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# The relationship between pericardial effusion and pulmonary involvement, prognosis, mortality in COVID-19 patients

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| *Aim* | Comprehensive studies on the coexistence of COVID-19 and pericardial effusion (PEff) are limited. In this study, we investigated the relationship between pneumonia severity and PEff, predisposing factors, and the effect of PEff on clinical prognosis and mortality in COVID-19 patients. |
| *Material and methods* | Between March and November 2020, 5 575 patients were followed up in our pandemic hospital due to COVID-19. 3 794 patients with positive polymerase chain reaction (PCR) test results and thorax-computerized tomography (CT) imaging at admission were included in the study. The clinical and demographic characteristics, CT images, hematological and biochemical parameters of these patients were retrospectively examined. Pulmonary involvement of 3794 patients was divided into three groups and its relationship with PEff was investigated retrospectively. |
| *Results* | There were 560 patients who did not have pulmonary involvement, 2 639 patients with pulmonary involvement below 50%, and 595 patients with 50% or more pulmonary involvement. As pulmonary-involvement or the severity of the disease increased, male gender and advanced age become statistically significant. The mean age of patients with PEff was higher, and PEff was more common in males. Patients with PEff had more comorbid diseases and significantly elevated serum cardiac and inflammatory biomarkers. The need for intensive care and mortality rates were higher in these patients. While the in-hospital mortality rate was 56.9% in patients with PEff and pulmonary involvement above 50%, in-hospital mortality rate was 34.4% in patients with pulmonary involvement above 50% and without PEff ($p<0.001$).The presence of PEff during admission for COVID-19 disease, the appearance of PEff or increase in the degree of PEff during follow-up were closely related to mortality and prognosis. |
| *Conclusion* | As the severity of pulmonary involvement or the clinical severity of the disease increased, PEff occurred in patients or the degree of PEff increased. The clinical prognosis of patients presenting with PEff was quite poor, and the frequency of intensive care admissions and mortality were significantly higher. PEff was an important finding in the follow-up and management of patients with COVID-19, and it reflected the clinical prognosis. |

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| *Keywords* | COVID-19; pericardial effusion; clinical prognosis; pneumonia severity |
| *For citations* | İbrahim Saraç, Gökhan Tonkaz, Emrah Aksakal, Faruk Aydınyılmaz, Kaan Alişar, Sidar Şiyar Aydın, Selim Aydemir, Remziye Doğan, Oktay Gülcü, Kamuran Kalkan. The relationship between pericardial effusion and pulmonary involvement, prognosis, mortality in COVID-19 patients. Kardiologiia. 2022;62(9):67–73. [Russian: Ибрагим Сарач, Гекхан Тонказ, Эмра Аксакал, Фарук Айдыныылмаз, Каан Алишар, Сидар Шияр Айдын, Селим Айдемир, Ремзие Доган, Октай Гюльджю, Камуран Калкан. Взаимосвязь между перикардиальным выпотом и поражением легких, его ассоциации с прогнозом и смертностью у пациентов с COVID-19. Кардиология. 2022;62(9):67–73]. |

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## Introduction

The 2019 coronavirus disease (COVID-19) pandemic continues around the world, and tens of thousands of people continue to die from this disease or its complications [1]. Patients with cardiovascular disease (CVD) or with increased cardiovascular risk factors are more susceptible to development of major clinical complications of COVID-19 [2]. One of these conditions is pericardial effusion (PEff), which is the most common clinical presentation of pericardial diseases. PEff can be a complication of lung parenchyma infections, pleural infections, and some other diseases, and it is often seen as acute viral pericarditis [3]. The effect of SARS-CoV-2 in the pericardium occurs by a direct cytotoxic and/or immune-mediated mechanism [4]. In a study that examined a limited number of patients, the incidence of PEff in COVID-19 patients was approximately 5% [5].

In another study, patients with severe/critical COVID-19 had a higher incidence of PEff than patients with mild disease. In addition, a relationship between the presence of PEff and the severity of the disease was found [6]. In fact, extensive studies on the coexistence of COVID-19 and PEff are limited. The main purpose of this study was to investigate the relationship between pneumonia severity and PEff in COVID-19 patients, as well as the predisposing factors, and the effect of PEff on the clinical prognosis and mortality.

## Material and Methods

### *Patients*

Polymerasechainre action (PCR) tests were routinely performed to diagnose COVID-19 in all patients. Acombinedswabsample was taken in accordance with the specified procedures in all patients admitted to the emergency department [7]. The patients were managed in accordance with the guidelines published by the Turkish Ministry of Health on theuse of thoracic computerized tomography (CT) in COVID-19 patients.

These guidelines refer to large-scale, comprehensive studies [8]. Between March and November 2020, 5 575 patients were followed up in our pandemic hospital due to COVID-19. The PCR test results of 1160 patients were negative. 505 patients with positive PCR test results did not have chest CT imaging. An additional 116 patients with lung malignancy, a history of lobectomy, tuberculosis, or atelectasis, or who were under treatment for a recent diagnosis of pleural effusion, PEff, and non-COVID-19 pneumonia were excluded. Thus, a total of 3794 COVID-19patients with CT imaging at admission were included in this retrospective study. The study was performed in accordance with the Helsinki Declaration and with the approval of the local ethics committee.

### *The treatment management of the patient*

The patients were treatedaccording to the treatment guidelines published by the Ministry of Health. All patients were given favipravir 2×1600 mg loading doses followed by 2×600 mg maintenance doses for 5–10 days. Patients with oxygen desaturation and lung involvement were given 6 mg/day IV dexamethasone or equivalent 40 mg/day prednisone, or 32 mg methylprednisolone for 5–10 days. Patients who developed acute respiratory distress syndrome (ARDS) were given 250 mg/day methylprednisolone or pulse steroid (1000 mg prednisolone) for 3 days. Subsequently, 6 mg/day dexamethasone or 0.5–1 mg/kg/day prednisolone was given as maintenance. In patients who did not respond to this treatment, or in patients with macrophage activation syndrome (MAS), or in patients with findings of rapidly progressive MAS, monoclonal antibodies (MABs), 4–8 mg/kg IV infusion, or 400 mg standard IV single dose, or two doses within 12 hrs, not to exceed a maximum of 800 mg was administered. Appropriate empirical antimicrobial therapy (beta-lactam, macrolide, quinolone) was initiated ifclinical imaging or microbiological examination showedsigns of sepsis or findings suggestive of secondary bacterial infection. Prophylactic low molecular weight heparin was given to patients without contraindications [9].

### *Pericardial Effusion*

CT was accepted as the imaging modality for the evaluation of PEff. The smallest amount of pericardial fluid detectable by CT is approximately 10 ml [10]. The presence of >4 mm of fluid between both pericardial layers on CT is considered abnormal. In this study, the classification of PEff size in CT was performed as in the classification model according to transthoracic echocardiography (TTE) [3].

The severity of pulmonary involvement on CT. Assessment and patients groups. Chest CT severity score

In some studies, the clinical classification, i.e., mild, widespread, severe or critical illness, formed as a result of visual, semiquantitative evaluation of patients with COVID-19 pneumonia according to CT findings was compatible with the prognosis [6, 11, 12].This method is an adaptation of a method previously used to describe CT findings that correlated with clinical and laboratory parameters in post-severe acute respiratory syndrome (SARS) patients, and the percentage of involvement of each 5 lung lobes was calculated semi-quantitatively, i.e., visually [11–16].

In the current study, two radiologists, who were blinded to the clinical data, evaluated the CT findings in consensus as in previous, similar studies [17, 18]. The chest severity score (CT-SS, potential values from 0 to 20) was computed by summing up individual scores from 5 lung lobes; scores of 0, 1,2,3, or 4 were assigned, respectively, for each region if parenchymal opacification involved 0%,1%–25%, 25%–50%,≥50%–75%, or 75%–100% of that region. Patients without pulmonary involvement were classified as Group 1, those with pulmonary involvement below 50% were classified as Group 2 (minimal and mild involvement), and those with pulmonary involvement ≥50% were classified as Group 3 (moderate and severe involvement). An interobserver discrepancy was observed in the evaluation of the CT of 87 patients. The final decision on the pulmonary involvement of these patients was made based on the CT of those who recently had another CT or the clinical manifestations of those who did not have another CT.

### *Chest CT scan*

All CT images of lung parenchymawere reviewed at a window width and level of 1000 to 2000 Hounsfield units (HU) and –700 to –500 HU, respectively. Chest CT imaging was performed using a Toshiba Aquilion 64-detector CT scan-


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ner (Otawara, Japan). All patients were examined in the supine position, and CT images were acquired during a single inspiratory breath-hold. The scanning range was from the apex of the lung to the costophrenic angle. CT scan parameters were: x-ray tube parameters 120 kVp, 110–270 mAs, anf FoV 400 mm; section thickness 5 mm.

### *Statistical Analysis*

All data were analyzed with SPSS 22.0 software (SPSS Inc., Chicago, IL, USA). Categorical variables are presented as number (%), and continuous variables are presented as median (interquartile range (IQR)). Baseline characteristics were classified according to predefined subgroups and evaluated via appropriate statistical tests. Chi-square tests statistical tests were used for categorical variables. Mann–Whitney U tests for continuous variables with non-normal distribution and Kruskal Wallis-H tests were used for the analysis of variables in three groups with non-normal distributions. A regression analysis was performed on the statistically significant variables obtained from a univariate analysis, and independent predictors of in-hospital mortality were investigated. To investigate the relationship of tomographic variables with mortality, these variables were included in the regression analysis. A p value ≤0.05 was considered significant.

## Results

İn our study, there were 560 patients (group 1) who did not have pulmonary involvement, 2639 patients (group 2) with pulmonary involvement below 50%, and 595 patients (group 3) with 50% or more pulmonary involvement. The medianage of group 1 was 47, group 2 was 63, and group 3 was 70 (p<0.001). The rate of male patients was 45.4% in the 1st group, 47.9% in the 2nd group and 58.2% in the third group (p<0.001). The baseline cardiac and noncardiac comorbidities of thepatients, laboratory data at the time of admission to the emergency department, pericardial and pleuralinvolvementrates according to the severity of pulmonary involvement, as well as the need for intensive care and mortality rates during follow-uparegiven in Table 1. Presence of PEff according to the degree of pulmonary involvement, respectively; 0.7% in group 1, 2.3% in group 2, and 13.3% in group 3. In addition, when the intensive care needs of these patients in their follow-up are examined; It was observed as 5.4% in group 1, 11.3% in group 2 and 47.6% in group 3. The total mortality rates of these patients during the hospitalization were 1.6% in the 1st group, 8.5% in the 2nd group, and 37.5% in the 3rd group (Table 1).

Group 1 (560 patients) did not receive steroid treatment. Steroid therapy was routinely started for patients with hypoxia and pulmonary involvement [Groups 2 (2639 patients) and 3 (595 patients)]. Data of the patients that needed intensive care and that received pulse steroid and monoclonal antibodies (MABs) treatment during their follow-up are shown in Tables 1 and 2. In terms of mortality and need for pulse steroid and MABs treatment, there was no statistically significant difference between Groups 2 and 3 (Table 1), although pulse steroid and MABs treatmentstended to be higher in the PEff group (Table 2).

PEff was present in 145 of the patients. The clinical characteristics, demographic data, laboratory parameters, need for intensive care during follow-up, and mortality rates of the groups, separated according to the presence of PEff, are presented in Table 2. In the group with PEff, cardiac and non-cardiac comorbidities, laboratory findings showing the severity of COVID-19 pneumonia at admission, rates of pulmonary involvement, need for intensive care hospitalization and total mortality were found to be statistically significant.

Of the 145 patients with PEff, 76 needed intensive care, and 65 died. In addition, PEff was observed in 137 of 534 patients that did not have PEff at admission and needed intensive care during their follow-up (Figure 1).

In addition, the relationship between pulmonary involvement and the presence of PEff and pleural effusion and mortality is shown in Table 3. These parameters were evaluated by regression analysis. Lung involvement, presence of PEff,

**Figure 1.** The frequency of PEff and clinical course of patients during and after admission to the hospital

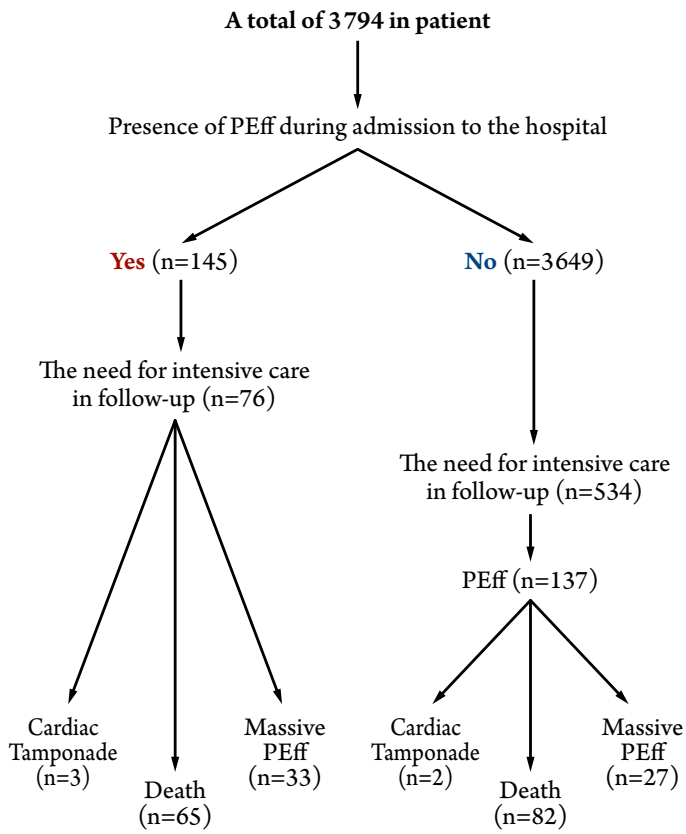

**Table 1.** Patient characteristics according to the degree of pulmonary involvement

| Variable | Group 1 Pulmonary Involvement (None) (n=560) | Group 2 Pulmonary Involvement (<50%) (n=2 639) | Group 3 Pulmonary Involvement (≥50%) (n=595) | p Value |
|---|---|---|---|---|
| Age (yr) | 47 (31-63) | 63 (52-73) | 70 (63-78) | <0.001 |
| Gender/Male | 254 (45.4) | 1265 (47.9) | 346 (58.2) | <0.001 |
| HT | 151 (27) | 1316 (49.9) | 371 (62.4) | <0.001 |
| DM | 76 (13.6) | 756 (28.6) | 194 (32.6) | <0.001 |
| CAD | 63 (11.3) | 560 (21.2) | 184 (30.9) | <0.001 |
| HF | 19 (3.4) | 130 (4.9) | 69 (11.6) | <0.001 |
| COPD | 52 (9.3) | 346 (13.1) | 96 (16.1) | 0.002 |
| CVD | 6 (1.1) | 55 (2.1) | 11 (1.8) | 0.279 |
| AF | 21 (3.8) | 142 (5.4) | 51 (8.6) | <0.001 |
| HL | 34 (6.1) | 346 (13.1) | 83 (14) | <0.001 |
| CRF | 14 (2.5) | 61 (2.3) | 22 (3.7) | 0.153 |
| **Laboratory Values** | | | | |
| Hb (g/dl) | 13.65 (12.67–14.9) | 13.4 (12.36–14.47) | 13 (11.4–14.2) | <0.001 |
| Wbc ($10^3$/μl) | 6.21 (4.64–7.82) | 6.71 (5.23–8.97) | 8.73 (6.67–11.61) | <0.001 |
| Neutrophilcount ($10^3$/μl) | 3.74 (2.59–5.24) | 4.7 (3.38–6.91) | 7.02 (4.99–9.96) | <0.001 |
| Lymphocytecount ($10^3$/μl) | 1.52 (1.19–2.09) | 1.24 (0.89–1.68) | 0.85 (0.6–1.29) | 0.033 |
| Plateletcount ($10^3$/μl) | 225 (186-269) | 230 (184–287) | 225 (172-293) | 0.06 |
| ALT (U/l) | 27.1 (18–37.4) | 32 (22–50.5) | 37.5 (23.9–60.4) | <0.001 |
| Ferritin (ng/ml) | 108.7 (38.4–238.4) | 264.6 (123.8–529.1) | 516.7 (247.5–913.3) | <0.001 |
| CRP (mg/l) | 5.13 (3.14–21.06) | 33.3 (12.9–65.8) | 68.7 (39.8–119) | <0.001 |
| D-dimer (μg/ml) | 190 (56–474) | 330 (91–1017) | 1307 (327-4786) | <0.001 |
| Procalcitonin (ng/ml) | 0.07 (0.02–0.3) | 0.09 (0.02–0.44) | 0.33 (0.07–1.13) | 0.205 |
| $SO_2$ (pulse oximeter,%) | 90.2 (87.2–94,7) | 83.1 (72.6–89.1) | 76.1 (60.3–84.5) | <0.001 |
| Troponin I (ng/ml) | 0.004 (0.002–0.019) | 0.009 (0.002–0.05) | 0.05 (0.009–0.43) | <0.001 |
| Creatinine (mg/dl) | 0.8 (0.66–0.97) | 0.87 (0.73–1.1) | 0.99 (0.78–1.33) | <0.001 |
| Albumin (g/l) | 4.1 (3.8–4.4) | 3.82 (3.5–4.1) | 3.35 (3.02–3.7) | <0.001 |
| **CT Findings** | | | | |
| Pericardial Effusion | 4 (0.7) massive: 0 | 62 (2.3) massive: 3 | 79 (13.3) massive: 6 | <0.001 |
| Pleural Effusion | 19 (3.4) | 172 (6.5) | 193 (32.4) | <0.001 |
| CT-SS | 0 | 6 (4-8) | 13 (11-14) | <0.001 |
| **DiseaseProgression** | | | | |
| Needfor ICU | 30 (5.4) | 297 (11.3) | 283 (47.6) | <0.001 |
| In-hospitalMortality | 9 (1.6) | 225 (8.5) | 223 (37.5) | <0.001 |
| **Treatmentin ICU and Mortality** | | | | |
| PulseSteroid | 0 | 119 (40.1) | 137 (48.4) | 0.192 |
| MortalitywithPulseSteroid | 0 | 68 (57.1) | 89 (64.9) | 0.264 |
| MABs | 0 | 43 (14.5) | 52 (18.4) | 0.525 |
| MortalitywithMABs | 0 | 25 (58.1) | 34 (65.4) | 0.378 |

Data arenumber (%) or median (IQR). HT, hypertension; DM, diabetes mellitus; CAD, coronary artery disease; HF, heart failure COPD, chronic obstructive pulmonary disease, CVD, cerebrovascular disease; AF, atrial fibrillation; HL, hyperlipidemia; CRF, chronic renal failure; ASA, acetylsalicylic acid; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BB, beta blocker; CCB, calcium channel blockers; Hb, hemoglobin; Htc, hematocrit; Wbc, white blood cell; AST, aspartate aminotransferase; ALT, alanine aminotransferase; LDH, lactate dehydrogenase; CRP, C-reactive protein; $SO_2$, oxygen saturation; Na, sodium; K, potassium; INR,international normalized ratio; TG, triglycerides; HDL, high density lipoprotein; LDL, low density lipoprotein; CT-SS, computerized tomography severity score; ICU, ıntensive care unit; IQR, interquartile range; MABs, monoclonal antibodies.

and presence of pleural effusion were independent predictors of mortality (p<0.001, 0.019, and <0.001, respectively).

## Discussion

Pericardial diseases typically caused by viruses include pericarditis, PEff and pericardial tamponade (PT). The exact pathophysiological mechanism of pericardial involvement in COVID-19 patients has not been fully elucidated. Although SARS-COV-2 shows cardiotropic properties, there is no strong evidence of direct infection and damage to the pericardium and myocardium. The systemic inflammatory reaction caused by the virus is thought to be respon-


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**Table 2.** Baseline characteristics according to the presence or absence of pericardial effusion

| Variable | Pericardial Effusion (–) (n=3649) | Pericardial Effusion (+) (n=145) | p value |
|---|---|---|---|
| Age (yr) | 63 (49–73) | 72 (65–79) | <0.001 |
| Gender/Male | 1791 (49.1) | 74 (51) | 0.652 |
| HT | 1737 (47.6) | 101 (69.7) | <0.001 |
| DM | 969 (26,6) | 57 (39.3) | 0.001 |
| CAD | 749 (20.5) | 58 (40) | <0.001 |
| HF | 172 (4.7) | 46 (31.7) | <0.001 |
| COPD | 453 (12.4) | 41 (28.3) | <0.001 |
| CVD | 69 (1.9) | 3 (2.1) | 0.878 |
| AF | 193 (5.3) | 21 (14.5) | <0.001 |
| HL | 440 (12) | 23 (15.9) | 0.170 |
| CRF | 86 (2.4) | 11 (7.6) | <0.001 |
| **Laboratory Values** | | | |
| Hb (g/dl) | 13.4 (12.3–14.5) | 12.6 (10.9–14.1) | <0.001 |
| Wbc ($10^3$/μl) | 6.84 (5.26–9.18) | 8.54 (6.19–10.74) | <0.001 |
| Neutrophilcount ($10^3$/μl) | 4.78 (3.35–7.15) | 6.51 (4.57–9.45) | <0.001 |
| Lymphocytecount ($10^3$/μl) | 1.24 (0.86–1.70) | 0.82 (0.57–1.26) | <0.001 |
| Plateletcount ($10^3$/μl) | 229 (184–285.7) | 215.3 (160.8–275) | 0.007 |
| ALT (U/l) | 31.6 (21.5–50) | 32.4 (21.8–54.5) | <0.001 |
| Ferritin (ng/ml) | 260.4 (115.6–552.3) | 414.4 (166.5–926.3) | <0.001 |
| CRP (mg/l) | 32.9 (10.6–70) | 66.2 (34.7–120.8) | <0.001 |
| D-dimer (μg/ml) | 350 (96.7–1147) | 1091 (252–4557) | <0.001 |
| Procalcitonin (ng/ml) | 0.1 (0.023–0.49) | 0.57 (0.13–1.84) | <0.001 |
| $SO_2$ (pulse oximeter,%) | 85.4 (75.4–90.6) | 78.2 (64.5–86.3) | 0.006 |
| Troponin I (ng/ml) | 0.01 (0.002–0.08) | 0.07 (0.01–0.61) | <0.001 |
| Creatinine (mg/dl) | 0.87 (0.73–1.09) | 1.15 (0.85–1.62) | <0.001 |
| Albumin (g/dl) | 3.8 (3.44–4.13) | 3.37 (3.05–3.71) | <0.001 |
| **CT Findings** | | | |
| Pulmonaryinvolvement | None: 556 (15.2)<br>< 50%: 2577 (70.6)<br>≥ 50%: 516 (14.1) | None: 4 (2.8)<br>< 50%: 62 (42.8)<br>≥ 50%: 79 (54.5) | <0.001 |
| Pleural Effusion | 302 (8.3) | 82 (52.6) | <0.001 |
| CT-SS | 6 (4–8) | 11 (6–16) | <0.001 |
| **DiseaseProgression** | | | |
| Needfor ICU | 534 (14.6) | 76 (52.4) | <0.001 |
| In-hospital Mortality | 392 (10.7) | 65 (44.8) | <0.001 |
| Pulmonary Involvement (n)/ In-hospital Mortality | ≥50%: 516/178 (34.4) | ≥50%: 79/45 (56.9) | <0.001 |
| | < 50%: 2577/207 (8) | < 50%: 62/18 (29) | |
| **Treatment in ICU and Mortality** | | | |
| PulseSteroid | 215 (40.3) | 41 (53.9) | 0.088 |
| Mortality with Pulse Steroid | 122 (56.7) | 25 (60.9) | 0.370 |
| MABs | 75 (14.1) | 20 (26.3) | 0.063 |
| Mortality with MABs | 46 (61.3) | 13 (65) | 0.875 |

Data arenumber (%) or median (IQR). HT, hypertension; DM, diabetes mellitus; CAD, coronary artery disease; HF, heart failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; AF, atrial fibrillation; HL, hyperlipidemia; CRF, chronic renal failure; ASA, acetylsalicylic acid; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BB, beta blocker; CCB, calcium channel blockers; Hb, hemoglobin; Htc, hematocrit;Wbc, white blood cell; AST, aspartate aminotransferase; ALT, alanine aminotransferase; LDH, lactate dehydrogenase; CRP, C-reactive protein; $SO_2$, oxygen saturation; Na, sodium; K, potassium; INR, international normalized ratio; TG, triglycerides; HDL, high density lipoprotein; LDL, low density lipoprotein; CT-SS, computerizedtomography severity score; ICU, ıntensive care unit; IQR, interquartile range; MABs, monoclonal antibodies.

sible for cardiac involvement, including pericarditis. In addition, pericardial involvement is associated with endothelial damage resulting from increased inflammation [19].

The pericardium normally contains a small amount (15–50 ml) of fluid [20]. While patients with PEff may occasionally be asymptomatic, sometimes they present with general condition disorder and hemodynamic disorder [21, 22]. The effect of PEff on the incidence and clinical prognosis of PEffas related to the severity of the disease or the stage of pulmonary involvement has not yet been demonstrated in large series [23].

**Table 3.** Univariate and multivariate analysis for mortality of COVID-19 patients.

| Variables | Univariate OR, 95 CI% | p value | Multivariate OR, 95 CI% | p value |
|---|---|---|---|---|
| Pulmonary Involvement | 6.43 (5.18–7.97) | <0.001 | 4.06 (3.20–5.14) | <0.001 |
| Pericardial Effusion | 5.68 (4.00–8.05) | <0.001 | 1.66 (1.08–2.55) | 0.019 |
| Pleural Effusion | 9.58 (7.53–12.19) | <0.001 | 5.64 (4.31–7.38) | <0.001 |

OR, oddsratio; CI,confidenceinterval.

In our study, as pulmonary involvement or the severity of the disease increased, male gender and advanced age became statistically significant. In fact, the importance of age, gender and comorbidity in the progression of the disease is now well known [24, 25]. In all three groups of the current study, cardiovascular disease and other comorbidities were observed more frequently in patients with increased severity of pulmonary involvement, consistent with the literature [26]. In this study, as in the literature, markers such as lymphocyte number and percentage, d-dimer, ferritin, C-reactive protein (CRP) and troponin had a statistically significant relationship in patients with severe disease and pulmonary involvement. Again, consistent with the literature [27], a close relationship was observed between the severity of pulmonary involvement, i.e., with high CT-SS and adverse clinical prognosis and mortality. Also, statistical significance was observed in patients with PEfff or age, gender, comorbidities such as HT, CAD, CHF, CRF, DM, and cardiac and serum inflammatory biomarkers, as previously reported [28].

In our study, pulmonary involvement, pleural effusion, need for intensive care and in-hospital death were more common in PEff patients. Other studies have shown a higher incidence of PEff in COVID-19 patients with severe and critical illnesses than in non-critical patients [6, 15]. In the current study, the in-hospital mortality rate was 56.9% in Group 3 patients with PEff, but it was 34.4% in Group 3 patients without PEff. As seen in this study, the severity of pulmonary involvement and the presence of conditions such as PEff and pleural effusion provide important information on the progression of the disease. Although the rate of massive effusion was low in patients with PEff, the need for intensive care was seen at the rate of 50% during their follow-up, and the degree of effusion increased in approximately one third of the patients and progressed to a serious effusion. As it is known, the prevalence of pulmonary involvement is the main finding that determines mortality and prognosis in patients with COVID-19. In our study, we found that the presence of PEff, as well as the severity of pulmonary involvement and other specific accompanying findings, were closely associated with mortality and prognosis. In the regression analysis, we found that PEff is an independent predictor of mortality in addition to pulmonary involvement and pleural effusion.

## Conclusion

As the severity of pulmonary involvement increased and the clinical severity of the disease increased, PEff occurred or the degree of PEff increased. For this reason, it appears that PEff should not be ignored when evaluating CT findings of COVID-19 patients. The degree of PEFF is an important finding that should be considered in making appropriate treatment plans and for predicting the course of the disease.

### *Limitations*

First, this study was designed retrospectively, and the data were obtained from files or electronic records. Due to the COVID-19 pandemic, a significant proportion of patients did not have TTE. At thebeginning of the COVID-19 pandemic, patientswere not administeredroutine TTE fortheetiology of dyspnea, and a significantproportion of inpatientsdid not have TTE. Therefore, retrospective evaluation of PEff was made with the findings in CT.

Patient comorbidities and the additional prescribed drugs generally differed. Patients in the intensive care unit received standard antiviral and steroid therapy, and the dose and duration of use were different. Thus, the effect of these agents on the course of PEff could not be evaluated.

*No conflict of interest is reported.*

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