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Brief Report

Is there a potential role for echocardiography in adult patients with CAP?

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ABSTRACT

Background: The role of echocardiography in adult patients with community-acquired pneumonia (CAP) has not been tested in a clinical trial. The aim of the study was to assess the cardiac changes secondary to CAP by echocardiography and to find out the correlation between echocardiographic findings and the severity of CAP.
Methods: A total of 111 unselected consecutive adult patients hospitalized with CAP were enrolled. The control group consisted of 100 consecutive sex- and age-matched patients. The severity of CAP was evaluated with the pneumonia severity index and the CURB-65 (confusion, urea, respiratory rate, arterial blood pressure and age) score. Blood samples were taken and echocardiography was performed within the first 48 hours.
Results: White blood count, N-terminal pro–brain natriuretic peptide, and red blood cell distribution width were significantly higher in the CAP group compared with the control group. The 2 groups did not differ in terms of left and right ventricle ejection fraction, left atrial diameter, pulmonary artery systolic pressure, and left ventricular end-diastolic and end-systolic diameter. However, tricuspid annular plane systolic excursion (21.1 ± 4.3 vs 22.3 ± 4.1 mm; $P = .04$), aortic distensibility (2.5 ± 0.9 vs 3.5 ± 0.9 cm^2:dyne:10, $P < .001$), and aortic strain ($5.8\% \pm 2\%$ vs $6.5\% \pm 1.9\%$, $P = .009$) were significantly reduced in CAP group than in controls. The plasma concentration of N-terminal pro–brain natriuretic peptide correlated with aortic strain, aortic distensibility, tricuspid annular plane systolic excursion, pneumonia severity index score, and CURB-65 score.
Conclusions: Tricuspid annular plane systolic excursion and elastic properties of aorta may play a role in the diagnosis and clinical assessment of CAP severity, which could potentially guide the development of new prognostic models.

1. Introduction

Despite the efficacy of modern treatment, community-acquired pneumonia (CAP) is the leading cause of death due to infection and also a frequent cause of medical consultation in hospital's emergency departments (EDs) [1]. Prognostic scores, like the CURB-65 (confusion, urea, respiratory rate, arterial blood pressure and age) score and the pneumonia severity index (PSI), have been developed and validated to estimate the risk of adverse outcome and to register a patient with CAP for hospital admission [2,3]. Several serum biomarkers have been also investigated in patients with CAP. Procalcitonin and C-reactive protein are commonly used biomarkers in CAP as indicators of severity of disease and predictors of mortality [4]. Elevated N-terminal pro–brain natriuretic peptide (NT-proBNP) has been shown to be associated with adverse prognosis in several cardiac conditions [5] as well as acute ischemic stroke [6] and critically ill patients [7]. N-terminal pro–brain natriuretic peptide is also shown to have a good correlation with clinical scores and to be an important predictor of short- and long-term mortality and acute kidney injury in the ED and in hospitalized patients with CAP [8,9]. A growing number of echocardiographic markers have been evaluated as possible predictors of prognosis in patients with pulmonary and infectious diseases such as sepsis [10], septic shock [11], human immunodeficiency virus infection [12], pulmonary tuberculosis [13], and chronic obstructive pulmonary disease [14]. However, the value of right ventricular systolic functions or aortic stiffness indices has not been evaluated in infectious conditions such as sepsis, pneomonia, or infective endocarditis.

Although effects of pneumonia on cardiac structures are theoretically possible because of increased systemic inflammatory activity, prothrombotic conditions, biomechanical stress on coronary arteries, variations in coronary arterial tone, and altered myocardial metabolic balance during infections, the role of transthoracic echocardiography has never been evaluated in patients with CAP. As echocardiography is a noninvasive, reliable, cost-effective, and reproducible diagnostic

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tool to evaluate cardiac function and structures, we aimed to investigate left and right ventricular functions and aortic elastic properties in CAP patients. Furthermore, we also aimed to observe relationships between echocardiographic findings and inflammatory and cardiac serum biomarkers in patients with CAP.

2. Methods

This prospective observational study was conducted at a university-affiliated hospital in Turkey from March 2015 to May 2015. All patients ≥18 years of age and with CAP diagnosis hospitalized through the ED were prospectively recruited. After they gave written informed consent, we enrolled 111 consecutive patients. Patients with active pulmonary tuberculosis, those with hospital-acquired pneumonia, severely immunocompromised patients, patients undergoing chronic dialysis, and patients sent for ambulatory treatment were excluded. Pneumonia was defined by the presence of 2 or more of the following recently acquired symptoms or signs: temperature >38°C, dyspnea, cough, sputum production, pleuritic chest pain, or bronchial sounds or crackles on chest auscultation, plus radiographical findings of pneumonia.

Community-acquired pneumonia is defined as pneumonia acquired outside a hospital or long-term care facility that occurs within 48 hours of hospital admission or in a patient presenting with pneumonia who does not have any of the characteristics of health care–associated pneumonia (ie, hospitalized in an acute care hospital for 2 or more days within 90 days of infection; resided in a nursing home or long-term care facility; received recent intravenous antibiotic therapy, chemotherapy, or wound care within the past 30 days of the current infection; or attended a hospital or hemodialysis clinic). The control group consisted of 100 consecutive sex- and age-matched patients admitted to the ED during the same period who presented with shortness of breath as their primary complaint and had no obvious traumatic or infectious cause of dyspnea. The study protocol was approved by the regional ethics committee.

3. Data collection

Sociodemographic characteristics and clinical data were collected on all subjects at presentation. Patients' demographic and clinical data were collected by the emergency medicine and infectious disease physicians by using a standard questionnaire. Patients' informed consent was obtained by the same team. The vital signs including systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, and body temperature were recorded at the triage area on arrival to the ED. Complete blood count, routine biochemical analyses, and NT-proBNP and troponin I concentrations were measured within the first 24 hours. Severity of pneumonia was quantified by the PSI, a validated prediction score for 30-day mortality in patients with CAP and CURB-65 score (confusion, blood urea nitrogen >20 mg/dL, respiratory rate >30 breaths per minute, blood pressure <90/60 mm Hg, and age ≥65 years) [15].

4. Tranthoracic echocardiography

Standard M-mode and 2-dimensional color Doppler echocardiography was performed in all patients using Philips System (Philips Epiq 7G, Andover, MA) within 2 days of hospital admission. Transthoracic echocardiography was performed and interpreted by 2 experienced echocardiographers (OB and VD). Standard views, including the left lateral decubitus and supine positions, were obtained. The M-mode traces were recorded at a speed of 50 mm/s, and the Doppler signals were also recorded at a speed of 100 mm/s. M-mode echocardiographic measurements were obtained based on the standards of the American Society of Echocardiography [16]. Diameter of the ascending aorta was measured from the same view on the M-mode tracing at 3 cm above the aortic valve. The systolic diameter was measured at the maximal anterior motion of the aorta, whereas the diastolic diameter was measured at the peak of the QRS complex on the simultaneously recorded electrocardiogram. Five consecutive cardiac beats were measured routinely and averaged. Blood pressure was measured with an external sphygmomanometer.

The aortic stiffness index, aortic distensibility, and aortic strain were determined as aortic elasticity properties. The formulae used in the calculation of these parameters were as follow [17,18]:

$$\text{Aortic strain } (\%) = (\text{aortic systolic diameter} - \text{diastolic diameter}) \times 100 / \text{diastolic diameter},$$

$$\text{Aortic distensibility } \left(\text{cm}^2/\text{dyn}\right) = (2 \times \text{aortic strain})/(\text{systolic pressure} - \text{diastolic pressure}).$$

The mitral and tricuspid inflow velocity was traced and the following variables derived: peak velocity of early (E) and late (A) filling and deceleration time (DT) of the E wave velocity. The ratio of early to late peak velocities (E/A) was calculated for left and right ventricle in the apical 4-chamber view. Left ventricular ejection fraction was measured by transthoracic echocardiography using the modified Simpson rule.

Tricuspid annular plane systolic excursion (TAPSE), which is an index of right ventricular systolic function, was estimated by 2-dimensional echo-guided M-mode recordings from the apical 4-chamber view with the cursor placed at the free wall side of the tricuspid annulus [19]. The pulmonary artery systolic pressure was estimated by continuous wave Doppler evaluation of tricuspid regurgitation.

5. Statistical analysis

Data were analyzed using SPSS for Windows (version 15; SPSS Inc, Chicago, IL). The continuous variables were expressed as mean ± standart deviation and were compared between groups by 2-tailed Student *t* test. Nonparametric tests were also used when necessary (Mann-Whitney *U* test). Fisher exact (χ^2) test was used in comparison of categorical variables. Statistical differences among groups were tested by one-way analysis of variance and Kruskal-Wallis tests for parametric and nonparametric variables, respectively. Univariate and multivariate logistic regression analyses were applied to determine crude and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the relationship between TAPSE, aortic distensibility, aortic strain, and CAP. Intraobserver and interobserver variabilities were calculated as a relative error. Correlation analyses were performed using the Pearson test. For all analyses, $P < .05$ was considered statistically significant.

6. Results

6.1. Baseline characteristics of study patients

There were 111 patients (mean age, 65.8 ± 13.8; 52% male) in the CAP group and 100 patients (mean age, 66.5 ± 13.2; 49% male) in the control group. The baseline characteristics of patients with CAP and control group are presented on Table 1. The control group consisted of 100 consecutive sex- and age-matched patients admitted to the ED with shortness of breath who had no obvious traumatic or infectious cause of dyspnea. The reasons of dyspnea was asthma in 25 patients, chronic obstructive pulmonary disease in 18 patients, neuromuscular and psychiatric diseases in 13 patients, left ventricular failure in 12 patients, pleural effusion in 8 patients, renal failure in 5 patients, metabolic acidosis in 3 patients, pulmonary embolism in 3 patients, pneumothorax in 1 patient, and other uncommon diseases in 12 patients.

There was no statistically difference between the groups in terms of age, sex, systolic and diastolic blood pressure, history of heart failure, atrial fibrillation, cerebrovascular disease, or chronic obstructive pulmonary disease. However, CAP patients had a higher prevalence of diabetes mellitus, hypertension, and coronary artery disease. The mean CURB-65 score and PSI score values were 1.7 ± 1.2 and 3.2 ± 1.2 in our CAP group, respectively.