SCIE DOI: 10.14744/scie.2024.01488
South. Clin. Ist. Euras. 2025;36(1):7-11

Original Article

The Relationship Between Computed Tomography Score of Showing Disease Severity and Laboratory Parameters in Covid-19 Pneumonia

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Submitted: 05.10.2023
Revised: 06.11.2024
Accepted: 16.12.2024

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Keywords: Covid-19 pneumonia; CT Score; laboratory parameters.

ABSTRACT

Objective: We aimed to predict the distinction between mild and severe Covid-19 pneumonia by using computerized tomography (CT) and laboratory system.

Methods: Our study was planned retrospectively. Our study included 587 patients, 263 (44.8%) women and 324 (55.2%) men, who applied to the emergency department. Hemogram and biochemistry parameters were used. The Chest CT Severity Score (CT score) was calculated for each patient's lung involvement (0: No involvement, 1: 0%-25%; 2: 26%-50%; 3: 51%-75%; 4: 76%-100%). A distinction was made between mild and severe Covid-19 pneumonia.

Results: According to the logistic regression analysis, when the Hb and ALP values increase by 1 unit, the risk of high involvement is respectively; 9.4%(p=0.045)(OR=0.906) and 0.8% (p=0.010)(OR=0.992) will decrease. When ALT and CRP values increase by 1 unit, the risk of high involvement is respectively; It will increase by 1% (p=0.041)(OR=1.010) and 1.6% (p=0.000)(OR=1.016). In addition, as NLR, PLR, and AST/ALT ratios increase, the CT score will increase (r=0.226; p=0.000, r=0.163; p=0.000, r=0.209; p=0.000, respectively).

Conclusion: CT score can be estimated using laboratory data that is quick and easy to access. We found that Hb, ALT, ALP and CRP values and CT score are predictable in Covid-19 cases. We think that our study will contribute to other studies on Covid-19 pneumonia.

INTRODUCTION

The novel coronavirus disease 2019 (COVID-19), which is caused by SARS-CoV-2, was defined for the first time in the city of Wuhan in China in 2019 by the diagnosis of COVID-19-associated pneumonia among pneumonia cases of unknown cause. It has then spread to the whole world. This outbreak was announced as the COVID-19 pandemic by the World Health Organization. With daily increases in numbers, the number of mortalities associated with COVID-19 has exceeded 6 million since the onset of the pandemic.[1] In comparison to 2019, when we first identified the disease, substantial advancements have been realized in the diagnosis and treatment of COVID-19. Scientific studies continue to be carried out intensively worldwide.

Computed Tomography (CT), hemogram, and biochemistry tests help us with the diagnosis and differential diagnosis of COVID-19 patients. For the diagnosis of COVID-19 pneumonia, the CT score and a semi-quantitative method

determining the severity of pulmonary involvement were utilized. CT scoring has a high level of sensitivity in the management of COVID-19.[2,3] We believe that we can contribute to the diagnosis and treatment of COVID-19 pneumonia by using CT scores and laboratory parameters.

Our clinical experience during the COVID-19 pandemic has shown us that timely diagnosis and early intervention increase the survival rates of patients. We thought that we could distinguish mild and severe COVID-19 infection cases by using hemogram and biochemistry parameters, which are tested faster, without waiting for the CT imaging and interpretation results of patients with COVID-19 pneumonia. The results of this study will allow us to estimate the severity of the CT score. We think that this will be beneficial for us to start treatment faster for our patients.

MATERIALS AND METHODS

The sample of our study included 587 patients, of whom 263 (44.8%) were female, and 324 (55.2%) were male, who presented to the Emergency Clinic. The ages of the patients varied in the range of 19-96 (57.15±14.82). The information of patients who were diagnosed with COVID-19 pneumonia during the COVID-19 pandemic was retrospectively analyzed. The sample included patients whose routine blood test and thoracic CT results were available. Patients with chronic renal failure, chronic liver disease, immunosuppression, or malignancies were excluded. Ap-

Table 1. Laboratory parameters of the mild and severe groups

	Mild Groups (n=183)		Severe Groups (n=404)		
Parameter	**$\bar{X}$±S.S.**	**Medyan [Min-Max]**	**$\bar{X}$±S.S.**	**Medyan [Min-Max]**	**Statistical analysis* Probability**
Hb	13.45±2.29	13.6 [6.5-21.2]	13.04±2.18	13.3 [3.7-34.0]	p=0.010
PLT	272.75±95.24	265.0 [25.0-644.0]	249.29±99.73	231.0 [2.3-754.0]	p=0.001
Nötrofil	5.65±3.63	4.8 [0.9-23.1]	5.36±3.88	4.2 [0.6-27.7]	p=0.076
Lenfosit	1.71±0.78	1.6 [0.3-4.2]	1.48±0.92	1.3 [0.3-9.9]	p=0.000
AST	33.84±63.85	23.0 [9.0-755.0]	42.11±38.14	32.0 [11.0-474.0]	p=0.000
ALT	27.18±26.51	18.5 [5.0-240.0]	33.71±33.98	25.0 [6.0-378.0]	p=0.000
ALP	86.75±40.32	77.0 [26.0-279.0]	78.40±34.27	72.0 [18.0-282.0]	p=0.021
CRP	22.11±33.94	3.3 [0.0-116.2]	45.54±41.466	32.0 [0.0-122.7]	p=0.000
D-dimer	761.15±1057.52	399.5 [25.0-6898.0]	1124.89±2832.82	397.0 [17.0-28500.0]	p=0.580
Troponin	21.97±66.67	0.0 [0.0-370.0]	20.93±48.43	0.0 [0.0-280.0]	p=0.332
Ferritin	361.13±433.72	147.2 [7.9-1391.6]	471.33±1130.66	244.2 [5.5-9090.0]	p=0.328
Procalsitonin	5.34±17.74	0.1 [0.1-83.4]	1.72±7.02	0.2 [0.1-52.3]	p=0.134
NLR	4.51±5.53	2.7 [0.7-45.9]	4.79±4.94	3.2 [0.2-31.2]	p=0.256
PLR	198.73±175.43	159.8 [14.5-1836.0]	211.96±145.21	170.6 [1.8-1093.6]	p=0.091
AST/ALT	1.33±0.58	1.2 [0.4-3.7]	1.47±0.80	1.3 [0.3-10.0]	p=0.050

SS: Severity Score; Hb: Hemoglobin; PLT: Platelet; AST: Aspartate transaminase; ALT: Alanine transaminase; ALP: Alkaline phosphatase; CRP: C Reactive protein; NLR: Neutrophil-to-lymphocyte ratio; PLR: Platelet to lymphocyte ratio.

proval was obtained from the Ethics Committee (protocol number: 2021.61.03.01).

CT score was used to assess pulmonary involvement observed in CT. Each of the five lung lobes was visually scored on a scale of 0 to 5, with 0 indicating no involvement and 5 indicating more than 75% involvement. (0: None, 1: 0-25%; 2: 26-50%; 3: 51-75%; 4: 76-100%). Patients were divided into two groups according to CT score in terms of severity score; mild (less than 7) and severe (18 and above).[4] Hemogram sub-parameters, liver enzyme levels, and coagulation parameters were recorded. CT scans of the patients participating in the study were evaluated by expert radiologists.

Statistical analyses were done with IBM SPSS Statistics 24 package program. The results were interpreted using frequency tables and descriptive statistics.Non-parametric tests were used to analyze the non-normally distributed measurements. Among such non-parametric methods, the "Mann-Whitney U" test was used to compare measurement values between two independent groups. Distribution of genders in severe-non severe groups were tested Pearson's $\chi 2$ cross-tables. Binary logistic regression analysis with the backward LR method was utilized to identify the factors influencing the risk of severe pulmonary involvement.

RESULTS

According to the results of the statistical analyses of the laboratory parameters of the mild and severe groups, which were determined based on CT score, there were statistically significant between the groups in terms of their Hb, PLT, lymphocyte, AST, ALT, ALP, and CRP values ($p<0.05$). The patients who were in the severe group had significantly lower Hb, PLT, lymphocyte, and ALP values than those in the mild group. The AST, ALT, and CRP values in the severe group were significantly higher than those in the mild group. There was no statistically significant difference between the severe and mild groups in terms of their neutrophil, d-dimer, troponin, ferritin, procalcitonin, NLR, PLR, or AST/ALT results ($p>0.05$) (Table 1)

A positive, very weak, and statistically significant relationship was identified between CT score and NLR values ($r=0.226$; $p=0.000$). There was a positive, very weak, and statistically significant relationship between CT score and PLR values ($r=0.163$; $p=0.000$). There was also a positive, very weak, and statistically significant relationship between CT score and AST/ALT values ($r=0.209$; $p=0.000$). There was no statistically significant relationship between CT score values and D-dimer values ($p>0.05$) (Table 2).

Table 2. Relationships between CT score values and some biochemistry parameters

Correlation* (N=587)		
Variable	**CT score**	
	r	**p**
NLR	0.226	0.000
PLR	0.163	0.000
AST/ALT	0.209	0.000
D-dimer	0.119	0.102

*"Spearman's correlation coefficient" was used to test the relationship between two non-normally distributed variables. NLR: Neutrophil-to-lymphocyte ratio; PLR: Platelet to lymphocyte ratio; AST: Aspartate transaminase; ALT: Alanine transaminase.

There was no significant difference between the sex distributions of the mild and severe groups ($p>0.05$) (Table 3).

The optimal final model that was obtained as a result of the Backward LR logistic regression analysis conducted based on the risk of CT score using the parameters that were found significant in the univariate analyses is presented in Table 2. In the model, Hb, ALT, ALP, and CRP values were determined to be significant predictors of CT score. A 1-unit increase in Hb and ALP values would correspond to a decrease in the risk of CT score by respectively 9.4% ($p=0.045$; OR=0.906) and 0.8% ($p=0.010$; OR=0.992). When ALT and CRP values increase by 1 unit, the risk of severe involvement. It will increase by 1% (OR=1.010) ($p=0.041$) and 1.6% (OR=1.016) ($p=0.000$) respectively (Table 4).

RT-PCR results were available for 257 of the 587 patients (151 positive RT-PCR, 106 negative RT-PCR). If we had access to all patients' RT-PCR results, we could present more statistically significant data in our study.

Table 3. Sex distributions of the mild and severe groups

Involvement risk	**Low-Risk (n=183)**		**High-Risk (n=404)**		**Statistical analysis* Prob.**
Variable	**n**	**%**	**n**	**%**	
Sex					
Female	82	44.8	181	44.8	$\chi^2=0.000$
Male	101	55.2	223	55.2	p=0.999

*Pearson's χ^2 cross-tables were used to investigate the relationship between the two variables.

Table 4. Logistic regression model for the risk of severe involvement.

Variable	B	SE	Wald	df	p	OR	Lower	Upper
Hb	-0.099	0.049	4.018	1	0.045	0.906	0.822	0.998
PLT	-0.002	0.001	3.507	1	0.061	0.998	0.996	1.000
ALT	0.010	0.005	4.170	1	0.041	1.010	1.001	1.019
ALP	-0.008	0.003	6.720	1	0.010	0.992	0.986	0.998
CRP	0.016	0.003	25.081	1	0.000	1.016	1.010	1.022
Constant	2.521	0.798	9.970	1	0.002	12.437		

SS: Severity Score; Hb: Hemoglobin; PLT: Platelet; ALT: Alanine transaminase; ALP: Alkaline phosphatase; CRP: C Reactive Protein; OR: Odds Ratio; B: Logistic regression; SE: Standart error; df: Degrees of freedom.

DISCUSSION

It is known that during the COVID-19 pandemic, the early diagnosis of COVID-19 pneumonia prevented the rapid spread of the disease, and mortality rates, especially those among high-risk cases, could be reduced with early treatment.[5,6] COVID-19 pneumonia can be diagnosed by thoracic CT and/or RT-PCR. Several studies have shown that COVID-19 pneumonia has a typical appearance on CT.[7,8] In the study performed by Ai et al.,[9] while the thorax CT result was positive in 97% of 601 patients (RT-PCR positive), the thorax CT result was positive in 75% of 413 patients (RT-PCR negative). Since we were able to reach 257 (43.7%) of the RT-PCR results of the patients in our study; we could not find any statistically significant data between CT-score and RT-PCR. With the increase in the number of similar studies, during the pandemic, to increase their survival rates, the treatment of patients started in the early period by the interpretation of their CT images without waiting for their RT-PCR results.

Conclusion

In our study, we identified positive correlations between the severity of CT score in COVID-19 pneumonia cases and laboratory parameters, which are easily accessible. In pneumonia cases, an increase in neutrophil counts indicates an early inflammatory response. In the early period of acute infections, neutrophils kill bacteria, fungi, and viruses via oxidative bursts and phagocytosis.[10] COVID-19 patients display neutrophilia, thrombocytopenia, and due to the reduction in CD4+T cell counts, lymphopenia. Therefore, in COVID-19 cases, NLR and PLR values also rise to some extent, and they are proportional to the severity of the disease.[11,12] In our study, the Hb, PLT, ALP, and lymphocyte count values of the severe group were significantly lower than those of the mild group (Table 1). We determined that as NLR values increased, CT score values also increased. In their study where CT images were taken at 4-day intervals in 84 patients, Zhang et al.[13] reported significantly higher neutrophil counts when the CT score values were the highest. Imran et al.[14] found a positive correlation between NLR and CRP values and severe COVID-19 infection. They argued that NLR is a biomarker for the early diagnosis of severe COVID-19 pneumonia. Using NLR, which can be easily measured based on routine blood test results, patients with severe CT score can be detected in the early period. Liu et al.[15] also made the same conclusion. In the meta-analysis conducted by Chan et al.[11] which included a total of 3508 patients and 20 studies, it was seen that the NLR and PLR values of patients with severe COVID-19 were higher than those of patients with non-severe COVID-19 11(T). In this study, we also observed that as PLR values increased, CT score values also increased. In the study in which they included 554 individuals, Medetalibeyoglu et al.[16] stated that patients with AST/ALT values greater than 1 were more likely to be hospitalized in intensive care units and have more severe pneumonia, and these values were associated with a higher risk of mortality. In our study, it was also found that as the AST/ALT ratio rose, CT score values also became higher. However, the ROC analysis would have been more useful if their sensitivity and specificity had been determined as a distinct number in the numerical parameters in our study results.

Consequently, treatment can be started quickly in severe Covid-19 cases by using laboratory parameters that are cheaper, easily accessible and provide quick results, without using expensive procedures such as CT and RT-PCR testing. In Covid-19 cases, we found that CT score are predictable with Hb, ALT, ALP and CRP values.

Ethics Committee Approval

The study was approved by the Tekirdağ Namık Kemal University Non-Interventional Clinical Research Ethics Committee (Date: 30/03/2021, Decision No: 2021/61/03/01).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: S.P.K., O.E.; Design: O.E., T.İ.K.O.; Supervision: S.P.K., O.E.; Materials: S.P.K., O.E., S.A., T.İ.K.O.; Data collection &/or processing: S.P.K., O.E., S.A., T.İ.K.O.; Analysis and/or interpretation: S.P.K., O.E., S.A., T.İ.K.O.; Literature search: S.P.K., O.E., S.A., T.İ.K.O.; Writing: S.P.K., T.İ.K.O.; Critical review: S.P.K., O.E., S.A., T.İ.K.O.

Conflict of Interest

None declared.

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Covid-19 Pnömonisinde Hastalık Şiddetini Gösteren Bilgisayarlı Tomografi Skoru ile Laboratuvar Parametreleri Arasındaki İlişki

Amaç: Bilgisayarlı tomografi (BT) ile laboratuvar verilerini kullanarak, hafif ve ciddi Covid-19 pnömonisi ayrımını öngörmeyi amaçladık.

Gereç ve Yöntem: Çalışmamız retrospektif olarak planlandı. Çalışmamıza acil servise başvuran 263'ü (%44.8) kadın, 324'ü (%55.2) erkek olmak üzere 587 hasta dahil edildi. Hemogram ile biyokimya parametreleri kullanıldı. Her hastanın akciğer tutulumu için Chest CT Severity Score (CT score) hesaplandı (0: Tutulum yok, 1: 0%-25%; 2: 26%-50%; 3: 51%-75%; 4: 76%-100%). Hafif ve ciddi Covid-19 pnömonisi ayırımı yapıldı.

Bulgular: Lojistik regresyon analizine göre, Hb ve ALP değeri 1 birim arttığında yüksek tutulum riski sırasıyla; %9.4 (p=0.045)(OR=0.906) ve %0.8 (p=0.010)(OR=0.992) azalacaktır. ALT ve CRP değeri 1 birim arttığında yüksek tutulum riski sırasıyla; %1 (p=0.041)(OR=1.010) ve %1.6 (p=0.000)(OR=1.016) artacaktır. Ayrıca NLR, PLR ve AST/ALT oranı arttıkça BT skoru artacaktır (sırasıyla, r=0.226; p=0.000, r=0.163; p=0.000, r=0.209; p=0.000).

Sonuç: Ulaşımı hızlı ve kolay olan laboratuvar verilerini kullanarak BT skoru tahmin edilebilir. Covid-19 vakalarında Hb, ALT, ALP ve CRP değerleri ile CT skorunun tahmin edilebilir olduğunu tespit ettik. Çalışmamızın Covid-19 pnömonisi ile ilgili yapılmış diğer çalışmalara katkı sağlayacağını düşünmekteyiz

Anahtar Sözcükler: BT Skor; Covid-19 pneumonia; laboratuvar parametreleri.