Relationship Between Clinical Features and Computed Tomographic Findings in Hospitalized Adult Patients With Community-Acquired Pneumonia

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ABSTRACT

Background: Data on the relationship between the clinical and microbiological features of community-acquired pneumonia (CAP) and its computed tomography (CT) findings are limited. The aim of the present study was to investigate the clinic-microbiological features of patients with CAP presenting with ground-glass opacity (GGO) and centrilobular nodules or tree-in-bud pattern on CT images.

Methods: Patients with CAP who underwent a CT scan at presentation were retrospectively classified using CT findings into consolidation, GGO and bronchiolitis groups. These 3 groups were compared in terms of clinical parameters and microbiological data.

Results: A total of 40 patients (2.4%) were allocated to the bronchiolitis group and 46 (2.8%) to the GGO group. The most common pathogen in the bronchiolitis group was *Mycoplasma pneumoniae*, which was significantly more frequently isolated in this group. The bronchiolitis group was characterized by a higher percentage of cough, a lower percentage of chest pain and lower blood levels of inflammatory markers. Common pathogens in the GGO group were not significantly different from those in the other 2 groups. Unlike that observed in the consolidation group, complicated parapneumonic effusion or empyema was not observed in the bronchiolitis or GGO group. Outcome variables were similar in the 3 groups.

Conclusions: The bronchiolitis group was characterized by a higher frequency of *M. pneumoniae* and a less severe form of CAP. The GGO and consolidation groups was similar with respect to causative microorganisms and the clinical features of CAP. No patient in the bronchiolitis or GGO group exhibited complicated parapneumonic effusion or empyema.

Key Indexing Terms: Bronchiolitis; Community-acquired pneumonia; Computed tomography; *Mycoplasma pneumoniae*.
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INTRODUCTION

Community-acquired pneumonia (CAP) remains an important cause of morbidity and mortality worldwide, despite the use of an antibiotic armamentarium and the availability of vaccines.[1] Therefore, early diagnosis and appropriate antimicrobial treatment are critical steps in the management of CAP. Chest radiography is usually used in combination with a constellation of compatible symptoms or signs, such as cough and sputum production to confirm the diagnosis of pneumonia.[2,3] Computed tomography (CT) is useful when the plain chest radiograph does not reveal findings that explain the patient's clinical presentation.[4] CT images can provide more detailed information regarding lung parenchyma,[1] suggest specific causative agents,[5] rule out noninfectious pneumonia[5] and detect other underlying conditions.[4] Thus, CT provides additional benefits for the diagnosis of CAP and aids its typing.[2] In particular, when performed early, CT can affect the diagnosis and clinical management of CAP in the emergency department.[4] Accordingly, the use of CT in patients with suspected CAP can be expected to increase in real world practice.

A variety of microbial agents, including typical and atypical pathogens, can cause CAP. A considerable number of studies on the CT findings of CAP triggered by different pathogens, including *Streptococcus pneumoniae*,[6-8] *Klebsiella pneumoniae*,[9,10] *Mycoplasma*

pneumoniae,[11-14] *Chlamydia pneumoniae*[14,15] and *Legionella pneumophila*,[16,17] have been published. Patients with CAP attributed to a specific pathogen present with more than 1 CT pattern, although 1 of these patterns predominates.[5] CAP has been classically divided into 3 patterns based on CT findings, that is, consolidation-predominant, peribronchial nodules-predominant and ground-glass opacity (GGO)-predominant.[5] However, data on relationships between the clinical and microbiologic features of CAP and CT findings are scarce. In CAP, pure or nearly pure GGO lesions are uncommon regardless of causative pathogens,[16,18] and a CT finding multiple centrilobular nodules is also rare.[19] We hypothesized that the clinical manifestations of patients with CAP are related to CT findings, and thus, we compared the clinical features and microbiologic data of CAP patients classified based on CT findings.

MATERIALS AND METHODS

Study Design

We retrospectively enrolled consecutive patients with CAP admitted to and treated at the Respiratory Department of Kyungpook National University Hospital (KNUH), a tertiary referral center, in Daegu, South Korea between January 2011 and December 2016.[20] Baseline patient characteristics were recorded at admission, although not all patients underwent the same laboratory tests. Pneumonia was diagnosed using the following criteria: (1) a new radiographic infiltrate, (2) 1 or more symptoms or signs consistent with pneumonia (cough, sputum, dyspnea, fever or pleuritic chest pain) and (3) the exclusion of other causes.[21] Patients with hospital-acquired pneumonia,[22] healthcare-associated pneumonia,[22] an active thoracic malignancy or taking immunosuppressants or steroids (>15 mg/day of prednisone for >14 days) were excluded. Patients without an available chest CT scan at presentation were also excluded.

The CT findings of CAP were classified into 3 categories: bronchiolitis, GGO and consolidation. These 3 groups were compared in terms of clinical characteristics and microbiologic data. The study was approved by the Institutional Review Board of KNUH, which waived the requirement for written informed patient consent because of the retrospective nature of the study.

Radiologic Data

Two chest radiologists (J.K.L. and K.M.S.) reviewed the chest CT scans of patients with CAP and classified them into the 3 groups (Figure). In the bronchiolitis group, chest CT indicated centrilobular nodules or tree-in-bud pattern in most lesions with no or minimal GGO or consolidation (Figure).[23] In the GGO group, chest CT indicated focal or diffuse GGO with no or minimal centrilobular nodules, tree-in-bud pattern or consolidation. In the consolidation group, chest CT indicated consolidation with or without variable extents of the CT features of bronchiolitis or GGO.

Data Collection

Two chest physicians (H.S. and S.I.C.) reviewed medical records. Resident physicians initially recorded baseline data, which were confirmed by attending chest physicians. Demographic data included age, sex, smoking history and alcohol consumption. Heavy drinking was defined as the consumption of 7 or more drinks (>60 g of alcohol) on 1 occasion for men, and 5 or more drinks (>40 g of alcohol) on 1 occasion for women at least twice a week. We reviewed symptoms, vital signs, comorbidities, pneumonia severity indices,[24] CURB-65 scores,[25] Eastern Cooperative Oncology Group (ECOG) performance statuses[26] and retrospectively calculated Charlson comorbidity indices.[27] Use of mechanical ventilation, corticosteroid treatment, vasopressor infusion and pleural drainage with percutaneous catheters or chest tubes were checked. Outcome variables included length of hospital stay, 30-day mortality, in-hospital mortality and clinical success. Treatment success was defined as improvements in clinical symptoms or signs and radiologic findings. Laboratory data included complete blood count, erythrocyte sedimentation rate, liver function testing, C-reactive protein (CRP), procalcitonin, N-terminal of prohormone brain natriuretic peptide, blood urea nitrogen, creatinine, sodium, lactate dehydrogenase, lactate and arterial blood gas analysis.

Microbiological Data

The criteria for a causative pathogen were as follows[21]: a microorganism isolated from blood or pleural fluid; positive urinary antigen test for *S. pneumoniae* or *L. pneumophila* serogroup 1 (BinaxNOW *S. pneumoniae* and *Legionella* urinary antigen cards, Alere, Scarborough, ME); a culture of bacteria from a sputum sample (>25 neutrophils and <10 squamous epithelial cells per low-power field) collected within 24 hours of admission plus a compatible Gram-stain finding; identification of *M. pneumoniae* based on a positive immunoglobulin M (IgM) result or a 4-fold increase in immunoglobulin G (IgG) levels in convalescent versus initial blood samples by chemiluminescence immunoassay (LIAISON, Dia-Sorin, Saluggia, Italy) or positivity for *M. pneumoniae* in a sputum by polymerase chain reaction (PCR) (AmpliSens *Mycoplasma pneumoniae*-FEP PCR, Central Research Institute for Epidemiology, Moscow, Russia); the presence of *C. pneumoniae* as determined by a positive IgM or a 4-fold increase in IgG levels by micro-immunofluorescence (an in-house method) or by enzyme-linked immunosorbent assay (Diesse Diagnostica Senese, Monteriggioni, Italy); positivity for a respiratory virus (adenovirus, influenza [types A and B], parainfluenza virus [types 1, 2, 3 and 4], rhinovirus, respiratory syncytial virus [types A and B], bocavirus, metapneumovirus, coronavirus [229E, NL63 and OC43]