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COVID-19 patients' lung involvement severity as a predictor of kidney dysfunction and coagulopathy disorders

Farinaz Fattahi[1], Mohammad Reza Farnia[2], Bareza Rezaei[2], Hooman Rafiei[2], Aisan Ghasemi Oskui[3], Amir Mohammad Amiri[4], Mohammad Reza Rezaei[2*]

Abstract

Introduction: Kidney dysfunction, coagulopathy disorders, and lung involvement are the most common disorders caused by the COVID-19 virus.

Objectives: This study aimed to investigate the correlation of lung involvement severity with kidney dysfunction and coagulopathy disorders in COVID-19 patients.

Patients and Methods: This descriptive-analytical study was conducted on 97 patients with COVID-19 referred to Imam Reza hospital in Kermanshah from December 2020 to June 2021. Lung involvement severity, kidney function tests, and coagulation laboratory data were collected. Logistic regression test was conducted to explore the correlation between lung involvement with kidney dysfunction and coagulopathy disorders.

Results: Out of 97 patients, 53 (54.6%) were male, with a mean age of 59.31 ± 16.44 years. The correlation between lung involvement severity with kidney function tests, including, blood urea nitrogen, serum creatinine, and coagulation factors, including prothrombin time (PT), partial thromboplastin time (PTT), and D-dimer, were significant ($P>0.05$). Lung involvement severity significantly predicted kidney dysfunction and coagulopathy disorders.

Conclusion: Lung involvement severity would be able to predict kidney dysfunction and coagulopathy disorders in patients with COVID-19.

Keywords: Lung involvement, COVID-19, Kidney dysfunction, D-dimer, Coagulopathy, SARS-CoV-2

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Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has appeared in Wuhan, China for the first time (1). This pneumonic disease caused by coronavirus was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) (2,3). Using chest computed tomography (CT) was a rapid, accessible, and cost-able tool for the diagnosis of this disease instead of the time-consuming and high cost of real-time polymerase chain reaction (RT-PCR) test (1). In recent reports, between 70% to 80% of lung involvements have been matched with clinical manifestations, and its use has been mentioned as an applied tool in the diagnosis and progression of the disease (4). In addition to pulmonary involvement in patients with COVID-19, organ failure and various laboratory disorders have been reported in previous studies; Huang et al reported that heart muscle inflammation and troponin rise are two of the most common complications caused by COVID-19 (5). Chan et al stated that cytokines activation in patients with COVID-19 would be associated with lymphoid organ atrophy, such as the spleen, and disrupt lymphocyte circulation (6). Kidney injury is another common complication caused by COVID-19 that has been reported in previous studies (7-9). The other reported common complication in COVID-19 patients especially, in severe stage, is coagulation disorders (10,11). It seems that the COVID-19 virus would be able to activate the coagulation factors through different mechanisms and lead to hypercoagulability (12).

Objectives

Considering the high and same-time prevalence of pulmonary involvement, kidney dysfunction, and coagulopathy disorders due to COVID-19 reported in previous studies, this study aimed to investigate the

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[1]Department of Emergency Medicine, School of Medicine, Milad Hospital, Isfahan University of Medical Sciences, Isfahan, Iran. [2]Department of Emergency Medicine, Taleghani and Imam Reza Hospitals, School of Medicine, Kermanshah University of Medical Science, Kermanshah, Iran. [3]Department of Emergency Medicine, Clinical Research Development Center of Taleghani and Imam Reza Hospitals, School of Medicine, Kermanshah University of Medical Science, Kermanshah, Iran. [4]Student Research Committee, School of Medicine, Kermanshah University of Medical Science, Kermanshah, Iran.

***Corresponding Author:** Mohammad Reza Rezaei, Email: mohammadreza.rezaei@kums.ac.ir

Implication for health policy/practice/research/ medical education

In a descriptive-analytical study on 97 patients with COVID-19, we found that the correlation between lung involvement with kidney function and coagulation disorder was significant, and lung involvement severity significantly predicted kidney dysfunction and coagulopathy disorders..

correlation between pulmonary involvement severity with renal and coagulation disorders in patients with COVID-19.

Patients and Methods

Study design and participants

This descriptive-analytical study was conducted on 97 patients with COVID-19 referred to Imam Reza hospital in Kermanshah from December 2020 to June 2021. Inclusion criteria included the definite diagnosis of COVID-19 based on RT-PCR and radiologic findings. At the admission, the chest CT-scan was captured, and the lung involvement severity was determined by an emergency medicine specialist. The laboratory data, including renal function tests and coagulation factors were checked and allocated into two groups of normal and abnormal. Data were recorded in a checklist, and the correlation between lung involvement with kidney dysfunction and coagulopathy disorders were investigated.

Data collection

Demographic characteristics were collected from patients' clinical documents or patients' interviews. Laboratory data were obtained through the health information system (HIS). To calculate lung involvement, a chest CT-scan was captured and analyzed by the researchers (emergency medicine specialists). Radiologic findings were evaluated by the percentage of lung involvement, and based on these results; we classified the cases into three stages severe, moderate, and mild. Lung involvement for each lobe was calculated with a score of one for patients with <5% lung involvement, a score of two for 5-25%, a score of three for 25-50%, a score of four for 50-75%, and a score of five for 75-100% lung involvement. For the total score lung involvement calculation, the scores of all five lobes were added together. Patients without lung involvement were considered normal. To classify lung involvement severity, a score of 1-8 was considered mild, 9-15 moderate, and >15 to 25 was severe (13).

Statistical analysis

Data were analyzed with SPSS version 26. The results for quantitative data were reported as "mean ± standard deviation (SD)" and for qualitative data as "frequency (percentage)". Quantitative variables were used to represent the mean of the data centers and standard deviation was performed to represent the distribution of the data. Analytical tests such as chi-square, Fisher's exact test, and logistic regression were performed to explore the association between lung involvement severity with kidney dysfunction and coagulopathy dysfunction. A *P* value less than 0.05 was considered significant.

Results

Demographic and clinical characteristics of studded patients were summarized in Table 1. Results demonstrated that most patients were male and without underlying disease. Most of them have severe lung involvement and in the final outcomes got recovery (Table 1).

Results showed that the correlation between the lung involvement severity with kidney function tests such as blood urea nitrogen (BUN) and serum creatinine (Cr) was statistically significant; also, its correlation with coagulation factors such as prothrombin time (PT), partial thromboplastin time (PTT), and D-dimer was significant (Table 2).

Results demonstrated that the correlation of lung involvement severity with kidney dysfunction and coagulopathy disorders was significant. Lung involvement severity could significantly predict BUN, serum creatinine, PT, PTT, and D-dimer abnormalities (Table 3).

Discussion

Our results demonstrated that lung involvement severity and as a result COVID-19 disease severity significantly could predict kidney dysfunction and coagulopathy disorders in COVID-19 patients, and patients with severe pulmonary involvement experienced more renal and coagulation disorders. This finding is similar to a study by Saurabh et al, which reported that SARS-CoV-2 patients' disease severity and lung involvement are significantly

Table 1. Baseline characteristics of studded patients

Variables	Sub-variable	No.	Percent
Gender	Male	53	54.6
	Female	44	45.4
Underlying diseases			
Heart diseases	Yes	83	85.6
	No	14	14.4
Diabetes mellitus	Yes	78	80.4
	No	19	19.6
Hypertension	Yes	81	83.5
	No	16	16.5
Chronic kidney diseases	Yes	92	94.8
	No	5	5.2
Outcomes	Death	11	11.3
	Recovery	86	88.7
Lung involvement severity	Normal	19	19.6
	Mild	22	22.7
	Moderate	26	26.8
	Severe	30	30.9
	Mean	**SD**	**Min**	**Max**
Age (year)	59.31	16.44	21	93

SD, Standard deviation; Max, Maximum; Min, Minimum

Table 2. The correlation between lung involvement severity with clinical factors and laboratory tests

Lab tests	Sub-variable	Lung Involvement severity				*P* value
		Normal No. (%)	Mild No. (%)	Moderate No. (%)	Severe No. (%)	
BUN	Normal	6 (54.5)	2 (18.2)	2 (18.2)	1 (9.2)	0.029[a]
	Abnormal	13 (15.1)	20 (23.3)	24 (27.9)	29 (33.7)	
Serum Cr	Normal	16 (31.3)	14 (27.5)	13 (25.5)	8 (15.7)	0.001[b]
	Abnormal	3 (6.5)	8 (17.4)	13 (28.3)	22 (47.8)	
PT	Normal	15 (26.8)	16 (28.6)	15 (25)	11 (19.6)	0.011[b]
	Abnormal	4 (9.8)	6 (14.6)	12 (29.3)	19 (46.3)	
PTT	Normal	16 (28.1)	14 (24.6)	14 (24.6)	13 (22.7)	0.037[b]
	Abnormal	3 (7.5)	8 (20)	12 (30)	17 (42.5)	
D-dimer	Normal	16 (24.6)	17 (26.2)	18 (27.7)	14 (21.5)	0.026[b]
	Abnormal	3 (9.4)	5 (15.6)	8 (25)	16 (50)	

BUN; Blood urea nitrogen, Cr; Creatinine, PT; Prothrombin time, PTT; Partial thromboplastin time.
[a] Fisher's exact test; [b] Chi-square.

associated with coagulopathy disorders such as D-dimer and PT prolongation (14). Yao et al stated that D-dimer was statistically significantly higher in severe disease SARS-CoV-2 patients compared to non-severe (15). Zhou et al reported that D-dimer would be able to use as a predictor of disease severity and mortality in COVID-19 patients (10). Previous meta-analysis and original studies also proved that COVID-19 disease severity is associated with higher D-dimer levels and other coagulopathy disorders (16-19). It seems that increasing the level of D-dimer value and other coagulation factors in patients with COVID-19 would be able to activate the coagulation cascades and causes the blood vessels' microthrombi that causing disseminated intravascular coagulation (16).

Table 3. Correlation of lung involvement severity with kidney dysfunction and coagulopathy disorders using logistic regression

Lung involvement severity	OR	*P* value	95% CI	
			Lower	Upper
BUN				
Normal	Reference			
Mild	4.61	0.086	0.80	26.45
Moderate	5.53	0.053	0.97	31.45
Severe	13.38	0.022	1.46	122.717
Cr				
Normal	Reference			
Mild	3.04	0.148	0.67	13.77
Moderate	5.33	0.24	1.24	22.80
Severe	14.66	<0.001	3.35	64.10
PT				
Normal	Reference			
Mild	1.46	0.644	0.33	5.98
Moderate	3.21	0.89	0.83	12.34
Severe	6.47	0.006	1.71	24.48
PTT				
Normal	Reference			
Mild	3.04	0.148	0.67	13.77
Moderate	4.57	0.041	1.06	19.57
Severe	6.97	0.008	1.67	29.11
D-dimer				
Normal	Reference			
Mild	1.56	0.578	0.32	7.66
Moderate	2.37	0.256	0.532	10.49
Normal	6.09	0.013	1.46	25.38

BUN, Blood urea nitrogen; Cr, Creatinine; PT, Prothrombin time; PTT, Partial thromboplastin time; OR, odds ratio; CI, confidence interval.

The other finding in this study is to investigate the correlation of lung involvement severity with kidney dysfunction; Results showed that lung involvement severity is associated with BUN and serum creatinine abnormality and significantly predicted kidney dysfunction. This result is consistent with the study by Cheng et al, which reported that kidney dysfunction is a predictor of COVID-19 disease severity and mortality (20). A meta-analysis study by Singh et al showed that renal dysfunction is significantly associated with SARS-CoV-2 disease severity (21). Additionally, Henry et al in a meta-analysis study, reported that kidney disorder and COVID-19 disease severity are correlated (22). It seems that kidney dysfunction in patients with COVID-19 is caused by dehydration and decreased urinary output, which causes diffused complications and other organ failures.

Conclusion

Results in this study, in line with previous studies, demonstrated that the correlation between lung involvement severity with kidney function tests and coagulation factors was significant; therefore, we conclude that lung involvement severity would be able to predict kidney dysfunction and coagulopathy disorders in patients with COVID-19.

Limitations of the study

These data belong to a single center. Therefore, our data should be compared with the data of the other countries.

Authors' contribution

Conceptualization: MrF and AA.
Methodology: AGh.
Validation: FF.
Formal analysis: MrR and HR.
Research: BR.
Resources: AGh and HR.
Data curation: AA and MrR.
Writing–original draft: AA, FF, BR, and HR.
Writing–reviewing and editing: AGh, MRF, and MrR.
Visualization: AA and HR.
Supervision: FF.
Project management: MrR.

Conflicts of interest

The authors declare that there is no conflict of interest.

Ethical issues

The research followed the tenets of the Declaration of Helsinki. The Ethics Committee of Kermanshah University of Medical Sciences approved this study. (Ethical code #IR.KUMS.MED.REC.1400.128). Accordingly, written informed consent was taken from all participants before any intervention. Besides, the authors have observed ethical issues (including plagiarism, data fabrication, and double publication).

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