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The effect of main pulmonary artery diameter on the prognosis of COVID-19 patients in the ICU

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ABSTRACT

Aim: The aim of this study was to examine the effect of main pulmonary artery diameter (MPAD), which is evaluated in patients when first admitted to the intensive care unit due to COVID-19, on mortality.

Material and Method: Thoracic computed tomography examinations performed during the initial admission to hospital of patients who were treated in the intensive care unit between October 1, 2020, and June 1, 2021, were evaluated retrospectively. Cox regression analysis was performed with the program R-Project to evaluate the relationship between MPAD and mortality.

Results: No significant correlation was found between MPAD and mortality in models used with or without adjusting for age and sex (respectively P: 0.890 and P: 0.920).

Conclusion: The MPAD value measured at the initial admission of COVID-19 patients hospitalized in the intensive care unit is not a parameter that can be used to predict mortality.

Keywords: COVID-19, main pulmonary artery diameter, intensive care unit, mortality

INTRODUCTION

Coronavirus disease is contracted through a newly identified viral infection caused by SARS-CoV-2, which can cause respiratory tract disease (1). This disease was first seen in the city of Wuhan located in Hubei Province in the People's Republic of China in the last days of 2019 (2). Due to the abundance of asymptomatic cases, it spread rapidly around the world (3). On March 11, 2020, this situation was declared a pandemic by the World Health Organization(WHO) (4). According to WHO data, as of January 15, 2022, the number of cases in the world exceeded 326 million and deaths exceeded 5.55 million (https://www.worldometers.info/coronavirus/). Although SARS-CoV-2 infection usually affects the lung and respiratory system, it can disrupt the structural integrity of the endothelial wall of the vascular structures and disrupt the functionality of the vascular structure. Endothelial cells provide vascular vasodilation and anticoagulation in the circulatory system through the cytokines they secrete in physiological state. When an inflammatory process such as COVID 19 is experienced, this situation reverses and causes vasoconstriction and procoagulation (microthrombus, etc.). This situation affects the entire vascular system as well as the pulmonary artery system, which plays an important role in the cardiopulmonary circulation. It can lead to increased pressure in the pulmonary artery, that is, pulmonary hypertension (5, 6).

Pulmonary hypertension can be regarded as the main reason for increases in the diameter of the pulmonary artery. Pulmonary hypertension is the case when mean pulmonary artery pressure, usually measured by cardiologists, is above 25 mmHg in right heart catheterization (7). During this procedure, the patient should be at rest (7). If the mean pulmonary artery pressure is between 21 and 24 mmHg, it is called borderline pulmonary hypertension (8). Diseases causing pulmonary hypertension are classified into five groups according to clinical, physiopathologic, and hemodynamic characteristics. Generally, primary lung pathologies are included in group 3 (9). The diagnosis of pulmonary hypertension is made by electrocardiogram, chest X-ray, pulmonary function tests, arterial blood gas, Doppler echocardiography, lung ventilation-perfusion

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scintigraphy, and thoracic computed tomography (CT). The increase in pulmonary pressure causes an increase in the diameter of the pulmonary artery. Pulmonary hypertension is suspected if the main pulmonary artery diameter (MPAD) is greater than or equal to 29 mm or the ratio of the diameter of the main pulmonary artery to the diameter of the ascending aorta is greater than one in thoracic CT (10, 11). It has been shown by previous studies that the increase in pulmonary diameter is associated with prognosis in patients other than COVID-19 (5, 6, 11). In line with all this information, the effect of MPAD in predicting the probability of mortality due to SARS-CoV-2, the biggest pandemic this century, was examined.

MATERIAL AND METHOD

This study was approved by the Ministry of Health of the Republic of Turkey and Adıyaman University Non-Invasive Clinical Researches Ethics Committee (Date: 15.03.2022, Decision No: 2022/3-31). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patient Selection

Patients hospitalized in the intensive care unit of our hospital between October 1, 2020 and June 1, 2021 due to SARS-CoV-2 infection were included in this retrospective study. Those over the age of 18 were included. Patients who were confirmed by real-time polymerase chain reaction (RT-PCR) for the SARS-CoV-2 RNA test and who had involvement congruent with COVID-19 pneumonia on thoracic CT imaging were included. Those with a negative RT-PCR for the SARS-CoV-2 RNA test and with no involvement in the thoracic CT examination were excluded. Patients with chronic liver disease, chronic kidney disease, malignancy, chronic obstructive pulmonary disease (COPD), and/or hematological diseases were excluded (**Diagram 1**). The criteria for admission to the intensive care unit were set according to those included in the COVID-19 adult patient treatment guideline of the Ministry of Health of the Republic of Turkey (12).

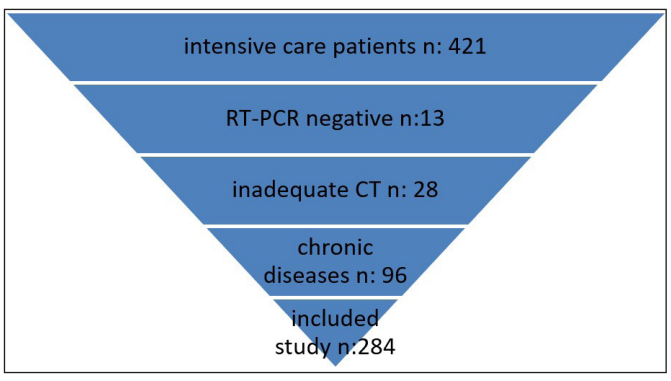

Diagram 1. Flow-chart for patient selection

Image Acquisition

Patients included in the study were screened using a 16-detector CT scanner (MX16, Philips Medical Systems, Eindhoven, the Netherlands). Pulmonary artery diameter was measured using the program Oracle Database version 1.10.48.299 on the images obtained. These patients were evaluated by a radiologist (M.Ç.) with at least 10 years of experience in the field of thoracic CT images upon initial admission to the hospital. Patients were excluded from the study in the event of conditions that prevented the main MPAD from being evaluated in the thoracic CT examination (artifact, inappropriate extraction, scoliosis, etc.). As recommended in the literature, MPAD was measured from wall to wall of the pulmonary artery at the level where it was seen at its widest level in the axial plane (13, 14) (**Figure 1**).

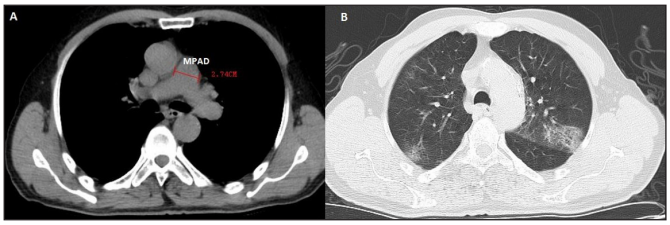

Figure 1. Axial noncontrast thoracic computed tomography images of a 63-year-old male patient A) Measurement of the main pulmonary artery diameter (27 mm) B) Peripheral ground-glass areas due to COVID-19 involvement in the upper lobes of both lungs at the time of initialadmission

Statistical Analysis

Frequency analysis, descriptive statistics, and survival analysis of the study were performed. Cox regression analysis was also performed to examine the effects of pulmonary artery diameter on the survival period of the patients. The results were obtained separately for the adjusted model and the unadjusted model, which was obtained by removing the effects of age and sex in Cox regression analyses. The margin of error was taken as 5% and the significance level was considered $P < 0.05$. The entire analysis was conducted with the program R-Project (R CoreTeam, 2020) (15).

RESULTS

In total 284 patients were included in the study. The results of the patients were calculated according to the descriptive statistics. Of the patients, 169 (59.5%) were male and 115 (40.5%) were female. Of these followed-up patients, 182 (64.1%) died and 102 (35.9%) were discharged alive. The mean age of the patients was 69.82 (range: 27-95) years (**Table 1**).

The mean MPAD of the patients was 29.33 mm. The narrowest MPAD was 21 mm and the widest was 44 mm (**Table 2**). No significant correlation was found between MPAD and mortality in the model unadjusted for age

and sex (P: 0.890). No significant correlation was found between MPAD and mortality in the model adjusted for age and sex either (P: 0.920). According to these results, an increase in MPAD did not cause a statistically significant increase in mortality (**Table 3**).

Table 1. Patients included in the study and their outcomes

	n	%
Sex		
Male	169	59.5
Female	115	40.5
Outcome		
Exitus	182	64.1
Alive	102	35.9

Table 2. Descriptive statistics of MPAD

	Mean	SD	Min	Max
MPAD	29.33	3.88	21.00	44.00

Table 3. Cox regression analysis results used as age and sex factor adjustment and established without correction effect

	Adjusted Model				Unadjusted Model			
	OR	Lower limit	Upper limit	P	OR	Lower limit	Upper limit	P
MPAD	1.003	0.961	1.047	0.890	1.002	0.959	1.047	0.920

DISCUSSION

It was demonstrated that there was no significant relationship between MPAD, which was evaluated in the thoracic CT examination obtained during the initial admission of patients who needed intensive care due to COVID-19 pneumonia and were followed up in the intensive care unit, and mortality. Although there are many studies in the literature evaluating the relationship between MPAD and COVID-19, the present study is unique in terms of study population and study design, since patients in intensive care units were evaluated and there were a large number of patients.

In the study by QQ Zhu et al. (16) that investigated the prediction of mortality using the pulmonary artery diameter of 180 COVID-19 patients, the contribution of pulmonary artery diameter to the increase in mortality was significant. In that study, the MPAD cut-off value used was 29 mm and a pulmonary artery diameter above 29 mm was considered large. However, in the present study, the effect of MPAD increase on mortality was examined without using a cut-off value. In addition, the mortality rates in the present study were quite high compared to those in the study by QQ Zhu et al. (16) (64.1% vs. 7.8%) due to the high mean age of the patients included in the present study (69.82 years vs. 46.99 years) and the patients requiring intensive care treatment.

In the study conducted by Erdoğan et al. (17) investigating the effect of MPAD, ascending aorta diameter, and the ratio of these two diameters on the prognosis of COVID-19 patients, the increase in the diameter of these vessels had a significant effect on mortality. They showed that MPAD was the most significant in relation to mortality among the three parameters they evaluated. In the study by Erdoğan et al., in which they included 255 patients hospitalized for COVID-19, the mean age was 55 and the mortality rate 21.9% (17). However, the patient profile included in the present study differed from the patient profile of Erdoğan et al.'s study, which caused the results obtained in the two studies to be different.

In their study conducted with 101 patients, Yıldız et al. (18) showed that the correlation of MPAD with the severity of COVID-19 pneumonia was significant. In that study with a small group of patients, they did not evaluate the relationship between MPAD and mortality (18). The relationship between pneumonia severity and MPAD was not examined in the patients included in the present study. Since the patient group in the present study consisted of intensive care unit patients, evaluation of pneumonia severity was not considered. The mortality status of the patients was evaluated as the prognosis.

In a COVID-19 study using the data of 1469 patients hospitalized in seven tertiary hospitals in Italy, the relationship between MPAD and mortality was examined (19). In that study, MPAD equal to or greater than 31 mm was the parameter that increased the mortality rates of COVID-19 patients. Although the border diameter length referenced was greater, it was determined that the mortality rate increased as MPAD increased. The mean age of the patients in that study was 69 years, which is similar to that of the present study. The mortality rate was 21%, which is lower than the rate in the present study (19). However, in that multicentric study, thoracic CT examinations were not obtained during the initial admission of the patients to the hospital, and thoracic CT examinations obtained 72 hours after admission were evaluated. Another difference from the present study is that only intensive care patients were included. In addition, cut-off values were not used to evaluate the diameter of the pulmonary artery in the present study.

Although the primary outcome revealed that it had no significant effect on mortality due to MPAD and COVID-19, this study has some limitations. One of the main limitations is that it was carried out as a single-center, retrospective, and nonrandomized study. The effect of COVID-19 disease could not be evaluated because MPAD was not evaluated during the intensive care period. The lack of data on the history of the patients in terms of pulmonary thromboembolism and heart diseases is another limitation of the study. In addition, thoracic CT images included in the study were without contrast and were obtained without using electrocardiography gating.

In the present study, information about the dynamic state of the pulmonary artery could not be obtained, since additional examinations such as echocardiography and right heart catheterization were not performed. Finally, the long-term effect of COVID-19 disease was not investigated, since MPAD follow-up could not be performed after treatment.

CONCLUSION

Despite the limitations of this study, it was shown that MPAD obtained at the time of initial admission to the hospital in intensive care units due to COVID-19 disease is not a parameter that can be used to predict mortality.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study was approved by the Ministry of Health of the Republic of Turkey and Adıyaman University Non-invasive Clinical Researches Ethics Committee (Date: 15.03.2022, Decision No: 2022/3-31).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

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Author Contributions: The author declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Çil B, Kabak M. Comparative evaluation of tocilizumab versus high dose methylprednisolonetherapy in mild acute respiratory distress syndrome related to COVID-19 pneumonia: a retrospective cohort study. New Trend Med Sci 2021; 2: 130-5.
2. Hui DS, Azhar EI, Madani TA, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health—The latest 2019 novel coronavirus outbreak in Wuhan, China. Int J Infect Dis 2020; 91: 264-6.
3. Sohrabi C, Alsafi Z, O'neill N, et al. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). Int J Surg 2020; 76: 71-6.
4. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun 2020; 109: 102433.
5. Sharma A, Tiwari S, Deb MK, Marty JL. Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2): a global pandemic and treatment strategies. Int J Antimicrob Agents 2020; 56: 106054.
6. Libby P, Lüscher T. COVID-19 is, in the end, an endothelial disease. Eur Heart J 2020; 41: 3038-44.
7. Hoeper MM, Bogaard HJ, Condliffe R, et al. Definitions and diagnosis of pulmonary hypertension. Turk Kardiyoloji Dernegi Arsivi 2014; 42: 55-66.
8. Douschan P, Kovacs G, Avian A, et al. Mild elevation of pulmonary arterial pressure as a predictor of mortality. Am J Respir Crit Care Med 2018; 197: 509-16.
9. Simonneau G, Galie N, Rubin LJ, et al. Clinical classification of pulmonary hypertension. J Am Coll Cardiol 2004; 43: 5-12.
10. Nazzareno G, Marc H, Jean LV, Simon G, Irene L, Adam T. ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension. The Joint Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS). Eur Heart J 2016; 37: 67-119.
11. Tan RT, Kuzo R, Goodman LR, Siegel R, Haasler GR, Presberg KW. Utility of CT scan evaluation for predicting pulmonary hypertension in patients with parenchymal lung disease. Chest 1998; 113: 1250-6.
12. Republic of Turkey Ministry of Healhty, Adult patient treatment in COVID-19, December 2021. https://covid19.saglik.gov.tr/Eklenti/42169/0/covid19rehberieriskinhastayonetimivetedavi20122021v6pdf.pdf. (Accessed February 10,2022).
13. Truong QA, Massaro JM, Rogers IS, et al. Reference values for normal pulmonary artery dimensions by noncontrast cardiac computed tomographyclinical perspective: The Framingham Heart Study. Circ Cardiovasc Imaging 2012; 5: 147-54.
14. Mahammedi A, Oshmyansky A, Hassoun PM, Thiemann DR, Siegelman SS. Pulmonary artery measurements in pulmonary hypertension: the role of computed tomography. J Thorac Imaging 2013; 28: 96-103.
15. R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
16. Zhu QQ, Gong T, Huang GQ, et al. Pulmonary artery trunk enlargement on admission as a predictor of mortality in in-hospital patients with COVID-19. Jpn J Radiol 2021; 1-9.
17. Erdoğan M, Öztürk S, Erdöl MA, et al. Prognostic utility of pulmonary artery and ascending aorta diameters derived from computed tomography in COVID-19 patients. Echocardiography 2021; 38: 1543-51.
18. Yildiz M, Yadigar S, Yildiz BŞ, et al. Evaluation of the relationship between COVID-19 pneumonia severity and pulmonary artery diameter measurement. Herz 2021; 46: 56-62.
19. Esposito A, Palmisano A, Toselli M, et al. Chest CT-derived pulmonary artery enlargement at the admission predicts overall survival in COVID-19 patients: insight from 1461 consecutive patients in Italy. Eur Radiol 2021; 31: 4031-41.