Original Research Article

Spontaneous Pneumothorax and Pneumomediastinum in Covid-19 Pneumonia Patients

Prathibha Nag[1], Aravindh Ram V R[2*], Harsha Jain[3]

[1]3rd year Post Graduate, Department of Pulmonary Medicine, BMCRI, Bengaluru, Karnataka, India

[2]Assistant Professor, Department of Respiratory Medicine, SDS TRC & RGICD, Bengaluru, Karnataka, India

[3]DM Postgraduate, Department of Pulmonary Medicine, Vardhaman Mahavir Medical College & Safdarjung Hospital, Delhi, India

Received: 03-10-2021 / Revised: 06-12-2021 / Accepted: 22-12-2021

Abstract

Background: The term spontaneous pneumothorax(PNX) refers to the presence of air in the pleural space that is not caused by trauma or other obvious precipitating factor (trauma or iatrogenic during a procedure). To this date, there are only rare mentions of pneumothorax as a complication of COVID-19 viral pneumonia including few case reports. **Objective:** to describe the clinical characteristics of patients with these pathologies, effect of chest drain placement and consider whether development of these can be used as a marker of poor prognosis. **Materials and methods:** A Retrospective observational study was conducted SDSTRC and RGICD, Bengaluru. All adult patients who present to the our hospital with RTPCR positive for Covid 19**.** Duration of study was March 2020 to October 2021. We included Patients Aged 18> years both male and female with Symptoms suggestive of Covid 19 & RTPCR positive for SARS COV 2. **Results:** During the study period, we had admitted and treated 1500 COVID-19 pneumonia patients, all of these patients were nasopharyngeal swab positive for COVID-19. Three patients developed a pneumothorax , two patient developed pneumomediastinum and one patient developed subcutaneous emphysema ; the incidence of was 0.2%. , 0.13% and 0.06% respectively**. Conclusion:** Spontaneous pneumothorax and pneumomediastnum is a rare complication of COVID-19 viral pneumonia. It may occur at any time during the course of the disease. Pleural cavity decompression may help prevent development of life-threatening tension**.** Clinicians should be vigilant about the diagnosis and treatment of this complication.

Keywords: Spontaneous pneumothorax, pneumomediastnum, Covid-19 Pneumonia Patients,

Introduction

The world is facing a major health crisis due to the pandemic infection by the novel Coronavirus SARS-COV-2, since December 2019 when the outbreak began in Wuhan China. Since December 2019, a series of cases of viral pneumonia caused by a new coronavirus identified on samples of the airways named SARS-CoV-2 appeared in Wuhan in China and quickly propagated all over the world. The clinical presentation of the Coronavirus disease 2019 (Covid-19) includes fever, dry cough, and dyspnea, consistent with a respiratory tract infection[1]. The term spontaneous pneumothorax (PNX) refers to the presence of air in the pleural space that is not caused by trauma or other obvious precipitating factor (trauma or iatrogenic during a procedure). While primary spontaneous pneumothorax occurs without a clinically apparent lung condition; secondary spontaneous pneumothorax is a complication of preexisting lung disease[2,3]. To this date, there are only rare mentions of pneumothorax as a complication of COVID-19 viral pneumonia including few case reports[4-7].

Pneumomediastinum(PNM) can be primary, or spontaneous, if the cause is idiopathic, or secondary if it responds to a known etiology, whether traumatic or iatrogenic[1]. It is also a well-known complication of barotrauma of the chest including positive airway pressure and mechanical ventilation. Other associated risk factors include smoking and pre-existing lung parenchymal and airways disease. PNM may result from diffuse alveolar damage leading to alveolar rupture and interstitial emphysema with air dissecting along the bronchovascular sheaths into the mediastinum[4]. Spontaneous pneumomediastinum is usually self-limiting with no interventions required. Rarely, in cases of tension pneumomediastinum, severe cardio-pulmonary compromise can occur. Air can also travel towards the thoracic inlet and into the neck soft tissue causing cervico-facial subcutaneous emphysema. The incidence of this complication is still not yet exactly known. Elevated incidence of pneumomediastinum and pneumothorax occurring during SARS and MERS pneumonia (respectively 1.7-12%[8,9]. and 16,4% [10]), either spontaneous or associated to ventilation. Conversely, these complications have not been reported when NIV was used for the treatment of common pneumonia patients, [6-7] Also pneumothorax has been linked to poor prognosis in patients infected with the acute Middle East respiratory syndrome corona-virus (MERS-CoV) [9] Some cases of PNX and PNM have been recently reported in patients with COVID-19 pneumonia, most of them spontaneous[11-13] in some cases related to NIV[14,15] or endotracheal intubation (ETI) [16,17].

Herein we review the incidence and outcomes of pneumothorax in over 1500 patients admitted to our institution for COVID-19 pneumonia. We discuss 14 cases of patients with COVID-19 pneumonia who developed spontaneous pneumothorax, pneumomediastinum and subcutaneous emphysema and describe their clinical and radiographic characteristics and outcomes in the context of other cases reported to date. Our study aims to describe the clinical characteristics of patients with these pathologies, effect of chest drain placement and consider whether development of these can be used as a marker of poor prognosis.

Materials and methods

A Retrospective observational study was conducted SDSTRC and RGICD, Bengaluru. All adult patients who present to the our hospital with RTPCR positive for Covid 19**.** Duration of study was March 2020 to October 2021. Herein we review the incidence and outcomes

*Correspondence
Dr. Aravindh Ram V R
Assistant Professor, Department of Respiratory Medicine, SDS TRC & RGICD, Bengaluru, Karnataka, India.
E-mail: aravindhram1@gmail.com

of pneumothorax in over 1500 patients admitted to our institution for COVID-19 pneumonia. We discuss 14 cases of patients with COVID-19 pneumonia who developed spontaneous pneumothorax, pneumomediastinum and subcutaneous emphysema and describe their clinical and radiographic characteristics and outcomes in the context of other cases reported to date.

Inclusion criteria

1. Patients Aged 18> years both male and female
2. Symptoms suggestive of Covid 19 & RTPCR positive for SARS COV 2

Methodology

A retrospective review of charts of patients admitted with COVID-19 disease was performed at our hospital between March and November 2020. During this time period we treated 1500 patients with COVID-19. Their diagnosis of Covid 19 was made based on polymerase chain reaction (PCR) testing of nasopharyngeal swab sampling. All patients had routine chest x-ray. The presence or absence of pneumothorax, pneumomediastinum and subcutaneous emphysema was determined based on review of clinical documentation and chest radiographic imaging. Patients who had an of the above at any time during their clinical course were thoroughly reviewed. Baseline laboratory data including inflammatory markers C-reactive protein (CRP), lactate dehydrogenase (LDH), Ferritin, D-dimer, White blood cell count (WBC), lymphocyte and neutrophil counts were documented for each patient. The incidence of spontaneous pneumothorax and penumomediastinum in COVID-19 patients was then calculated.

Results

During the study period, we had admitted and treated 1500 COVID-19 pneumonia patients, all of these patients were nasopharyngeal swab positive for COVID-19. Three patients developed a pneumothorax, two patient developed pneumomediastinum and one patient developed subcutaneous emphysema ; the incidence of was 0.2%. , 0.13% and 0.06% respectively**.** Characteristics of these patients are summarized in Tables 1 and 2.

Table 1: Demographics and clinical characteristics for patients with COVID-19 and pneumothorax, pneumomediatinum and subcutaneous emphysema

Variables	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12	Case 13	Case 14
Age in years	48	31	53	81	32	62	43	67	31	49	46	49	41	39
Sex	Female	Male	Male	Male	Male	Male	Male	Male	Male	Male	Female	Male	Female	Male
Durations of symptoms	7days	10days	15days	4 days	4 days	7 days	7 days	5 days	10 days	15 days	4 days	9 days	10 days	8 days
Comorbidities	Nil	Nil	Htn	T2dm	Nil	T2dm	Htn	T2dm, htn	Nil	T2dm	T2dm, Hypothyroid	T2dm, htn	Nil	T2dm
Smoking history	Nil	Nil	Nil	Nil	Nil	Nil	Yes	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Underlying lung disease	Nil	Nil	Nil	Nil	Nil	Nil	Copd	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Pneumothorax	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Side		R	R		R	R	L	R	B/l	R	R	L	L	L
Pneumomediatinum	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
Subcutaneous emphysema	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No
Wbc count	11500	5100	8100	12900	24900	8400	6900	5800	15200	12110	3200	4500	6000	5200
Neutrophil count	90	64	89	81	82	93	64	71	88	69	91	68	79	86
Lymphocyte count	6	29	6	13	14	5	24	14	9	21	5	19	16	9
Crp(mg/dl)	>90	34	70	>90	>90	>90	46	23	93.56	39	>90	38	42	29
Ferritin (ng/ml)	290	822	>1000	581	>1000	682		435						
Ldh (u/l)	550	998	614	679	601	590		288	>1000		343			
D dimer	1363	233	815	3960	844	1496	485	865	4920	930	4700	1256	1698	823
Trop i	1.94	18.96	8.74	0.04	17.64	8.9		0.04	0.026		0.012			
Hba1c	5.5			11.2		9.3	5.8	7		9.4	10.4	6.3	9	7.2
Risk factor for ptx,ptm	Imv	None	None	None	None	None	None	None	Imv	None	None	None	None	None
Pleural cavity decompression	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Patient outcome	Died	Died	Died	Died	Died	Discharged after 1mth	Discharged after 2wks	Discharged after 2wks	Died	Discharged after 2wks	Died	Discharged after 3wks	Discharged after 4wks	Discharged after 2wks

Discussion

An underlying pulmonary disease is the primary risk factor for the development of secondary spontaneous pneumothorax. These include chronic obstructive pulmonary disease (COPD) with emphysema, cystic fibrosis, tuberculosis, lung cancer, HIV associated Pneumocystis jiroveci pneumonia (PJP), and other pulmonary cystic lung diseases[2,3,12]. Increased alveolar pressure and diffuse alveolar injury in severe COVID-19 pneumonia is common which may make the alveoli more prone to rupturing, especially as patients often have pronounced cough leading to spontaneous pneumothorax and pneumomediastinum

In case of pulmonary infections due to SARS-COV, the virus causes breakdown of the alveolar membrane integrity as it infects both type I and II pneumocytes[15]. Therefore, the damage of alveolar membrane in coronavirus infections can be one of the mechanism leading to alveolar rupture. Consequently, spontaneous pneumothorax and pneumomediastinum is more likely to occur when there are extensive pulmonary lesions on CT-expression of the severity of alveolar damage. These changes, in addition to possible overdistention of the alveoli by using mechanical ventilation may put patients at risk for developing peumothorax and pneumomediastinum.

Patients with COVID-19 infection can develop severe pneumonia leading to acute respiratory distress syndrome (ARDS). Their disease is characterized radiographically by ground glass opacities, evolving into consolidative changes and in late stages of the disease, fibrotic changes[8,13]. Similar changes including severe lung injury and diffuse alveolar damage were thought to contribute to the mechanism of spontaneous pneumothorax and pneumomediastinum complicating severe acute respiratory syndrome[14].

Table 2: Summarizes the literature report that has been published on pneumothorax and pneumomediastinum in COVID-19 patients

	Age Yr/ Gender	CT characteristics	Complication	Risk Factors	Time to onset, days	Chest tube	Time to resolution (Days)	Outcomes
Zhou et al. [4]	38/M	Bilateral GGOs and consoloidations in the lower lobes	Pneumomediastinum	None	11		14	Survived
Wang et al. [6]	36/F	Bilateral patchy GGOs and consolidations	Pneumomediastinum	NIV	Day 0- 12 days after onset of symptoms			Died due to ARDS
Sun et al. [7]	38/M	Patchy peripheral GGOs. Progression to consolidations and bullae	Mediastinal emphysema, Giant bullae, pneumothorax	NIV	Pneumomediastinum 7 days Bullae 21 days PNX 30 days	None		
Aiolfi et al. [5]	56/M 70/M	Bilateral peripheral GGOs	Pneumothorax	Invasive Mechanical Ventilation Preexisting emphysema	2 and 5 days after intubation	Yes		Thoracotomy and bleb resection were performed for persistent pneumothorax
Liu et al. [12]	38/M	Bilateral patchy GGOs and consolidations, progression to cystic formation	Pneumothorax	None	26	None	5	Survived
Wang et al. Wang et al. [11]	62/M	Bilateral areas of GGOs in the peripheral areas	Pneumomediastinum Pneumothorax Subcutaneous emphysema	None	20	None	16	Survived

In this case series, we identified 14 out of 1500 COVID-19 pneumonia patients , all of these patients were nasopharyngeal swab positive for COVID-19. 11 patients developed a pneumothorax(2 patient with pneumomediastinum) , 2 patient developed pneumomediastinum alone and 1 developed subcuatneous emphysema; the incidence of was 0.73% , 0.13% and 0.06% respectively. Male preponderance is observed (11 out of 14 cases) to have increased risk of developing pneumothorax compared to females. (3 out of 14 cases).All 14 cases belonged to were moderate to severe category with 7pts being discharged after 2-4 wks and 7 died due to severity of the disease. Majority of the cases who died belong to severe category with correlating raised CRP, LDH, D-dimer, Neutrophil/Lymphocyte ratio, and uncontrolled sugars values. It was observed that overall nonsmokers with no preexisting lung diseases were more affected by covid 19 infection and smokers had lesser mortality compared to non-smokers.

Aiodfi and colleagues reported two cases of COVID-19 pneumonia patients who developed persistent pneumothorax while on mechanical ventilation[5]. However, Wang et al. reported a case of a patient who developed spontaneous pneumothorax. Gattinoni et al. found that the

incidence of pneumothorax is higher in patients with ARDS who are on mechanical ventilation for a long duration of time (87% vs. 30% in those with > 2 weeks of mechanical ventilation vs. < 1 week).

Pneumothorax and pneumomediastinum is higher in those with ARDS, ranging between 14 to 87%. It correlates directly with the severity and duration of ARDS, barotrauma and volutrauma caused by mechanical ventilation. This happens in cases of high peak inspiratory pressures (PIP) (greater than 40 to 50 cm H2O), high positive end-expiratory pressure (PEEP), high tidal volumes and minute ventilations[14-16]. Furthermore, ARDS represents a heterogeneous group of a condition in which a conglomerate of relatively healthy and diseased alveoli mix. Commonly, the dependent areas of the lung tend to consolidate due to interstitial edema and represent regions of decreased lung compliance. During lung recruitment maneuvers while managing ARDS, overdistention of "normal" non-dependent lung regions with relatively higher compliance and less airway resistance occurs. These alveoli then can rupture due to disproportionate distribution of volume and pressure from the ventilator causing increase shear forces.

Another possible triggering factor is prolonged coughing, which is a common symptom of COVID-19 disease. Cough may enhance leakage of air out of the alveoli by causing sudden lengthening and shortening of the pulmonic vessels and associated bronchi during respiration and further moving the "train of bubbles" along the vascular sheaths. It is a well-known risk factor for pneumomediastinum and pneumothorax[14]. Our patients had significant cough upon presentation to the hospital and during the early part of their hospital stay. The coughing spells, exerting strain upon the already damaged and weakened alveoli from COVID-19 pneumonia, could have directly contributed to the development of pneumomediastinum. The pathophysiology of SPM in SARS patients is thought to be related to diffuse alveolar damage (DAD) which leads to gas leak into the pulmonary interstitium causing pneumomediastinum[7]. Air can also travel towards the thoracic inlet and into the neck soft tissue causing cervico-facial subcutaneous emphysema[6].

An important finding of our study was the presence of elevated inflammatory markers including CRP, LDH, Ferritin, D-dimer, in almost all patients who developed spontaneous Pneumothorax. Cytokine storm has been thought to play a role in disease pathophysiology. This form of hyperactive and dysregulated immune response may lead to hyperinflammatory form of ARDS and is associated with critical illness and increased mortality. Majority of our patients were non-smokers and had no underling lung pathology to predispose them.

We believe that the combination of severe inflammation and prolonged duration of illness in COVID-19 patients gives rise to pneumothorax, pneumomediastinum, and pneumatoceles due to degenerative changes in the lung parenchyma. Other factors are most likely needed for the development of pneumothorax, and these may become clearer as we continue to move through this pandemic. Managing pneumothoraces in these patients is likely crucial to prevent the development of life-threatening tension pneumothoraces. While operative management in these patients is definitely an option, it seems that management with chest tubes or even observation provides satisfactory outcomes, although a prolonged duration of stay may result in non-operative management due to the time needed for resolution of air leaks from injured and fibrotic pulmonary parenchyma.

Limitations

Single centred study**,** In-house CT thorax was not available in our centre**,** Needs multi centered large studies to know about the exact incidence , etiology and outcomes as pandemic still ongoing

Conclusion

Spontaneous pneumothorax and pneumomediastnum is a rare complication of COVID-19 viral pneumonia. It may occur at any time during the course of the disease. Pneumothorax, pneumomediastinum and cystic lung lesions such as pneumatoceles in COVID-19 patients likely result from prolonged inflammatory damage to lung parenchyma with development of degenerative changes and subsequent air leaks. This indeed appears similar to the pathogenesis of pneumothoraces in SARS which also is caused by a virus from the same Coronaviridae family. Pleural cavity decompression may help prevent development of life-threatening tension**.** Patients with baseline ground-glass opacities and consolidations and those who are mechanically ventilated appear to be at high risk. Clinicians should be vigilant about the diagnosis and treatment of this complication.

Acknowledgement

The authors are thankful to their patients who wholeheartedly took part in this study and also to Dr. Neelu Purwar for her valuable suggestions during preparation of this manuscript.

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Conflict of Interest: Nil

Source of support: Nil