The effect of being vaccinated on respiratory mechanics and mortality in critically ill patients with COVID-19

ABSTRACT

Background: The Coronavirus disease 2019 (COVID-19) is a disease that affects the human population globally and often causes the death of hundreds of thousands of people with lung involvement. In recent years, it is an unprecedented reason for occupancy in hospital wards and intensive care units.
Aims: In this study, it was aimed to compare the lung dynamics, prognosis, and mortality of vaccinated and unvaccinated patients in the intensive care unit.
Study Design: Patients hospitalized in Intensive Care Units between August 1, 2021 and September 30, 2021 were retrospectively examined.
Methods and materials: A total of 197 vaccinated and unvaccinated patients over 18 years of age, with positive Polymerase Chain Reaction (PCR) tests, and hospitalized in the intensive care unit were included in the study. Age, gender, comorbidity, vaccination, oxygen support, mechanical ventilator parameters, intubation times, radiology data and mortality of the patients included in the study were examined.
Results: This study, COVID-19 disease is more common in male gender, patients over 65 years of age and those with comorbidities. Unvaccinated patients are 4 times more likely vaccinated patients to be in intensive care. Almost all patients need oxygen support, but intubation is more often in unvaccinated patients. Mortality rates in the intensive care unit; it was found in 18% vaccinated patients, 64% unvaccinated patients, 53.8% overall. The most common causes of mortality were Acute Respiratory Distress Syndrome (ARDS) and sepsis.
Conclusion: Severe ARDS is more often to unvaccinated patients. Lung dynamic compliance <18 mL/cmH_2O is related with mortality. Severe lung damage on Computed Tomography (CT) score is related with ARDS and mortality. Mortality is more often to unvaccinated patients.

Keywords: COVID-19*, critically, respiratory, unvaccinated, vaccinated*

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1.INTRODUCTION

The Coronavirus disease 2019 (COVID-19) is a virus that affects the human population globally and often causes the death of hundreds of thousands of people with lung involvement. In recent years, it is an unprecedented reason for occupancy in hospital wards and intensive care units. Vaccine and drug studies are carried out in many countries to end this pandemic. It has been proven in many studies in the literature that the vaccine is protective and successful against COVID-19 [1]. For this reason, it has been reported that people should be vaccinated against this disease. The mortality rate has been reported to be between 50-97% in ventilator-dependent patients admitted to intensive care units in COVID-19 [2,3]. The reasons for the high mortality rate in the pandemic process need to be investigated. Therefore, in this study, it was aimed to compare the lung dynamics, prognosis, and mortality of vaccinated and unvaccinated patients in the intensive care unit.

2.MATERIALS AND METHODS

Patients hospitalized in Ersin Arslan Training and Research Hospital Mücahitler COVID-19 Intensive Care Units between August 1, 2021 and September 30, 2021 were retrospectively examined. A total of 197 vaccinated and unvaccinated patients over 18 years of age, with positive PCR tests, and hospitalized in the intensive care unit were included in the study. All patients younger than 18 years of age, who were not hospitalized in the intensive care unit and whose PCR test was negative, were excluded from the study. Age, gender, comorbidity, vaccination, oxygen support, mechanical ventilator parameters, intubation times, radiology data and mortality of the patients included in the study were examined. Radiological data were based on CO-RADS (Table 1), and computed tomography (CT) of the thorax was categorized (Table 2) according to lobar involvoments and the score and severity of the five lobes [4]. According to this classification; the rate of involvement of lobes were calculated and scored in the lung. The severity of the disease was categorized as mild, moderate and severe by numerical scoring. Acute Respiratory Distress Syndrome (ARDS) scoring was performed according to the Berlin Criteria (Table 3). The obtained data were analyzed statistically with the Kolmogorov Smirnov Test and SPSS (Statistical Package for the Social Sciences).

Table 1.CO-RADS Classification

	Chance of COVID-19	**CT Findings**

CO-RADS 1	Highly unlikely	Normal or non-infectious abnormalities
CO-RADS 2	Unlikely	Abnormalities consistent with infections other than COVID-19
CO-RADS 3	Equivocal	Unclear whether COVID-19 is present
CO-RADS 4	Probable	Abnormalities suspicious for COVID-19
CO-RADS 5	Highly likely	Typical COVID-19
CO-RADS 6	PCR proven	

*CO-RADS: COVID-19 Reporting and Data System

Table 2. Lobar scores and overall severity of the five lobes

Lobar Involvement	**Lobar Score**
5% or less	1
5%-25%	2
26%-49%	3
50%-75%	4
>75%	5
Total Score (numerical)	**Severity (category)**
7 or less	Mild
8-17	Moderate
18 or more	Severe

Table 3. Berlin Criteria for the diagnosis of ARDS

Timing	New or worsening respiratory distress within 1 week
Lung Imaging	Bilateral opacity unexplained by effusion, collapse or nodule
Edema	Objective demonstration that respiratory distress is not due to heart failure or hypervolemia
Oxygenation	
Mild	200 mmHg<PaO_2/FiO_2<300 mmHg+PEEP or CPAP ≥5 cmH_2O
Moderate	100 mmHg<PaO_2/FiO_2<200 mmHg+PEEP≥5 cmH_2O
Severe	PaO_2/FiO_2≤100 mmHg + PEEP≥5 cmH_2O

*PaO2: Arterial Partial Oxygen Pressure, *FiO2: Fraction of inspired oxygen
*CPAP: Continuous positive airway pressure, *PEEP: Positive end-expiratory pressure

3.RESULTS

All patients hospitalized in the intensive care unit between August and September 2021 were analyzed retrospectively. A total of 197 patients who met research criteria were included. 41.6% were female, 58.4% were male and the mean age was 64 (median:67 range:21-95). 141 patients had a history of comorbidity (71.5%). In order from most to least; diabetes mellitus 32.9% hypertension 30.9% coronary artery disease 16.7% chronic obstructive pulmonary disease 13.7% chronic renal failure 7.6%. The majority of patients hospitalized in the intensive care unit were unvaccinated. 44 patients completed their vaccinations (2 or 3 doses) and 125 patients unvaccinated (vaccinated 22.3% incompletely vaccinated 14.2% unvaccinated 63.5%). 115 patients needed mechanical ventilator and were intubated (58.3%). The other 82 patients needed oxygen support but were not intubated (41.7%). Oxygen support was provided with a 28.8% reservoir mask, 7.2% CPAP (Continious Positive Airway Pressure), 6.2% nasal cannula, 1.5% HFOT (High-flow nasal cannula oxygen therapy) (Table 4).

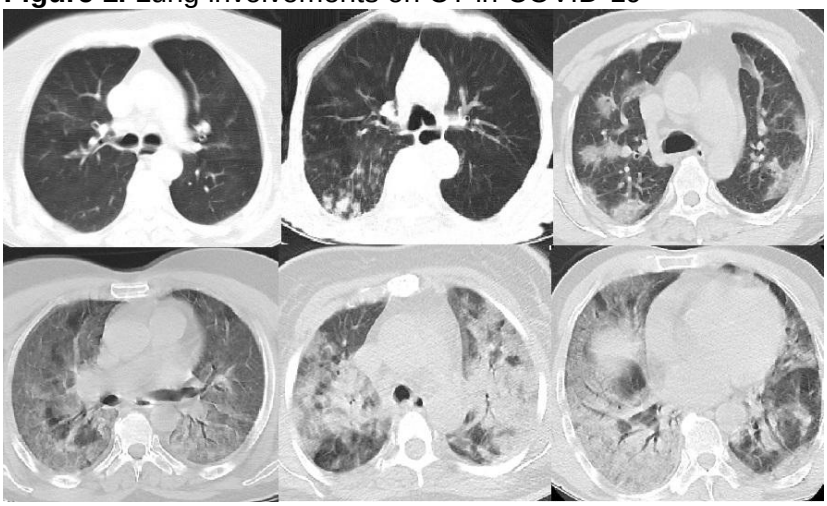
Table 4. Demographic data of the study

Parameters	n	Mean
Ages	197	64 (21-95)
Gender		
Male	115	58.4%
Female	82	41.6%
Comorbidity	141	
Diabetes Mellitus	46	32.9%
Hypertension	43	30.9%
Coronary Artery Disease	23	16.7%
Chronic Obstructive Pulmonary Disease	20	13.7%
Chronic Renal Failure	11	7.6%
Vaccinated		
Completed	44	22.3%
Incompletely	28	14.2%
Unvaccinated	125	63.5%
Oxygen support		
Mechanically ventilated	115	58.3%
Reservoir mask	55	28.8%
Continious Positive Airway Pressure	13	7.2%
Nasal cannula	11	6.2%
High-flow nasal cannula oxygen therapy	3	1.5%

The mean intubation day of intubated patients in the intensive care unit was 3.3 days (median:2 range:1-7), and the intubation time 8.1 days (median:7 range:1-30). Mechanical ventilator parameters; PEEP (Positive End Expiratory Pressure) average 9.1 (median:10 range:5-10), PS (Pressure Support) 18.6 (median:18 range:12-28), lung compliance 20.7 (median:19 range:10-41). According to the Berlin Criteria, ARDS (Acute respiratory distress

syndrome) days were average 4.4 (median:4 range:1-15). It was determined that 32.9% severe, 14.7% moderate and 5.1% mild ARDS. Radiological classification was determined as 43.1% Co-rads 5, 12.2% Co-rads 4, 7.5% Co-rads 3, 3.5% Co-rads 2 and 2.5% Co-rads 1 (31.2% unknown due to no first CT). CT score was determined as 17.2% severe, 31.9% moderate and 15.7% mild (Figure 1).

Figure 1. Lung involvements on CT in COVID-19



The mean length of hospitalized in the intensive care unit was 9.4 days (median:8 range:1-36). The mortality rate was found to be 53.8% (92.3% unvaccinated or incompletely vaccinated and 7.7% vaccinated). Causes of mortality were determined 45.3% ARDS, 26.5% sepsis, 8.5% congestive heart failure, 8.5% acute myocardial infarction, 6.6% acute renal failure, 2.8% MODS (multiple organ dysfunction syndrome), 1.8% chronic renal failure.

4.DISCUSSION

COVID-19 caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus) has been spread all over the world. This disease, which caused the death of hundreds of thousands of people, is being studied by scientists. Many studies have reported that the vaccine is effective in preventing the disease. However, many people do not get vaccinated due to their individual opposition to vaccination. Immunity to SARS-CoV-2 infection is a critical determinant of patients outcome [5]. For this reason, vaccination of people is recommended in many countries.

In the current study, it was observed that 63.5% of the patients hospitalized in the intensive care unit were not vaccinated at all, 14.2% were undervaccinated, and 77.7% of the patients in total were not vaccinated. The effectiveness of the Sinovac vaccine has been reported as 78% and the Biontech vaccine as 95% and neither vaccine is a safety threat [6]. In this study, 40 patients were fully vaccinated with Sinovac and 4 patients with Biontech, and a total of 22.3% were vaccinated. COVID-19 is more common in male gender, patients over 65 years of age and those with comorbidities ($p<0.05$). The mean age of unvaccinated patients hospitalized in the intensive care unit is 67, and there is no significant relationship with age. However, 75% of the unvaccinated patients had at least one chronic disease history ($p<0.05$).

Almost all of the patients in this study needed oxygen support. 58.3% of the patients needed mechanical ventilation and were intubated. Endothelial dysfunction with thromboinflammation has been reported in ARDS caused by COVID-19 pneumonia. Impairment in pulmonary perfusion is explained by microthrombosis and macrothrombosis [7,8]. It has been reported that it is seen in 42% of patients presenting with ARDS COVID-19

and in 61-81% of patients in need of intensive care [9]. In the present study, ARDS was detected at a rate of 94.4% in COVID-19 pneumonia patients hospitalized in the intensive care unit, according to the Berlin Criteria. ARDS scoring was 32.9% severe, 14.7% moderate, and 5.1% mild. Severe ARDS was more common in unvaccinated patients ($p<0.05$).

Alveolar damage in the lung, hyaline membrane formation, interstitial edema and fibroblast proliferation are the pathophysiology of ARDS. In COVID-19 ARDS, diffuse alveolar damage and typical pathological changes are seen in the lung. Fibrosis of the lung has been reported in COVID-19 [10-12]. Therefore, disturbances in lung elasticity and compliance occur. The normal value for dynamic lung compliance is 50-80 mL/cmH_2O. In this study, it was found that lung compliance, measured within the first 24 hours after intubation, decreased in almost all intubated patients. The mean value was found to be 20.7 mL/cmH_2O of lung compliance.

Table 5. Statistical analysis of the study

Parameters	**Completed Vaccinated**	**Unvaccinated**	**Mortality**
	p<	**p<**	**p<**
Male		0.05	0.05
Female	0.04		
Comorbidity		0.05	0.05
ARDS		0.02	0.04
Compliance of the lung <18 mL/cmH2O		0.03	0.05

Contrary to what is known in classical viral pneumonias, COVID-19 pneumonia was found to be more aggressive in this study. In some studies, the need for mechanical ventilation was reported as 86-97% in this disease [13,14]. In this study, almost all patients needed oxygen support, and the rate of invasive mechanical ventilation was 58.3%. The disease has been observed to cause severe lung damage ranging from pneumonia to severe ARDS. It was reported that the decrease in lung compliance over time after the day of intubation is associated with mortality in COVID-19 [15]. In this study, the mean lung compliance was found to be 20.7 (median:19 range:10-41).

According to the study, lung dynamic compliance <18 mL/cmH_2O is associated with mortality ($p<0.05$). Lobar scores and overall severity of the five lobes were evaluated on CT (Table 2). According to CT scores, it was determined as 17.2% severe, 31.9% moderate and 15.7% mild. Pulmonary involvement is more common to unvaccinated patients. Severe lung damage on CT is associated with ARDS and mortality ($p<0.05$). In this study, mortality rates in the intensive care unit; it was found in 18% vaccinated patients, 64% unvaccinated patients, 53.8% overall. The most common causes of mortality were ARDS and sepsis. Mortality is more common in unvaccinated patients ($p<0.05$) (Table 5).

5.CONCLUSION

According to this study, COVID-19 disease is more common in male gender, patients over 65 years of age and those with comorbidities. Unvaccinated patients are four times more than vaccinated patients to be hospitalized in intensive care. Almost all patients need oxygen support, but intubation is more common to unvaccinated patients. Mortality rates in the intensive care unit; it was found in 18% vaccinated patients, 64% unvaccinated patients, 53.8% overall. The most common causes of mortality were ARDS and sepsis. Severe ARDS is more common to unvaccinated patients. Lung dynamic compliance <18 mL/cmH_2O is

associated with mortality. Severe lung damage on CT score is associated with ARDS and mortality. Mortality is more common in unvaccinated patients.

ETHICAL APPROVAL

The study was approved by the Republic of Turkey Ministry of Health (numbered 2021/09 18T22_38_39) and Medical Ethics Committee of Gaziantep University (numbered 2021/322).

COMPETING INTERESTS DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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