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# Lung abscess: analysis of the results as community-acquired or nosocomial

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**Aim:** To assess the etiology, underlying disease, treatment procedures, and mortality rate of lung abscesses by dividing the patients into community-acquired lung abscess (CALA) and nosocomial lung abscess (NLA) subgroups.

**Materials and methods:** We reviewed and analyzed data on 62 adult cases of CALA and NLA treated during 2000–2011 at a tertiary university hospital in Turkey.

**Results:** Of these 62 patients, 44 had CALA and 18 had NLA. Etiologic microorganisms were isolated in 20 of the 44 patients (45.4%) in the CALA group and in 15 of the 18 patients (83.3%) in the NLA group. Among these patients, *Staphylococcus aureus* (20.0%) and *Pseudomonas aeruginosa* (26.7%) were the most common microorganisms in the CALA and NLA groups, respectively. Computed tomography-guided drainage was performed in 20 patients in the study and the abscess was cured in 17 (85%) patients. The overall mortality rate was 12.9%. It was 4.5% and 33.3% in the CALA and NLA groups, respectively ($P < 0.05$).

**Conclusion:** Lung abscess continues to be a significant cause of morbidity and mortality despite appropriate treatment. Medical therapy is started empirically, and so it is important to separate patients into subgroups of CLA or NLA.

**Key words:** Lung abscess, etiology, treatment, percutaneous drainage

## 1. Introduction

An abscess is defined as a collection of pus in any part of the body (1). In the lungs, there may be single or multiple abscesses and they are the result of a variety of causes (1). Anaerobes comprise 60%–80% of lung abscess etiologic pathogens, and anaerobes and microaerophilic streptococci account for the majority of these microorganisms (2). However, in recent years Wang et al. reported *Klebsiella pneumoniae* (33%) to be the most common etiologic pathogen in Taiwan and concluded that the bacterial etiology of lung abscesses has changed (3). Later, another study found that the *Streptococcus* species and anaerobes were the most common pathogens in Japan (4). However, the studies included only community-acquired lung abscesses (CALAs). A 2.4% mortality rate has been reported for patients with community-acquired infections, compared to a 66.7% mortality rate for patients with nosocomial infections (5). Because of this high mortality rate, nosocomial lung abscesses (NLAs) should not be ignored.

In this report, we investigated 62 lung abscess patients by etiology, underlying disease, treatment procedure, and mortality rate by dividing the patients into CALA or NLA subgroups.

## 2. Materials and methods

Data for all adults (age > 18 years) who received a diagnosis of lung abscess between January 2000 and December 2011 at a tertiary care university hospital in Kayseri, Turkey, were found by a computer registry system. The local ethics committee approved the study protocol. Patients were included in the study if they met all of the following 3 criteria: 1) symptoms of pulmonary infection, such as fever and cough, were present; 2) a cavity with an air fluid level in it was observed on a chest radiograph or computed tomography (CT); and 3) documented bacteriological data were available. Sixty-five inpatient files were identified. Three subjects, however, were excluded for reasons such as unsuitable data or cavitary lung carcinoma. Thus, 62 cases were analyzed.

The diagnosis of lung abscesses was established on the basis of clinical symptoms, laboratory data, and the findings of imaging studies (a cavity seen on a chest radiograph

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was confirmed by a chest CT) (4). The cases were classified into 2 groups: community-acquired infections with clinical signs of lung abscess on admission or <48 h after admission, and nosocomial infections with a lung abscess developing >48 h after admission (5,6). Empyema was diagnosed by aspiration of gross pus from the pleural space. Cases where the aspirated pleural fluid was nonpurulent, a positive Gram stain, or a positive culture were also accepted as empyema. Isolation and identification of causative organisms were carried out by the standard procedures. Percutaneous transthoracic aspiration (PTA) was tomography-guided. All catheters were inserted into the patients under CT guidance. Depending on the abscess location, the patients were scanned in supine, prone, or oblique positions. The catheter was inserted using the Seldinger or trocar technique. A 12-F or 14-F chest drain catheter (Medi-tech/Boston Scientific, Watertown, MA, USA) was used.

Contingency data were analyzed by 2-tailed chi-square test and continuous data were analyzed by Student's t-test or the Mann–Whitney U test. A P value of <0.05 was considered to be statistically significant, and all probabilities were 2-tailed. All statistical analyses were performed with SPSS 15.0 for Windows.

## 3. Results

### 3.1. Patient characteristics and risk factors

Of the 62 patients, 44 were in the CALA group and 18 were in the NLA group. The mean age of the patients was 51.9 ± 16.9 years in total. The mean age was 50.3 ± 17.9 and 55.7 ± 14.0 years in CALA and NLA patients, respectively (Table 1). The most common prior lung illness was chronic obstructive pulmonary disease (COPD) and the most common extrapulmonary condition was periodontal disease in both groups (Table 1).

### 3.2. Symptoms and radiographic location

Patients had symptoms for 21.2 ± 25.7 days and 14.5 ± 19.1 days in the CALA and NLA groups, respectively. Fever (72.7%) and cough (72.7%) were the most common symptoms in the CALA group (Table 2). Similarly, fever (88.9%) was the most common symptom in the NLA group. Lesion location included the right upper lobe in 31.8% and right lower lobe in 29.5% of cases in the CALA group (Table 2). However, the NLA group lesions were mostly located in the right upper lobe, left upper lobe, and left lower lobe at the same rate of 27.8%.

### 3.3. Diagnostic methods and results

The diagnostic methods used for bacteriology-confirmed lung abscesses included the following in the CALA and

**Table 1.** Baseline characteristics and risk factors of patients.

| Characteristics and risk factors | Community-acquired infection, n (%) | Nosocomial infection, n (%) | Total, n (%) |
|---|---|---|---|
| Age ± SD, years | 50.3 ± 17.9 | 55.7 ± 14.0 | 51.9 ± 16.9 |
| Male | 28 (63.6) | 16 (88.9) | 44 (70.9) |
| Smoking history | 21 (47.7) | 9 (50.0) | 30 (48.4) |
| Total packs/years ± SD | 41.9 ± 20.5 | 40.5 ± 13.8 | 41.5 ± 18.5 |
| Alcoholism | 4 (9.1) | 0 | 4 (6.5) |
| Underlying disease | | | |
| None | 8 (18.2) | 4 (22.2) | 12 (19.3) |
| Prior lung illness | | | |
| COPD | 5 (11.4) | 6 (33.3) | 11 (17.7) |
| Bronchiectasis | 3 (6.8) | 1 (5.6) | 4 (6.5) |
| Old pulmonary tuberculosis | 1 (2.3) | 2 (11.1) | 3 (4.8) |
| Lung cancer | 3 (6.8) | 4 (22.2) | 7 (11.3) |
| Extrapulmonary condition | | | |
| Periodontal disease | 20 (45.4) | 7 (38.9) | 28 (43.5) |
| Diabetes mellitus | 11 (25.0) | 2 (11.1) | 13 (21.0) |
| Malignancy | 3 (6.8) | 1 (5.6) | 4 (6.5) |
| Steroid use | 2 (4.5) | 2 (11.1) | 4 (6.5) |
| Others | 10 (22.7) | 7 (38.9) | 17 (27.4) |

**Table 2.** Symptoms and radiographic location of patients.

| | Community-acquired infection, n (%) | Nosocomial infection, n (%) | Total, n (%) |
|---|---|---|---|
| Symptoms | | | |
| Duration, mean ± SD, days | 21.2 ± 25.7 | 14.5 ± 19.1 | 19.8 ± 27.1 |
| Fever | 32 (72.7) | 16 (88.9) | 48 (77.4) |
| Cough | 32 (72.7) | 13 (72.2) | 45 (72.6) |
| Sputum | 29 (65.9) | 14 (77.8) | 43 (69.4) |
| Chest pain | 18 (40.9) | 5 (27.8) | 23 (37.1) |
| Hemoptysis | 7 (15.9) | 3 (16.7) | 10 (16.1) |
| Dyspnea | 16 (36.4) | 8 (44.4) | 24 (38.7) |
| Weakness | 18 (40.9) | 10 (55.6) | 28 (45.2) |
| Weight loss | 6 (13.6) | 4 (22.2) | 10 (16.1) |
| Radiographic location | | | |
| Right upper lobe | 14 (31.8) | 5 (27.8) | 19 (30.6) |
| Right middle lobe | 3 (6.8) | 1 (5.6) | 4 (6.5) |
| Right lower lobe | 13 (29.5) | 1 (5.6) | 14 (22.6) |
| Left upper lobe | 6 (13.6) | 5 (27.8) | 11 (17.7) |
| Left lower lobe | 5 (11.4) | 5 (27.8) | 10 (16.1) |
| Multiple and/or bilateral | 3 (6.8) | 1 (5.6) | 4 (6.5) |

NLA groups, respectively: sputum culture, 8 episodes (17.7%) and 6 episodes (24.0%); bronchial lavage fluid culture, 6 episodes (37.5%) and 7 episodes (53.8%); pleural effusion culture, 5 episodes (41.6%) and 9 episodes (52.9%); PTA culture, 6 episodes (37.5%) and 2 episodes (50.0%) (Table 3). A positive blood culture result was detected in 3 episodes (15%) in the NLA group, but there were no positive results in the CALA group. Positive surgical specimen cultures were detected in 1 episode each (33.3%) in both groups.

**3.4. Documented laboratory and bacterial findings**

The mean white blood cell (WBC) count was 14,580 ± 5910 and 13,887 ± 8231 mL and the sedimentation rate was 71.5 ± 30.2 and 82.7 ± 29.2 mm/h in the CALA and NLA groups, respectively. There was no significant statistical difference in WBC count or sedimentation rates in patients in the CALA or NLA groups ($P > 0.05$). Etiologic microorganisms were isolated in 20 of the 44 patients (45.4%) in the CALA group. Among these 20 patients, infection by a single microorganism occurred in 16 (80.0%), infection by 2 microorganisms occurred in 2 (10.0%), and infection by 3 microorganisms occurred in 2 (10.0%). *Staphylococcus aureus* (4 patients, 20.0%) was the most common microorganism, followed by *Streptococcus pneumoniae* (3 patients, 15.0%) and *Pseudomonas aeruginosa* (3 patients, 15.0%) in the CALA group. Etiologic microorganisms were isolated in 15 of the 18 patients (83.3%) in the NLA group. Among these 15 patients, infection by a single microorganism occurred in 10 (66.7%), infection by 2 microorganisms occurred in 4 (26.7%), and infection by 3 microorganisms occurred in 1 (6.7%). *Pseudomonas aeruginosa* (4 patients, 26.7%) and *Nocardia* spp. (3 patients, 20.0%) were the most common microorganisms in the NLA group. Twenty-six bacteria were isolated from the CALA group and 25 bacteria were isolated from the NLA group (Table 4). Of these microorganisms, *Staphylococcus aureus* (4 episodes, 15.4%) and *Pseudomonas aeruginosa* (5 episodes, 20.0%) were the most common organisms in the CALA and NLA groups, respectively (Table 4). In the CALA group, *Echinococcus granulosus* (n = 1) and *Aspergillus* spp. (n = 1), and in the NLA group, *Candida albicans* (n = 3), were isolated as nonbacterial microorganisms. Anaerobic cultures were determined in 12 patients with 15 episodes. Eight of them were obtained from PTA specimens, 4 from pleural effusion, and 3 from bronchial lavage fluid culture. There were no positive results in the anaerobic cultures.

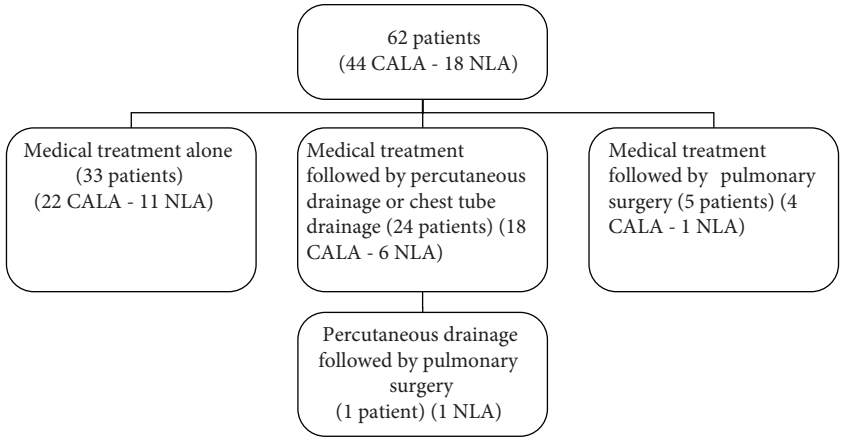


**Figure.** Analysis of the treatment of 62 patients with lung abscess.

### 3.5. Treatments and outcomes

The mean hospitalization stay was 18.2 ± 10.7 and 25.4 ± 14.1 days in the CALA and NLA groups, respectively, and the difference was statistically significant ($P < 0.05$). Concomitant empyema was seen in 8 (18.2%) and 5 (27.8%) patients in the CALA and NLA groups, respectively. The treatment modalities are shown in the Figure. Twenty-two patients (50.0%) were treated only medically in the CALA group. Medical treatment followed by percutaneous drainage was performed in 16 patients (36.4%), chest tube drainage for empyema was performed in 2 (4.5%) (the amounts of the pleural effusion of the other 6 patients with empyema were small and these patients did not require tube drainage), and pulmonary surgery was performed in 4 patients (9.1%) in the CALA group. Eleven patients (61.1%) were treated only medically and 4 patients (22.2%) received medical treatment followed by percutaneous drainage in the NLA group. Chest tube drainage for empyema was performed in 2 patients (11.1%) (the other 3 patients with empyema received medical treatment and these patients did not require tube drainage), and pulmonary surgery was also performed in 2 patients (11.1%).

Ampicillin/sulbactam; 1st-, 2nd-, or 3rd-generation cephalosporin ± clindamycin; or metronidazole was administered as empirical therapy in 35 (79.5%) of the 44 patients in the CALA group (Table 5). Five of the patients (14.3%) received other chemotherapeutics because initial antibiotic treatments were ineffective or inappropriate. Six patients (13.6%) received fluoroquinolone, 2 patients (4.5%) received cefoperazone/sulbactam + amikacin, and 1 patient (2.3%) received piperacillin/tazobactam ± clindamycin or metronidazole. There was no failure to respond to treatment.

Fluoroquinolone was administered as empirical therapy in 2 (11.1%) of the 18 patients in the NLA group (Table 6). Both of them needed second-line antibiotics and after that they died. Five patients (27.8%) received piperacillin/tazobactam ± clindamycin or metronidazole and 2 of them received other antibiotics because initial antibiotic treatments were ineffective. Eleven patients (61.1%) received carbapenem and only 3 patients needed second-line antibiotic treatment.

**Table 3.** Diagnostic methods and results of patients.

| | Community-acquired | | Nosocomial infection | | Total | |
|---|---|---|---|---|---|---|
| Diagnostic method | Episodes studied | Diagnostic studies, n (%) | Episodes studied | Diagnostic studies, n (%) | Episodes studied | Diagnostic studies, n (%) |
| Sputum culture | 45 | 8 (17.7) | 25 | 6 (24.0) | 70 | 14 (20.0) |
| Bronchial lavage fluid culture | 16 | 6 (37.5) | 13 | 7 (53.8) | 29 | 13 (44.8) |
| Pleural effusion culture | 12 | 5 (41.6) | 17 | 9 (52.9) | 29 | 14 (48.2) |
| Blood culture | 28 | 0 | 20 | 3 (15.0) | 48 | 3 (6.2) |
| Culture of PTA specimens | 16 | 6 (37.5) | 4 | 2 (50.0) | 20 | 8 (40.0) |
| Culture of surgical specimens | 3 | 1 (33.3) | 3 | 1 (33.3) | 6 | 2 (33.3) |

**Table 4.** Bacteriological findings of 20 patients in CALA and 15 patients in NLA groups.

| Community-acquired infection (20 patients) | | Nosocomial infection (15 patients) | |
|---|---|---|---|
| Microorganisms | Isolates, n | Microorganisms | Isolates, n |
| *Staphylococcus aureus* | 4 | *Pseudomonas aeruginosa* | 5 |
| *Streptococcus pneumoniae* | 3 | *Acinetobacter baumannii* | 4 |
| *Klebsiella pneumoniae* | 3 | *Nocardia* species | 4 |
| *Pseudomonas aeruginosa* | 3 | *Staphylococcus aureus* | 3 |
| *Staphylococcus epidermidis* | 2 | *Salmonella* species | 3 |
| Alpha-hemolytic *Streptococcus* | 2 | *Staphylococcus epidermidis* | 2 |
| *Corynebacterium* species | 2 | *Streptococcus anginosus* | 1 |
| *Salmonella* species | 1 | *Burkholderia cepacia* | 1 |
| *Streptococcus cristatus* | 1 | *Serratia marcescens* | 1 |
| *Stenotrophomonas maltophilia* | 1 | *Citrobacter* species | 1 |
| *Haemophilus influenzae* | 1 | Total | 25 |
| *Gemella morbillorum* | 1 | | |
| *Proteus* species | 1 | | |
| *Streptococcus pyogenes* | 1 | | |
| Total | 26 | | |

Two patients died in the CALA group and 6 patients died in the NLA group. The overall mortality rate was 12.9%. It was 4.5% and 33.3% in the CALA and NLA groups, respectively. There was a statistically significant difference in mortality rates for patients in the CALA and NLA groups ($P < 0.05$). *Proteus* and *Aspergillus* spp. were isolated in each of the 2 patients who died in the CALA group. Both of them had diabetes mellitus. One of them was treated with medicine alone. Medical treatment followed by percutaneous drainage was performed in the other patient. Six patients died in the NLA group. Two or more pathogens were isolated in 5 patients in the NLA group and 4 of them (80.0%) died. Death occurred in 2 (66.7%) of 3 cases with *Nocardia* spp., 1 (25.0%) of 2 cases with *Pseudomonas aeruginosa*, 1 (50.0%) of 2 cases with *Staphylococcus aureus*, and both of the 2 cases with *Acinetobacter baumannii*. Of these 6 patients, 5 received only medical treatment and 1 received medical treatment followed by percutaneous drainage. Four patients received corticosteroids ± cyclophosphamide for idiopathic thrombocytopenic purpura, systemic lupus erythematosus, or juvenile rheumatoid arthritis. Two (50%) of them died and *Nocardia* species were isolated in 3 of the 4 immunocompromised patients. First-line antibiotic failure was detected in all of the exitus patients in the CALA and NLA groups.

## 4. Discussion

For a review and analysis of the cases with lung abscess treated in our hospital in the past 12 years, the 62 cases were divided into 2 groups: community-acquired infection and nosocomial infection. We found that the mortality rate was significantly higher in NLA patients.

Predisposing factors responsible for lung abscess include dental extraction, COPD, alcoholism, solid cancer, diabetes mellitus, general anesthesia, and others (4,5). Lung abscess can also occur as a complication of community-acquired or hospital-acquired pneumonia, especially with *Staphylococcus aureus*, *Staphylococcus milleri*, and *Pseudomonas aeruginosa* (6,7). COPD and periodontal diseases were the most common risk factors (4,8). In the present study, similarly, COPD was the most common underlying prior lung illness, and periodontal diseases were the most common extrapulmonary condition in both of the groups separately and overall.

Many different types of specimens were used to identify etiologic microorganisms in the lung abscesses. In most bacteriological studies of lung abscesses, transtracheal aspiration, protected bronchial brushing, and PTA were the most common procedures for collection of uncontaminated specimens (9–11). Takayanagi et al. reported that sensitivity was 81.6% for protected specimen brush via fiberoptic bronchoscopy (PSB), 70% for PTA,

**Table 5.** First-line antibiotics, failure rate, second-line antibiotics, and outcome in community-acquired infection.

| First-line antibiotics | Patients | Failure rate | Second-line chemotherapeutics | Death |
|---|---|---|---|---|
| Ampicillin/sulbactam; 1st-, 2nd-, 3rd-generation cephalosporin ± clindamycin; or metronidazole | 30 | 5 (16.7%) | Carbapenem (n = 1), cefoperazone/sulbactam + amikacin (n = 1), fluoroquinolone (n = 1), albendazole (n = 1), amphotericin b (n = 1) | 2 (6.7%) |
| Fluoroquinolone | 6 | 0 | 0 | 0 |
| Piperacillin/tazobactam ± clindamycin or metronidazole | 1 | 0 | 0 | 0 |
| Cefoperazone/sulbactam + amikacin | 1 | 0 | 0 | 0 |

27.8% for pleural effusion, and 22% for bronchial lavage fluid culture (4). Another report showed that sensitivity was 66% for PTA and 21% for pleural effusion (3). However, in the present study, PSB was not used and bronchial lavage culture sensitivity was 44.8%, PTA was 40.0%, and pleural effusion was 48.2%. Although the sensitivities of pleural effusion and bronchial lavage fluid culture were higher, the sensitivity of PTA was lower than in the other studies.

We also reviewed the etiologic agents in the study. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the most common microorganisms in the CALA and NLA groups, respectively. Mori et al. also examined patients by dividing them into 2 groups, CALA and NLA (5). They reported that *Staphylococcus aureus* was the most common etiologic pathogen of CALA, and *Pseudomonas aeruginosa* and *Klebsiella* spp. were the most common pathogens of NLA, which was similar to our results except for *Klebsiella.* It is known that alcoholism is an important risk factor associated with *Klebsiella pneumoniae* lung abscesses (12). In our study, the alcoholism rate was very low compared with other reports (4,12) and this may be the reason that *Klebsiella pneumoniae* was isolated less than the others.

Pulmonary nocardiosis is an important cause of opportunistic infection in immunocompromised patients. However, it is not so easy to diagnose nocardiosis. A high degree of clinical suspicion is required, and communication with the microbiology laboratory is paramount due to the slow growth in standard cultures. Early diagnosis is important in nocardiosis because of the high mortality rate (11%–48%) (13–15). In the present study, 4 patients received corticosteroids ± cyclophosphamide, and *Nocardia* species were isolated in 3 of them. Furthermore, death occurred in 2 (66.7%) of these 3 cases. It should also be emphasized that *Acinetobacter baumannii*, which is the most frequent pathogen for ventilator associated pneumonia (16), was detected in 2 patients with lung abscesses and both of them died.

Ampicillin + sulbactam and clindamycin ± cephalosporin are both well tolerated and have proven to be equally effective in the treatment of aspiration pneumonia and lung abscesses (17). Takayanagi et al. reported that ampicillin/sulbactam and 2nd-, 3rd-, or 4th-generation cephalosporin, with or without clindamycin, were administered as empirical therapy,

**Table 6.** First-line antibiotics, failure rate, second-line antibiotics, and outcome in nosocomial infection.

| First-line antibiotics | Patients | Failure rate | Second-line antibiotics | Death |
|---|---|---|---|---|
| Fluoroquinolone | 2 | 2 (100%) | Cefoperazone/sulbactam + amikacin (n = 1), carbapenem (n = 1) | 2 (100%) |
| Piperacillin/tazobactam ± clindamycin or metronidazole | 5 | 2 (40%) | Fluoroquinolone + amikacin (n = 1), cefoperazone/sulbactam + colistin (n = 1) | 2 (40%) |
| Carbapenem | 11 | 3 (27.3%) | Fluoroquinolone + colistin + linezolid (n = 1), ceftriaxone + trimethoprim sulfamethoxazole (n = 1), liposomal amphotericin B (n = 1) | 1 (9.1%) |

and the failure rate was 11.9% and 7.1%, respectively (4). Similarly, in the present study, ampicillin/sulbactam; 1st-, 2nd-, or 3rd-generation cephalosporin ± clindamycin; or metronidazole were administered as empirical therapy in 35 patients (79.5%), and the failure rate was 14.3% in CALA. However, empirical therapy was different in NLA. The preferred agents for empiric therapy for nosocomial pneumonia (late onset disease or multidrug resistance) are antipseudomonal cephalosporin and antipseudomonal carbapenem *or* β-lactam/β-lactamase inhibitor *plus* antipseudomonal fluoroquinolone (6). Carbapenems possess a broad spectrum of antibacterial activity that makes them suitable for the empiric treatment of nosocomial pneumonia in certain situations (18). In the present study, carbapenems also had the lowest failure rate (27.3%) in the NLA group.

In recent years, CT-guided percutaneous catheter drainage has been found to be a useful and safe procedure for the treatment of lung abscesses (19). The success rate was reported to be 79%–100%, and CT-guided drainage should be considered as the first therapeutic choice in most patients with lung abscess who do not respond to medical therapy as an alternative to open surgery (19–22). In our hospital, similarly, when lesions do not respond to antibiotics, CT-guided drainage is applied. CT-guided drainage was performed in 20 patients in our study. The abscess was cured in 17 (85%) patients, which is consistent with other reports.

Mortality from lung abscess was reported to be from 1.0% to 20.0% in twentieth century studies (3,4,8,23). However, these studies included only CALA patients. Mori et al. reported that the mortality rate was 66.7% in NLA patients (5). In the present study, the mortality rate was 4.5% and 33.3% in CALA and NLA, and the difference was statistically significant ($P < 0.05$). The main difference between these 2 groups is the need to be especially careful with NLA patients.

One limitation of the present study is that it was retrospective. A second limitation is that the number of anaerobic cultures was not enough. Anaerobic cultures were determined in 12 patients (19.3%) with 15 episodes, and there were no positive results. The reason for this is probably that the samples were not taken or protected properly. In addition, PSB is not commonly used in our hospital, so there were no studied specimens to investigate.

In conclusion, lung abscess continues to be a significant cause of morbidity and mortality despite appropriate antibiotic therapy and invasive methods. Mortality was dramatically higher in the NLA group. Medical treatment is started empirically, and so it is important to separate patients into subgroups of CLA or NLA. If the response to medical therapy is poor, percutaneous drainage should be the first choice of treatment.

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