

The relationship between the severity of radiological involvement in COVID-19 pneumonia and the neutrophil-lymphocyte ratio, the platelet-lymphocyte ratio, and C-reactive protein level

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March 07, 2024

Abstract

Background: Various studies describing the clinical characteristics of patients with COVID-19 pneumonia have shown that patients with a severe disease course have a tendency to have higher C-reactive protein (CRP) levels, neutrophil-lymphocyte ratio (NLR) and platelet-lymphocyte ratio (PLR). **Aims:** The aim of this study was to determine whether or not there was a correlation between the CRP value, NLR, and PLR, which are simple, effective, and repeatable predictive values, and the lung involvement severity score determined from the thoracic computed tomography (CT) findings of patients with COVID-19 pneumonia. **Methods:** This retrospective study included 200 patients admitted to the COVID-19 clinic of Erzincan Binali Yildirim University Mengucek Gazi Training and Research Hospital between 01.10.2020 and 31.12.2020. The thoracic CT examination results and CT scores of the patients were recorded. The relationships were investigated between the thoracic CT score and the systemic inflammatory mediator levels. **Results:** A positive correlation was determined between the radiological scoring and NLR at a weak level ($r=0.22$, $p=0.001$), PLR at a weak level ($r=0.18$, $p=0.012$) and CRP at a moderate level ($r=0.43$, $p<0.001$).

INTRODUCTION

The outbreak of unexplained pneumonia in Wuhan, China in December 2019 rapidly spread and attracted worldwide attention(1). On 30 January 2020, the disease caused by the SARS-CoV-2 virus was named coronavirus disease 2019 (COVID-19), and a global pandemic was declared by the World Health Organisation on 11 March 2020 (2, 3).

Biomarkers of inflammation in the blood such as white blood cell (WBC) count, NLR, PLR, and serum CRP have been investigated as independent predictors of the prognosis of inflammatory diseases (4, 5).

NLR is easily calculated from routine blood test by dividing the absolute neutrophil count by the absolute lymphocyte count, and is important in showing the general inflammatory status of the patient (6).

Recent research has shown that severe COVID-19 cases tend to have higher NLR (7).

CRP is an acute inflammatory protein, which increases up to 1000-fold in regions of infection and inflammation. CRP is a routinely measured inflammatory marker, which has been reported to be increased in the majority of COVID-19 patients and to be associated with disease severity (7-9).

A confirmed diagnosis of COVID-19 infection requires PCR identification of viral nucleic acid and lung imaging (10). Most patients have lung imaging results indicating bilateral pulmonary involvement with parenchymal ground-glass appearance and consolidated pulmonary opacities, sometimes with a rounded morphology

and peripheral lung distribution. There is a notable absence of lung cavitation, discrete pulmonary nodules, pleural effusions, and lymphadenopathy (10).

The aim of this study was to determine whether or not there was a correlation between the CRP value, NLR, and PLR, and the lung involvement severity score according to the thoracic CT findings of patients who developed COVID-19 pneumonia.

METHOD

This retrospective study included 200 patients admitted to the COVID-19 clinic of Erzincan Binali Yildirim University Mengucek Gazi Training and Research Hospital between 01.10.2020 and 31.12.2020. Demographic characteristics and laboratory test results of the patients were retrieved from the hospital electronic medical records system. Patients were excluded from the study if they were aged <18 years, were pregnant, were followed up in the Intensive Care Unit (ICU) or transferred to the ICU during follow up, or if basic data were incomplete. A record was made of the hemogram taken on the day of admission, CRP values and thorax CT results.

Cellular blood counts (WBC, leukocyte subtypes, hemoglobin level, platelet count) were performed using the Sysmex XN-1000 Hematology System (Sysmex Corporation, Kobe, Japan). CRP was measured using the nephelometric method on a BN II System™ (Siemens, Munich, Germany).

The NLR was determined by dividing the absolute neutrophil count by the absolute lymphocyte count, and PLR by dividing the absolute platelet count by the absolute lymphocyte count.

The CT images were acquired using a third-generation dual-source CT device (Somatom Force, Siemens Healthineers, Germany). After scout acquisition, imaging was conducted in the supine position, in a cranio-caudal direction with the following parameters: 80/140 SnkVp, 60 mAs, and rotation time 0.33 s. Imaging reconstruction was performed in axial, coronal and sagittal planes with 1.5mm slice thickness.

The CT severity scores were calculated using the Pan et al method (11).

CT severity score
0
1
2
3
4
5
CT: Computed tomography Scores were defined for each lobe and the total of the scores for each lobe constituted the total score.

Table 1: CT severity scoring

Statistical Analysis

Data obtained in the study were analyzed statistically using IBM SPSS vn. 22 software (IBM Corpn, Armonk, NY, USA). Continuous variables were stated as mean±standard deviation (SD), median (minimum-maximum) values, and categorical variables as number (n) and percentage (%). Relationships between the radiological scoring and the other variables were evaluated with Spearman correlation analysis and presented as scatterplots. In the interpretation of the correlation coefficients, a value of $r<0.03$ indicated a weak correlation, $0.3-0.7$ a moderate correlation, and >0.7 a strong correlation. A value of $p<0.05$ was accepted as statistically significant.

Results

Evaluation was made of 200 patients comprising 88 (44%) males and 112 (56%) females with a mean age of 63.4 ± 14.3 years (range, 24-94 years). The laboratory test results and radiological values of the patients on the day of hospital admission are shown in Table 2.

	Mean \pm SD	Median (Min-Max)
WBC	6842.2 \pm 3157.4	6300(500-31100)
NEUTROPHIL	4.6 \pm 2.4	4.1(0.6-16.1)
LYMPHOCYTE	1.7 \pm 1.4	1.5(0.3-19.4)
PLATELET	228.2 \pm 94	211(14-719)
NLR	3.7 \pm 3.5	2.6(0.4-22.1)
PLR	172.7 \pm 118.7	142.6(5.9-1071)
CRP	37.9 \pm 37.2	22(3-178)
RADIOLOGY	10.6 \pm 5.2	11(0-25)

Table 2.

A positive correlation was determined between the radiological scoring and NLR at a weak level ($r=0.22$, $p=0.001$), PLR at a weak level ($r=0.18$, $p=0.012$) and CRP at a moderate level ($r=0.43$, $p<0.001$) (Figure 1).

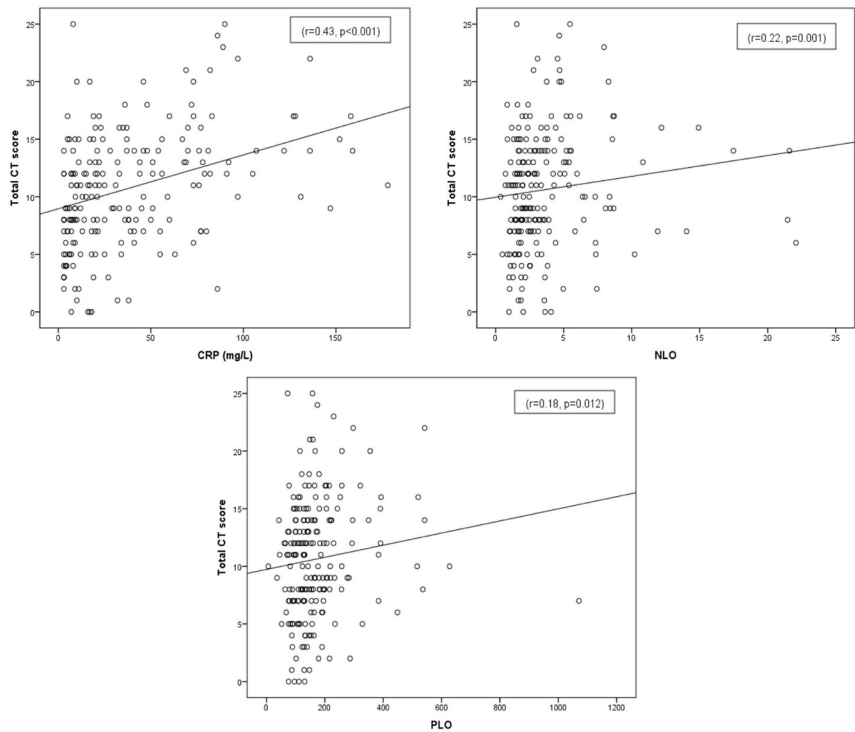


Figure 1.

DISCUSSION

In recent years, researchers have examined the value of ratios such as NLR, PLR, and monocyte-lymphocyte ratio (MLR) in the diagnosis and prognosis of several inflammatory conditions.

The results of this study demonstrated that there was a relationship between CRP, NLR, and PLR, and the severity score of lung involvement according to thoracic CT findings in patients with COVID-19 pneumonia.

NLR in the peripheral blood is associated with disease activity and the systemic inflammatory status, and has been shown to have prognostic value in autoimmune diseases, malignant tumours, and infectious diseases (12-15).

In a previous study of 61 COVID-19 patients, NLR was reported to be the most useful marker showing the incidence of severe COVID-19, with a cutoff value of ≥ 3.13 for the differentiation of severe and non-severe disease (16).

Shang et al evaluated the clinical data of 443 COVID-19 patients and found that NLR, CRP, and thrombocytes could be useful in determining the severity of disease, and although NLR was the best determinant, all the parameters should be taken into consideration (17). PLR, which is a new inflammation index, reflects the level of systemic inflammation.

Previous studies have reported that PLR is closely associated with tumours, diabetes, coronary heart disease, and connective tissue diseases, and an increase in PLR is related to tumour size, lymph node infiltration, distant metastasis, and prognosis, and could be used as a potential inflammatory marker for the clinical diagnosis of community-acquired pneumonia (18).

In a study of 30 patients diagnosed with COVID-19, Qu et al suggested that an elevated PLR in the blood parameters prolonged the length of stay in hospital and there could be a relationship with disease prognosis (19).

The results of the current study demonstrated a weak positive correlation between the lung involvement severity score determined on CT and the PLR and NLR in patients who developed COVID-19 pneumonia.

CRP is an acute phase protein synthesised by hepatocytes. In lung diseases with inflammatory characteristics, the serum CRP level is generally increased as a response to inflammatory cytokines such as interleukin-6 (IL-6), IL-1, or tumour necrosis factor alpha (TNF- α) (20, 21).

In COVID-19 patients, CRP increases as a response to pro-inflammatory cytokines and the majority of previous studies have reported this increase (22, 23).

In a previous study, CRP levels in COVID-19 patients on hospital admission were a determining factor independently of disease severity during hospitalisation, and CRP was reported to show good performance in the prediction of negative outcomes in COVID-19 patients (24).

In the current study, a moderate level correlation was observed between CRP levels on admission to hospital and the lung involvement severity score.

In daily practice, NLR, PLR, and CRP are lower cost markers than cytokines because blood count is widely used in the clinic routine. Therefore, NLR, PLR, and CRP on first admission to hospital can be used as a useful marker of the extent of radiological involvement. The use of these ratios in the prediction of the severity of the radiological involvement can provide both early intervention and reduce the exposure to ionising radiation required by thoracic CT.

Limitations of this study could be said to be the relatively small patient population, that it was conducted in a single centre, and the retrospective design. However, to the best of our knowledge, it is the first study to have been conducted on this subject.

The results of this study demonstrated that it can be concluded that in COVID-19 patients with higher NLR, PLR, and CRP values, the lungs will be more affected radiologically. Nevertheless, there is a need for further studies on this subject.

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