Original Article

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Pneumothorax, pneumomediastinum and subcutaneous emphysema as respiratory complications of COVID-19

Prabhat Rawal,[1] Surendra Man Shrestha,[1] Anju Gurung,[1] Dipesh Poudel[1]

[1]Department of Anesthesiology and Critical Care, Nepal A.P.F. Hospital.

ABSTRACT

Background: Pneumothorax, pneumomediastinum and subcutaneous emphysema are respiratory complications of Coronavirus disease 2019 occurring with noteworthy frequency in patients especially with severe disease. They can be life-threatening and often complicate patient managment.

Methods: This was a retrospective, observational study of patients admitted in Nepal Armed Police Force hospital from 13/05/2020 to 28/12/2021 diagnosed with pneumothorax, pneumomediastinum or subcutaneous emphysema singly or in combination. Data were collected from clinical charts, imaging records and electronic medical records of Severe Acute Respiratory Syndrome Coronavirus-type 2 positive patients 18 years and older. The frequency and type of the defined complications, the inflammatory markers and ventilatory parameters just prior to their diagnosis, the duration of hospitalization and ICU admission and in-hospital mortality rate were studied.

Results: Out of 4013 COVID-19 patients admitted in the hospital during the period, a total of 28 patients were observed to develop the complications, the overall incidence being 0.7% among hospitalized patients and 5.6% among ICU patients. The proportion of subcutaneous emphysema (64.3%) was highest followed by pneumomediastinum (46.4%) and then pneumothorax (39.3%) existing singly or in combination among the 28 patients, where four patients developed the complications spontaneously. Mean Positive End Expiratory Pressure of 12.1±2.6 cmH_2O and Peak Inspiratory Pressure or Pressure Support of 30.9±10.3 cmH_2O were observed for patients under positive pressure ventilation. Most of the patients who developed the complications (78.6%) died during treatment.

Conclusions: Pulmonary air leak complications occur frequently in COVID-19 patients treated with or without positive pressure ventilation signifying increased disease severity, risk of ICU admission and high mortality rate. Hence, clinicians should be vigilant of these complications in all patients affected with COVID-19 and institute timely management.

Keywords: Barotrauma; COVID-19; incidence; pneumomediastinum; pneumothorax.

INTRODUCTION

Since its inception, Coronavirus disease 2019 (COVID-19), has manifested with varied clinical spectrum involving multiple organ systems, although, primarily described to be of respiratory origin.[1] Spontaneous pneumothorax (PTX), pneumomediastinum (PM) and subcutaneous emphysema (SE) occurring together or as isolated entities, are known respiratory complications of COVID-19 caused by extra-alveolar spread of air.[2]

Pneumothorax is defined as the presence of air in the pleural cavity, that in the mediastinum is pneumomediastinum and air in subcutaneous tissue is subcutaneous emphysema. These complications, depending upon their extent, can cause life threatening respiratory distress and hemodynamic instability. Moreover, these conditions are of noteworthy occurrence among critically ill COVID-19 patients where grave outcomes have been observed, thus, posing many challenges for the clinician during patient treatment.[2]

Correspondence: Dr Prabhat Rawal, Department of Anesthesiology and Critical Care, Nepal A.P.F. Hospital. Email: prabhat.rawal@gmail.com, Phone: +9779851221327.

The occurrence of these complications have been sparsely reported in literature in the context COVID-19 patients in Nepal.[3] This research, therefore, aimed to study the incidence and clinical characteristics of these complications and their impact on the outcome of hospitalized COVID-19 patients in a tertiary care centre in Nepal.

METHODS

This was a retrospective, observational study of patients admitted in Nepal Armed Police Force (APF) hospital over a period of 18 months from 13/05/2020 to 28/12/2021 diagnosed with PTX, PM or SE singly or in combination. Permission for research was granted by Nepal APF Hospital administration and ethical clearance was obtained from Nepal Health Research Council (Protocol Registration no. 649/2021P). The need for informed consent was waived as data collection was retrospectively done from clinical patient records and complete anonymity of patients' personal information was maintained. The primary objective was to study the incidence and type of the defined complications. In addition, clinical characteristics of such patients in terms of inflammatory markers, ventilatory parameters, duration of hospitalization and ICU admission and in-hospital mortality rate were studied.

This process included a meticulous search for any evidence of the defined complications through the electronic clinical records of 4013 COVID-19 patients with Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) confirmed Severe Acute Respiratory Syndrome Coronavirus type-2 (SARS-CoV-2) positive status admitted in the hospital during the defined period. Those patients 18 years and older having radiological evidence of either PTX, PM or SE at any point during their clinical course were taken into consideration and their clinical records were thoroughly evaluated. However, patients admitted in the hospital with 'suspected' or 'probable' COVID-19 status, patients diagnosed to have COVID-19 by Rapid Diagnostic Tests (RDT) only and patients with well-established risk factors (such as COPD) for the development of pneumothorax were excluded from the investigation. COVID-19 pneumonia was diagnosed and classified by the treating physicians as per World Health Organization (WHO) Interim Guidelines 2020.[4]

The clinical record files and daily electronic medical records of patients meeting the inclusion criteria were retrieved from the record section of the hospital and thoroughly assessed for data collection. Radiological records of high definition digital chest X-rays antero-posterior or postero-anterior views done daily while the patients were admitted were also reviewed to study the extent of the defined complications and correlated with the corresponding reports written by board certified radiologists of the hospital as part of their routine clinical work. CT scan records were not searched for because it was not done routinely per protocol and only performed for selected patients suspected with pulmonary embolism. The highest levels of COVID-19 inflammatory markers just prior to the development of the defined complications were also recorded. Oxygenation and ventilatory parameters were extracted at the point of time when PTX, PM and SE were radiologically diagnosed. Other relevant clinical data were also collected along with the above data into a structured proforma.

The data were arranged in the master sheet created using Microsoft-Excel and analyzed using Statistical Package for the Social Sciences version 24 (SPSS-24). Data were expressed as mean ± standard deviation for normally distributed variables and as median with interquartile range for non-normally distributed continuous variables. Discrete and categorical variables were represented by numbers and percentages.

RESULTS

Out of 4013 COVID-19 patients admitted to the hospital over the defined period, which included predominant infection with the Delta variant (B.1.617.2) of SARS-CoV-2, a total of 28 patients were observed to develop either PTX, PM, SE or a combination of the complications, the overall incidence being 0.7% among hospitalized patients. The overall number of in-hosptial COVID-19 patients admitted to the ICU, with or without the complications, within the defined period, was 504. This number includes the 28 patients having either PTX, PM or SE as they were observed to be admitted in the ICU on detection of the complications or at some point during their hospital stay. Hence, the incidence of defined complications among ICU patients was 5.6%(28/504). The incidence of each of the complications singly or in combination have been further analyzed in Table 1.

Table 1. Proportion of each of the defined complications among total number of patients with the complications.

S.No.	Complications (n=28)	Frequency	Percentage out of total patients with the complications (n=28)	Percentage out of total ICU patients (n'= 504)	Percentage out of total hospitalized patients (N=4013)
1.	Pneumomediastinum + Subcutaneous Emphysema	8	28.6%	1.6%	0.2%
2.	Pneumothorax	6	21.4%	1.2%	0.15%
3.	Subcutaneous Emphysema	6	21.4%	1.2%	0.15%
4.	Pneumomediastinum	3	10.7%	0.6%	0.07%
5.	Pneumothorax + Subcutaneous Emphysema	3	10.7%	0.6%	0.07%
6.	Pneumothorax+Pneumomediastinum + Subcutaneous Emphysema	1	3.6%	0.2%	0.02%
7.	Pneumothorax+Pneumomediastinum	1	3.6%	0.2%	0.02%
	Total	28	100%	5.6%	0.7%

Individually the incidences of PTX= 2.2% (11/504), PM= 2.6% (13/504) and SE= 3.6% (18/504) respectively among ICU patients ICU patients and PTX= 0.2% (11/4013), PM= 0.3% (13/4013) and SE= 0.5% (18/4013) espectively among total hospitalized patients. The proportion of SE (64.3%) was highest followed by PM (46.4%) and then PTX (39.3%) existing singly or in combination (table 1) among the 28 patients. All patients with pneumothorax required placement of chest tube on the affected side while one patient developed tension pneumothorax (1/11= 9.1%) and required needle thoracostomy prior to chest tube insertion. No conditions of bilateral pneumothorax and iatrogenic pneumothorax due to central venous catheter insertion were reported.

The mean age of patients who developed the defined complications was 51.5 years and most of them were males (71.4%) as shown in table 2. The age-wise distribution of the individual complications is depicted in figure 1. The mean duration of hospital stay and ICU admission were 18 days and 12.7 days respectively. Most of the patients who developed the complications (22/28=78.6%) died during treatment while 6 patients (21.4%) survived and were discharged home.

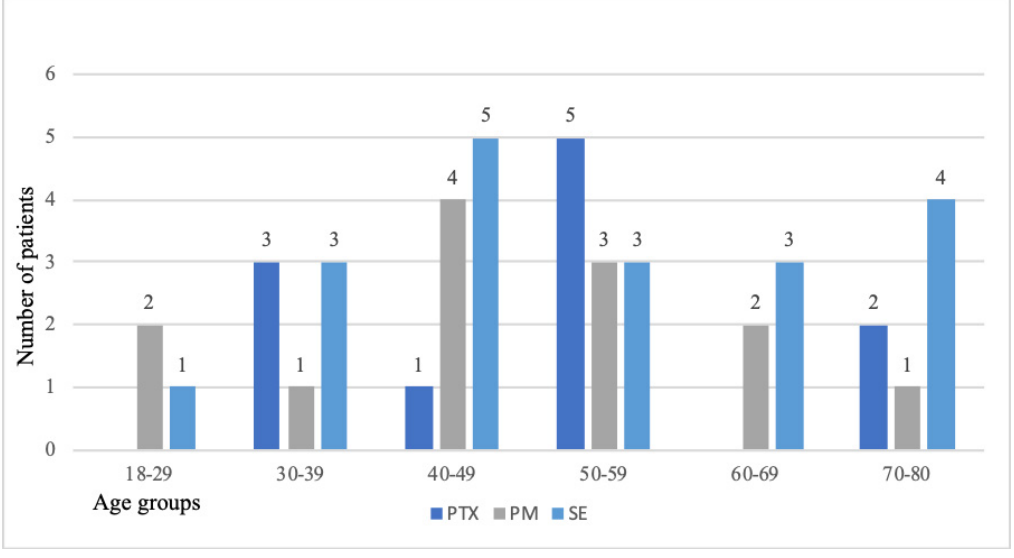


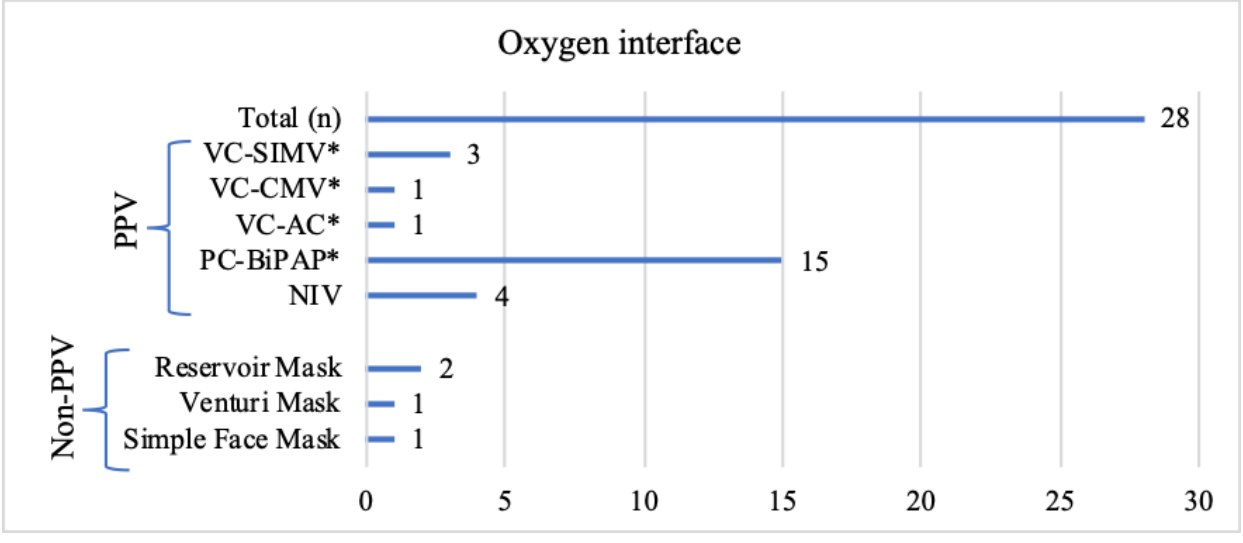
Figure 1. Age-wise distribution of occurrence of PTX, PM and SE individually.

Table 2. Demographic and clinical characteristics of COVID-19 patients with PTX, PM and/or SE.					
Variables (n=28)	Ratio (Percentage)	Mean± SD*	Median (IQR) *	Range (Min-Max)	Data skewness*
Age (years)		51.5 ± 14.4	51 (41.3-63.8)	27-77	0.1
Sex: Male Female	20 (71.4 %) 8 (28.6%)				
Immunization status: Unvaccinated Received one dose Received two doses	20 (71.4%) 7 (25.0%) 1 (3.6%)				
D-Dimer level on admission (μg/mL)		3.4 ± 2.4	2.9 (1.9-4.4)	0.5-10	1.1
CRP Level on admission (mg/L)		118.8 ± 67.2	116 (74.3-164.2)	9.8-258	0.2
Total duration of hospital stay (days)		18 ± 7.9	18 (10-25)	6-34	0.8
Total duration of ICU stay (days)		12.7 ± 6.9	13 (7-18)	1-31	0.8
Clinical outcome: death discharge after recovery	22 (78.6%) 6 (21.4%)				
Interval (until recovery or death) after the onset of defined complications (days)		8.9 ± 6	7.5 (4.8-12.3)	0.5-25	1.1

Table abbreviations: ICU= Intensive Care Unit, IQR= Interquartile range, Max= Maximum value, Min= Minimum value, SD= Standard Deviation

*Selection of mean or median for data representation is based on skewness of data set (Median for skewness <-1 or >1 and Mean for skewness between -1 and 1)

Among the patients developing any of the defined complications, 85% (24/28) had received positive pressure ventilation (PPV), most of them (20/28) having undergone endotracheal intubation and mechanical ventilation as shown in figure 2. Only four patients developed the complications spontaneously while being treated with other modes of oxygen therapy without PPV which is 0.8% of ICU patients and 0.1% of total hospitalized patients.



Legend: NIV= Non-invasive ventilation, PC-BiPAP= Pressure Control-Bilevel Positive Airway Pressure, PPV= Positive Pressure Ventilation, VC-AC= Volume Control-Assist Control, VC-CMV= Volume Control-Controlled Mandatory Ventilation, VC-SIMV= Volume Control-Synchronized Intermittent Mandatory Ventilation

*Patients undergone endotracheal intubation and invasive ventilation

Figure 2. Modes of oxygen therapy in COVID-19 patients with the defined complications.

The patients were observed to develop the complications after a median duration of 2.5 days following PPV with a mean Positive End Expiratory Pressure (PEEP) value of 12.1 ± 2.6 cmH_2O and mean Peak Inspiratory Pressure (Pinsp/PIP) or Pressure Support (Psupp) value of 30.9 ± 10.3 cmH_2O as shown in table 3. All intubated patients were on lung protective ventilation.

Table 3. Respiratory parameters of COVID-19 patients with the defined complications

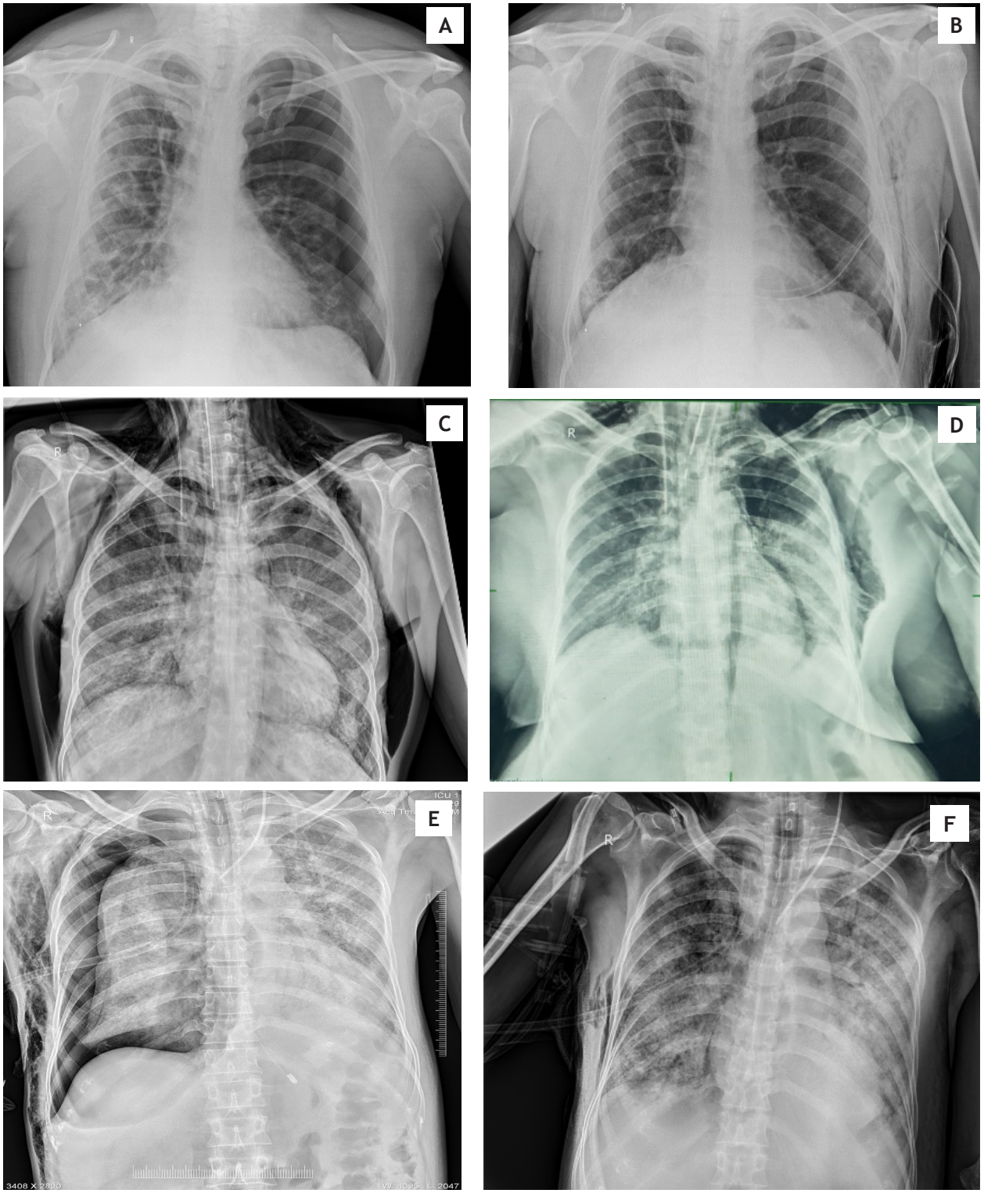
Respiratory parameters (n=28)	Frequency (Percentage)	Mean± SD†	Median (IQR) †	Range	Skewness
Oxygen interface: No positive pressure	4 (14.3%)				
Non-invasive ventilation	4 (14.3%)				
Invasive ventilation	20 (71.4%)				
PF Ratio*		103.2± 57.6	85 (64-110)	50-275	1.7
SPO_2 (%)*		81.3 ± 11.7	84 (77-90)	50-95	-1.2
PEEP (cmH_2O)*		12.1 ± 2.6	12 (10-14)	8-18	0.9
Pinsp/Psupp (cmH_2O)*		30.9 ± 10.3	31 (25-40)	12-45	-0.4
Lung recruitment maneuvers:					
Yes	11 (39.3%)				
No	17 (60.7%)				
Duration of PPV till the onset of complications (days)		5 ± 5.9	2.5 (1-6)	0.5-23	1.8
Occurrence of complications: before					
after	2 (10 %)				
ET Intubation (n= 20)	18 (90 %)				

Table abbreviations: ET= Endotracheal, PF = PaO_2/FiO_2 (Arterial partial pressure of oxygen/Fraction of inspired oxygen), PEEP= Positive End Expiratory Pressure, Pinsp= Inspiratory pressure, PPV=Positive PressureVentilation, Psupp= Pressure support, SPO_2= Peripheral oxygen saturation

*Respiratory and ventilatory parameters at the time of diagnosis of the defined complications

†Selection of mean or median (values in bold) for data representation is based on skewness of data set (Median for skewness <-1 or >1 and Mean for skewness between -1 and 1)

A total of 205 critically ill COVID-19 patients died during the defined period in the hospital. The overall mortality rate was 40.7% (205/504) among all critically ill COVID-19 patients, while mortality was 78.6% (22/28) in those that developed the defined complications.



Figures 3. A) Spontaneous left pneumothorax B) Resolving spontaneous left pneumothorax in patient A after chest tube insertion C) Subcutaneous emphysema in intubated patient with incipient pneumomediastinum "D) Distinct pneumomediastinum with subcutaneous emphysema in intubated patien E) Right pneumothorax and subcutaneous emphysema in intubated patient treated with chest tube in situ F) Resolving right pneumothorax and subcutaneous emphysema in patient E with chest tube in situ.

Table 4. Overall data of individual patients with either PTX, PM or SE or combined.

Patient S.No.	Age (years)	Sex	D-Dimer (µg/mL)*	CRP (mg/L)*	PaO_2 / FiO_2 Ratio*	O_2 Interface *	PEEP (cmH_2O)*	Pinsp/PIP/Psupp (cmH_2O)*	Recruitment maneuver	Type of air leak complication	Duration of PPV prior to detection of complications	Total hospital stay duration (days)	ICU stay duration (days)	interval from onset of PTX/PM/ SE to recovery or death (days)	In-hospital mortality (M) vs Recovery(R)
1	34	M	2	41	55	Intubated	10	15	Yes	PTX+PM	15	12	12	5	M
2	48	M	0.9	12	80	Reservoir mask	N/A	N/A	No	PTX	0	10	9	9	R
3	71	M	2.9	70	275	Intubated	12	18	No	SE	1	10	8	7	R
4	77	M	3.5	124	75	Face mask	N/A	N/A	Yes	PTX+SE	0	23	7	7	M
5	69	M	3.5	143	80	Intubated	12	18	No	SE	2	20	4	2	M
6	55	F	3.6	196	71	Intubated	10	36	No	PTX	14	22	19	9	M
7	46	M	3.3	154	64	Intubated	10	36	No	SE+PM	5	13	10	5	M
8	39	M	0.85	9.8	118	Reservoir mask	N/A	N/A	No	PTX+SE	0	25	18	17	R
9	29	M	4.2	174	97	Intubated	15	45	No	SE+PM	1	25	20	19	M
10	35	M	2.5	92	92	Intubated	14	25	Yes	SE	4	10	8	4	M
11	31	M	2.2	20	93	Intubated	12	25	No	PTX	5	9	7	2	M
12	55	F	>10	134	167	Intubated	12	30	Yes	SE+PM	4	14	14	10	M
13	72	M	3.5	90	107	NIV	10	24	No	PTX	1	22	5	20	R
14	52	F	8.5	258	93	Intubated	12	45	No	PTX	13	29	13	5	M
15	42	M	2.1	110	74.4	Intubated	15	38	No	SE	6	31	31	25	M
16	58	M	4.5	117	85	Intubated	12	45	Yes	PM	3	18	6	3	M
17	75	F	2.3	58	79	NIV	10	25	No	SE	22	28	26	4	M
18	27	F	9.3	115	217	Intubated	14	35	Yes	PM	1	6	6	5	M
19	43	M	1.85	143	61	NIV	12	25	No	SE+PM	3	21	21	18	M
20	52	M	6.6	156	50	Intubated	10	31	No	PTX+SE	0	13	13	13	M
21	60	F	0.7	96	47	Intubated	12	28	Yes	SE+PM	9	28	20	13	M
22	65	F	6.9	250	110	Intubated	12	40	Yes	SE+PM	2	9	9	7	M
23	45	M	1.7	200	56	Intubated	10	40	Yes	SE+PM	5	13	13	12	M
24	54	M	2	95	215	Venturi mask	N/A	N/A	No	PTX	0	34	1	0.5	M
25	41	M	4.7	167	72	Intubated	10	40	Yes	SE	6	18	13	8	M
26	70	F	0.5	23	178.7	Intubated	8	24	No	SE+PM	6	15	14	9	R
27	50	M	>10	192	62	Intubated	12	40	Yes	PTX+PM+SE	3	12	12	9	M
28	48	M	>10	87	91	NIV	10	20	No	PM	2	14	12	10	R

Table abbreviations: CRP= C-Reactive protein, PEEP= Positive end-expiratory pressure, PIP= Peak inspiratory pressure, Pinsp= Inspiratory pressure, PPV= Positive pressure ventilation, Psupp= Pressure support, PM= Pneumomediastinum, PTX= Pneumothorax, SE= Subcutaneous emphysema

*denotes the values just prior to or at the time of first detection of either PTX, PM or SE

N/A= Not applicable as positive pressure ventilation was not applied

DISCUSSION

Air leak from the tracheobroncheal tree to adjacent spaces outside the anatomical location of the respiratory tract leads to complications described as pneumothorax (PTX), pneumomediastinum (PM) and subcutaneous emphysema (SE).[5, 6] However, the term 'barotrauma' alone cannot represent these entities because in Acute Respiratory Distress Syndrome (ARDS), volutrauma, atelectrauma, and biotrauma are additional mechanisms of lung injury.[2, 4, 7] Moreover, these changes have also been observed in patients with viral respiratory illness treated with oxygen therapy without positive pressure ventilation (PPV).[5, 8, 9] The term 'barotrauma' used here implies all the three complications with or without PPV for simplicity of description.

In initial reports, occurrence of PTX, PM or SE in COVID-19 patients was 1-2% in hospitalized patients which is comparable to 0.7% in our study.[10, 11] Higher incidence (4.2%) was observed by Shrestha et al in a meta-analysis where various studies were based on CT scan detection of the complications.[12] Their frequency of occurrence in critically ill COVID-19 patients with or without PPV in our study (5.5%) is comparable to the findings of a retrospective cohort study by Jones et al (9.6%).[2] Guven et al and McGuinness et al demonstrated a barotrauma incidence of 13% and 15% respectively which could range from 5.9-40% exclusively in intubated patients, much higher than in non-Coronavirus ARDS.[13-15] The incidence of primary spontaneous PTX, PM and SE was 0.8% of ICU patients and 0.1% of hospitalized patients in our study accounting for 15% (4/28) of patients with the complications. Similarly, Hamouri et al and Zantah et al demonstrated a 0.8% and 0.6% in-hospital incidence of air leak complications respectively in non-ventilated COVID-19 patients.[5, 16]

Individually, the incidence of PTX was 0.2% among all hospitalized patients similar to that in various studies.[17, 18] Among ICU patients, however, the incidence of PTX in our study (2.2%) is lesser than most studies such as by Chopra et al (10-24%).[5, 12, 17, 19] The lower incidences observed in our study may be due to lesser sensitivity of chest X-ray diagnosis in our cohort as opposed to chest CT diagnosis in other studies. Iatrogenic PTX, however, is only a minor risk factor influencing this occurrence.[20] The incidence of PM alone (2.6%) in our study is similar the findings by Pokhrel et al (2.8%), in a study of COVID-19 ARDS patients in Nepal.[3] SE was observed to be highest among the three complications (SE=64.3%, PM=46.4% and PTX=39.3% among the 28 patients) in our study, as also observed by Jones et al.[2] The three entities have also been observed in various combinations with PM and SE being the most frequent (28.6%) in our study (Table 1). Manna et al and various others have reported stronger associations of PM and SE suggesting a common pathology of origin.[21-23] PM was also found to be a predictive factor for PTX development in ARDS patients.[21] Although SE is almost always co-existent with PM, its incidence is observed to be higher in our study probably because it is easier to observe clinically and with X-ray imaging. It has also been observed in various studies that the incidence of PTX, PM and SE is higher in COVID-19 ARDS than in non-Coronavirus ARDS.[7, 12] COVID-19, however, cannot be established as the cause of the complications based on these observational studies, as yet.[17, 18]

In our study, 85% of patients with the complications (20/28) were intubated while 14.3% (4/28) had received non-invasive ventilation (NIV) during treatment. The median Pinsp/PIP or Psupp observed was 31 (25-40) and PEEP was 12 (10-14) cmH_2O using lung protective ventilation strategy at the time of diagnosis of the complications. Jones et al, with similar treatment methods observed a median PIP of 30 cmH_2O and Lemmers et al reported median PEEP to be 9 cm H_2O.[2, 7] Likewise, mean PIP and PEEP were 29 to 31 and 10 to 11 cmH_2O respectively in various studies, pointing to the fact that such complications can be observed even at relatively lower ventilatory pressure levels. [3, 17, 19] Also, lung protective ventilation was not enough to prevent the complications, though increased risk of PTX was observed in mechanically ventilated patients.[15, 17, 19] Moreover, these complications have been observed with notable incidence in non-ventilated COVID-19 patients.[5] The pathology of these complications, therefore originate from lung inflammation and systemic immune dysregulation with severe disease rather than ventilator induced barotrauma.[17] Lung microthrombosis, diffuse alveolar damage leading to pneumatocoele formation and their rupture along the alveolar tree releases the alveolar air which centripetally dissects through the bronchovascular sheaths of the pulmonary interstitium towards the hila, resulting in PM. This is known as 'Macklin effect'. [7, 24] The mediastinal air further dissects into subcutaneous planes of the neck and thorax manifesting as SE and towards the pleura manifesting as PTX.[3, 15]

Mean PaO_2/FiO_2 ratio was observed to be 105 by Chopra et al and 131 by Lemmers et al at the time of diagnosis of the complications as compared to mean 103.2 (median 85) in our study.[7, 19] Low PF ratio were suggested to indicate an increase in dead space and shunting from ventilation-perfusion mismatch,

and diffusion impairment from severe COVID-19 that predisposes to the development of pneumothoraces.[17] Clinical evidence of tension pneumothorax was seen in 32% (26/80) by Chopra et al as compared to 9.1% (1/11) in ours where sample number of patients with PTX was lower.

The duration of PPV till the onset of complications is median 2.5 (1-6) days in our study. Chong et al observed that is was 5.4 days after mechanical ventilation initiation while Chopra et al observed a longer course of mean 10 days.[17, 19] Various studies have reported an early manifestation of PM and SE, within three days of onset of mechanical ventilation.[7, 21] Although the application of PPV cannot be directly related to the interval until onset of these complications, it can be inferred that the complications are more likely to occur in patients with greater disease severity requiring intensive oxygen and ventilation therapy, as also suggested by other authors.[19]

Disease severity has also been correlated with higher values of inflammatory markers resulting from the sequelae of cytokine storm, thrombosis and microangiopathy during COVID-19 pathogenesis.[16] Our study showed a median D-dimer of 2.9 (1.9-4.4) mcg/ml and mean CRP of 118.8 $\pm$ 67.2 mg/l among patients with the defined complications which are notably high. Chopra et al demonstrated higher values of median D-dimer 6 (12)mg/l and CRP 19(13) mg/dl (i.e. 190 mg/l) and similar values were observed by Guven et al and Manna et al.[15, 19, 23] Linear association between barotrauma occurrence and clinical severity of COVID-19 has been observed in a meta-analysis which also explains the rise in inflammatory markers.[12]

The duration of hospital stay of COVID-19 patients with barotrauma complications have also been observed to be longer as compared to patients without them.[12] Lemmers et al observed a median hospital stay of 18 (12-28) days and ICU stay of 11 (6-21) days which is similar to ours (18 and 13 days respectively).[7] Hamouri et al observed a shorter period of median 9 days in patients with spontaneous PT, PM or SE while Chong et al and Miro et al observed a longer period of 21-25 days of hospital stay for COVID-19 patients with PTX.[5, 17, 25] Chopra et al reported a much longer median duration of hospitalization upto 42 days where they studied 85 patients with the complications.[19] In our study mortality was higher and the number of patients with the complications was less (28) as compared to theirs which may explain the discrepancy in the duration of hospital stay. In all instances, it signifies a complicated course of disease with additional challenges in treatment for the clinicians.

The manifestation of either PTX, PM and SE, thus, correlates with greater COVID-19 disease severity, prolonged hospitalization, increased likelihood of ICU admission and mortality.[12, 17, 25] We observed a mortality of 78.6% overall among COVID-19 patients with the defined complications. In similar situations, high death rates have been observed by Chong et al (74.2%) and Turk et al (71%) which is similar to ours and even upto 100% by McGuinness et al.[13, 17, 22] Others have reported a mortality of 56.5% to 66.7% which was significantly higher than in patients without barotrauma.[7, 21] Also, mortality was higher in COVID-19 patients with PTX or PM under invasive mechanical ventilation.[19, 21] Therefore, the onset of these complications, even if clinically benign, may be an indicator of poor prognosis in COVID-19 patients although causation cannot be implied.[19]

Mean age of patients with PTX, PM or SE in our study is 51.5 years and majority are males (71.4%) which is similar to other studies.[15, 19] Although higher mortality has been observed in COVID-19 patients above 70 years with PTX, no differences have been observed in the incidence of PTX among patients in different age groups.[17] There were two additional deaths among patients having the defined complications with co-morbidities (chronic obstructive pulmonary disease and pulmonary tuberculosis respectively), which would otherwise have depicted a mortality of 80% (24/30) as opposed to 78.6%, while they were excluded from analysis in our study. Also, pre-existing lung diseases, concurrent co-morbidities and active smoking were not shown to be risk factors for the development of these complications in COVID-19 patients in previous studies.[17, 19] The association of COVID-19 with PTX, PM and SE reflects greater disease severity in patients and common pathologenesis although causalty cannot be established between them.[18]

Limitations of this study are its retrospective nature as well as the inclusion of patients with the defined complications on the basis of primary diagnosis with chest X-ray only. If CT scan reports had been available for the cohort, the sensitivity of detection of the complications might have been higher. The presence of prior lung disease, smoking status, body mass index, respiratory rate and other comorbidities, which could possibly affect the manifestation of the complications were not investigated. Also, additional mechanical ventilation parameters such as plateau pressure, driving pressure, tidal volume, minute ventilation, static and dynamic lung compliance and airway resistance

could not be studied because of lack of real time data due to retrospective nature of the study. Finally, the association of PTX, PM and SE with the duration and parameters of PPV could not be established in our study due to the limited number of patients with the defined complications over the period and absence of a control group for comparison.

CONCLUSIONS

Pneumothorax, pneumomediastinum and subcutaneous emphysema are pulmonary air leak complications of COVID-19 that occur with a relatively high incidence in patients under mechanical ventilation or even spontaneously signifying increased disease severity. Such patients are likely to undergo prolonged hospital treatment and additional critical care with high risk of mortality. Hence, clinicians should be vigilant of these complications in all patients affected with COVID-19. Further studies in future pandemics or larger retrospective studies should be conducted, comparing the clinical characteristics of COVID-19 patients with similar viral illnesses to establish the risk factors for the development of these complications and recommend standard treatment protocols to minimize them.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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