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Original article

Risk factors for mortality in patients with septic pulmonary embolism

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ABSTRACT

Data regarding prognostic factors for patients with septic pulmonary embolism (SPE) are lacking. The purpose of the present study was to investigate the clinical features of SPE and to ascertain the risk factors for mortality in patients with this condition.

Patients with SPE, whose data were retrospectively collected from a tertiary referral center in Korea, were categorized by the presence or absence of in-hospital death into two groups: death and survival groups. The two groups were compared for clinical and radiologic parameters.

SPE was community-acquired in most patients (78%). The most common focus of primary infection was that of bone, joint, or soft tissue (33%), followed by liver abscess (17%). The in-hospital mortality was 12%. Multivariate analysis showed that tachypnea (odds ratio [OR] 4.73, 95% confidence interval [CI] 1.09–20.53, $p = 0.038$) and segmental or lobar consolidation on computed tomography (CT) scan (OR 10.79, 95% CI 2.51–46.43, $p = 0.001$) were independent predictors of in-hospital death in SPE patients.

Taken together, the primary infectious foci of SPE in Korea are different from those reported in Western countries. Tachypnea and segmental or lobar consolidation on CT scan may be independent risk factors for in-hospital death in these patients.

1. Introduction

In septic pulmonary embolism (SPE), fibrin thrombi, which contain pathogens originating from the primary infectious site, obstruct small pulmonary vessels and lodge in the pulmonary parenchyma, thereby leading to septic infarction [1]. Septic pulmonary emboli occur in the right side of the heart or in the systemic veins [2]. Initial sites of infection have been shown to vary depending on the study population, including intravenous drug use [3], infective endocarditis [4], liver abscess [5], periodontal disease [6], infected central venous catheter or pacemaker [7], and peritonsillar abscess (Lemierre's syndrome) [8]. Because SPE patients usually have nonspecific symptoms, such as fever and cough, an opportune diagnosis can be delayed. Thus, early detection of SPE along with prompt administration of appropriate antibiotics plays a crucial role in the successful treatment of patients with this condition [9,10].

However, SPE is an uncommon clinical entity [11], and most published studies have been either individual case reports or small case series. To our knowledge, data regarding prognostic factors for SPE are lacking. The purpose of the present study was to investigate the clinical features of SPE and to ascertain the risk factors for mortality in these patients.

2. Patients and methods

2.1. Study design

The present study was retrospectively conducted in a tertiary referral center, Kyungpook National University Hospital (KNUH) in Daegu, South Korea. To identify patients with SPE, we reviewed the list of patients hospitalized to the Respiratory Department, searched electronic medical records under the diagnosis of “septic emboli”, and checked the chest computed tomography (CT) readings with the search terms of “septic pneumonia”, “septic pulmonary embolism”, or “septic emboli” from January 2001 through June

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2015. Similar to a previous study [7], SPE was defined if the following criteria were fulfilled: 1) clinical manifestations suggesting infection, such as fever; 2) multiple nodules or multifocal lung infiltrates on CT compatible with SPE; 3) exclusion of other possible causes for the pulmonary lesions; 4) either clinical and radiographic improvement following appropriate antibiotic treatment or death due to septic shock; and 5) the presence of primary infection foci. This study was approved by the Institutional Review Board of the KNUH (2015-09-005), which waived the requirement for written informed consent because of the retrospective nature of the study.

2.2. Data collection

Data were reviewed by two physicians (H.G.O. and S.I.C.). Demographic data, including age, gender, smoking history, and alcohol consumption, were recorded. Heavy drinking was defined as the consumption of seven or more alcoholic drinks (>60 g of alcohol) on one occasion for men and five or more drinks (>40 g of alcohol) on one occasion for women at least twice a week. As has been previously described for the classification of patients with pneumonia [12], SPE patients were classified into community-acquired, healthcare-associated, and hospital-acquired SPE, according to the environments of infection. Symptoms, vital signs, and comorbid conditions were reviewed, and the Charlson comorbidity index (CCI) was retrospectively calculated [13]. Mechanical ventilation, vasopressor infusion, and therapeutic intervention, such as incision and drainage, were checked. Length of hospital stay (LOS), admission to an intensive care unit, 30-day mortality, and in-hospital mortality were determined for end result analysis. Laboratory data, including complete blood counts, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP), were reviewed.

2.3. Radiological evaluation

Two experienced radiologists (J.K.L. and K.M.S.) who were blinded to the patients' clinical information reviewed chest CT scans. In the case of discrepancies in the readings of the two radiologists, a final decision was reached by consensus. We examined the number of lesions, the number of lobes affected by SPE, pleural effusion, segmental or lobar consolidation, lymphadenopathy, and the extent of disease on CT scans. Similar to the categorization system used in a previous study [14], patients were classified into four groups by measuring the maximum fluid thickness between the visceral and parietal pleurae on a CT scan: no pleural effusion; small pleural effusion, fluid thickness of 5–20 mm; moderate pleural effusion, fluid thickness of 21–50 mm; and large pleural effusion, fluid thickness > 50 mm. Segmental or lobar consolidation was defined as homogeneously increased lung attenuation that obscured vessels and airway walls, that occupied one or more segments [15]. Mediastinal and hilar lymphadenopathy was considered present when the short axis diameter of the nodes was greater than 10 mm [15]. The extent of disease was defined as the total area of lung parenchymal lesions and categorized, using a system modified from a previous study, as follows: less than 20%; 21–40%; 41–60%; 61–80%; and more than 80% of the whole lung field [16].

2.4. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). *P*-values < 0.05 were considered statistically significant. Data were expressed as medians with interquartile ranges (IQR) for continuous variables and numbers with percentages for categorical variables. The Mann–Whitney *U* test was used to compare continuous variables between the death and survival groups, and chi-square test or Fisher's exact test was used to compare categorical variables. To identify predictors of in-hospital death, unconditional multiple logistic regression was used using variables of $p < 0.05$ in univariate analysis. The Hosmer–Lemeshow test was used as a goodness-of-fit test to assess the fit of logistic regression models.

3. Results

3.1. Clinical characteristics

A total of 89 patients were included in this study. Baseline characteristics of the patients are presented in Table 1. Among the patients, males were 71% (n = 63), ever-smokers were 50% (44/88), and heavy drinkers were 28% (24/85). Most patients (78%) had community-acquired SPE. The most common predisposing condition of SPE was hospitalization (n = 9), followed by central venous catheterization (n = 7). Bone, joint, or soft tissue infection (29 [33%]) was the most common focus of primary infection, followed by liver abscess (15 [17%]) and endocarditis (11 [12%]) (Fig. 1). Periodontal abscess (n = 6) and perianal abscess (n = 4) were also

Table 1
Baseline characteristics of the patients (n = 89).

Characteristics	
Age, years	55 ± 16
Male	63 (70.8)
Smoking	
Ever-smoker	44/88 (50.0)
Pack-years	29 ± 19
Heavy drinking	24/85 (28.2)
Charlson comorbidity index	
0	38 (42.7)
1	25 (28.1)
2	19 (21.3)
3	3 (3.4)
4	4 (4.5)
Comorbidities	
Diabetes	36 (40.4)
Malignancy	11 (12.4)
Heart disease[a]	11 (12.4)
Chronic kidney disease	9 (10.1)
Collagen vascular disease	2 (2.2)
Cerebrovascular accident	2 (2.2)
Psychiatric condition	2 (2.2)
Environment of infection	
Community-acquired	69 (77.5)
Healthcare-associated	11 (12.4)
Hospital-acquired	9 (10.1)
Predisposing condition	
Hospitalization	9 (10.3)
Central venous catheter insertion	7 (8.0)
Corticosteroid or immunosuppressant	3 (3.4)
Acupuncture or injection	3 (3.4)
Chemotherapy	2 (2.3)
Arteriovenous fistula or graft	2 (2.3)
Duration of intravenous antibiotic therapy, days	22 (14–30)
Duration of oral antibiotic therapy, days	10 (0–21)
Echocardiography	57 (65.5)
Intervention	51 (57.3)
Mechanical ventilation	11 (12,4)
Vasopressor infusion	18 (20.2)
30-day mortality	8 (9.0)
In-hospital mortality	11 (12.4)
Length of hospital stay, days	24 (14–39)

Data are presented as mean ± standard deviation, median (interquartile range) or n (%).
[a] Heart diseases include congestive heart failure (n = 4), ischemic heart disease (n = 3), and atrial fibrillation (n = 1).