Asian Journal of Research in Surgery

6(4): 31-36, 2021; Article no.AJRS.83121

The Relationship of Pneumothorax with Acute Respiratory Distress Syndrome and Mortality in Covid 19

Bayrakçi Onur[1*]

[1]Department of Thoracic Surgery, Ersin Arslan Training and Research Hospital, Turkey.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

Editor(s):
(1) Dr. Wagih Mommtaz Ghannam, Mansoura University, Egypt.
(2) Dr. Ramesh Gurunathan, Sunway Medical Center, Malaysia.
Reviewers:
(1) Sherreen Yehia Zakaria Elhariri, International Medical University (IMU), Malaysia.
(2) Rui Haddad, Pontifical Catholic University of Rio de Janeiro, Brazil.
(3) Hakki Ulutas, University of Inonu, Turkey.
(4) Manuel Emilio Milla Pino, National University of Jaen, Peru.
Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: https://www.sdiarticle5.com/review-history/83121

Original Research Article

Received 20 November 2021
Accepted 29 December 2021
Published 30 December 2021

ABSTRACT

Background: Pneumothorax is defined by the accumulation of air between the visceral and parietal pleura. The degree of collapse after rupture of the visceral pleura determines the clinic of the pneumothorax. Acute respiratory distress syndrome is an important lung disease responsible for morbidity and mortality in critically patients, including Covid-19 patients.
Aims: It was aimed to related pneumothorax with ARDS and mortality in Covid-19 patients hospitalized in the Intensive-care unit.
Study Design: This study was done retrospectively between 1 Sep 2020 and 31 Dec 2020 in Ersin Arslan Training and Research Hospital Covid Intensive-care unit.
Methodology: Patients older than 18 years of age, positive polymerase chain reaction test, with lung involvement in computed tomography and admitted in the Intensive-care unit were included in the study. Age, gender, comorbidities, severity of ARDS, presence and treatment of pneumothorax, hospital stays and mortality of the patients were retrospectively examined. Statistical analysis of the study was done with the Chi-square test.
Results: 79 of the patients were males (66.4%) and 40 females (33.6%). The mean age was 68.2 ± 1.93 (33-92) years.71.4% of them had a history of chronic illness. The order of comorbidities from

**Corresponding author: E-mail: dronurbayrakci@gmail.com;*

most to least were hypertension, diabetes mellitus, and chronic obstructive pulmonary disease Lung involvements in CT were 60.5% multifocal and 29.5% unifocal. ARDS severity were 36.9% mild, 39.5% moderate, and 23.6% severe. Pneumothorax was found in 10% of the patients. Surgical treatment (tube thoracostomy) was required in 58.3% of patients with pneumothorax. 68% of the patients were mechanical ventilated. The mean length of stays in the intensive-care unit were 9.9 ± 1.28 (1-38) days. The mortality rate was 41.1%.

Conclusion: According to this study, Covid-19 is seen more frequently in males and over 60 years of ages in patients admitted to the Intensive-care unit. Pneumothorax is more often in multifocal involvement of the lungs and moderate or severe ARDS. Pneumothorax is related with mortality in Covid-19.

Keywords: ARDS; Covid-19; pneumothorax; surgical; treatment.

1. INTRODUCTION

Pneumothorax is defined by the accumulation of air between the visceral and parietal pleura. Occurs due to trauma or non-traumatic causes. The degree of collapse after rupture of the visceral pleura determines the clinic of the pneumothorax [1]. If it occurs due to an underlying disease, it is defined as secondary spontaneous pneumothorax (SSP). The incidence of SPP is 2 - 6.3 / 100.000, more often in males [2]. The incidence of pneumothorax is more often in comorbidities such as COPD. Interstitial involvement and endothelial damage occur after diffuse alveolar damage in acute respiratory distress syndrome (ARDS), and causes worsening of lung compliance and scarring [3]. ARDS is an important lung disease responsible for morbidity and mortality in critically patients, including Covid-19 patients [4]. Although mild ARDS and pressure-controlled ventilator modes were used in Covid-19 patients during the pandemic process, an increase in the frequency of pneumothorax was observed. In this study, it was aimed to related ARDS with pneumothorax and mortality in Covid-19 patients hospitalized in the Intensive-care unit.

2. MATERIALS AND METHODS

This study was done between 1 Sep 2020 and 31 Dec 2020 in Ersin Arslan Training and Research Hospital Covid Intensive-care unit. Patients older than 18 years of age, positive Polymerase Chain Reaction (PCR) test, with lung involvement in Computed Tomography (CT) and admitted in the intensive-care unit were included in the study. A total of 119 patients compatible with these criteria were identified. Age, gender, comorbidities, presence of ARDS, lung involvements in CT, presence and treatment of pneumothorax, hospital stays and mortality of the patients were retrospectively examined. Berlin criteria were used for the diagnosis of ARDS (Table 1). Statistical analysis of the study was done with the Chi-square test due to non-parametric variables. The study was approved by the Republic of Turkey Ministry of Health (2020/12-10T13_04_00) and Medical Ethics Committee of Gaziantep University (2021/16).

Table 1. The berlin definition of acute respiratory distress syndrome

Acute Respiratory Distress Syndrome	
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging	Bilateral opacities - not fully explained by effusions, lobar / lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (eg. echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation	
Mild	200 mmHg < PaO_2/FiO_2 ≤ 300 mmHg with PEEP or CPAP ≥ 5 cm H_2O
Moderate	100 mmHg < PaO_2/FiO_2 ≤ 200 mmHg with PEEP ≥ 5 cmH_2O
Severe	PaO_2/FiO_2 ≤ 100 mmHg with PEEP ≥ 5 cmH_2O

PEEP: Positive End Expiratory Pressure, CPAP: Continious Positive Airway Pressure

3. RESULTS

79 of the patients were males (66.4%) and 40 females (33.6%). The mean age was 68.2 ± 1.93 (33-92) years (Table 2). 71.4% of them had a history of chronic illness. The order of comorbidities from most to least were hypertension (HT, 44.7%), diabetes mellitus (DM, 31.7%), and chronic obstructive pulmonary disease (COPD, 15.2%). Lung involvements in CT were 60.5% multifocal and 29.5% unifocal. According to the number of lobes damaged in the lung, 1 lobe (36.9%) was most frequently affected, and at least 2 lobes (6.7%) affected. ARDS severity were 36.9% mild, 39.5% moderate, and 23.6% severe. Pneumothorax was found in 10% of the patients. Surgical treatment (tube thoracostomy) was required in 58.3% of patients with pneumothorax. 68% of the patients were mechanical ventilated. The mechanical ventilator mode of the pneumothorax patients was pressure controlled (80%). The mean length of stays in the intensive-care unit were 9.9 ± 1.28 (1-38) days. The mortality rate was 41.1%.

Table 2. Demographic characteristics of the study

	Mean	Std Dev	95%(+/-)
Age	68.2 (33-92)	10.64	1.93
Male	66.4%	0.47	0.08
Female	33.6%		
Stay of hospitalized (days)	9.92	6.98	1.28

Table 3. Statistical analysis of parameters with pneumothorax and mortality

	n	Pneumothorax			Mortality		
		p<	CV	ODDS	p<	CV	ODDS
Ages							
18-40	1	0.002	0.275	1.091			
41-60	30						
>60	88				0.02	0.107	1.847
Comorbidity							
Yes	85	0.0001	0.026	1.224	0.01	0.181	2.700
HT	38	0.01	0.229	0.645	0.0001	0.102	1.932
DM	27				0.0001	0.093	0.576
COPD	13	0.0001	0.419	14.286	0.0001	0.153	1.149
No	34				0.04	0.181	0.370
ARDS							
Mild	44				0.002	0.284	0.207
Moderate	47	0.08	0.181	0.276	0.004	0.258	6.955
Severe	28	0.002	0.275	5.733	0.0001	0.025	1.184
Lung Involvement							
Unifocal	47						
Multifocal	72	0.01	0.213	8.295	0.06	0.164	2.829
Number of lobes							
4	27	0.001	0.285	6.090			1.684
5	24	0.02	0.040	1.365	0.04	0.181	0.351
Mechanical Ventilated							
Yes	81	0.0001	0.110	2.535	0.0002	0.341	6.500
No	38			0.394			0.154

Table 4. Statistical analysis of pneumothorax treatment

	Treatment of Pneumothorax					
	Medical			Surgical		
	p<	CV	ODDS	p<	CV	ODDS
ARDS						
Mild						
Moderate						
Severe	0.04	0.180	5.340	0.03	0.189	4.889
Lung Involvement						
Unifocal				0.02		0.903
Multifocal				0.02	0.202	1.108
Stay of hospitalized (days)						
1-10						
16-20				0.003	0.272	8.583
>20						
Pneumothorax						
Right	0.0001	0.446	32.700	0.0001	0.646	90.833
Left	0.0001	0.426	37.333	0.0001	0.350	22.000

As a result, pneumothorax and mortality were more often in males. Despite pneumothorax was more often in those older than 60 years, it was statistically significant in the 18-40 ages group (p<0.002). The mortality was related with those older than 60 ages (p<0.02). Presence of chronic disease history was related with both pneumothorax (p<0.0001) and mortality (p<0.01), and mortality was more often in those with comorbidity (circa 3 times more) than in those without (p<0.04). COPD (p<0.0001) was associated with pneumothorax, and it was 14 times more with COPD. As is known, ARDS is a cause of mortality. Severe ARDS was related with a high value of evidence (p<0.0001) for mortality. Mortality with moderate ARDS (p<0.004) was increased approximately 7 times. Multifocal involvement in CT was related with both pneumothorax (p<0.01) and mortality (p<0.06). Regardless of the percentage of lung lobe involvement, of up to 3 lobes were not related with pneumothorax and mortality. However, affected of 4 lobes (p<0.001) were related with pneumothorax, and affected of 5 lobes were related with both pneumothorax (p<0.02) and mortality (p<0.04). Presence of mechanical ventilated (p<0.0001) was related with pneumothorax, and pneumothorax (p<0.0001) was related with mortality (Table 3).

Severe ARDS was related with medical (p<0.04) and surgical (p<0.03) treatment of pneumothorax. Based on the evidence, severe ARDS was required surgical treatment. Left pneumothorax (p<0.0001) was related with medical treatment and right pneumothorax (p<0.0001) with surgical treatment. Unifocal or multifocal involvements (p<0.3) in CT were not related with medical treatment of pneumothorax, and both required surgical treatment (p<0.02). Surgically treated pneumothorax patients were associated with longer (16-20 days, p<0.003) hospital stays (Table 4).

4. DISCUSSION

Secondary spontaneous pneumothorax (SSP) is more often in patients aged 60-60 years, and 3 times more in males. The incidence of pneumothorax secondary to COPD is 26 / 100.000 [2]. In this study, SSP was more often in patients older than 60 years, and 2 times more in males than females. The rate of pneumothorax was found to be 10% in Covid-19 patients hospitalized in the Intensive-care unit. It was understood that Covid-19 significantly increased the pneumothorax rates. It has been reported that a history of chronic disease in Covid-19 is associated with poor prognosis [5]. Patients with comorbidities (71.4%) in intensive-care were approximately 2 times more than those without. Comorbidity was related with both pneumothorax and mortality. The comorbidities were in order of frequency, hypertension, diabetes mellitus, and COPD. Pneumothorax was related with HT as an independent variable and COPD as an dependent variable in this study.

ARDS is a deadly disease and frequently observed in Covid-19. Mortality rates in ARDS range from 34.9% to 40%, depending on its severity [6]. It was reported that mortality rates

due to ARDS in patients with and without Covid-19 are similar [7]. Therefore, as in ARDS, hypoxemia and lung dynamics are very important. ARDS severity of the patients were determined according to the Berlin criteria in the study. Regardless of ARDS severity, it was related with mortality. Odds ratios according to their severity were mild 0.2, moderate 6.9 and severe 1.1. When the severity of ARDS increased, the mortality rates were increased. If ARDS was mild, it was not related with pneumothorax, and moderate or severe ARDS were related with pneumothorax. Spontaneous pneumothorax, subcutaneous and mediastinal emphysema are a complication of Covid-19 pneumonia [8]. As it is known, pneumothorax is a treatable disease, and if tension progresses to pneumothorax, it can result with death. Early detection of pneumothorax in chest x-ray is possible. Therefore, pneumothorax should be investigated especially in Covid-19 patients. It was reported that pneumothorax increases mortality in patients with ARDS, and it was detected at a rate of 1.7% to 77% [9,10]. In this study, pneumothorax was found to be associated with mortality in Covid-19. Since ARDS is related with pneumothorax, appropriate management of hypoxemia can prevent fatal pneumothorax complication. Because, mild ARDS was not found to be significantly associated with pneumothorax in the study.

A higher rate of involvement in the lung indicates more severe illness. It was supported by the statistical analysis of the study. Multifocal affected of the lung were related with both pneumothorax and mortality. Therefore, unifocal involvement of the lung was not significant for pneumothorax. Multifocal involvements of lung were found to be a risk factor for pneumothorax in Covid-19. Any a rate involvement of up to 3 lobes of the lung were not related with pneumothorax and mortality. However, affected of 4 lobes of the lung were related with pneumothorax, and affected of 5 lobes were related with both pneumothorax and mortality. Hence, affected of 4 lobes were found as a risk factor for pneumothorax. Barotrauma is known as the cause of pneumothorax. This study was supported the relationship between mechanical ventilated and pneumothorax. Generally, it was found that pressure-controlled ventilator mode was preferred in patients with pneumonia during the Covid-19 process. Although the increased incidence of pneumothorax was related with barotrauma, it was thought that Covid-19 might be due to serious lung damage.

Treatment of pneumothorax is observation, tube thoracostomy, pleuridesis, thoracoscopy and thoracotomy. Patients of pneumothorax with ARDS are critically illness, and not suitable for thoracoscopy and thoracotomy [10]. Major surgery was not done on any patient in the study. Classically, observation and oxygen support were preferred in patients with minimal pneumothorax (<5%). In patients with mechanical ventilated, low pressure support (PS) and low positive end expiratory pressure (PEEP) were recommended first. However, if there were no response to non-surgical methods, thorax tube was performed. The thorax tube could not be removed until death, especially in severe ARDS patients, due to continued air leakage. Pneumothorax in patients with ARDS is associated with many factors such as smoking, COPD, severity of ARDS, and mechanical ventilation settings [11]. In a multicenter retrospective study, it was reported that pneumothorax was not seen as an independent marker of poor prognosis in Covid-19 [12]. However, since pneumothorax was found to be related with mortality, it was thought to be a poor prognostic marker in the study. Moreover, mild ARDS was not related with pneumothorax, but moderate and severe were related. Pneumothorax with severe ARDS was required surgical treatment. Left pneumothorax was more related with non-surgical methods, and right pneumothorax with surgical methods. Surgical treatment was more associated with hospital stays.

5. CONCLUSION

According to this study, Covid-19 is seen more frequently in males and over 60 years of ages in patients admitted to the Intensive-care unit. Pneumothorax is more often in multifocal involvement of the lungs and moderate or severe ARDS. Pneumothorax is related with mortality in Covid-19.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The study was approved by the Republic of Turkey Ministry of Health (2020/12-10T13_04_00) and Medical Ethics Committee of Gaziantep University (2021/16).

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. McKnight CL, Burns B. Pneumothorax. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.
2. Gupta D, Hansell A, Nichols T, et al. Epidemiology of pneumothorax in England. Thorax. 2000;55(8):666-71.
3. Matthay MA, Zemans RL, Zimmerman GA, et al. Acute respiratory distress syndrome. Nat Rev Dis Primers. 2019; 5:18.
4. Welker C, Huang J, Gil IJN, et al. Acute Respiratory Distress Syndrome Update, With Coronavirus Disease 2019 Focus. J Cardiothorac Vasc Anesth. 2021;S1053-0770(21):00188-9.
5. Singh AK, Gupta R, Ghosh A, et al. Diabetes in COVID-19: Prevalence, pathophysiology, prognosis, and practical considerations. Diabetes Metab Syndr Clin Res Rev. 2020;14(4):303-310.
6. Villar J, Blanco J, Kacmarek RM. Current incidence and outcome of the acute respiratory distress syndrome. Curr Opin Crit Care. 2016;22:1–6.
7. Camporota L, Sanderson B, Dixon A. Outcomes in mechanically ventilated patients with hypoxaemic respiratory failure caused by COVID-19. Br J Anaesth. 2020;125:e480–e483.
8. Elhakim TS, Abdul HS, Pelaez Romero C. Spontaneous pneumomediastinum, pneumothorax and subcutaneous emphysema in COVID-19 pneumonia: A rare case and literature review. BMJ Case Rep. 2020;13(12):e239489.
9. Sihoe A.D, Wong R.H, Lee A.T, et al. Severe acute respiratory syndrome complicated by spontaneous pneumothorax. Chest. 2004;125(6):2345–2351.
10. Wang XH, Duan J, Han X, et al. High incidence and mortality of pneumothorax in critically Ill patients with COVID-19. Heart Lung. 2021;50(1): 37–43.
11. Terzi E, Zarogoulidis K, Kougioumtzi I. Acute respiratory distress syndrome and pneumothorax. J Thorac Dis. 2014;6(Suppl 4):S435–S442.
12. Martinelli WA, Ingle T, Newman J, et al. COVID-19 and Pneumothorax: A Multicentre Retrospective Case Series. Eur Respir J. 2020;56(5):2002697.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/83121