ORIGINAL RESEARCH

To investigate the Spontaneous Pneumothorax and Pneumomediastinum in Covid-19 Pneumonia Patients

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ABSTRACT

Aim: To investigate the Spontaneous Pneumothorax and Pneumomediastinum in Covid-19 Pneumonia Patients.

Material and methods: 100 COVID-19 positive individuals with pneumothorax and pneumomediastinum were analyzed in a retrospective study. The patients were diagnosed using polymerase chain reaction (PCR) assays (RT-PCR) of the nasopharyngeal swab samples, together with thorax CT scans. Individuals who had positive CT chest results were subsequently confirmed by PCR. The thorax CT scans clearly show the signs of coronavirus pneumonia at the time of diagnosis and throughout the follow-up.

Results: 71% of the participants were male. The prevalent comorbidities were concurrent hypertension-diabetes and Alzheimer's disease. 93% of the patients had pneumothorax, 12% had both pneumothorax and pneumomediastinum, and 7% had isolated pneumomediastinum. Tube thoracostomy was performed on 97 out of 100 patients, while the other 3 patients were managed conservatively without surgery. The median length of hospital stay was 18.14 days. There was no notable disparity in the pneumothorax rates between patients who received mechanical ventilation and those who did not. There was no substantial difference in pneumothoraxproportions between men and women. Several inflammatory markers (WBC, CRP, D-Dimer, Ferritin, and IL6) and blood gas values (PaCO2 and pH) showed substantial differences between patients who died and those who survived.

Conclusion: Spontaneous pneumothorax and pneumomediastinum are uncommon occurrences associated with COVID-19 viral pneumonia. It may happen at any point along the progression of the illness. Elderly people with comorbidities who undergo mechanical breathing seem to have a higher risk of death. Significant differences were seen in the levels of inflammatory markers (WBC, CRP, LDH, D-dimer, ferritin, and IL6) and blood gas values (elevated PaCO2 and decreased pH) between patients who died and those who survived.

Keywords: Pneumothorax, Pneumomediastinum, Covid-19, Pneumonia

INTRODUCTION

Since December 2019, the globe has been experiencing a significant health crisis caused by the new coronavirus SARS-COV-2 pandemic that originated in Wuhan, China. Since December 2019, instances of viral pneumonia caused by a novel coronavirus known as SARS-CoV-2 have emerged in Wuhan, China, and spread globally. COVID-19 symptoms often include fever, dry cough, and difficulty in breathing, which are indicative of a respiratory infection [1].Spontaneous pneumothorax (PNX) is the accumulation of air in the pleural space without being triggered by trauma or a specific reason, like a medical treatment. Primary spontaneous pneumothorax occurs without an evident lung ailment, whereas secondary spontaneous pneumothorax is a consequence of an existing lung illness [2, 3]. Currently, there are limited references to pneumothorax as a consequence of COVID-19 viral pneumonia, with only a small number of case reports available [4–7]. Pneumomediastinum may be classified as primary if the origin is unknown or idiopathic, or secondary if it is linked to a recognized cause, such as trauma or medical intervention. It is a common consequence of chest barotrauma caused by positive airway pressure and mechanical ventilation. Additional risk factors include smoking and pre-existing lung parenchymal and airway diseases. Pneumomediastinum may develop from extensive damage to the alveoli in the lungs, leading to their

rupture and the accumulation of air in the tissues surrounding the bronchial tubes and blood vessels in the chest cavity. Spontaneous pneumomediastinum often resolves on its own without the need for any therapies. In rare instances of tension pneumomediastinum, there might be substantial cardio-pulmonary compromise. Air may move into the thoracic inlet and into the soft tissues of the neck, creating cervico-facial subcutaneous emphysema. The actual prevalence of this issue remains unknown. Increased occurrence of pneumomediastinum and pneumothorax during SARS and MERS pneumonia, with rates ranging from 1.7% to 12% and 16.4%, respectively, either occurring spontaneously or in relation to ventilation. However, similar issues have not been documented when non-invasive ventilation (NIV) was used in treating typical pneumonia patients. Pneumothorax has been associated with a worse outcome in individuals with acute Middle East respiratory syndrome coronavirus (MERS-CoV) infection [8–10]. Recent reports have documented occurrences of pneumothorax (PNX) and pneumomediastinum (PNM) in patients with COVID-19 pneumonia, with most cases being spontaneous and some associated with non-invasive ventilation (NIV) or endotracheal intubation (ETI).

MATERIAL AND METHODS

Patients have a confirmed diagnosis of COVID-19 at our medical facility. 100 COVID-19-positive individuals with pneumothorax and pneumomediastinum were analysed in a retrospective study. The patients were diagnosed using polymerase chain reaction (PCR) assays (RT-PCR) of the nasopharyngeal swab samples, together with thorax CT scans. Individuals who had positive CT chest results were subsequently confirmed by PCR. The thorax CT scans clearly show the signs of coronavirus pneumonia at the time of diagnosis and throughout the follow-up. The defining traits include bilateral multilobar ground-glass opacification, particularly in the lower lobes, with a predominant distribution in the periphery or posterior regions. The research participants were monitored for a minimum of 30 days. No bulla, cyst, severe emphysema, pneumothorax, or abnormalities were found in the medical history or first CT scans of the patients. The data was collected from the patients' medical records, which included demographic details, existing health conditions, various laboratory tests (such as complete blood count, blood gases, D-dimer, C-reactive protein (CRP), LDH, ferritin, and IL-6), radiological assessments (PA lung, Thorax CT), clinical treatment, prognosis, and survival outcomes. All patients who had tube thoracostomies were equipped with closed undersea drainage systems (CUDS) that included high-efficiency particulate air (HEPA) filters.

STATISTICAL ANALYSIS

The data was analysed using SPSS version 25.0 software by SPSS Inc. in Chicago, IL, USA. The data was shown as frequencies, percentages, means, medians, standard deviations (SD), and interquartile ranges (IQR). A Kolmogorov-Smirnov test was conducted to assess the normal distribution of the numerical variables. The independent sample t-test was used to compare data that adhered to parametric assumptions. Skewed variables were analysed using the Mann-Whitney U test, while categorical variables were analysed using the Chi-Square test or Fisher's exact test. Cox regression analysis was used to identify important variables influencing survival. A p-value below 0.05 was deemed statistically significant.

RESULTS

71% of the participants were male. The prevalent comorbidities were concurrent hypertension, diabetes, and Alzheimer's disease. 93% of the patients had pneumothorax, 12% had both pneumothorax and pneumomediastinum, and 7% had isolated pneumomediastinum. Table 1. A tube thoracostomy was performed on 97 out of 100 patients, while the other 3 patients were managed conservatively without surgery. The median length of hospital stay was 18.14 days. There was no notable disparity in the pneumothorax rates between patients who received mechanical ventilation and those who did not. There was no substantial difference in pneumothoraxproportions between men and women. Several inflammatory markers (WBC, CRP, D-dimer, ferritin, and IL6) and blood gas values (PaCO2 and pH) showed substantial differences between patients who died and those who survived, as seen in Table 2. The median survival time was 10 days, with a 95% confidence interval of 6.45 to 14.54 days. A Cox regression model was constructed, including variables with significance values below 0.1. Due to the limited sample size, only D-dimer and pH were included in the model. The analysis identified pH ($p = 0.04$, HR = 0.31) and sex ($p = 0.06$, HR = 1.97) as the only significant independent predictors of survival.

Table 1. Basic parameter of the participants

	Number	Percentage
Gender		
Male	71	71
Female	29	29
Comorbidity		
None	38	38
Hypertension	10	10

Diabetes	9	9
Heart disease	6	6
Alzheimer	14	14
Cerebrovascularaccident	2	2
Hypertensionanddiabetes	16	16
Other	5	5
Additional respiratory disease		
None	77	77
Asthma	2	2
COPD	10	10
Emphysema	4	4
Lungcancer	5	5
Bronchiectasis	1	1
Tuberculosis	1	1
Placeofdiagnosis		
Outpatient	6	6
Transferto anotherclinic	26	26
Intensivecareunit	70	70
Pneumothorax		
Yes	93	93
No	7	7
Pneumothoraxside		
Right	49	49
Left	40	40
Bilateral	11	11
Pneumomediastinum		
Yes	7	7
No	93	93
Pneumothorax +Pneumomediastinum		
Yes	12	12
No	88	88
Treatment		
Spontaneous	2	2
NasalO_2	26	26
MV	71	71
CPAP	1	1
Subcutaneous emphysema		
Yes	26	26
No	74	74
Outcome		
Died	67	67
Alive	33	33

Table 2. Comparison of inflammatory markers and blood gas values with survival status.

	Died				**Survived**					
	Mean	**SD**	**Median**	**IQR**	**Mean**	**SD**	**Median**	**IQR**	**Test**	**p**
WBC	13.45	2.34	13.77	8.98	11.09	1.45	11.78	5.67	2.14	**0.03**
Lymphocytes	1.33	0.87	0.99	0.88	1.56	0.88	1.23	0.72	0.95	0.13
Neutrophils	24.89	3.76	14.76	6.94	25.76	5.76	13.33	6.12	1.94	0.05
CRP	75.76	6.98	45.98	96.77	32.34	3.87	17.28	35.76	2.99	**0.002**
LDH	468.99	13.54	441.98	235.57	355.87	12.76	347.998	149.87	2.98	**0.005**
D-Dimer	23.78	2.87	2.67	2.47	2.43	0.44	2.11	1.65	2.77	**0.007**
Ferritin	816.98	17.89	779	578.54	546.98	14.77	399.87	345.37	2.61	**0.01**
IL6	24.76	3.89	21.87	32.49	10.12	15.32	5.98	4.88	3.41	**0.001**
PaO_2	71.43	5.88	66.58	34.99	74.78	27.78	75.56	36.44	0.48	0.22
$PaCO_2$	61.69	6.98	57.94	20.25	45.98	14.94	43.22	13.32	3.52	**0.001**
HCO_3	25.99	8.46	26.64	9.78	24.77	5.56	22.78	8.21	0.78	0.22

SaO_2	81.87	4.76	86.38	22.55	87.54	13.78	94.58	12.59	1.62	0.14
pH	7.22	0.33	7.13	0.33	7.51	0.12	7.54	0.21	3.87	**<0.01**

Table3. Cox regression analysis computer output showing variables predicting survival.

Parameter		Wald	p	Exp(B)	95.0%CIfor Exp(B)	
					Lower	Upper
Age	0.03	3.03	0.08	1.11	0.98	1.15
Sex(Womenvs.Men)	0.29	3.44	**0.06**	1.26	0.99	4.54
Comorbidity(Presentvs.Absent)	-0.55	1.22	0.33	0.76	0.36	1.54
MVvs. noMV	0.41	2.38	0.15	1.77	0.78	4.57
pH	-1.31	4.78	**0.04**	0.33	0.05	0.67
D-Dimer	-.001	0.81	0.29	0.89	0.98	1.12

DISCUSSION

The human coronavirus is a primary pathogen causing respiratory tract infections [11]. Although over 80% of individuals infected with the virus are asymptomatic or have moderate symptoms, some instances may require hospitalization and mechanical ventilation. In patients with severe respiratory failure, this progression is linked to a high fatality rate [12]. Structural cystic and fibrotic abnormalities in the lung parenchyma that develop early in COVID-19 may increase the risk of pneumothorax. Pneumothorax may occur in about 1% of COVID-19 patients [13].Pneumothorax occurred in about 0.50% of COVID-19 participants in our research. Pneumothorax is a life-threatening complication in individuals with acute respiratory distress syndrome (ARDS). The occurrence ranges widely from 1.7% to 10%, particularly when subjected to mechanical ventilation. [14]. It's more likely for ARDS and pneumothorax to happen together when peak inspiratory pressure (PIP), positive end-expiratory pressure (PEEP), tidal volumes, and minute ventilation are all high. This is often linked to barotrauma resulting from increased airway pressure [15]. During research in the USA, 89 out of 601 COVID-19 patients (15%) had barotrauma as a result of invasive mechanical breathing. The incidence of pneumothorax in ARDS patients who received mechanical ventilation was notably greater compared to the pre-COVID-19 era [16]. Our research found no significant difference in the incidence of pneumothorax between individuals who received mechanical ventilation and those who did not. Pulmonary cystic lesions and pneumothorax may occur in people who have not had mechanical ventilation [17]. Some COVID-19 patients develop pneumothorax due to risk factors including mechanical ventilation, whereas in others, viral pneumonia alone might be the cause [18].Barotrauma alone is evidently not sufficient to trigger cyst development. Our study's findings, which include a significant number of pneumothorax instances not linked to mechanical ventilation, corroborate this perspective. We believe that COVID-19 may increase susceptibility to barotrauma. We feel that it is important to focus on reducing airway pressure in these individuals. As of now, there are no definitive recommendations regarding the time and parameters for mechanical ventilation in patients with COVID-19 pneumonia. Mortality was notably elevated in instances of pneumothorax, particularly in patients reliant on mechanical breathing. While Martinelli et al. reported a greater occurrence of pneumothorax in men, our investigation did not find a statistically significant difference between the sexes regarding pneumothorax. However, Martinelli et al. did not find a significant difference in survival between the sexes [19]. We observed a marginally significant increase in survival rates among female patients.While PA chest radiography was initially employed for all patients, we recognized that cystic parenchymal alterations, albeit uncommon, may be readily missed in conventional chest x-rays. Thorax CT is crucial for screening patients with suspected COVID-19 because of the importance, sensitivity, and user-friendly nature of its characteristics that show key radiological signs of the disease [20]. We used Thorax CT for all patients without any exceptions for both diagnosis and monitoring of illness development to guide medical therapy.

The prevalence of pneumothorax and/or lung illness was minimal in our research. Zanta et al. found that individuals who experienced spontaneous pneumothorax exhibited lymphopenia and elevated levels of inflammatory markers such as CRP, LDH, ferritin, D-dimer, and IL-6 [21]. Our research found substantial differences in inflammatory markers (WBC, CRP, D-dimer, ferritin, and IL6) between patients who died and those who survived. The results were consistent with the findings published by Zanta et al. A sudden increase in alveolar pressure that causes alveolar rupture and air to escape into the interstitial tissues is what causes mediastinal emphysema. Mediastinal emphysema was detected in certain instances, mostly as a result of elevated pressure from mechanical ventilation [22]. Wang et al. documented cases of spontaneous pneumothorax, pneumomediastinum, and subcutaneous emphysema in a non-mechanically ventilated patient [23].The survival rate was notably lower, particularly in situations where intubation was required. The death rate was 8% among intubated patients and 29.2% among non-intubated patients. Imam et al. found that older age and a higher number of co-existing medical

conditions were factors that might predict hospital death in COVID-19 patients [24]. Age, treatment groups, and the presence of comorbidities were significant factors linked to survival in univariate analyses in our research. In our study, the average length of leakage in individuals who had tube thoracostomy was 11.01 days. Long-term air leaks seem likely because of inflammation and damage to the lung tissue. Severe pneumonia may prevent the patient from undergoing surgical therapy. We used negative pressure on the Gomco® suction device for patients with severe lung issues who did not show improvement following tube thoracostomy. This helped to maintain lung expansion, and we believe it positively impacted our therapy. None of our instances required surgical intervention, which is noteworthy. Some individuals showed delayed improvements in pneumothorax, alongside others who reacted well to the medication. Therefore, the symptoms and treatment methods of COVID-19 pneumonia with pneumothorax must be managed with the utmost caution.

CONCLUSION

Spontaneous pneumothorax and pneumomediastinum are uncommon occurrences associated with COVID-19 viral pneumonia. It may happen at any point along the progression of the illness. Elderly people with comorbidities who undergo mechanical breathing seem to have a higher risk of death. Significant differences were seen in the levels of inflammatory markers (WBC, CRP, LDH, D-dimer, ferritin, and IL6) and blood gas values (elevated PaCO2 and decreased pH) between patients who died and those who survived.

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