Spontaneous pneumothorax and spontaneous pneumomediastinum in COVID-19 patients

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Abstract

Background: Spontaneous pneumothorax (SP) and or spontaneous pneumomediastinum (SM) are once in a while found clinical complication among the COVID-19 patients.
Objectives: This study aims to investigate the occurrence of spontaneous pneumothorax and or spontaneous pneumomediastinum, risk factors, and outcomes among COVID-19 patients.
Patients and methods: This is a retrospective chart review of all COVID-19 patients who complicated with a spontaneous pneumothorax and/or spontaneous pneumomediastinum with subcutaneous emphysema from April 2020 to December 2021.
Results: A total 49 COVID-19 patients who complicated with a spontaneous pneumothorax and/or spontaneous pneumomediastinum with subcutaneous emphysema were included in the study. Incidence of a SP and/or SM with SC emphysema among ICU admitted COVID-19 patients was 8.03% (49/610) and was 0.98% (49/5000) among all hospitalized COVID-19 patients. The overall mean age was 53.31± 15.36 and most of them were males 33 (67.35%) patients. 31 (63.27%) patients had co-morbidities. We had 24(48.98%) patients with spontaneous pneumothorax without spontaneous pneumomediastinum and subcutaneous emphysema, 17(34.69%) patients had spontaneous pneumothorax with spontaneous pneumomediastinum and subcutaneous emphysema and 8(16.33%) patients had spontaneous pneumomediastinum and subcutaneous emphysema without, Spontaneouspneumothorax.11(22.45%) patients were managed conservatively while right Chest tube was inserted in 16(32.65%) patients, left chest tube was inserted in 9(18.37%) patients and bilateral chest tubes were inserted in 13(26.53%) patients. Total mortality was 33 (67.35%) patients
Conclusions: Spontaneous pneumothorax is one of the complications of COVID-19 with a higher mortality rate and worse prognosis.
Key words: COVID-19, Emphysema, Pneumomediastinum, Pneumonia, Pneumothorax.

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Introduction

Coronavirus disease 2019 (COVID-19) contagious is an infection affecting all over the world **(Shaikh et al., 2021)**. Pneumonia caused by coronavirus COVID-19 is a very contagious disease with high mortality rate worldwide **(Zantah et al., 2020)**. The most common clinical manifestation of infected patients was fever, dyspnea, cough, abdominal pain, diarrhea; loss of smell, sore throat, and muscular pain **(Nakatsutsumiet al., 2020)**.**Chen et al. (2020)** reported that COVID-19 patients can develop aggressive pneumonia causing acute respiratory distress syndrome (ARDS). **Pieracci et al. (2020)** reported that the mechanism of spontaneous pneumothorax was thought to be due to extensive lung injury and diffuse alveolar damage as a complication of aggressive acute respiratory syndrome (SARS). **Chopra et al. (2021)** reported that the risk for developing pneumothorax is due to these changes in lung parenchyma and over distention of the alveoli caused by mechanical ventilation.

Spontaneous pneumothorax (SP) and or spontaneous pneumomediastinum (SM) with subcutaneous (SC) emphysema are once in a while found clinical complication and had occurred in 1% to 2% of the COVID-19 patients without traum a**(Vahedi et al., 2021)**. At first, the event of SP and SM was thought to be due to invasive ventilation-induced events but have recently been reported to affect may also non-mechanically ventilated patients without any evidence of barotrauma or volume trauma **(Tucker et al., 2020)**. In addition, some cases have happened even with regular ward admission **(Chen et al., 2020)**.

This study aims to investigate the incidence of SP and or SM, risk factors, and outcomes of patients with COVID-19 infection.

Patients and Methods

This is retrospective chart review of all patients with COVID-19 infection in tertiary hospital who developed a SP and/or SM with SC emphysema during the period from April 2020 to December 2021.

COVID-19 contagion was diagnosed by PCR sampling of nasopharyngeal swab. Daily chest x-ray was done for all patients routinely. The diagnosis of presence or absence of SP and/or SM with SC emphysema was made by reviewing of clinical follow up notes and chest x-ray imaging.

Inclusion criteria: Patients who diagnosed to have a SP and/or SM with SC emphysema at any time of their admission during their clinical course were included in this study and thoroughly reviewed.

Exclusion criteria: Patients with iatrogenic pneumothorax or pneumomediastinum occurred secondary to invasive procedures was excluded from the study.

Data collection: Gathered information included demographic characteristics (age and gender), presence of SP and/or SM with SC emphysema with affected side, way of management either by conservative management or by chest tube insertion including side of insertion and duration of keeping chest tubes inserted, length of stay either hospital or Intensive Care Unit (ICU), need of mechanical ventilation (MV), Positive End-Expiratory Pressure (PEEP) volume, presence of co-morbid diseases and mortality outcome**.**

Ethical considerations: Approval of this study was done by our local Research Ethics Board in our tertiary university institute for reviewing charts for of all patients with COVID-19 infection who complicated with a SP and/or SM with SC emphysema from April 2020 to December 2021.

Statistical analysis of the data

Statistical Package for the Social Sciences (SPSS) software version 25 (IBM SPSS 25 Statistics for Windows; IBM Corp., Armonk, New York, USA) was used for Statistical analysis.

Results

A total 49patients with COVID-19 infection who complicated with a SP and/or SM with SC emphysema were included in the study. Incidence of a SP and/or SM with SC emphysema in ICU admitted COVID-19 patients was 8.03% (49/610) and was 0.98% (49/5000) in all hospitalized COVID-19 patients. The overall mean age was 53.31± 15.36, out of them 33 cases (67.35%) males, **(Table.1)**.

Table1: Demographic data of the study population

Variables	Number (%)
Age (mean ± SD,years)	53.31± 15.36
Sex	
• Male (%)	33(67.35)
• Female (%)	16(32.65)
• Total	49(100)
Total number of hospitalized COVID-19 cases	5000(100)
• SP and/or SM with SC emphysema	49 (0.98)
Total number ofCOVID-19 patients admitted to ICU	610(100)
• SP and/or SM with SC emphysema	49(8.03)

SD : standard deviation

Total mortality among the included cases was 33 (67.35%) patients. 29 (87.88%) patients were managed by chest tube while 4 (12.12%) patients were managed conservatively. There were 18 (36.73%) patients with no co-morbidities however 31 (63.27%) patients had co-morbidities in the form of diabetes mellitus (DM) in 21(42.86%) patients, Dyslipidemia (DLP)in 10(20.41%) patients, Hypothyroidism in 5(10.20%), Bronchial asthma (BA) in 2(4.08%) patients, Hypertension (HTN) in 19(38.78%) patients, chronic kidney disease (CKD) in 5(10.20%) patients and coronary artery disease (CAD) in 7(14.29%) patients, **(Table.2)**

Table 2. Associated comorbidities and mortality outcome among the study participants

Variables	Number (%)
No Mortality	16(32.65)
Mortality	33(67.35)
No Co-morbidities	18 (36.73)
Co-morbidities	31 (63.27)
Total	49(100)
DM	21(42.86)
Dyslipidemia	10(20.41)
Hypothyroidism	5(10.20)
Bronchial asthma	2(4.08)
HTN	19(38.78)
CKD	5(10.20)
CAD	7(14.29)

(CKD) Chronic kidney disease; (CAD) Coronary artery disease; (DM) Diabetes mellitus; (HTN) Hypertension

We had 24(48.98%) patients with SP without SM and SC emphysema, 17(34.69%) patients with SP with SM and SC emphysema and 8(16.33%) patients with SM and SC emphysema without SP. Regarding the side of pneumothorax it was on right side in 18(36.73%) patients, on left side in 10(20.41%) patients and bilateral in 13(26.53%) patients,**(Fig. 1)**.

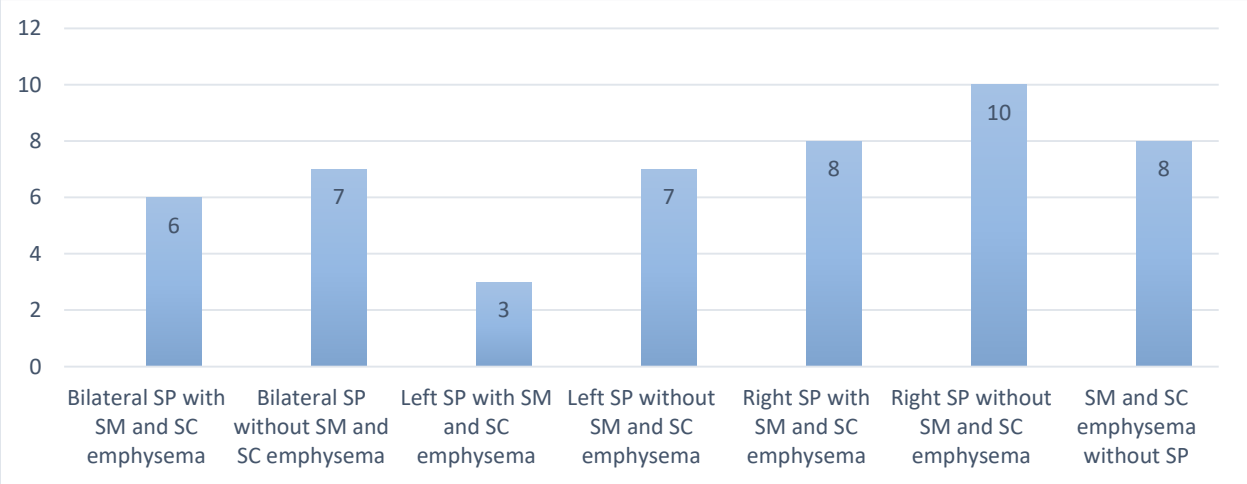

Fig. 1. Spontaneous pneumothorax (SP), Spontaneous pneumomediastinum (SM) and SC emphysema

Eleven (22.45%) patients were managed conservatively while right Chest tube was inserted in 16(32.65%) patients, left chest tube was inserted in 9(18.37%) patients and bilateral chest tubes were inserted in 13(26.53%) patients, **(Table. 3).**

Table 3. Management strategies of pneumothorax among the study group

Variables	Number (%)
Conservative treatment	11(22.45)
Right Chest tube insertion	16(32.65)
Left chest tube insertion	9(18.37)
Bilateral chest tube insertion	13(26.53)
Total	49(100)
Duration of chest tube insertion (mean ± SD, Days)	12.87±13.28

SD: standard deviation

Only one (2.04%) patient was not admitted to ICU. 39(79.59%) patients were on MV with mean duration of MV was (20.15 ± 19.30) days, while 10(20.41%) patients did not need MV. Regarding PEEP level, it was <5 in 3(6.12%) patients, ≥5 and <10 in8 (16.33%) patients and ≥10 in 29(59.18 %) patients. The overall mean hospital stay was (34.64 ± 28.93) days and ICU stay was (27.76 ± 20.81) days, **(Table. 4).**

Table 4.Length of hospital stay, ICU stay and need for mechanical ventilation among the study population

Variables	Number (%)
Intensive care unit admission	48(97.96)
Word admission	1(2.04)
No mechanical ventilation	10(20.41)
Mechanical ventilation	39(79.59)
Total	49(100)
PEEP (Positive End-Expiratory Pressure)	
• <5	3(6.12)
• 5 - 10	8(16.33)
• ≥10	29(59.18)
Duration of MV(mean ± SD, Days)	20.15± 19.30
Length of hospital stay (mean ± SD, Days)	34.64 ± 28.93
Length of ICU stay (mean ± SD, Days)	27.76 ± 20.81

SD: standard deviation

Discussion

COVID-19 contagion can complicate with severe pneumonia causing acute respiratory distress syndrome (ARDS). This disease can be identified radiographically by ground glass opacities, progressing to consolidative changes and fibrotic changes in late stages of the disease. These changes including severe lung injury and diffuse

alveolar damage can explain the mechanism of spontaneous pneumothorax complicating severe acute respiratory syndrome (SARS) **(Hosseiny et al., 2020).**

In this study, the incidence of a SP and/or SM with SC emphysema in ICU admitted COVID-19 patients was 8.03% (49/610) and was 0.98% (49/5000) in all hospitalized COVID-19 patients. In accordance with our study, **Chopra et al. (2021)** did a multicenter retrospective study included all COVID-19 patients who were admitted to ICU in four tertiary care hospitals in the United States. In their study, they included a total of 842 critically ill COVID-19. There were 594 patients (71%) on mechanical ventilation. The frequency of pneumothorax was 85/842 (10%), and 80/594 (13%) in patients who were on mechanical ventilation and they concluded that the occurrence of pneumothorax in mechanically ventilated patients with COVID-19 contagion was 13%. Mechanically ventilated patients with COVID-19 infection who complicated with pneumothorax had worse respiratory mechanics and gas exchange with greater mortality rate in comparison to those who did not develop pneumothorax. Moreover, **Shaikh et al. (2021)** retrospectively analyzed all COVID-19 patients with SP and/or SM from March to September 2020 as complication of COVID-19 infection. They included a total of 1100 admitted cases, out of them 43 cases were complicated with SP, SP + SM, or SM. The majority of their cases were males (42/97.9%), and diabetes mellitus was the most common co-morbid disease (13/30.2%). Twenty-two of the cases complicated by SP (51.2%), 11 cases developed both SP and SM (25.6%), and 10 cases developed SM only (23.3%). they concluded that Patients had aggressive COVID-19 pneumonia can develop SP and SM. male diabetic patients are more common to have this complication. Low lung compliance due to ARDS is important risk factor to develop SP, SP+ SM, or SM. Also, **Zantah et al. (2020)** did a chart review retrospectively for hospital admitted patients with COVID-19 infection. Their study included 3368 patients 902 cases diagnosed by positive PCR from nasopharyngeal swab. 6 cases who complicated by spontaneous pneumothorax were determined (0.66%). 4/6 cases were mechanically ventilated. All patients managed by placement of a chest tube so, they concluded that COVID-19 pneumonia can be rarely complicated by spontaneous pneumothorax that can occur without mechanical ventilation.

In the contrary to our study, **Wang et al. (2021)** in their study, disclosed that the overall incidence of pneumothorax was 2.01% (5/248) in all hospitalized COVID-19 cases. Furthermore, **Galindo et al. (2021)** concluded that cysts and pneumothorax were rare manifestations of COVID-19 pneumonia with mechanisms still not completely understood.

Most of our cases were male 33 (67.35%) patients. **Wang et al. (2021)** confirmed similar results

Presence of co-morbid diseases was considered a risk factor which increases severity of disease and worsens outcome. In this study 31(63.27%) cases had co-morbid disorders. **Bellettiet al. (2021)** confirmed

similar results as in their study where 22 (78.57%) cases had co-morbid disorders.

The incidence of SP and/or SM with SC emphysema in our study is related to prolonged duration of MV as most of our patients were mechanically ventilated (39(79.59%) patients) with long period (20.15 ± 19.30) days).**Shaikh et al. (2021)** confirmed similar results as in their study where the mean mechanical ventilation days were 25.37 ± 18.4.

Most of our patients were on high PEEP level [≥10 in 29(59.18 %) patients]. In accordance, **Shaikh et al. (2021)** found that39 (90.7%) of their patients were mechanically ventilated with high PEEP level.

Most of our cases are managed by chest tube insertion as right chest tube was inserted in 16(32.65%) patients, left chest tube was inserted in 9(18.37%) patients and bilateral chest tubes were inserted in 13(26.53%) patients. Correspondingly, **Shaikh et al. (2021)** summarized that most of their patients were managed by chest tube [29 cases (67.4%) of the cases required tube thoracostomy].

Development of SP and/or SM with SC emphysema is considered poor prognostic factor as total mortality in this study, was 33 (67.35%) patients in the study and also considered an indicator of severity of disease as most patients (48 (97.96%) patients) admitted to ICU with long ICU stay (27.76 ± 20.81) days and also long hospital stay (34.64 ± 28.93) days, a similar mortality rate in **a** previous study **(Zantah et al., 2020)** (the mortality was 4/6 (66.67%) patients).

Finally, we believe severe COVID-19 infection with prolonged hospital stay, prolonged ICU stay, MV especially with long time and high PEEP level increase incidence of SP and/or SM with SC emphysema which is considered as poor prognostic factor with high mortality.

The limitations of this study had several limitations firstly: its retrospective nature, secondly: it is a single-center experience, which may limit generalizability of the results. Lastly, the protocols of management were continuously updated during COVID-19 pandemic so not all patients were managed by the same protocol which may affect outcomes. However, these findings appeared consistent with data already published in medical literature.

Conclusions

SP and/or SM with SC emphysema is one of COVID-19 infection complication with a higher mortality rate and worse prognosis. Early diagnosis and rapid interference might improve the patients' outcome and increase their survival rate.

Declarations

Ethics approval and consent to participate

King Fahad Hospital of University Research Ethics Board approval was obtained for a retrospective chart review of all patients (IRB-2022-1-226). All patients were consented.

Consent for publication

Not applicable as there is no individual person's data in any form (including individual details, images or videos) in my study.

Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The author declares that I have no competing interests.

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Authors' contributions

Not applicable as it is single author study.

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References

- **Shaikh N, Al Ameri G, Shaheen M, Abdaljawad W, Al-Wraidat M, Al-Alawi A,et al (2021).** Spontaneous pneumomediastinum and pneumothorax in COVID-19 patients: A tertiary care experience. Health Sci Rep, 4: e339.
- **Zantah M, Castillo E, Townsend R, Criner FD (2020).** Pneumothorax in COVID-19 disease incidence and clinical characteristics. Respiratory Research, 21:236.
- **Nakatsutsumi K, Sekiya K, Urushibata N, Hosoi M, Arai H, Nagaoka E, et al(2020).** A successful case of extracorporeal membrane oxygenation treatment for intractable pneumothorax in a patient with COVID-19. Acute Medicine & Surgery,7: e612.
- **Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al (2020).** Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet, 395: 507–513.
- **Pieracci FM, Burlew CC, Spain D, Livingston DH, Bulger EM, Davis KA, et al (2020).** Tube thoracostomy during the COVID-19 pandemic: Guidance and recommendations from the AAST Acute Care Surgery and Critical Care Committees. Trauma Surg. Acute Care Open, 5: 1–4.
- **Chopra A, Al-Tarbsheh AH, Shah NJ, Yaqoob H, Hu K, Feustel PJ, et al (2021).** Pneumothorax in critically ill patients with COVID-19 infection: incidence, clinical characteristics and outcomes in a case control multicenter study. Respir Med, 184:106464.
- **Vahedi E, Madani S,Molaee H, Davoudi-Monfared E (2021).** Spontaneous Pneumothorax and Pneumomediastinum Following COVID-19. Hospital Practices and Research, 6(1):39-41.
- **Tucker L, Patel S, Vatsis C, Poma A, Ammar A, Nasser W, et al (2020).** Pneumothorax and Pneumomediastinum Secondary to COVID-19 Disease Unrelated to Mechanical Ventilation. Case reports in critical care, 2020, 6655428.
- **Hosseiny M, Kooraki S, Gholamrezanezhad A, Reddy S, Myers L (2020).** Radiology perspective of coronavirus disease 2019 (COVID-19): lessons from severe acute respiratory syndrome and Middle East respiratory

syndrome. Am J Roentgenol, 214:1078–1082.

- **Wang, X. H., Duan, J., Han, X., Liu, X., Zhou, J., Wang, X, et al (2021).** High incidence and mortality of pneumothorax in critically Ill patients with COVID-19. Heart & lung: the journal of critical care, 50(1), 37–43.
- **Javier Leonardo Galindo, Luisa Fernanda Jiménez, Juan Ricardo Lutz, María Alejandra Izquierdo, Viviana Lucía Rivillas, Jorge Alberto Carrillo (2021).** Spontaneous pneumothorax, with or without pulmonary cysts, in patients with COVID-19 pneumonia J Infect Dev Ctries, 15(10):1404-1407.
- **Belletti, A., Palumbo, D., Zangrillo, A., Fominskiy, E. V., Franchini, S., Dell'Acqua, A, et al (2021).** Predictors of Pneumothorax/Pneumomediastinum in Mechanically Ventilated COVID-19 Patients. Journal of cardiothoracic and vascular anesthesia, 35(12), 3642–3651.