

Early spontaneous pneumothorax, pneumomediastinum and pneumorrhachis in an adolescent with SARS-CoV-2 infection

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Abstract. – We report a case of spontaneous pneumomediastinum, pneumothorax, emphysema subcutaneous and pneumorrhachis, occurring in an adolescent resulting positive to SARS-CoV-2 nasopharyngeal swab. At the admission in Emergency Department, the child presented with left cervical and sternal pain, without respiratory symptoms. Radiological studies showed sizeable pneumomediastinum, bilateral apical pneumothorax, massive emphysema subcutaneous and pneumorrhachis. Patients' clinical conditions stood stable during the monitoring and he only needed conservative management. To our knowledge, this is the first description of spontaneous pneumomediastinum, pneumothorax, emphysema subcutaneous and pneumorrhachis, in a COVID-19 adolescent without concomitant pneumonia.

Key Words:

Pneumothorax, Pneumomediastinum, Pneumorrhachis, Adolescent, COVID-19.

Introduction

During the last 10 months, all the countries faced with COVID-19 that emerged in China and quickly spread worldwide causing severe acute respiratory syndrome (SARS-CoV-2).

Although the SARS-CoV-2 virus was initially described as a respiratory disease, during the next months it has been widely associated with a more complex and systemic syndrome, which include not only the respiratory tract but also seriously interest the cardiovascular, gastrointesti-

nal, and neurologic systems. There are far fewer data about COVID-19 in children, describing a relatively milder disease in children compared to adults¹, demonstrating a lower susceptibility to SARS-CoV-2 infection of children than adults. To date, spontaneous pneumothorax without concomitant COVID-19 pneumonia has not yet been described^{2,3}.

We describe the case of a child with COVID-19 presenting with spontaneous pneumomediastinum, pneumothorax, massive emphysema subcutaneous and pneumorrhachis not associated with pneumonia or acute respiratory symptoms.

Case Report

A 17-year-old boy accessed to the Pediatric Emergency Department complaining bilateral cervical and sternal pain, developed spontaneously, and intensified by deep inspiration. At the triage his temperature was 36.5°C, blood pressure was 120/80 mmHg, blood oxygen saturation 99%. Respiratory rate 30/min; Cardiac rate 88 bpm.

He did not have fever, cough or any other respiratory symptoms. He denied similar episodes in the past and similar events in his family history. He denied contact with people infected by SARS-CoV-2 virus, but he had been to a party in the previous days. The morning he went out for a running.

On physical examination, he appeared suffering, complaining severe pain. Chest evaluation showed pectus carinatum and reduced apical vesicular murmur, subcutaneous emphysema in the neck and in both anterior and posterior upper chest.

His medical history included mitral valve prolapse and joint instability, and this is the reason why he has been screened in childhood for Marfan Syndrome through genetic exams, resulted negative.

Arterial blood gas analysis showed: pH 7.38, pCO₂ 48.1 mmHg, Lac 0.8 mmol/L, BE 3.7 mmol/L, HCO₃⁻ 25 mmol/L. White blood cell count revealed normal values, as well as blood electrolytes and troponin. C-reactive protein level was within ranges. Electrocardiogram indicated sinus rhythm. Point-of-Care Ultrasound revealed a lung point (ultrasound sign of pneumothorax), chest X-Rays was performed, revealing bilateral apical pneumothorax, suspected pneumomediastinum and widespread subcutaneous emphysema.

A subsequent chest Computed Tomography (CT) scan showed a massive emphysema in cervical and axillary subcutaneous tissue (Figure 1A), in front and back thoracic wall. Moreover, it described pronounced pneumomediastinum (Figure 1B), bilateral pneumothorax (Figure 1C), and pneumorrhachis (Figure 1D).

Since his clinical conditions were steady and pain decreased after Paracetamol administration, the thoracic surgeon consultant indicated clinical observation, excluding surgical indication.

Reverse transcription (RT)-PCR analysis of SARS-CoV-2 in nasopharyngeal swab was performed, turning out to be positive.

Discussion

Spontaneous pneumothorax and pneumomediastinum are uncommon in children, although they are two of the most common thoracic diseases among adolescents. One explanation of the major incidence in young people is that their mediastinal tissue is looser than adults, who have a fibrosed sheath that make air migration difficult^{4,5}.

Typically, these conditions affect patients with a tall, thin body habitus. Most of pneumothoraxes occur at rest but, in some cases, there is an association with an acute increase in intrathoracic pressure (such as coughing or vomiting). Pneumomediastinum often can be triggered by asthma, respiratory infections and several circumstances involving a Valsalva maneuver. Pneumorrhachis can represent a rare complication of spontaneous pneumomediastinum when air enters within the spinal canal. It can be also traumatic or iatrogenic.

Although spontaneous pneumothoraxes arise in patients without clinically evident lung disease,

most patients have emphysema-like changes in the lung parenchyma. Nevertheless, the role of bullae and blebs as the only cause of spontaneous pneumothoraxes is questionable, as it is only demonstrated in about 20% of patients⁵. Peripheral airway obstruction with air trapping, indeed, seems to play a role in the pathogenesis of spontaneous pneumomediastinum⁴ and pneumothorax⁵.

Several cases of upper and lower lung infections (like fungal, bacterial, and viral pneumonia) have been reported to cause air leak, leading to spontaneous pneumomediastinum or pneumothorax. The pathophysiological reasons could be explained by the Macklin phenomenon⁶: an increased alveolar pressure (such in case of cough) and the airway obstruction from secretions increase the pressure gradient⁴.

Spontaneous pneumomediastinum and pneumorrhachis have already been described as potential complications of virus infections, as 2009 pandemic influenza A (H1N1) virus infection⁷, also in healthy children. Common flu virus infection also can cause pneumothorax, pneumomediastinum, subcutaneous emphysema and pneumorrhachis in a healthy child⁸. Even respiratory syncytial virus infection is described as cause of spontaneous subcutaneous emphysema, pneumothorax, pneumomediastinum and pneumorrhachis in a young boy undergoing chemotherapy⁹. However, some symptoms like persistent or violent cough occurred in these children and they could have caused the disease.

Spontaneous pneumothorax, pneumomediastinum and subcutaneous emphysema have been described in association with SARS CoV-2 infection in some adult patients. All these patients had at least one symptom related to the infection: cough, fever, dyspnea. Sometimes they were on therapy: oxygen therapy or antibiotic or steroid therapy. Moreover, their pulmonary Computerized Tomography showed signs of co-existing COVID-19 pneumonia¹⁰⁻¹⁴.

In the context of COVID-19, pneumothorax and pneumomediastinum also can be affected of barotrauma, for adult patients assisted by mechanical ventilation. Both pneumothorax and pneumomediastinum are known complications of intubation¹⁵.

However recent articles¹⁶⁻¹⁸ show the eventuality of spontaneous pneumothorax as late sequelae of COVID-19 pneumonia even in patients who did not require ventilation at admission, suggesting the hypothetic role of infection as cause of pneumothorax. Although not clearly understood,

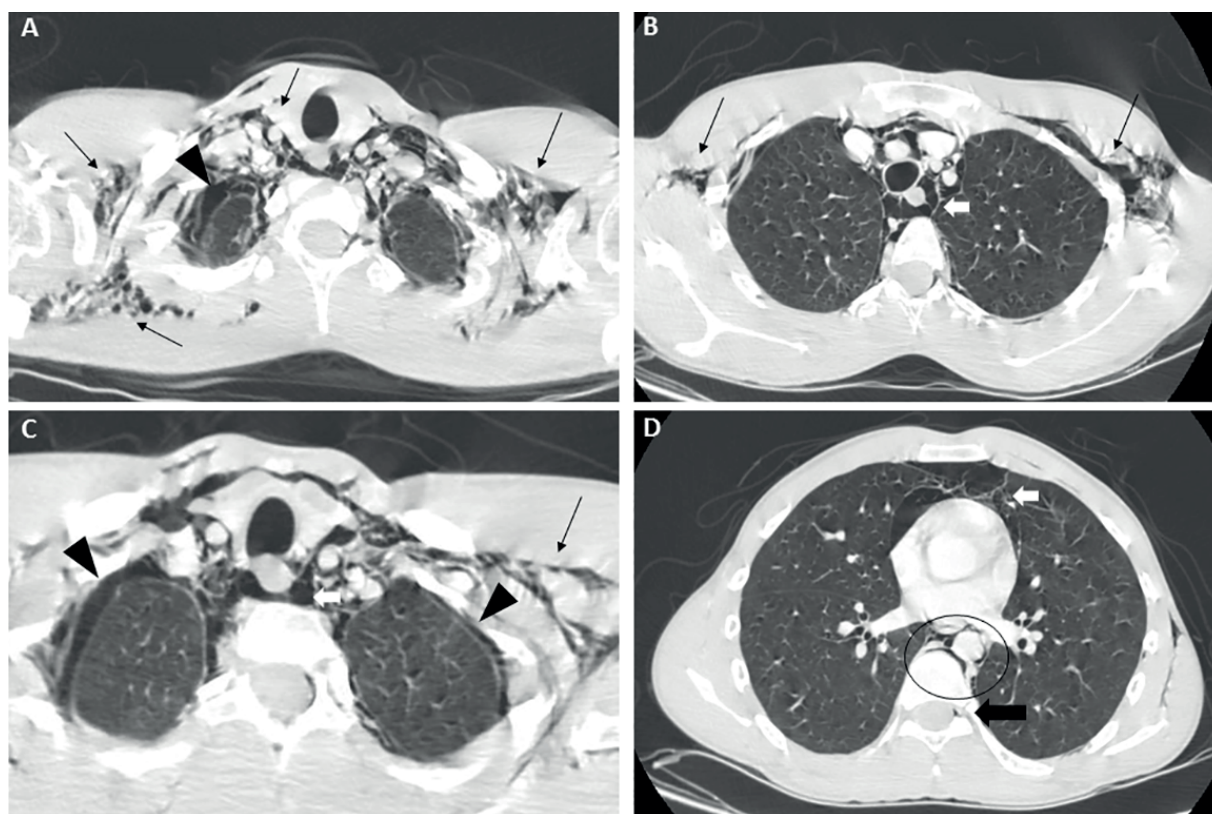


Figure 1. Chest Computed Tomography images. **A**, Massive subcutaneous emphysema (black arrows) with apical left pneumothorax (black arrowheads). **B**, Pneumomediastinum (white arrow) with subcutaneous emphysema in the axillary region (black arrows). **C**, Bilateral apical pneumothorax (black arrowheads). **D**, Pneumomediastinum (white arrow), air behind the aorta (black circle), and pneumorrhachis (thick black arrow).

the mechanism of the injury may be secondary to alveolar damage from the virus infection and to a rupture of the alveolar wall due to increased pressure from pronounced coughing that occurs in response to the virus. Additionally, COVID-19 determines ischemic parenchymal damage, activation of fibroblasts, with lung fibrosis, and inflammatory storm, which can exude into alveoli and airway leading to obstruction and cystic formation in the small airways¹⁹.

In contrast with the wide number of clinical reports of pneumomediastinum, pneumothorax and subcutaneous emphysema in adult patients affected by COVID-19, no reports are available about the same complications in children or about spontaneous pneumorrhachis both in adults and in children.

To the best of our knowledge, to date, this is the first case of pneumorrhachis associated with SARS-CoV-2 infection. Moreover, this is the first report of spontaneous pneumothorax, pneu-

momediastinum and pneumorrhachis related to SARS-CoV2 infection in a child. Moreover, lung ultrasound also detected the pneumothorax, confirming its potential role as a first-line imaging when pneumothorax is suspected²⁰.

Our patient instead did not show any symptoms related to SARS-CoV2 infection, he was a healthy child and he's never had symptoms like these before. In addition, he didn't have cough or other respiratory symptoms. Although his marfan-like habitus may have been a predisposing factor for the pneumothorax, he has never experienced before similar symptoms. This reinforces the suspicion that the SARS-CoV-2 infection may have been the trigger of the pneumothorax, in a child with physical predisposition to spontaneous pneumothorax.

Other studies are needed to understand if pneumothorax, pneumomediastinum and pneumorrhachis can be the only manifestation of SARS-CoV-2 infection in a patient without respiratory

symptoms. In addition, it is important to determine if coronavirus infection can be the only cause of pneumothorax, pneumomediastinum and pneumorrhachis in a predisposed child with *Marfanooid habitus*, who has never showed similar episodes before. This is particularly important in view of the raising cases of SARS-CoV-2 worldwide since fragile children and adolescents may be more exposed to the virus. If the association between spontaneous pneumothorax and SARS-CoV-2 infection would be confirmed from other reports, this may inform policy makers or personalized preventive strategies for specific fragile populations.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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