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# SARS-CoV-2 Induced Bilateral Massive Pneumothorax, Pneumopericardium and Pneumomediastinum in a One-Year Old Girl

**Fatima A. Dirani*, Batoul Kawtharany, Ali A. Jibbawi, Imad Chokr, Nabil Moughnieh and Rabab A. El Hajj**

Pediatric Department at Rafik Hariri University Hospital, Lebanon

***Corresponding author:** Dr. Fatima A. Dirani, Pediatric Department at Rafik Hariri University Hospital, Lebanon, E-mail: fatimadirani14@gmail.com

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## Abstract

**Introduction:** Pneumothorax, pneumomediastinum and pneumopericardium are three clinical conditions in which air is present abnormally within the pleural space, mediastinal peri-bronchial and perivascular areas and pericardial sac respectively. Reports from around the world mentioned COVID-19 inducing the above entities in adult patients either separately (pneumothorax alone) or in combination (pneumomediastinum and pneumopericardium).

**Case description:** We present the first pediatric case worldwide of a 1-year-old previously healthy girl presenting to the emergency department of Rafik Hariri University Hospital, Lebanon with tachypnea and cyanosis. CT scan of the chest was done and revealed severe massive bilateral pneumothorax, pneumomediastinum and pneumopericardium.

**Discussion:** COVID-19 is no more the easy-going infection for pediatric population as was thought previously upon the emergence of the pandemic. Many children have been reported to develop multi-organ failure requiring intensive care. A new entity to be feared in pediatric patients is the alveolar rupture into the intrathoracic spaces which may occur even prior to establishment of mechanical ventilation.

**Conclusion:** High suspicion for severe COVID-19 complications must be present when facing a clinically unstable patient during the COVID-19 pandemic. Rapid intervention must be established to avoid clinical deterioration of the patient.

**Keywords:** Pneumothorax; Pneumomediastinum; Pneumopericardium; SARS CoV-2; Pediatrics

## Introduction

Coronavirus disease 2019 (COVID-19) outbreak in China on December 2019 which rapidly evolved into the fifth reported pandemic since 1918 had led to more than 2.35 million deaths worldwide. Since the emergence of SARS-CoV-2, reports from around the world considered that the pediatric population was less severely affected than adults with an estimated mortality in children and neonates of 0.08% [1]. Also, reports mentioned that few children were requiring hospital admission and intensive care all of which had pre-existing medical conditions [2]. Up until May of 2020, the medical society considered children to be shielded against the COVID-19 severe complications, when a new entity was first reported in London, UK where eight children developed the manifestations of multi-organ failure and inflammatory syndrome that progressed to hypotensive shock after being infected with SARS-CoV-2 [3]. Since then, awareness on the severity of SARS-CoV-2 infection in the pediatric population have been raised worldwide.

By definition, pneumothorax is the accumulation of air within the pleural space. It can be divided into: traumatic and spontaneous pneumothorax. Spontaneous pneumothorax is rare among the pediatric population accounting for 4 per 100 000 population/year in males and 1.1 per 100 000 population/year in females [4].

Spontaneous pneumothorax can be further divided into: primary spontaneous pneumothorax (PSP) were no underlying lung disease is present and secondary spontaneous pneumothorax (SSP) were a pre-existing lung disease is found [5].

Here we present the first pediatric case worldwide, to our knowledge, of a one-year old girl rapidly developing massive bilateral pneumothorax, pneumomediastinum and pneumopericardium with subcutaneous emphysema as complications of COVID-19 infection.

## Case Presentation

### History and presentation

A one year old, previously healthy girl, fully immunized according to her vaccination record, presented to the emergency department of the coronavirus unit at Rafic Hariri University Hospital, for respiratory distress symptoms including tachypnea, shallow breathing and cyanosis. History goes back 7 days prior to presentation, when her parents developed symptoms of COVID-19 infection so they performed nasopharyngeal swab RT-PCR and were found out to be positive for SARS-CoV-2 infection. They mentioned that they were taking minimal precautions when dealing with their daughter. Then, 5 days later the girl started developing high grade fever and mild cough, and she was referred to a pediatrician who ordered a chest X-ray (CXR) that showed bilateral infiltrates in the right and left lungs (Figure 1). The physician prescribed prednisone, clarithromycin and salbutamol nebulizer for suspected COVID-19 acute infection. On following day, the girl's respiratory status started deteriorating quickly and she developed severe tachypnea with shallow breathing in addition to agitation and cyanosis. Here, she presented to our emergency department. The family mentioned also decreased oral intake of one day duration due to her respiratory status.

**Figure 1:** Chest X-ray one day prior to presentation showing bilateral infiltrates of lungs.

Vital signs upon presentation showed tachypnea with a rate of 60 breaths per minute, tachycardia with a rate of 188 beats per minute, desaturation reaching 60% on room air, high grade fever of 39°C. She showed normal blood pressure of 100/60 mmHg. Physical examination showed an agitated girl with perioral and facial cyanosis. Auscultation of the chest showed absence of breathing sounds bilaterally with Hamman's crunching sound clear on cardiac auscultation. She also showed signs of mild dehydration due to low oral intake since the previous day.

**Diagnostic focus and assessment**

Immediately after presentation, the patient was placed on oxygen by face mask with a combination of steroids and bronchodilators nebulizers. Intravenous fluid bolus was given for rehydration and anti-pyretic for fever. Also, a computed tomography (CT) scan of the chest was immediately done. It unfortunately revealed bilateral ground glass infiltrates with areas of air space opacifications (consolidations) showing air-bronchogram noted mainly at both lower lobes compatible with COVID-19. There was also bilateral pneumothorax more on the right, compressing the lung parenchyma. The CT scan also showed significant pneumopericardium and pneumomediastinum involving all mediastinal compartments and extending into the visualized deep neck spaces (Figure 2 and 3). The patient rapidly developed subcutaneous emphysema of the neck and upper chest.

To be mentioned that nasopharyngeal sample for SARS-CoV-2 RT-PCR was also taken and blood was drawn out for complete hematologic and biochemical workup and for culture. Results shown in Tables 1, 2, 3 and 4.

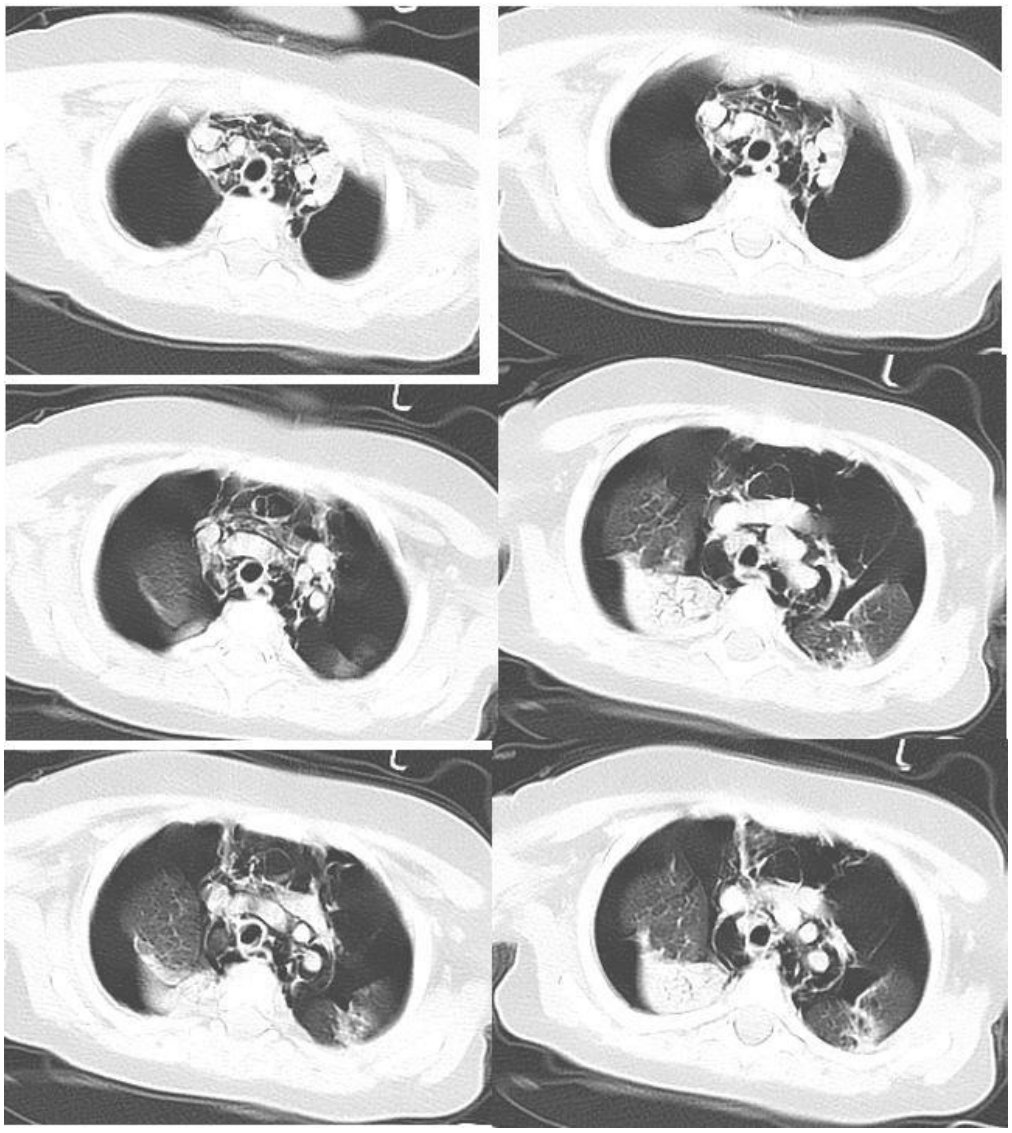

**Figure 2:** CT scan of chest showing pneumomediastinum, pneumopericardium and pneumothorax bilaterally.

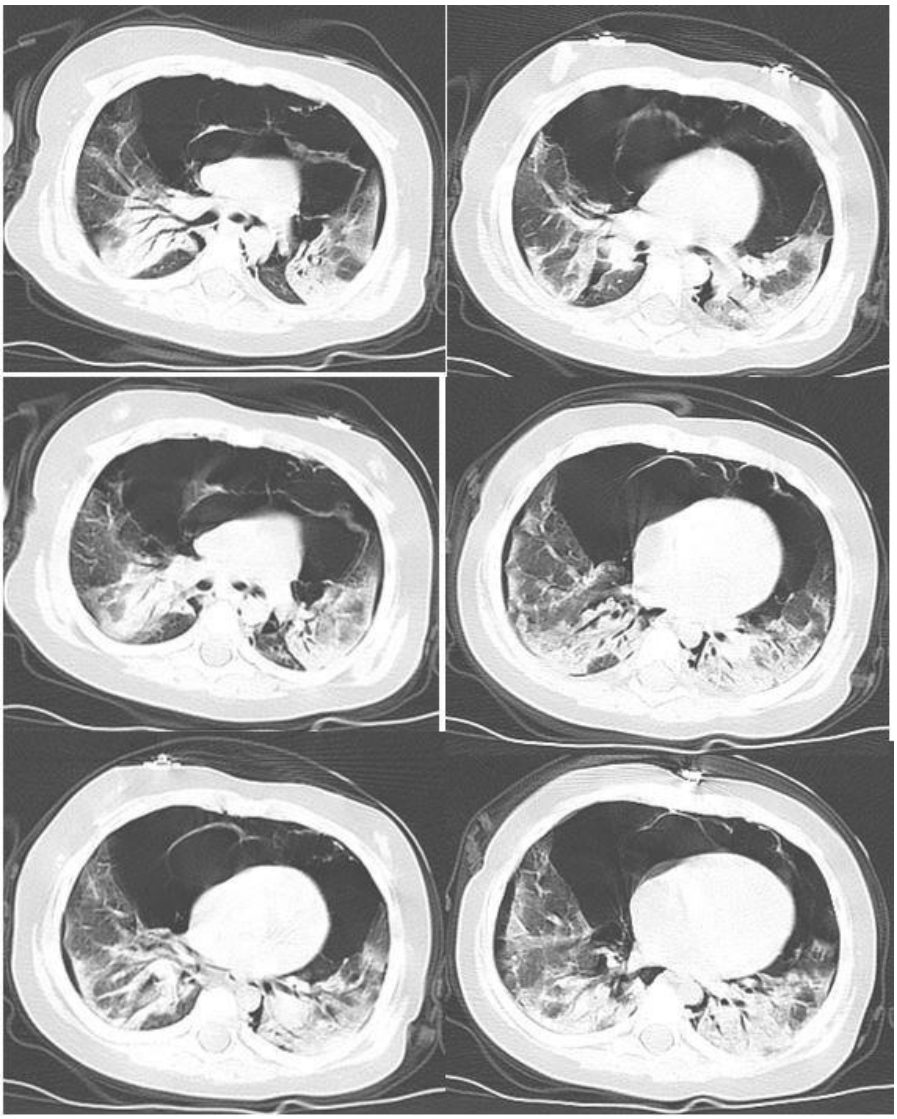

**Figure 3:** CT scan of chest showing pneumothorax bilaterally.

**Table 1:** Hematology laboratory test results.

| | |
|---|---|
| Haemoglobin (g/L) | 11.9 |
| White blood cells (cu/mm$^3$) | 9,460 |
| Haematocrit (%) | 37.2 |
| Mean cell volume (fL) | 80 |
| Platelets (cu/mm$^3$) | 185000 |
| Neutrophil (%) | 57 |
| Lymphocyte (%) | 35 |

| | |
|---|---|
| Monocyte (%) | 7 |
| Eosinophil (%) | 0.01 |
| Basophil (%) | 0.9 |
| INR | 1 |

**Table 2:** Arterial blood gases sample result.

| | |
|---|---|
| pH | 7.25 |
| pCO2 | 45.8 |
| pO2 | 50.3 |
| HCO3 (mmol/l) | 18.2 |
| O2 saturation (%) | 80 |

**Table 3:** blood culture and COVID-19 PCR results.

| | |
|---|---|
| Blood culture | Negative after 5 days |
| COVID-19 PCR | Positive for SARS-CoV-2 |

**Table 4:** Biochemistry, laboratory test results.

| | |
|---|---|
| SGOT(IU/L) | 87 |
| SGPT(IU/L) | 35 |
| Sodium (mEq/L) | 143 |
| Potassium (mEq/L) | 4.66 |
| Chloride (mEq/L) | 106.4 |
| CO2 (mEq/L) | 16.1 |
| Creatinine (mg/dL) | 0.42 |
| BUN (mg/dL) | 13 |
| CRP (mg/dL) | 2.3 |
| Cardiac troponin (ng/mL) | 0.011 |
| CPK (IU/L) | 43 |
| CK-MB mass (ng/ml) | 1.98 |
| D-Dimer (microgram/mL) | 0.56 |
| Interleukin-6 (pg/mL) | 55.13 |

**Therapeutic focus and assessment**

Urgent needle thoracentesis was done bilaterally, and large amount of air was aspirated. The girl was intubated due to her increased work of breathing, deteriorating condition and decreased mental status. Then two chest tubes were inserted simultaneously, one on the right side and the other on the left side. The patient was also started on vancomycin, ceftriaxone and azithromycin for a possible co-bacterial infection. Also, the patient was started on intravenous dexamethasone and one loading dose of Remdesivir was given.

Despite vigorous management, the patient's respiratory status deteriorated dramatically and she was in continuous desaturation despite ventilation and oxygenation. The patient passed away after a cardio-pulmonary arrest few hours after her admission to the hospital and she did not pick up after a thorough effective cardio-pulmonary resuscitation.

## Discussion

Pneumothorax which is the presence of air in the pleural space raises the concern of 3 possible mechanisms of entry of air to this space; either by a communication between the alveoli and the pleura, or a communication between the pleura and the atmosphere or the presence of an air producing organism within the pleural space. SSP is more recurrent than PSP due to the fact of the continuing existence of the underlying lung condition inducing the pneumothorax [6]. SSP can take place secondary to any of the following: airway disease, infection, congenital malformations, connective tissue disease, interstitial lung disease, malignancy and aspiration [5].

The most common presenting symptom of pneumothorax is chest pain followed by dyspnea. A seven-years' experience from nine pediatric emergency departments (EDs) was summarized in a study showing that only 13% of the pediatric spontaneous pneumothorax took place at ages less than 13 years. An additional finding is that out of the 219 cases presenting to the 9 EDs with an average of 30 cases per year, the majority were males especially in SSP (81% of SSP cases were males) [4]. This is an additional emphasize that makes the above case special; a one-year old female pediatric patient with COVID-19 induced SSP.

Pneumopericardium which was first described in 1844 is the accumulation of air within the pericardial space. It has 4 main etiologies: trauma (blunt, penetrating and barotrauma), fistula into an air containing organ, iatrogenic and air producing bacteria within the pericardial space. The most common cause of pneumopericardium in the pediatric population is related to mechanical ventilation induced damage to the bronchial tree. CT chest is the method of choice for the diagnosis of pneumopericardium rather than cardiac echography [7]. In the case presented above, pneumopericardium in a 1-year-old girl was not induced by mechanical ventilation but rather was diagnosed on presentation before the decision to intubate was established.

Pneumomediastinum is the accumulation of air within the mediastinum. It may be primary without any inducing event or secondary to trauma, hollow viscus perforation or even intrathoracic infections [8]. In 2014, a study on 13 patients who developed pneumomediastinum secondary to severe acute respiratory syndrome (SARS) deduced that the possible pathogenesis of the leak of air into the interstitial space of the lungs is the diffuse alveolar damage induced by the virus itself or by the immune response [9]. This is compatible with the case presented above were the 1-year-old girl was showing signs of COVID-19 induced pneumonia 1 day prior to presentation that developed rapidly into possible alveolar damage which ended up with a pneumomediastinum. To our knowledge, the only pediatric patient with COVID-19 related pneumomediastinum and pneumopericardium worldwide was a 17 years old female presenting with gastro-intestinal symptoms [10].

## Conclusion

The presentation of the above case highlights for both clinicians and parents the importance of strict isolation and precautions when dealing with children during the COVID-19 pandemic especially when a family member is infected with COVID-19. Also, regarding the diagnosis of severe COVID-19 induced lower respiratory tract disease; it is so important to use CT scan of the chest rather than CXR to help in earlier diagnosis and more detailed description of what's going within the thorax. Last, it is a necessity to have cardio-thoracic surgery experts and staff within the coronavirus treating units in hospitals that may save lives of many suffering patients who do not respond to the regular treatments.

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