Case Series

Air Leak Syndrome and Coronavirus Disease 2019 (Covid-19) Pneumonia – A Case Series

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Abstract

Background: The COVID 19 pandemic caused by Severe Acute Respiratory Syndrome Corona Virus – 2 has affected millions around the globe. It presents with a multisystem involvement, predominantly affecting the respiratory system. Spontaneous Air leak syndrome which includes subcutaneous emphysema, pneumomediastinum and pneumothorax has been reported as one of the complications of COVID-19 pneumonia.
Method: This is a series of 10 cases, which presented with one or more manifestations of air leak syndrome among patients with covid 19 positive admitted in intensive care unit of Meenakshi Mission Hospital and Research Center, Madurai, India.
Results: Out of the 365 cases analyzed, 10 cases developed either subcutaneous emphysema, pneumomediastinum or pneumothorax. The incidence rate was 2.73% per 1000 population. None of the 10 patients was on invasive mechanical ventilation before developing air leak syndrome. No one had undergone an invasive procedure like central venous cannulation, intubation or bronchoscopy prior to the onset of air leak. Age group of the sample was 38 to 68 years. All the cases had elevated D-Dimer values.
Conclusion: present case series shows that air leak syndrome can develop in COVID-19 patients receiving oxygenation through Nin-Invasive Ventilation (NIV) and High flow Nasal Cannula (HFNC).
Recommendation: Patients with covid 19 who develop subcutaneous emphysema and pneumomediastinum should be carefully monitored for signs of pneumothorax which can be life threatening in a sick patient with borderline oxygenation.

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

Article Summary: **Submitted:** 08-April-2022 **Revised:** 10-May-2022 **Accepted:** 02-June-2022 **Published:** 30-June-2022

Quick Response Code:

Web Site

http://ijmsnr.com/

DOI

10.55349/ijmsnr.2022222528

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Introduction

COVID-19 pneumonia causes a spectrum of signs and syndromes ranging from mild upper respiratory tract symptoms to full blown Acute Respiratory Distress Syndrome (ARDS). [1] The severe form of COVID pneumonia causes diffuse alveolar damage, organizing and fibrinous consolidation. Similar to other causes of ARDS, COVID-19 also causes micro and macro thrombi in the pulmonary vasculature leading to impaired oxygenation and further lung damage. Air leak syndrome is a clinical condition caused by leakage of air from the alveoli into spaces which are normally devoid of air. This includes subcutaneous emphysema, pneumothorax, pneumomediastinum, pneumopericardium and pneumoperitoneum. One or more forms of this air leak syndrome has been reported to occur during the course of COVID-19 illness. [2] The exact incidence of this syndrome, pathophysiology and its clinical significance is not well established. We present a series of 10 cases of alveolar air leak syndrome in COVID-19 pneumonia patients over a 6-months period in our intensive care unit.

Materials and Methods

Meenakshi Mission Hospital and Research Center, Madurai, Tamil Nadu, intensive care unit cared for 365 critically ill COVID-19 pneumonia patients between January and June 2021. All patients tested positive for COVID-19 on had a Real –Time Reverse Transcription Polymerase Chain Reaction (RT- PCR). Each patient had a High-Resolution Computed Tomography (CT) scan at admission and orderly chest X-Rays.

How to cite this article: Joshua EA, Sellamuthu K, Jeyaprakash R, Singh AK, Rameshkumar K, Sankarapandian C. Air Leak Syndrome and Coronavirus Disease 2019 (Covid-19) Pneumonia – A Case Series. Int J Sci and Med Res 2022;2(2):25-28

The diagnosis of alveolar air leak syndrome was made based on clinical examination and radiological imaging.

Ethical Approval:

This study was approved by the Institutional Review Board of Meenakshi Mission Hospital and Research Center, Madurai, Tamil Nadu, India. Participation in the study was voluntary and informed consent was obtained prior to participation in the study. Anonymity was maintained.

Results:

Out of the 365 cases we analyzed, 10 cases developed either subcutaneous emphysema, pneumomediastinum or pneumothorax. The incidence rate was 2.73% per 1000 population. All patients had comparable baseline characteristics. None of the patients had any pre-existing chronic respiratory conditions like chronic obstructive pulmonary disease (COPD), Pulmonary Tuberculosis, Interstitial lung disease, etc. We could not find any correlation between air leak syndrome and any of the inflammatory markers.

Table 1: Distribution of baseline characteristics of Covid-19 patients

Case No	Age	Sex	Comorbidities	D Dimer (ng/mL)	CRP (mg/L)	Ferritin (ng/mL)	IL-6 (pg/mL)	LDH (IU/L)
1	61	M	HTN	1667	1.52	1807.90	20.46	688
2	52	F	Nil	579	13.80	4521	62.09	1579
3	65	F	Nil	782	9.50	199	67.34	777
4	51	M	CLL, DM	755	1.09	316	252.62	912
5	37	F	DM, HTN, RA	957	11.50	306.60	-	559
6	60	M	HTN	223	12.4	429	20.50	730
7	68	M	HTN	546	1.41	910.30	27.93	510
8	65	M	Nil	937	10.70	1722.50	89.66	937
9	38	M	Nil	482	1.73	1083.50	69.73	765
10	58	M	DM	1054.99	28.9	535.63	64	438

Table 2: Distribution of Air leak syndrome, type and clinical outcome among cases

Case No	Age/ Sex	Oxygen Delivery Device	Lung Involvement	Day of Illness	Type	Outcome
1	61/M	HFNC, IMV	45%	Day 10	Subcutaneous Emphysema	Succumbed
2	52/F	NIV/IMV	40%	Day 18	Subcutaneous Emphysema, Unilateral Pneumothorax	Succumbed
3	65/F	HFNC, NIV, IMV	80%	Day 24	Subcutaneous Emphysema, Bilateral Pneumothorax	Succumbed
4	51/M	90%	HFM, HFNC	Day 24	Subcutaneous Emphysema, Pneumomediastinum	Discharged
5	37/F	30%	HFM, NIV	Day 15	Subcutaneous Emphysema	Discharged
6	60/M	35%	HFM, NIV, IMV	Day 21	Subcutaneous Emphysema	Succumbed
7	68%	50%	FM, HFM, HFNC	Day 21	Subcutaneous Emphysema, Pneumomediastinum	Discharged
8	65/M	80%	HFM, NIV, IMV	Day 27	Subcutaneous Emphysema, Pneumomediastinum, Bilateral Pneumothorax	Succumbed
9	38/M	60%	NIV	Day 20	Subcutaneous Emphysema, Unilateral Pneumothorax	Succumbed
10	58/M	80%	HFM, HFNC	Day 11	Subcutaneous Emphysema, Pneumomediastinum	Discharged

All cases were diagnosed by clinical examination and radiological imaging, chest Xray and HRCT whenever possible. None of the 10 patients were on invasive mechanical ventilation before developing air leak syndrome. No one had undergone an invasive procedure like central venous cannulation, intubation or bronchoscopy prior to the onset of air leak. So iatrogenic cause was ruled out. All 10 cases had developed air leak syndrome after 10 days of illness. The mean day of illness when one or more manifestations of air leak syndrome was diagnosed was 19.1. Of the 10 cases, 3 patients developed isolated subcutaneous emphysema and 3 patients developed subcutaneous emphysema and pneumomediastinum. The remaining 4 patients developed pneumothorax 24 to 48 after subcutaneous emphysema was diagnosed. These 4 patients required placement of intercostal drainage tubes, intubation and mechanical ventilation. 6 of the 10 patients died during the course of illness. But the cause of death was not directly related to the air leak syndrome. 2 patients were discharged after a full recovery and 1 patient was discharged against medical advice.

Discussion:

Many reviews on case reports and case series have brought to the fore the association of air leak syndrome with COVID-19 pneumonia. [3 – 5] Almost identical cases were reported during Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) epidemic. [6] part of these publications focus attention on the occurrence of spontaneous air leak syndrome in patients not receiving invasive mechanical ventilation. The phenomenon is not clear that, whether the diffuse alveolar damage caused by these viruses predisposes the alveoli to undergo rupture leading to air leak. The most common risk factors for alveolar air leak syndrome are positive pressure ventilation, blunt chest trauma, esophageal perforation, connective tissue disorders, smoking, cocaine abuse and pre-existing chronic obstructive and restrictive lung disease. [7] No one of our patients had any of these predisposing conditions.

According to the theories proposed in the Macklin Effect [8] as described in 1939 by Charles C. Macklin. During his experimental studies on cats, Macklin noticed that artificially over distending the lungs causes alveolar wall rupture and leakage of air. This air then dissects along the sheaths surrounding the pulmonic blood vessels and reaches the hilum from where it dissects in to the tissue planes of mediastinum and the neck. In patients with ARDS, alveolar over distension has been well described in patients undergoing invasive mechanical ventilation with conventional large tidal volume due to ventilator induced lung injury (VILI). No patients were on invasive mechanical ventilation at the time of developing air leak syndrome. This gives credence to the concept of Patient Self Inflicted Lung Injury (P-SILI). [9] The large swings in transpulmonary pressure during non-invasive ventilation, large tidal volumes generated due to the relatively high lung compliance, coughing on a tight-fitting NIV mask and mucus plugging can all cause increased intra alveolar pressure and alveolar rupture. [10 – 11]

Pulmonary vascular thrombosis causing parenchymal and pleural infarction has been proposed as a reason for air leak syndrome. All our cases had elevated D-Dimer values. One patient had a CT pulmonary angiogram due to clinical suspicion which ruled out any major or minor pulmonary thromboembolism. While other cases did not undergo a computed tomography by cause of risks involved in transport. There was no echocardiographic evidence of pulmonary thromboembolism or peripheral deep venous thrombosis. This shows there is a complex interplay of various factors causing alveolar rupture and air leak.

Conclusion:

This case series shows that air leak syndrome can develop in COVID-19 patients receiving oxygenation through NIV and HFNC. This should be ruled out whenever there is any sudden clinical deterioration. Patients who develop subcutaneous emphysema and pneumomediastinum should be carefully monitored for signs of pneumothorax which can be life threatening in a sick patient with borderline oxygenation.

Source of funding: This research did not receive any specific grant from funding agencies. No incentives was given to the study participants.

Conflict of Interest: The Authors reports no conflict of interest.

Acknowledgment: The Authors would like to thank all the patients who has participated in this study for their cooperation and support.

Authors' Contributions: EAJ, KS, RJ, AKS, KR conceived the study concept, design, analysed and interpreted the data, draft manuscript, Reviewed and revised the full manuscript.

Here, EAJ- Eugene Alex Joshua, KS – Karthikeyan sellamuthu, RJ – Rajesh Jeyaprakash; AKS – Anand Khushvinder Singh, KR – Kanagalakshmi Rameshkumar, CK – Chandrakala Sankarapandian.

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