogen in community-acquired pneumonia (10). Globally, the bacterial spectrum of lung abscess is evolving. Accordingly, future research should focus on pathogenic microbial changes in lung abscess. In conclusion, our data suggested a low level of positive bacterial cultures in the AL group patients, with a lower bacterial load, which could also explain the mild clinical symptoms of the disease.

In this study, the percentage of antibiotics used in combination was as high as 80.3%, while single antibiotics used was only 19.7%. For AL, the choice of antibiotics is similar to NAL. The β-lactam antibiotics remain the empirical first choice for treating lung abscess. Our study results were similar to empirical antibiotic treatment recommended in previous studies (12,27,32). However, this may not apply to empirical therapy in lesion poorly resorbed patients with lung abscess. Accurate microbiological evidence is of the utmost importance (33).

In general, most lung abscess can be cured by antibiotic therapy. However, the standard duration of antibiotic treatment for lung abscess is uncleary defined. Published studies have reported that treatment of lung abscess with antibiotics may require 3–20 weeks (10,27). However, due to its heterogeneity, the duration of antibiotic treatment in patients with lung abscess may be different. The duration of intravenous antibiotic treatment in our study was shorter in the AL group than the NAL group. This may be associated with the mild clinical symptoms of AL. Thus, clinicians may not pay enough attention and give a short duration of intravenous antibiotic treatment in hospital.

Meanwhile, the retrospective follow-up results showed that 36.8% patients eventually underwent surgical treatment after internal medical anti-infection therapy in the AL group. Surprisingly, the AL group patients had a significantly higher rate of surgery than the NAL group. This finding may be related to short duration of intravenous antibiotic treatment. Patients with lung abscess can have an unfavorable prognosis if the duration of antibiotic treatment was insufficient (9). In addition, the distribution of blood in the lung is influenced by anatomy of the lung and gravity factor (25,34). This results in a lower blood flow distribution in the apical segment of both lungs (25,35). Consequently, this may result in inadequate local blood antibiotic concentrations in AL, which could compromise the efficacy of anti-infection therapy (24). The above factors may lead to poor absorption of AL. Besides, a prior study have reported that upper lobe pneumonia had a higher rate of surgical treatment than lower lobe pneumonia after a long follow-up period (24).

The demand for surgery in patients with lung abscess has been extensively studied in prior research, with a range of 2–41% (10,19,20). Surgical intervention is necessary for patients with chronic lung abscess who do not respond to prolonged medical treatment, but it is not the first-choice strategy in treating lung abscess. Therefore, the correct choice of antibiotics, an appropriate course of treatment, and regular follow-up are essential. More importantly, when patients with lung abscess have inadequate anti-infection therapy and poor lesion resorption, especially for AL, clinicians should perform appropriate differential diagnosis rather than direct surgical treatment. When considering the possibility of other diseases, such as bronchial carcinoma, tuberculosis, Wegener's granulomatosis, and so on. In this case, to ensure diagnosis accuracy of lung abscess, further aggressive inspections are required to identify other underlying conditions, such as lung puncture. If the lesion is not another disease, in this regard, our research suggests that clinicians should give a full course of anti-infection therapy, waiting patiently for absorption of the lesion, particularly lung abscess with location at the apical segment region. Therefore, this may be a better medical strategy.

There are several limitations in this study. First, our study was a retrospective, single-center study with a relatively small sample size, which might have affected its accuracy. Second, the 10-year study period may make it challenging to interpret the results due to advancements in the diagnosis and treatment of lung abscess. In addition, due to the exclusion of missing and implausible data from this study, a selection bias could exist, as participants with AL for surgical intervention might have been more inclined. However, its generalizability to a wider population is limited. Therefore, a multicenter study with a larger sample size and a long-term follow-up is required.

Conclusions

In conclusion, this study revealed that the AL had atypical clinical features and a high rate of surgical treatment. The AL should not be ignored by clinicians. Therefore, it is necessary to conduct appropriate invasive investigations to facilitate differential diagnosis. These findings should be considered when managing the AL.

Acknowledgments

The authors would like to acknowledge all the staff at the Department of Respiratory and Critical Care Medicine, Shanghai Pulmonary Hospital, School of Medicine, Tongji University for their work.
Funding: This work was supported by the Bethune Foundation Project (No. bj-rw2020001j).

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-624/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-624/dss

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-624/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-624/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This single-center, observational, retrospective study was approved by Ethics Committee of Shanghai Pulmonary Hospital, School of Medicine, Tongji University (No. K16-274). Informed consent was obtained from all individual participants.

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Cite this article as: Wang L, Wu Y, Xu J, Wei P, Lu H. Clinical characteristics of apical segment lung abscess: a 10-year retrospective study. J Thorac Dis 2024;16(9):5650-5662. doi: 10.21037/jtd-24-624