

1
2 **Pneumoperitoneum resulting from severe**
3 **Coronavirus Disease 2019 (COVID-19)**
4 **Pneumonia**

5
6 **Chuah Jun Sen^{1,2*}, Lim Suat Yee³, Norsarah Shamsudin⁴, Tan Lin**
7 **Jun⁵, Tan Jih Huei²**

8 ¹*Department of General Surgery, Universiti Kebangsaan Malaysia Medical Centre,*
9 *56000 Cheras, Kuala Lumpur, Malaysia*

10 ²*Department of General Surgery, Hospital Sultanah Aminah, Ministry of Health*
11 *Malaysia, Johor Bahru, Malaysia*

12 ³*Department of Respiratory Medicine, Hospital Sultanah Aminah, Ministry of Health*
13 *Malaysia, Johor Bahru, Malaysia*

14 ⁴*Department of Radiology, Hospital Sultanah Aminah, Ministry of Health Malaysia,*
15 *Johor Bahru, Malaysia*

16 ⁵*Department of Anaesthesia and Intensive Care, Hospital Sultanah Aminah, Ministry of*
17 *Health Malaysia, Johor Bahru, Malaysia*
18
19

20 **ABSTRACT**
21

Introduction: Pneumoperitoneum is considered a surgical emergency, as it is highly associated with abdominal viscus perforation. Pulmonary origin of pneumoperitoneum secondary to invasive mechanical ventilation in severe COVID-19 pneumonia has been rarely reported in the existing literature.

Presentation of case: A 62-year-old female was diagnosed with stage 5 COVID-19 pneumonia and was intubated due to respiratory distress. She subsequently developed pneumomediastinum, pneumothorax, subcutaneous emphysema and pneumoperitoneum a few days post-intubation. However, there was no radiological evidence of abdominal viscus perforation from a computed tomography (CT) scan. Coupled with clinical findings and blood investigation, the patient was managed non-surgically with bilateral chest tubes and close monitoring of the intra-abdominal pressure. The pneumoperitoneum resolved a few days later. However, the patient continued to deteriorate throughout her stay at the ICU, due to concurrent nosocomial sepsis with kidney failure. Ultimately, the patient passed away on day 14 of her hospital stay.

Discussion: The management of pulmonary origin of pneumoperitoneum is mainly conservative with close observation of intra-abdominal pressure. Unnecessary non-therapeutic laparotomy of such a condition will potentially increase the mortality and morbidity of critically-ill COVID-19 patients.

Conclusion: Pneumoperitoneum resulting from severe COVID-19 pneumonia should be

managed non-operatively, provided there is clear evidence of the absence of viscus perforation. A radiological examination, coupled with clinical findings and blood investigation, is crucial in establishing an accurate diagnosis.

22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

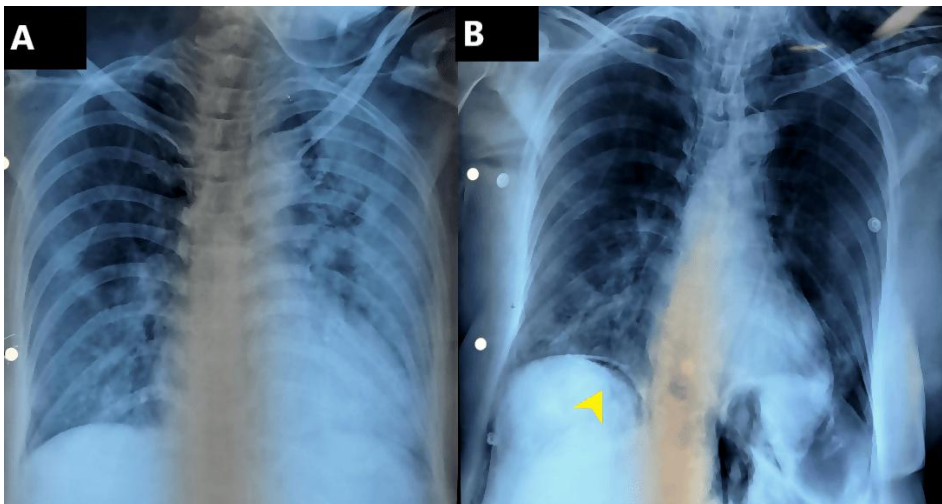
Keywords: pneumoperitoneum; pneumomediastinum; mechanical ventilation; COVID-19

1. INTRODUCTION

Pneumoperitoneum is an abnormal presence of air in the peritoneal cavity and is commonly treated as a surgical emergency associated with abdominal viscus perforation [1]. Patients with COVID-19 pneumonia and invasive mechanical ventilation are at higher risk of developing pneumomediastinum and pneumothorax [2,3]. Pneumomediastinum causing non-surgical aetiology of pneumoperitoneum in an invasive mechanical ventilated COVID-19 patient is a rare clinical entity in the literature. Establishing a correct diagnosis is crucial because the treatment for the underlying aetiology is different. Herein, we present such a case, which was managed conservatively with close observation of intraabdominal pressure. Non-therapeutic laparotomy will lead to higher rates of morbidity and mortality in a critically ill COVID-19 patient. Details of the case, including clinical presentation, imaging and management were discussed to alert surgeons and clinicians of such a rare condition.

2. PRESENTATION OF CASE

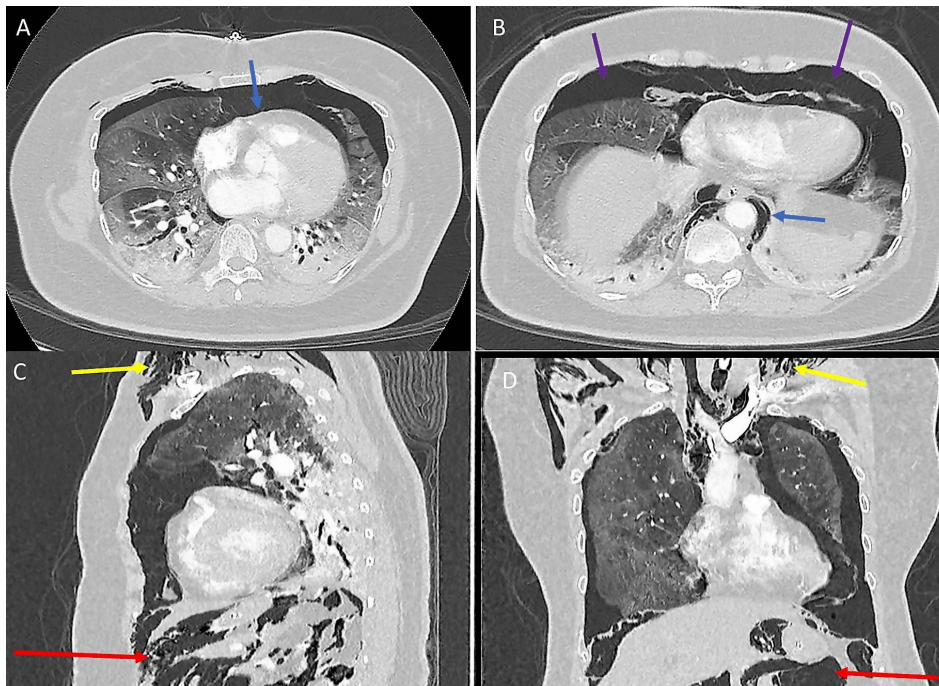
A 62-year-old female presented with shortness of breath associated with lethargy, poor appetite and cough for five days. Her co-morbid condition involved poorly-controlled diabetes mellitus, hypertension and dyslipidemia. On presentation, she appeared lethargic and tachypneic, with a respiratory rate of 32 breaths per minute and oxygen saturation (spO₂) of 88-90% under ambient air. A chest X-ray showed bilateral ground-glass opacity, primarily affecting the periphery and basal regions of both lungs (Fig. 1). Blood work showed acute kidney failure with raised C-reactive protein 124mg/L. A nasopharyngeal swab test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was positive. Diagnosis of stage 5 coronavirus disease 2019 (COVID-19) pneumonia was established, and multi-modal treatments were initiated.



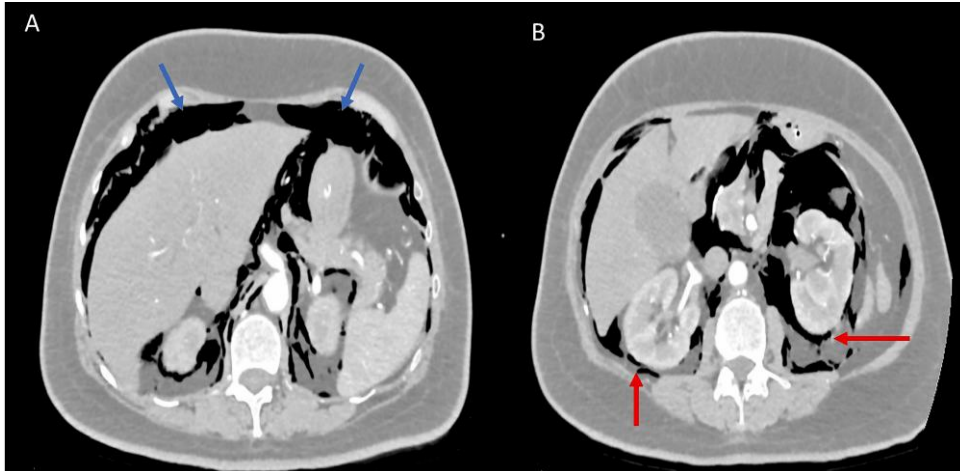
54

55 **Figure 1:** (A) Bilateral ground-glass opacity mainly affects both lungs periphery and basal
56 region. (B) Subcutaneous emphysema at the left supraclavicular region with linear lucency
57 outlining mediastinal and pericardium (pneumomediastinum and pneumopericardium) and
58 air under the diaphragm (pneumoperitoneum –arrowhead)
59

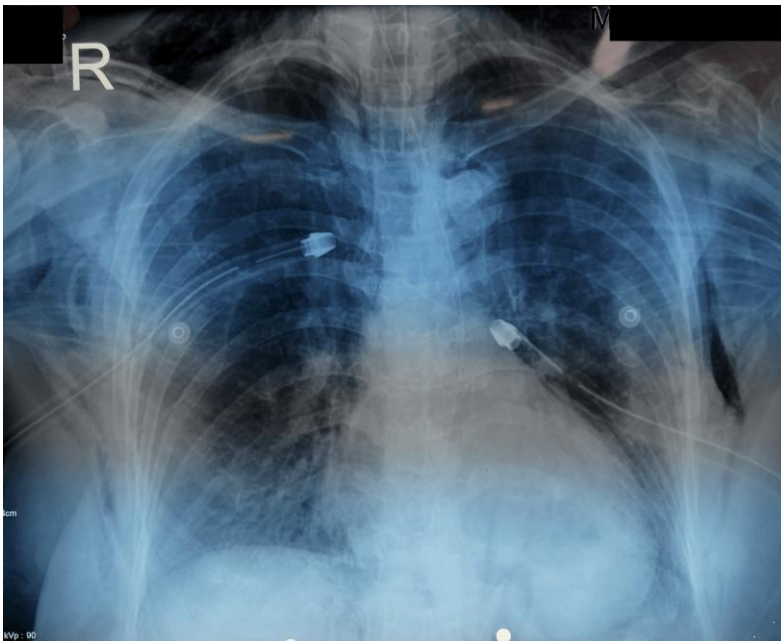
60 Subsequently, she was intubated and admitted to the intensive care unit (ICU). Over the
61 next four days, the patient's respiratory support gradually increased and she had multiple
62 desaturation episodes. She was nursed in the prone position and the ventilation setting was
63 set to high (fraction of inspired oxygen 0.8 with positive end expiratory pressure 10) to
64 maintain adequate oxygenation. She developed subcutaneous emphysema over the neck
65 and chest. The presence of pneumomediastinum, pneumoperitoneum and subcutaneous
66 emphysema was seen in a repeated chest X-ray (Fig. 1). Perforated abdominal viscus was
67 suspected. Hence, an urgent computed tomography (CT) scan of the thorax and abdomen
68 revealed diffuse ground glass densities in both lungs with pneumomediastinum,
69 pneumothorax and concurrent pneumoperitoneum, without evidence of perforated viscus
70 (Figs. 2, 3). Two chest tubes were inserted for bilateral pneumothorax. The patient was
71 managed non-operatively, given the lack of clinical and radiological findings of visceral
72 perforation. There was resolution of the pneumoperitoneum a few days later (Fig. 4).
73 However, the patient continued to deteriorate throughout her stay at the ICU, due to
74 concurrent nosocomial sepsis with kidney failure. Ultimately, the patient passed away on day
75 14 of her hospital stay.
76
77



78 **Figure 2:** Axial images (A,B), sagittal reconstruction (C), and coronal reconstruction (D) of
79 CT Thorax show extensive subcutaneous emphysema at the visualized lower neck (yellow
80 arrow), extensive pneumomediastinum (blue arrow), bilateral pneumothorax with an
81 extension of the air into the peritoneal cavity in keeping with massive pneumoperitoneum
82 (red arrow) in the visualized upper abdomen. Diffuse ground-glass densities affect both
83 lungs with dense consolidative changes at the dependent area of lungs (purple arrow).
84
85



86
87 **Figure 3:** Axial images (A,B) at **the** upper abdomen level demonstrates extensive
88 pneumomediastinum (blue arrows) involving visualized upper **abdominal** peritoneal cavity,
89 also extending to involve retroperitoneal spaces (red arrows).
90



91
92 **Figure 4:** Bilateral chest **tubes** inserted with **the** resolution of pneumoperitoneum.
93

94 3. DISCUSSION

95
96 Nearly 90% of pneumoperitoneum cases are associated with visceral perforation that
97 requires emergency surgical intervention [1]. The remainder of cases are attributed to non-
98 surgical aetiology such as mechanical ventilation, pneumothorax or cardiopulmonary
99 resuscitation. The simultaneous presence of pneumomediastinum and pneumoperitoneum in
100 a severe COVID-19 patient remained scarce in the literature.

101
102 COVID-19 potentially causes primary lung injury via diffuse alveolar damage, formation of
103 intravascular microthrombi or acute fibrinous and organizing pneumonia [4]. A high risk of
104 barotrauma was observed among COVID-19 patients on invasive mechanical ventilation,

105 with resultant pneumothorax or pneumomediastinum, as in the case presented [2]. Such
106 condition is associated with high mortality up to 60% [5]. Barotrauma leads to a rupture in
107 the alveolar, which in turn causes an air leak in the pulmonary interstitium. The air leak will
108 dissect along the bronchovascular sheaths, towards the pulmonary hilum and mediastinum
109 and cause pneumomediastinum, which is known as the Macklin Effect [6,7]. The free air is
110 then leaking into the peritoneal cavity from the thoracic cavity.

111
112 Two mechanisms are used to explain how free air leaks into the peritoneal cavity. The first
113 mechanism is thought due to communication between the thoracic and abdominal cavities
114 by an undiagnosed diaphragmatic hernias such as posterolateral (Bochdalek) or parasternal
115 (Morgagni) defects [8]. Another postulated mechanism is the passage of air from the
116 mediastinum through the major diaphragmatic portals into the retroperitoneum, leaking into
117 the peritoneal cavity [6]. The description latter is likely applied to our case, as evidenced by
118 massive retroperitoneal free air (Fig. 3).

119
120 Accurate interpretation of such a condition is crucial and requires good correlation with
121 radiological, clinical and blood investigation since non-therapeutic surgical intervention will
122 incur higher morbidity and mortality on critically-ill severe COVID-19 patients. Our patient
123 had radiographic evidence of the pneumoperitoneum, likely originating from the thorax, and
124 there was no viscus perforation or intraabdominal collection. Clinically, the patient was
125 hemodynamically stable and could tolerate enteral feeding well, with no rise in septic
126 parameters. Therefore, we can conclude that there was no viscus perforation. The patient
127 was managed conservatively with close monitoring for intra-abdominal pressure or
128 abdominal compartment syndrome if the pneumoperitoneum worsened. In the event of
129 abdominal compartment syndrome, immediate decompression via percutaneous drainage
130 may be helpful [9]. The pneumoperitoneum resolved a few days later.

131
132

133 4. CONCLUSION

134
135 Pneumomediastinum, pneumothorax and subcutaneous emphysema coupled with
136 pneumoperitoneum are rare complications of COVID-19 pneumonia. Non-surgical aetiology
137 of pneumoperitoneum can be managed non-operatively, provided there is clear evidence
138 absence of viscus perforation. A radiological examination, coupled with clinical findings and
139 blood investigation, are crucial in establishing an accurate diagnosis. Unnecessary
140 laparotomy will further compromise the outcome of critically-ill COVID-19 patients.

141
142

143 ACKNOWLEDGEMENTS

144
145 The authors thank all the efforts provided by the general surgery team and ICU team from
146 Hospital Sultanah Aminah, Johor Bahru. The authors would like to express appreciation
147 towards both intensivists, Dr Mahazir bin Kassim and Dr Seethal A/P Padmanathan for their
148 efforts and hard works.

149

150 **COMPETING INTERESTS**

151

152 Authors have declared that no competing interests exist.

153

154

155 **AUTHORS' CONTRIBUTIONS**

156

157 Conceptualization: CJS. Data curation: CJS, LSY, TLJ, TJH. Formal analysis: All authors.

158 Methodology: All authors. Project administration: All authors. Visualization: CJS, LSY, NS.

159 Writing – original draft: CJS. Writing – review & editing: All authors.

160

161 **CONSENT**

162

163 Written informed consent was obtained from the patient's family for publication of this case
164 report and accompanying images. A copy of the written consent is available for review by the
165 Editor-in-Chief of this journal on request.

166

167

168 **ETHICAL APPROVAL**

169

170 The authors conformed to the provisions of the Declaration of Helsinki in 1995 (as revised in
171 Brazil in 2013).

172

173 **REFERENCES**

174

- 175 1. Sharma M, Ojha P, Taweeseed PT, Ratnani I, Surani S. An Intriguing Case of
176 Pneumoperitoneum In a Patient With COVID-19: Do All Pneumoperitoneum Cases
177 Need Surgery? *Cureus*. 2020 Dec 25;12(12):e12279.
- 178 2. McGuinness G, Zhan C, Rosenberg N, Azour L, Wickstrom M, Mason DM et al.
179 Increased Incidence of Barotrauma in Patients with COVID-19 on Invasive Mechanical
180 Ventilation. *Radiology*. 2020 Nov;297(2):E252-E262.
- 181 3. Utomo SA, Notopuro F, Rosalina S. Massive emphysema subcutis, pneumothorax,
182 pneumomediastinum and pneumoperitoneum as uncommon complication of covid-19
183 pneumonia, a rare case. *Radiology Case Reports*. 2021;16(8):2133-2138.
- 184 4. Polak SB, Van Gool IC, Cohen D, von der Thüsen JH, van Paassen J. A systematic
185 review of pathological findings in COVID-19: a pathophysiological timeline and possible
186 mechanisms of disease progression. *Mod Pathol*. 2020;33(11):2128-2138.
- 187 5. Quincho-Lopez A, Quincho-Lopez DL, Hurtado-Medina FD. Case Report: Pneumothorax
188 and Pneumomediastinum as Uncommon Complications of COVID-19 Pneumonia-
189 Literature Review. *Am J Trop Med Hyg*. 2020;103(3):1170-1176.
- 190 6. Vidrio Duarte R, Vidrio Duarte E, Gutierrez Ochoa J, Gaviria Leiva MC, Pimentel-
191 Hayashi JA. Pneumoperitoneum in a COVID-19 Patient Due to the Macklin
192 Effect. *Cureus*. 2021;13(2):e13200.
- 193
- 194 7. Murayama S. Spontaneous pneumomediastinum and Macklin effect: Overview and
195 appearance on computed tomography. *WJR*. 2014;6(11):850. doi:10.4329/wjr.v6.i11.850
196

197 8. Lantsberg L, Rosenzweig V. Pneumomediastinum Causing Pneumoperitoneum. Chest.
198 1992;101(4):1176.

199 9. Fryman C, Mayo PH. A Patient With Coronavirus Disease 2019 Pneumonia and Sudden
200 Decompensation While Receiving Mechanical Ventilatory Support. Chest.
201 2021;159(4):e281-e283.
202

203
204
205