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CASE SERIES

A Case Series of Pneumomediastinum with Subcutaneous Emphysema Induced by Noninvasive Ventilation

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Noninvasive ventilation (NIV) is frequently utilized in the management of respiratory failure, particularly in cases of chronic obstructive pulmonary disease, congestive heart failure, and other acute respiratory conditions. Although generally safe, NIV can occasionally result in serious complications such as pneumomediastinum (PM) and subcutaneous emphysema (SE). PM, the presence of air in the mediastinum, can develop due to alveolar rupture caused by elevated airway pressures. This case series reports four instances of PM with associated SE, all induced by NIV in patients with coronavirus disease 2019.

Key words: Acute respiratory distress syndrome, chronic obstructive pulmonary disease, coronavirus disease of 2019, emphysema, noninvasive ventilation, pneumomediastinum

INTRODUCTION

The respiratory system is particularly vulnerable in coronavirus disease of 2019 (COVID-19), with severe cases leading to a range of complications.[1] Among the most notable respiratory issues are pneumonia, pulmonary embolism, fibrosis, hypoxemia, and chronic lung damage, with some patients developing acute respiratory distress syndrome (ARDS). These complications have significantly contributed to the global COVID-19 mortality, which has claimed over 12 million lives worldwide.[1,2]

Noninvasive ventilation (NIV) has emerged as a critical intervention for managing respiratory failure, reducing the need for invasive mechanical ventilation.[3] However, despite its benefits, NIV is not without risks. One rare yet significant complication is subcutaneous emphysema (SE), characterized by the abnormal presence of air in the tissues under the skin or mediastinum. Although typically benign, SE can serve as an early indicator of more serious conditions such as pneumothorax or pneumomediastinum (PM), which may require urgent medical attention. This case series focuses on instances where SE and PM developed in COVID-19 patients as a result of NIV. These cases underscore the importance of vigilant monitoring and timely recognition of these complications, as they may necessitate changes in respiratory management, including the need for invasive mechanical ventilation to prevent worsening outcomes.

CASE PRESENTATION

Case 1

A 47-year-old female with a history of diabetes, COVID-19 positive showed signs of ARDS [Table 1]. Initially managed with supplemental oxygen and stabilized, her respiratory condition worsened, requiring NIV. On the 5th day of NIV, she developed SE, manifesting as neck and chest swelling with crepitus. This prompted intubation and transition to invasive mechanical ventilation as the patient had severe respiratory distress. Postintubation, chest X-ray revealed a right-sided pneumothorax and PM, managed by tube thoracostomy. Unfortunately, despite aggressive interventions, her condition deteriorated due to hypotension and acute renal failure, leading to her death.

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Table 1: Patient characteristics, profile, management strategies, and outcome

Case	1	2	3	4
Age (years)	47	28	54	52
Gender	Female	Female	Female	Female
Comorbidities	Uncontrolled diabetes	No comorbidities	COPD	Diabetes
Initial symptoms of COVID-19	Cough Dyspnea Fever	Cough Fever Dyspnea	Cough Shortness of breath Fever	Cough Dyspnea Chest pain Fever
Radiological extension (severity) of COVID-19	Severe: >75%	Moderate: 50%–75%	Moderate: 50%–75%	Severe: >75%
Mechanical ventilation	Invasive mechanical ventilation	Noninvasive ventilation	Invasive mechanical ventilation	Noninvasive ventilation
SE	Severe	Moderate	Severe	Moderate
PM	NA	Moderate	Severe	NA
Days from MV to detection of SE	5	7	4	2
Ventilation parameters	ETT - 7.5 mm Mode - ACVC VT - 400 RR - 24/min PEEP - 10 cmH_2O FiO_2 - 100% Peak pressure - 35 cmH_2O Plateau pressure - 25 cmH_2O	Mode - NIV PS - 12 PEEP - 8 cmH_2O FiO_2 - 100%	ETT - 7.5 mm Mode - ACVC VT - 450 RR - 26/min PEEP - 10 cmH_2O FiO_2 - 100% Peak pressure - 30 cmH_2O Plateau pressure - 25 cmH_2O	Mode - NIV PS - 12 PEEP - 8 cmH_2O FiO_2-100%
Management	Conservative therapy with reducing airway pressure later on invasive mechanical ventilation	Conservative therapy with reducing airway pressure	Conservative therapy with reducing airway pressure later on invasive mechanical ventilation	Conservative therapy
Outcome	Worsening severe ARDS NIV failure Invasive MV Death	Moderate ARDS NIV support NRBM support Discharge from ICU	Worsening severe ARDS NIV failure Invasive MV Death	Moderate ARDS NIV support NRBM support Discharge from ICU
ICU length of stay	7	16	10	09

COPD=Chronic obstructive pulmonary disease; SCE=Subcutaneous emphysema; ETT=Endotracheal tube; ACVC=Assist control volume control; VT=Tidal volume; PEEP=Positive expiratory end pressure; RR=Respiratory rate; FiO_2=Fraction of inspiratory oxygen; ICU=Intensive care unit; ARDS=Acute respiratory distress syndrome; NIV=Noninvasive ventilation; NRBM=Nonrebreathing mask; N/A=Not available; PM=Pneumomediastinum; COVID-19=Coronavirus disease of 2019; SE=Subcutaneous emphysema; MV=Mechanical ventilation

Case 2

A 28-year-old female, COVID-19 positive with no significant medical history presented in respiratory distress [Table 1]. Despite high-flow oxygen therapy and medical management, her respiratory status deteriorated. After 7 days on NIV, the patient developed neck pain and swelling, which was diagnosed as SE with PM. Despite this complication, she remained hemodynamically stable with a SpO_2 of 97% and normal blood gas levels. With intensive care, her condition gradually improved. This case underscores the importance of multidisciplinary care in managing severe COVID-19 pneumonia and its complications.

Case 3

A 54-year-old woman, COVID-19 positive, presented with rapid breathing [Table 1]. She received a multifaceted treatment approach, including awake proning to improve oxygenation. As her condition deteriorated, NIV was initiated to support her breathing. However, on the 4th day of hospitalization, her condition further worsened with the sudden development of a right-sided pneumothorax and PM with SE, confirmed by an emergency chest X-ray. Emergency tube thoracostomy provided temporary relief by draining trapped air, but the presence of tension pneumothorax indicated a critical situation. Despite aggressive treatment, her condition continued to worsen, leading to her demise.

Case 4

A 52-year-old female, COVID-19 positive presented with severe breathlessness. Two days after starting NIV,

she developed neck pain and swelling [Table 1]. Physical examination revealed SE with PM, which was confirmed by chest and neck X-rays without evidence of pneumothorax. Remaining hemodynamically stable with a SpO_2 of 97% and normal blood gases, she was managed conservatively with nonrebreathing mask and close monitoring.

DISCUSSION

SE and PM are uncommon but significant complications that can arise in COVID-19 patients, especially those receiving mechanical ventilation. In COVID-19, SE can occur due to increased respiratory system pressure from factors such as barotrauma from mechanical ventilation or alveolar rupture caused by severe lung inflammation.[3,4] The virus primarily enters the body via angiotensin-converting enzyme-2 receptors, affecting type II pneumocytes responsible for surfactant production. This leads to impaired surfactant production, cellular injury, and reduced lung compliance, which further heightens the risk of air leaks.[4-6]

Using low tidal volume ventilation and limiting plateau pressures can help reduce the potential for barotrauma and the subsequent development of SE and PM. In addition, careful monitoring and adjustment of positive end-expiratory pressure (PEEP) are essential, as inadequate PEEP can create shear forces that damage dependent areas of the lung. Other risk factors that can predispose a COVID-19 patient to develop PM include extensive lung consolidation, prior smoking history, raised inflammatory markers, and low body mass index.[7]

Patients with COVID-19 ARDS on NIV are usually breathing spontaneously. They have very high respiratory efforts in turn resulting in large tidal volumes. This high tidal volume when entrained into an already damaged lung can lead to barotrauma and PM. This form of injury is known as patient self-inflicted lung injury (P-SILI).[8] Studies have shown that spontaneous PM is a surrogate marker of P-SILI in critically ill COVID-19 patients.[8,9]

Management of PM typically begins with conservative measures such as rest, supplemental oxygen, and analgesia. However, should the condition worsen, more invasive interventions may be required. The need for continuous clinical and radiological monitoring cannot be overstated, especially in severe cases where respiratory compromise is evident.

The correlation between PM and increased mortality, especially in intubated patients, emphasizes the importance of vigilant management strategies. The elevated risk of intubation and associated complications, such as pulmonary barotrauma, necessitates a multidisciplinary approach to care, ensuring timely intervention and adaptation of ventilation strategies.[10]

CONCLUSION

This case series emphasizes the occurrence of SE and PM in COVID-19 patients. It highlights the need for strict vigilance in identifying risk factors, timely intervention to prevent disease progression, and effective management, as these complications are associated with a poorer prognosis, especially in intubated patients.

Declaration of patient consent

This study was performed in accordance with and conforming to the Declaration of Helsinki. The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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Conflicts of interest

There are no conflicts of interest.

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