

## Pneumothorax in Mechanically Ventilated Covid 19 Patients

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### Abstract

Mechanical ventilator-associated pneumothorax is one of the most important undesirable fatal complications in intensive care. In our study 953 patients were retrospectively analyzed. 100 patients with positive Covid PCR test, with pneumonia and mechanical ventilation were included in the study in intensive care. 69% of the patients were male and 31% female. The mean age was 68.6 (range:33-92 median:69). Male gender, history of chronic disease, age > 65 are associated with mortality. In Covid 19 pandemi period, an increase in the rates of pneumothorax associated with mechanical ventilation has been observed. The relationship between pneumothorax and mortality is known in the literature. Therefore, it is important to investigate the increase in pneumothorax rate and causes of death. Mechanical ventilator-associated pneumothorax was detected in 12 patients. P<sub>peak</sub> > 35 cmH<sub>2</sub>O is associated with both pneumothorax and mortality. Pneumothorax is associated with mortality. Interstitial diffuse pneumonia is associated with ARDS, pneumothorax and mortality separately. In our study, general pneumothorax has been found 1.4%(n:953) and mechanical ventilator related pneumothorax 4.1%(n:288). Covid 19 is known to cause severe lung damage. It has been observed that especially patients with Covid 19 pneumonia interstitial involvement are much more susceptible to barotrauma.

**Keywords:** barotrauma, Covid 19, intensive care, mechanical ventilator-associated, pneumothorax.

### Introduction

Pneumothorax is defined as lung collapse due to air accumulation between visceral and parietal pleura. Barotrauma incidence is stated as 0-50% in patients undergoing mechanical ventilation depending on the underlying disease, and general barotrauma is stated as 6.5% in acute

respiratory distress syndrome(ARDS)[1-2]. Pneumothorax is seen in 84.2% of the patients with barotrauma[3]. Due to its close relationship with mortality, pneumothorax secondary to the barotrauma in intensive care is one of the most important undesirable fatal complications. The relationship between pneumothorax and mortality is known in the literature. In Covid 19 pandemi period, an increase in the rates of pneumothorax associated with mechanical ventilation has been observed. It has been aimed to determine the frequency of pneumothorax, its relationship with ventilator parameters and causes of mortality in Covid 19 patients in intensive care.

### **Materials & Methods**

Our study was conducted in the Intensive Care Unit of Gaziantep Ersin Arslan Training and Research Hospital. Patients with a positive Covid-19 Polymerase Chain Reaction (PCR) test, typical viral pneumonia on computed tomography (CT) and in need of intensive care during hospital treatment were retrospectively examined (n:953). Among these patients, 100 patients who were intubated in the intensive care unit and provided invasive mechanical ventilation and died in the intensive care unit were included in the study. Electronic medical records and patient files of the patients were analyzed retrospectively. After the evaluation, demographic and clinical characteristics of the patients, ventilator parameters, radiological examinations, arterial blood parameters were collected. Berlin Criteria were used in the ARDS definition. Data of patients who developed pneumothorax were compared with other parameters. Statistically, groups were first evaluated using the Kolmogorov Smirnow Test. Statistical data were obtained by performing the analyzes in the Statistical Package for the Social Sciences(SPSS) program.

### **Results**

After retrospective examinations, a total of 100 patients were included in the study.69% of the patients were male and 31% female. The mean age was 68.6 (n:100 range:33-92 median:69).Mortality due to Covid-19 was more common in male gender ( $p < 0.01$  69% n:69).When the relationship between age distribution and mortality was examined, the mortality rate was higher in patients over 65 years of age ( $p < 0.01$  n:67).74 patients had a history of chronic disease, 18 patients had no comorbidity, and medical history information was not available in 8 patients. A significant relationship was found between having a history of chronic disease and mortality ( $p < 0.01$  n: 74). Pneumothorax was detected in 14 patients, 12 of them mechanical ventilator-associated pneumothorax and 2 spontaneous pneumothorax(table 1).Pneumothorax rate 71% in men and 29% in women. There was no significant relationship with age. Chronic obstructive pulmonary disease(COPD) was seen in 6 patients with pneumothorax. A significant relationship was found between COPD and pneumothorax( $p < 0.01$ ). Pneumothorax was seen on the right in 10 patients and on the left in 4 patients. Subcutaneous emphysema developed in 10 patients. Medical treatment was sufficient in 6 patients by adjusting the ventilator settings (decreasing Pp, ventilator mood change, increasing frequency). However, surgical treatment (tube thoracostomy) were performed in 8 patients. Two patients were treated with a thoracic tube, and the tube thoracostomy could be terminated, while the thorax tube of the

other 6 patients could not be removed due to continued air leakage. 12 patients with mechanical ventilator-associated pneumothorax; 2 died within the first 24 hours after pneumothorax was detected, and 5 within the first 48 hours. A significant relationship was found between pneumothorax and mortality ( $p < 0.01$  12% n:12). It was observed that pressure-controlled mode was preferred for 2 patients and volume-controlled mode was preferred for 10 patients as the mechanical ventilator mode. A significant relationship was found between Positive End Expiratory Pressure (PEEP)  $> 8$  cmH<sub>2</sub>O with mortality ( $p < 0.05$  n: 40), but there was no statistically significant relationship between pneumothorax with PEEP ( $p = 0.47$  n:40). Pp  $> 35$  cmH<sub>2</sub>O was found to be associated with both mortality and pneumothorax ( $p = 0.001$  n: 16, figure 1). ARDS was detected in 33 of the patients and it was found to be associated with both pneumothorax and mortality ( $p < 0.05$ , figure 2). Whether ARDS or not, blood gas results were found to be associated with PaO<sub>2</sub> / FiO<sub>2</sub>  $< 100$  mortality ( $p < 0.01$  n: 62). There was an appearance compatible with interstitial pneumonia in the first CT of the patients who developed ARDS. Interstitial diffuse pneumonia in CT is associated with ARDS, pneumothorax and mortality separately ( $p < 0.05$  n: 31, figure 3). There was no significant relationship between tidal volume, PaO<sub>2</sub> and PCO<sub>2</sub> levels and pneumothorax and mortality (table 2). In our study, general pneumothorax has been found 1.4% (n:953) and mechanical ventilator related pneumothorax 4.1% (n:288).

### **Discussion**

In humans, normal breathing occurs with negative intra-thoracic pressure. However, patients who need a mechanical ventilator for reasons such as respiratory failure are ventilated by the respiratory device with positive pressure. Naturally, positive pressure ventilation is not physiological and causes complications such as alveolar barotrauma [4].

Barotrauma is usually caused by alveolar damage. Air passes through the damaged alveoli to many different places. In this case, complications such as pneumothorax, pneumomediastinum and subcutaneous emphysema are seen when there is excessive air passage [5]. Certain diseases, including COPD, asthma, and ARDS, can predispose a person to pulmonary barotrauma. These diseases are related to dynamic hyperinflation or poor lung compliance. Therefore, sensitivity to barotrauma occurs after increased alveolar pressure [6]. In our study, pneumothorax and subcutaneous emphysema were observed more frequently in patients with COPD, ARDS and diffuse interstitial pneumonia. The pressure created by the air in the alveoli at the end of expiration is known as auto-PEEP. Occasionally, auto-PEEP can cause ventilator incompatibility, increased tension of the alveoli and consequently barotraumata [7]. In the analysis of our study, PEEP value  $> 8$  was not found to be associated with pneumothorax. However, it was found statistically that it was associated with mortality. Plateau pressure; It is the pressure measured after inspiration and before expiration begins. Inspiratory pressure (IP); It is the pressure that continues through the inspiration and largely creates the tidal volume. Peak pressure is; It is the highest pressure recorded during the inspiration. Practically Peak pressure is equal to the sum of IP and PEEP. It has been reported that Pp  $> 50$  cmH<sub>2</sub>O causes alveolar damage during mechanical

ventilation [8]. In addition, pneumothorax if there is a high PEEP value It has been shown to be a risk factor in terms of [9]. In another study, it is recommended not to exceed Pp 40-45 cmH<sub>2</sub>O due to barotraumas [10]. In our study, on the other hand, no significant relationship was found between pneumothorax and PEEP. Although the PEEP value was 8, ventilator-associated pneumothorax was detected in 2 patients even at 32 and 33 Pp values. Statistically, when the Pp value is above 35, a significant relationship with pneumothorax has been detected. For this reason, it is recommended to have a Pp value below 35 in the mechanical ventilator in covid 19 pneumonia. This is thought to be due to severe damage to the lung, interstitial involvement, fibrosis, and decreased lung compliance, and increased airway resistance. Pneumothorax due to barotrauma; It is in the category of traumatic pneumothorax. In blunt thoracic trauma, 6.7% pneumothorax is seen without rib fracture [11]. Pneumothorax due to barotrauma is very rare in patients who are mechanically ventilated in the intensive care unit [12]. However, it was observed that this rate increased significantly during the Covid 19 pandemic period. In our study; Covid 19 intensive care mechanical ventilator-associated pneumothorax rate is 12%. Oxygen support and close observation are applied in pneumothorax below 20% in our clinical experience. Although there is pneumothorax due to mechanical ventilator; Tube thoracostomy was not performed in 6 patients with pneumothorax less than 20%. Close observation was taken by lowering Pp in the mechanical ventilator, changing the mood, increasing the respiratory frequency, and the medical approach was sufficient. However, the other 8 pneumothorax patients required a surgical method and underwent tube thoracostomy. Tube thoracostomy could be terminated by completing the treatment of only 2 pneumothorax patients (both spontaneous pneumothorax). The other 6 patients who underwent tube thoracostomy and received ventilator support; could not be terminated due to continued air leak.

### **Conclusions**

Mechanical ventilator-associated pneumothorax is one of the most important undesirable fatal complications in intensive care. Covid 19 is known to cause severe lung damage. It has been observed that especially patients with Covid 19 pneumonia interstitial involvement are much more susceptible to barotrauma. Therefore, it is recommended to have PEEP < 9 cmH<sub>2</sub>O and P peak < 35 cmH<sub>2</sub>O in terms of ventilation. Chest radiography as often as possible in patients receiving mechanical ventilator support may help to detect possible pneumothorax early. Since it is known to infect Covid 19 with the respiratory tract; If the patient has a tube thoracostomy, special attention should be paid to its isolation.

### **Conflict of interest**

All authors declared that there is no conflict of interest.

### **Ethical Approval**

Republic of Turkey Ministry of Health, 2020/12-10T13\_04\_00 numbered and Gaziantep University Medical Ethics Committee 2021/16 numbered approval have been received.

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Tables and Figures

	Gender	Age	Chronic disease	Pneumonia type	Pneumothorax type
1	Male	66	Diabetes mellitus	Interstitial pneumonia	MVA
2	Male	61	COPD	Interstitial pneumonia	MVA
3	Male	70	COPD	Lobular pneumonia	MVA
4	Female	76	COPD	Interstitial pneumonia	MVA
5	Male	71	COPD	Interstitial pneumonia	MVA
6	Female	84	COPD	Interstitial pneumonia	MVA
7	Male	65	No disease	Interstitial pneumonia	Spontaneous
8	Male	33	No disease	Unknown	MVA
9	Male	71	COPD	Interstitial pneumonia	MVA
10	Female	92	Obesity	Interstitial pneumonia	MVA
11	Male	63	Coronary artery disease	Interstitial pneumonia	Spontaneous
12	Female	53	No disease	Lobular pneumonia	MVA
13	Male	54	No disease	Lobar pneumonia	MVA
14	Male	79	Hypertension	Lobar pneumonia	MVA

Table 1: Characteristics of pneumothorax patients

\*COPD: Chronic obstructive pulmonary disease MVA: Mechanical ventilator associated

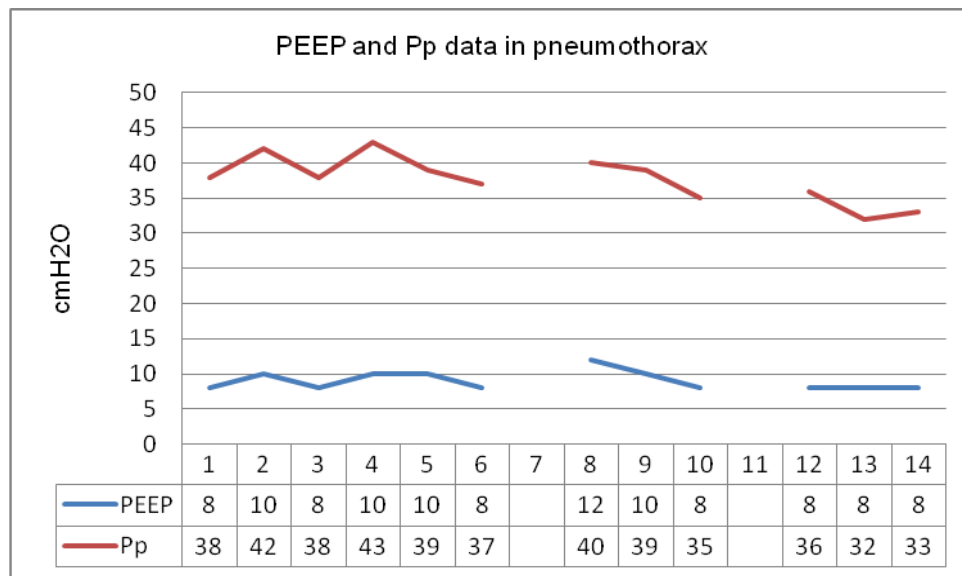


Figure 1: PEEP and Pp data in pneumothorax

\*PEEP: Positive End Expiratory Pressure Pp: peak pressure

\*Patients 7 and 11 spontaneous, others mechanical ventilator-associated pneumothorax

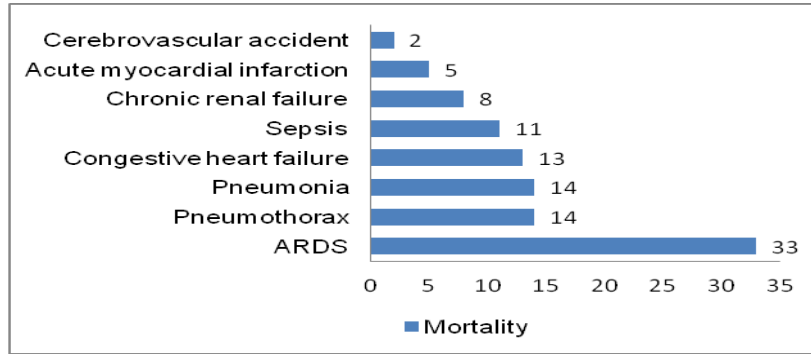


Figure 2: Mortality distribution  
ARDS: Acute respiratory distress syndrome

Parameters	n	Pneumothorax (p)	Mortality (p)
Male	69	0.052	<0.01
Female	31	0.30	0.08
>65 age	67	0.06	<0.01
PEEP >8 cmH2O	84	0.06	<0.01
Ppeak >35 cmH2O	50	<0.01	<0.01
PaO2 / FiO2 < 100	83	<0.01	<0.01
Interstitial pneumonia	68	<0.01	<0.01
Comorbidity	72	<0.01	<0.01
COPD	14	<0.05	<0.01
ARDS	33	0.06	<0.01

Table 2: Statistical analysis of parameters with pneumothorax and mortality

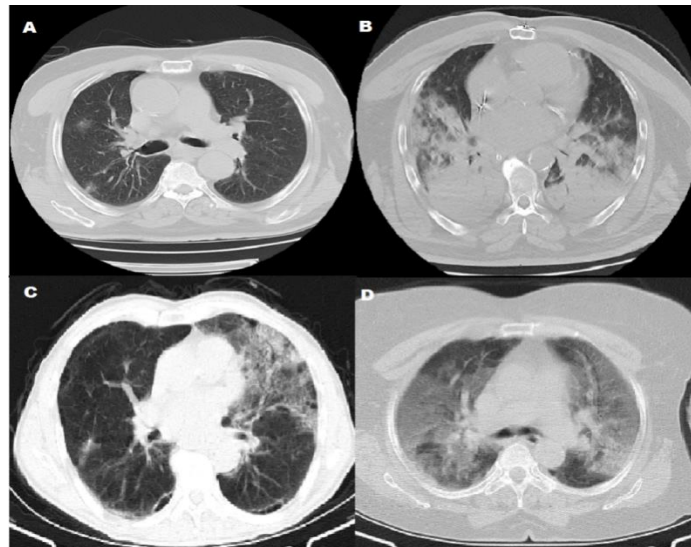


Figure 3: Pneumonia types in Covid 19  
A.Lobular B.Lobar C.Interstitial D.Common Interstitial