

Spontaneous Pneumothorax and Pneumomediastinum in Covid-19 Pneumonia

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ABSTRACT

Fifteen to twelve percent of COVID-19 patients who had mild to severe symptoms were hospitalized. Most of hospitalized patients had respiratory failure and admitted to the intensive care unit with the diagnosis of acute respiratory distress syndrome (ARDS). Pneumothorax (PX) and pneumomediastinum (PM) which can be seen as traumatic or spontaneous in intensive care unit (ICU) patients have a higher incidence in COVID-19 patients. Patients that admitted to ICU between April 2020 and November 2021, were reviewed for development of pneumothorax, pneumomediastinum and subcutaneous emphysema retrospectively. There was 13 patients who were developed these conditions in the study period. Five of them was male and median age for all patients was 62. Eight of them were intubated and mechanically ventilated. Only two of them discharged from ICU. The most common reason for death was sepsis due to secondary infections. Patients followed with physical examination, chest XR and computerized tomography (CT) if needed. Acute deterioration, increased oxygen demand and crepitation in the physical examination should be alarming findings in COVID-19 patients for PX and PM. Early management of these symptoms can be life saving.

Keywords: COVID-19, pneumothorax, pneumomediastinum, subcutaneous emphysema

Introduction

Coronavirus disease-19 (COVID-19) which is caused by the SARS-CoV-2 virus, is a world-wide pandemic described clinically as viral pneumonia. According to weekly epidemiological reports by World Health Organization (WHO), by the end of November 2021 total patient numbers are 250 million and 5 million deaths has been counted (1). Fifteen to twelve percent of COVID-19 patients who had mild to severe symptoms were hospitalized. Most of hospitalized patients had respiratory failure and admitted to the intensive care unit with the diagnosis of acute respiratory distress syndrome (ARDS) (1, 2).

Pneumothorax (PX) is a complication that can be seen in intensive care units (ICU) as traumatic or spontaneous. Spontaneous pneumothorax (SPX) refers to presence of air between pleural layers without a precipitating factor. Pneumomediastinum (PM) defined as presence of air in mediastinal cavity. PM can be also spontaneous, but it is a very rare complication. One of the reasons behind SPX and SPM is barotrauma that is caused by

mechanical support. The rate of SPX in ARDS patients reported to be %10 and correlated with high airway pressures (3,4).

Since January 2020, there are multiple case reports and case series about SPX in COVID-19 patients. There is an increased incidence of SPX in COVID-19 patients according to the reports but there are no certain rates known about this complication. Barotrauma, prolonged coughing and structural changes due to viral infection is thought to be the underlying mechanism (5,6,7).

Here we report thirteen COVID-19 patients who had spontaneous pneumothorax and pneumomediastinum during ICU follow-up. Patients who were admitted to ICU between April 2020 and November 2021 were evaluated retrospectively. Demographic characteristics, comorbidities, treatment and monitorization parameters which were recorded in the ICU. Patients with ARDS who needed mechanical ventilation had followed up in line with the guideline recommendations as restricting tidal volumes to 6 ml/kg and plateau pressures to 30

Table 1. Clinical characteristics of cases.

	Age	Gender	Intubation Day (total)	Pao ₂ /FiO ₂ rate	Mechanic Ventilation Parameters (at diagnosis)			Diagnosis day after intubation	Outcome	
					Mode	PS	PEEP			Tidal Volume (ml/kg)
Case 1	56	Male	30	114	SIMV-PS	8	12	5	7	Dead
Case 2	62	Female	6	110	SIMV-PS	10	10	5	1	Dead
Case 3	67	Male	3	182	SIMV-PS	12	8	4	0	Dead
Case 4	59	Male	7	105	SIMV-PS	14	6	5	0	Dead
Case 5	60	Male	-	210	-	-	-	-	-	Discharged
Case 6	65	Female	-	140	-	-	-	-	-	Dead
Case 7	84	Female	5	130	SIMV-PS	10	6	4	0	Dead
Case 8	57	Female	20	140	SIMV-PS	14	8	5	15	Dead
Case 9	52	Female	-	125	-	-	-	-	-	Dead
Case 10	49	Female	-	145	-	-	-	-	-	Discharged
Case 11	62	Male	25	160	SIMV-PS	10	12	5	20	Dead
Case 12	73	Female	15	120	SIMV-PS	10	12	5	9	Dead
Case 13	65	Male	-	140	-	-	-	-	-	Still in ICU

cm H₂O (8). Diagnosis of SPX and SPM is made by chest XR and computerized tomography (CT). Computerized tomography is used for both diagnosis and differential diagnosis. Most of our patients had multiple underlying problems, CT is mostly used for differential diagnosis and to eradicate other pathologies. Clinical characteristics of patients are shown in Table 1. Mechanical ventilation settings that shown in table 1 are determined at the time of diagnosis. Patient's medical treatments were organized according to the ministry of health guidelines.

Case Series

Case 1

Hypertensive 56 year-old male, admitted to ICU with dyspnea and acute respiratory failure. His condition had worsened in 6th day of his COVID-19 test positivity. Ventilator settings were PEEP: 12 cmH₂O, VT: 6ml/kg, and peak inspiratory pressure 23-cm H₂O. On the 7th day subcutaneous emphysema was seen on chest X-ray. Widespread subcutaneous emphysema and pneumomediastinum was observed on thorax CT (Figure 1). The patient died at 30th day of ICU admission because of septic shock.

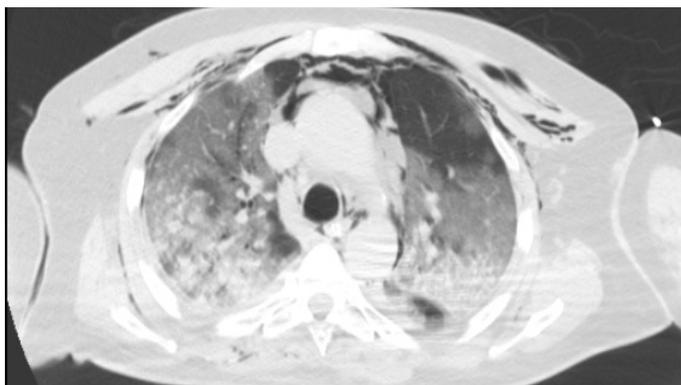


Figure 1. Widespread air densities in mediastinum is shown at thorax CT.

Case 2

Sixty-two year-old female patient was admitted to ICU with increased dyspnea. She had only rheumatoid arthritis as comorbidity. High flow nasal oxygen (HFNO) was used after ICU admission. After 4 days she had intubated due to increasing CO₂ pressure and hypoxia. Ventilator settings were PEEP: 12 cmH₂O, tidal volume: 5 ml/kg. Thorax CT was performed and widespread air densities in mediastinum was observed. There was bilateral pneumothorax up to 6-6.5 cm (Figure 2). Patient died at 10th ICU day due to sepsis.

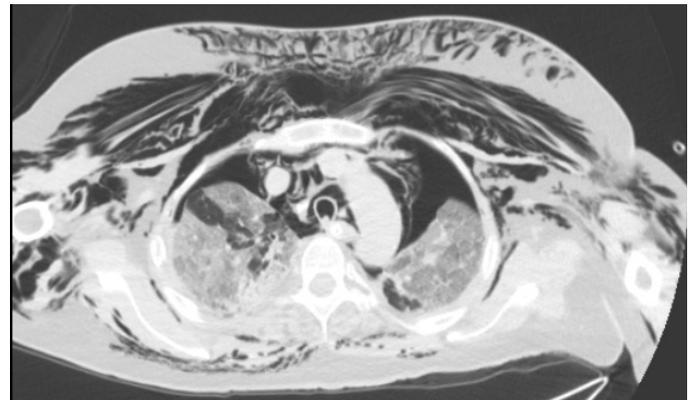


Figure 2. Pneumomediastinum and pneumothorax in thorax CT.

Case 3

Sixty seven year-old male with chronic hypertension admitted to ICU due to hypoxia at 8th day of COVID-19 test positivity. HFNO was used until he was intubated at 7th ICU day. Subcutaneous emphysema, pneumomediastinum and bilateral pneumothorax were revealed on thorax CT that performed when patient's oxygen demand was increased (Figure 3). The patient died at 10th ICU day.

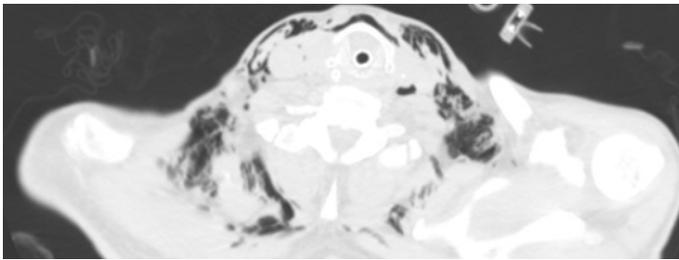


Figure 3. Subcutaneous emphysema and pneumomediastinum is seen in thorax CT

Case 4

Fifty nine year-old male with no known comorbidities attended from emergency department with dyspnea at 10th day of COVID-19 test positivity. He was intubated in emergency service and admitted to ICU. At admission, he had subcutaneous emphysema and pneumomediastinum at thorax CT. The patient died at 7th ICU day because of sepsis.

Case 5

Sixty year-old male with lung squamous cell carcinoma admitted to ICU at 15th day of COVID-19 test positivity. He had followed with nasal oxygen. Because of the oxygen demand increased, thorax CT was performed and large pneumothorax was seen (Figure 4). Chest tube was inserted and patient's oxygen demand was decreased. He discharged to ward at 4th day of ICU stay.

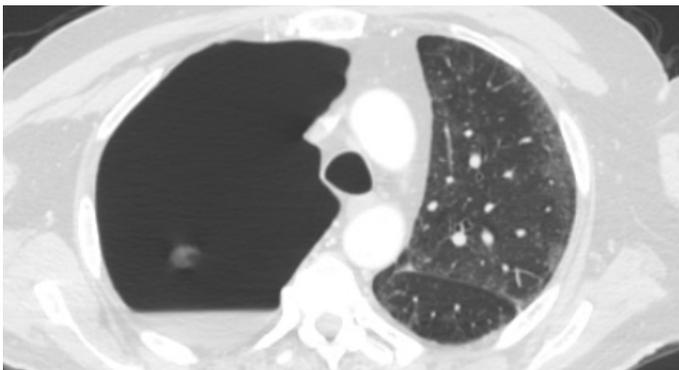


Figure 4. Pneumothorax is seen at both chest XR and thorax CT.

Case 6

Sixty five year-old female with rheumatoid arthritis admitted to ICU with the diagnosis of meningoencephalitis, acute respiratory failure and invasive mechanic ventilation requirement. At 2nd day of intubation, crepitation over thorax and neck were palpated. She died at 5th day of admission.

Case 7

Eighty four year-old female patient brought to emergency department with melena and deterioration in general condition. She had chronic obstructive pulmonary disease and cerebrovascular disease as comorbidities. Because of deep hypoxia, she subsequently intubated and performed thorax. Pneumothorax and ground glass opacities, compatible with COVID-19 pneumonia, was revealed in thorax CT (Figure 5). The patient had admitted to ICU and chest tube inserted for large pneumothorax. She died at 5th day of ICU due to massive gastrointestinal hemorrhage.

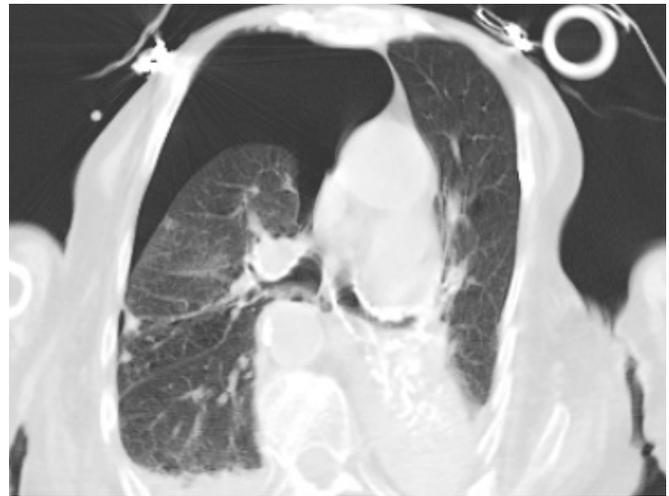


Figure 5. Large area of pneumothorax was seen at CT.

Case 8

Fifty seven year-old female with hypothyroidism was admitted to the emergency department with hypoxia and subsequently intubated. She had diagnosed as sepsis due to COVID-19 and taken to ICU. Broad spectrum antibiotics were administered. At 15th day of admission, subcutaneous emphysema was noticed. She died at the 20th day of ICU stay.

Case 9

Fifty two year-old female with ovarian carcinoma was admitted to ICU on his 4th day on the wards and 6th day of seropositive testing for COVID-19. Because of she was pancytopenic and dyspnea symptoms were mild, she was followed with non-invasive ventilation and HFNO. At 14th of admission, subcutaneous emphysema developed and minimal pneumothorax was observed at chest XR. She died at 16th day of ICU due to sepsis.

Case 10

Forty nine year-old female was staying in ICU at another hospital for 20 days with non-invasive mechanical ventilation requirement. At 20th day of ICU stay pneumothorax was observed (Figure 6) and transferred to our ICU. Chest tube was inserted after that non-invasive ventilation requirement was ended. She had discharged to wards with nasal oxygen at the 2nd day of ICU admission.

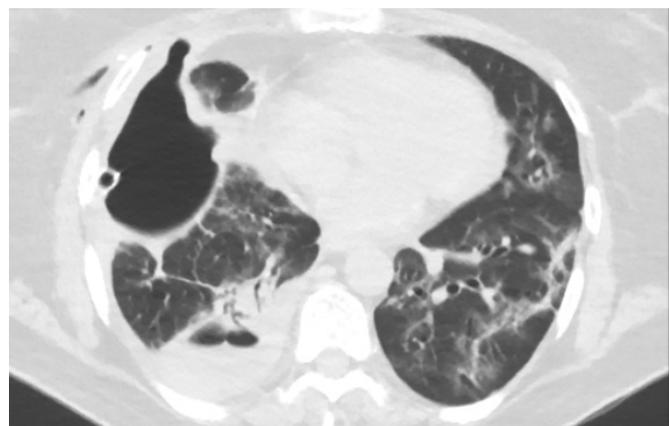


Figure 6. Pneumothorax and chest tube is seen at CT.

Case 11

Sixty two year-old male with diabetes mellitus and chronic hypertension was admitted to ICU at 30th day of his COVID-19 test positivity and 20th day of ICU admission. He had pulmonary fungal infection and hemodialysis requirement. At chest XR and thorax CT pneumothorax was observed and chest tube was inserted. He died due to complications of sepsis at 10th day of admission.

Case 12

Seventy three year-old female with hypertension, hypothyroidism, and chronic heart failure with pacemaker was admitted to ICU from the emergency department due to acute respiratory failure and subsequently intubated. At 9th day of ICU admission, pneumothorax was noticed at chest XR. Chest tube was inserted (Figure 7) She died at 15th day of ICU admission.

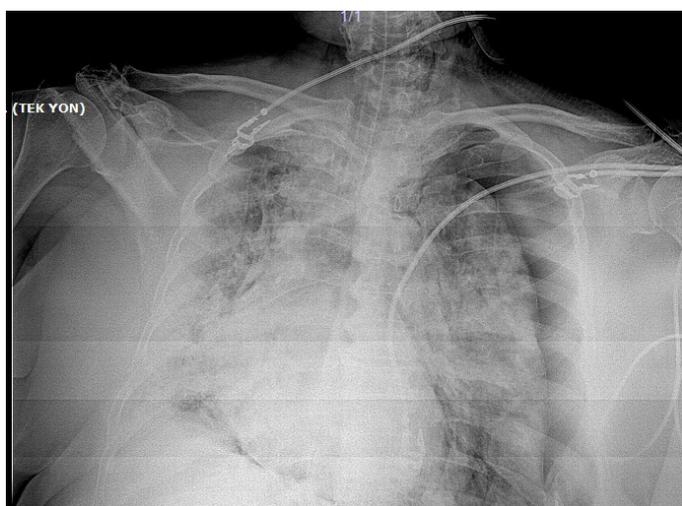


Figure 7. Pneumothorax is seen at chest XR.

Case 13

Sixty five year-old male with chronic obstructive lung disease was admitted to ICU from wards because of increased dyspnea. At the 6th day of ICU admission, non-invasive ventilation was started. On chest XR pneumothorax was observed. Chest tube was inserted and patient's non-invasive ventilation requirement was decreased. He is still in ICU and we are planning to discharge.

Discussion

Spontaneous pneumothorax and pneumomediastinum refers to air presence in the mediastinum or pleural cavities due to several etiologies except trauma and iatrogenic. Some case reports and case series were reported spontaneous pneumothorax and pneumomediastinum in COVID-19 patients (3-12).

In a multicenter retrospective case series, Martinelli et al. reported 60 patients with SPX and 11 patients with SPM from 16 centers. In this report, 28th day mortality was not different from COVID-19 patients without SPX or SPM. SPX incidence was higher in males and mortality was higher in older patients these were >70 years (9).

In a review of 15 case reports, it has been noticed that most of the cases has SPX or SPM at admission to ICU. The cases did not need ventilation support before SPX and SPM. The review concludes the report as increased need of ventilation support can be a sign for SPX or SPM (10).

In a literature review, majority of PX cases were male (%88.8) and %55.5 had some comorbidities. %66 of PM cases were male and only %33 of them had comorbidities. Fever was the most frequent symptom (%100) followed by dyspnea (%80) and cough (%60). %60 of cases concluded with death (11).

In our study the mean age was 62 and occurrence in male and females was similar. Eight patients were intubated and their mechanical ventilation settings were similar. Four of the intubated patients had SPX or SPM at the admission. The patients that were followed with noninvasive mechanical ventilation had better survival than with invasive mechanical ventilation.

Patients' history was insignificant for risk of SPX and SPM. Most of them did not have a prior lung disease. All of them worsened after SPX or SPM and needed further ventilation support.

Etiology for SPX and SPM in COVID-19 is not clear. There are some hypotheses for these complications. Barotrauma is one of them. However, some cases have SPX or SPM before ventilation support. Some reports say that prolonged coughing maybe an etiologic factor. Cough may enhance air leakage due to forceful movements of vessels and alveoli. Structural changes due to COVID-19 make leakage easier (12).

Barotrauma has long been known as a complication of mechanical ventilation and has been associated with increased mortality. It has been shown in multiple studies that barotrauma has higher incidence at COVID-19 patients. Barotrauma has been noted even in non-mechanically ventilated patients who are usually considered at lower risk for barotrauma. In a retrospective case control study, barotrauma in COVID-19 patients reviewed through 827 patients' data. %3.6 of these patients had barotrauma and many of them were mechanically ventilated and had longer duration in ICU. It has been noted that barotrauma is associated with longer duration spent on invasive mechanic ventilation and HFNO (13).

High levels of pressure are one of the reason for barotrauma. COVID-19 patients have multiple reasons to be vulnerable for barotrauma as discussed before. Coughing, alveolar damage and need of higher pressure values led to vulnerability which results with barotrauma. We can see barotrauma in our clinical practice as SPX and SPM. The mechanic ventilation values which seen in Table 1 are the settings at the time of diagnosis. As we can see most of the patients have high PEEP levels. Because of ARDS in these patients, to secure oxygenation, we had to use high PEEP levels.

SPX and SPM seem to be more frequent in males. This may be due to severity of disease in males. This data is similar with survival. Severe cases have more SPX and SPM incidence, so their survival rate is low. Like our cases, most of the reports have low survival rate.

Conclusion

Barotrauma is a common complication in ICU with usage of mechanic ventilation. Due to multiple reasons, COVID-19 causes lungs to be more vulnerable to barotrauma. The results of barotrauma are SPX and SPM. Worsening general conditions

of COVID-19 patients, increased need of oxygen and ventilation support should be alarming for SPX and SPM. With appropriate approach and early detection of these circumstances may decrease need of invasive ventilation and ICU.

AUTHOR CONTRIBUTIONS:

Concept: CE, MK, SYT; **Design:** CE, MK, SYT; **Supervision:** HS; **Fundings:** CE, MK; **Materials:** CE, MK, SYT; **Data Collection and/or Processing:** CE, MK, SYT; **Analysis and/or Interpretation:** CE; **Literature Search:** CE; **Writing Manuscript:** CE; **Critical Review:** HS.

Informed Consent: The cases evaluated retrospectively from hospital data.

Peer-review: Externally peer-reviewed.

Conflict of Interest: Authors have no conflicts of interest to declare.

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