# Pneumothoraces Associated With Vaping Cannabis Concentrate

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abstract

Vaping-associated spontaneous pneumothorax (VASP) is a new diagnosis created to describe spontaneous pneumothorax associated with the use of vape devices. We describe a case of bilateral VASP in a previously healthy 15-year-old male who was vaping cannabis concentrate. This is the first case report of VASP involving the sole usage of cannabis concentrate. This patient reported vaping for only 6 months before initial presentation. As rates of vaping cannabis concentrate increase among adolescents, VASP should be considered in the differential diagnosis of chest pain in adolescents who vape nicotine or cannabis.

Vaping is the colloquial term for use of e-cigarettes, which heat and convert a liquid containing nicotine, cannabis, and/or flavoring to an aerosol for inhalation. Since 2014, e-cigarettes have been the most commonly used tobacco product among adolescents. Popularity of e-cigarettes among high school students peaked in 2019, with 27.5% reporting daily e-cigarette use.[1] By 2023, 10% of high school students reported current use of e-cigarettes, and of those who vaped, 89% reported using flavored products.[2] Additionally, e-cigarettes are frequently used to vaporize cannabis and cannabis concentrate. In California, 38% of adolescents reported having used cannabis concentrate in their lifetime and 21% reported having used cannabis in the last 30 days.[3,4] Cannabis concentrate is made by exposing the cannabis flower that harbors a high concentration of tetrahydrocannabinol (THC) to the chemical butane and then heating this mixture in a machine that removes the butane and the plant matter. Cannabis concentrate has a much higher THC content (ranging from 39% to 80%) than the marijuana plant (12% to 20%).[5] Cannabis vaping devices can be broadly categorized into dab pens and vaporizers. Dab pens are used exclusively to vape cannabis concentrates.[6] Cannabis concentrates vary as a function of moisture level, heating process, and other production processes and are referred to as "shatter," "wax," "badder/budder," and "crumble," depending on their consistency.[5,7] Vaporizers, on the other hand, can be used with cannabis concentrates or with dried or liquid forms of cannabis.

In the last decade, use of THC e-cigarettes has increased 7-fold among children ages 12–17 years (1.6% to 8.4%).[8] In 2021, among people aged 12 years or older who vape, 71.1% vape nicotine, and 40.1% vape cannabis.[9] Among adolescents who use cannabis, most report trying cannabis concentrate.[7]

To date, an increasing number of cases of spontaneous pneumothorax have been reported to have occurred in previously healthy patients with a recent history of vaping or during vaping (Table 1). VASP is presumed to result from a combination of chronic alveolar inflammation, the abnormal replacement of intact visceral pulmonary mesothelial cells by a porous inflammatory elastofibrotic layer, and altered airway and alveolar pressures needed to achieve a "vape hit."[10] We report a case of VASP occurring in an previously healthy 15-year-old patient and document the first occurrence in a pediatric patient associated with vaping cannabis concentrate in cartridge form.

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**TABLE 1** Literature Describing Primary Spontaneous Pneumothorax in Patients With Vaping History

| Article Name | Publication Date | Age, Sex | Substance | Length of Vaping History |
|---|---|---|---|---|
| Vaping is a risk factor for spontaneous pneumothorax: Two cases | Sep 2019 | 15, M<br>16, M | Not specified | Not specified |
| Recurrent spontaneous pneumothoraces and vaping in an 18-y-old man: a case report and review of the literature | Sep 2019 | 18, M | Nicotine | 1.5 y |
| A Case Report of Secondary Spontaneous Pneumothorax Induced by Vape | Nov 2019 | 35, M | Nicotine, but mainly THC | 4 y |
| Reporting of pneumothorax in association with vaping devices and electronic cigarettes[30] | Dec 2021 | 34, M | Not specified | 3 y of vaping after 10 y of cigarette smoking |
| Recurrent spontaneous pneumothorax in a 15-y-old female associated with electronic cigarettes[31] | Oct 2022 | 15, F | Nicotine and tetrahydrocannabinol (THC) | Daily vaping for at least 6 mo between first and second vaping associated spontaneous pneumothorax admission, length of history not stated |
| Pneumothorax secondary to vaping[32] | May 2021 | 19, M | Nicotine | 1 y of daily vaping after 1 y of cigarette smoking |
| Vaping associated spontaneous pneumothorax - A case series of an enigmatic entity![10] | Oct 2021 | 19, M<br>20, F<br>18, M<br>35, M | THC, all | Case 1: not specified<br>Case 2: not specified<br>Case 3: 2 mo<br>Case 4: 7.5 y of cigarette smoking and vaping |
| The "Big Hit of Vape" That Led to a Pneumothorax | Jan 2022 | 29, M | Not specified | 8 y of vaping after 3 y of cigarette smoking |
| Recurrent spontaneous pneumothorax in a 15-year-old female associated with electronic cigarettes[34] | July 2022 | 15, M | Nicotine, THC | Daily e-cigarette use with. nicotine and cannabinoid cartridges for unspecified amount of time |

## CASE

A 15-year-old male presented with his parents to an emergency department (ED) with left-sided chest pain that had started 2 days prior while he was doing push-ups. He reported a mild cough but denied fever, coryza, trauma to the chest, and recent sick contacts. He had no personal or family history of pneumothorax or Marfan syndrome or other connective tissue disease, and he denied smoking. On confidential interview (without parents present), he disclosed that he had been vaping THC for 6 months twice per week, with increasing frequency in the past month (3 times per day). During the prior 6 months, he had smoked cannabis 2 to 3 times in total. He had used modifiable cartridges, which were filled with "live resin" cannabis concentrate. Per available information on dispensary websites, the THC concentration of the live resin vape pod the patient was using was 85% or higher.[11]

Vital signs in the ED included temperature of 37.3 °C, heart rate of 103 beats per minute, blood pressure of 135/80, respiratory rate of 16 breaths per minute, and oxygen saturation of 97% on room air. His height was 172.1 cm (~55th percentile for age), his weight was 58.7 kg (~55th percentile for age), and his body mass index was normal (19.6 kg/m$^3$).[12] He displayed normal pulmonary effort and breath sounds and had no stridor or chest wall tenderness. Chest radiograph (CXR) revealed a left apical pneumothorax that measured 3 cm in breadth with no other abnormalities (Fig 1A). The patient was admitted to the surgery service for observation. The following morning, a repeat CXR showed a stable pneumothorax (Fig 1B) and the patient remained well on room air. He was discharged from the hospital with instructions to return in 24 hours for repeat CXR. At that time, his CXR was unchanged (Fig 1C), but he complained of pain with deep inspiration, so he was readmitted to the hospital and placed on supplemental oxygen. The next morning, repeat imaging revealed a stable pneumothorax. Interventional radiology placed a chest tube, and 24 hours later, repeat CXR showed resolution of pneumothorax (Fig 1D), so the tube was removed. After the patient was pain-free and stable on room air for 6 hours, the medical team discharged him home. Before discharge, the

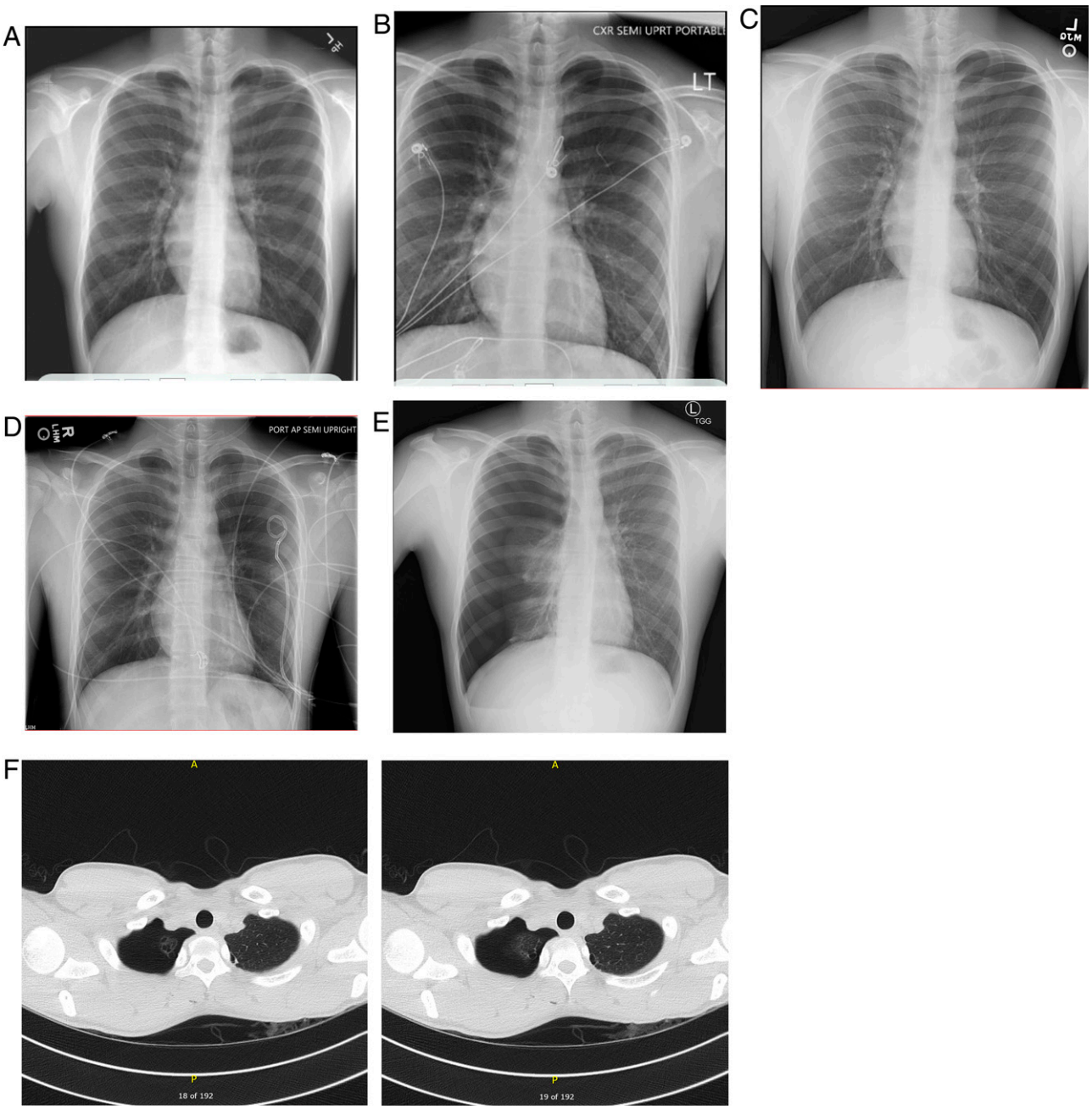


**FIGURE 1.**
(A) CXR at ED showing left pneumothorax. (B) CXR morning of discharge from hospital #1. (C) CXR in urgent care/on admission at hospital #2. (D) CXR after chest tube. (E) CXR on re-presentation to the ED concerning for right tension pneumothorax. (F) Chest CT image showing bilateral apical blebs at hospital #3. CT, computed tomography; CXR, chest x-ray.

patient expressed desire to stop vaping because of concern for its possible role in the pneumothorax.

He remained asymptomatic on follow-up with his primary care physician 6 days after discharge. A month later, he had returned to working out without chest pain and reported that he had ceased vaping.

Approximately 3 months after his initial admission, he re-presented to the ED after he began having difficulty breathing during football tackle practice. His CXR showed a right pneumothorax with left tracheal deviation consistent with a tension pneumothorax (Fig 1E) and, in the ED, a pigtail catheter was placed. However, a repeat CXR the next day was concerning for a persistent air leak, and that same day a chest CT showed bilateral apical blebs (Fig 1F). The medical team transferred the patient to the pediatric tertiary care hospital, where he underwent

bleb resection and mechanical and chemical pleurodesis of his right lung under video-assisted thoracoscopy. He healed well from that procedure, and 2 months later, he received the same planned procedures for his left lung, which on admission still showed a persistent pneumothorax.

Pathology demonstrated mild to moderate pleural fibrosis with focal subpleural fibroplasia and rounded spaces (blebs) within a thickened pleura lined focally by histiocytes and multinucleate giant cells. Focal lymphocytic and eosinophilic inflammation was present.

In the 6 months since the final procedure, the patient has not had any recurrent pneumothoraces. In follow-up conversations, the patient denied any usage of vaping products after the initial hospitalization for his first pneumothorax.

## DISCUSSION

Pneumothorax is the accumulation of air within the pleural space as a consequence of rupture of alveolar tissue. In 30% of cases of pneumothorax, lung disease (such as cystic fibrosis or emphysema) has weakened the pulmonary tissue and predisposed it to rupture.[13] Fully 70% of pneumothoraces occur in the absence of lung disease[13,14] In the majority of these spontaneous pneumothoraces, no cause can be identified.[15] There is currently a lack of consensus on a definitive pediatric guideline for diagnosis and treatment of pneumothorax.[16]

However, in a multi-yearstudy at one tertiary care center, 100% of patients with a history of vaping who developed spontaneous pneumothorax required chest tube placement. https://journals.sagepub.com/doi/abs/10.1177/00031348211048849 Known risk factors for spontaneous pneumothorax include a tall thin habitus, a history of smoking, a family history of pneumothorax, and rapid atmospheric pressure changes (eg, as generated by scuba diving).[17–19] We suggest that a history of vaping should be considered as another risk factor for spontaneous pneumothorax. In our patient, both episodes of pneumothorax occurred while the patient was engaged in physical activity. Spontaneous pneumothorax has occurred acutely in association with push-ups, weightlifting, and blunt thoracic trauma during sports.[20–25] However, the pathology in our patient (pleural fibrosis, bleb formation, chronic inflammation) was more consistent with accumulated damage over time rather than with an acute rupture of alveolar tissue in otherwise healthy lungs. Therefore, we propose that although exertion or blunt force could have been the precipitating cause of the patient's pneumothoraces, vaping initiated and perpetuated chronic pulmonary changes that predisposed him to these morbidities.

Previous case reports of VASP documented a duration of vaping between 2 months to 8 years before the spontaneous pneumothorax (Table 1). This case report shows that even a short period of vaping might be sufficient to increase the risk of a spontaneous pneumothorax and suggests that predisposing lung damage can persist well after cessation of vaping.

A better known consequence of vaping is e-cigarette or vaping associated lung injury (EVALI).[26] EVALI is usually diagnosed after presentation of chest pain or shortness of breath in a recent vape user (within 90 days) in the setting of pulmonary infiltrates on CXR and acute respiratory failure.[27] The etiology of lung damage in EVALI is not precisely established, but bronchoalveolar lavage of EVALI patients has shown lipid deposition of vitamin E acetate (found in e-cigarette liquids).[28] This supports the hypothesis that lung damage in our patient could be due to an inflammatory response within the alveoli that extended to the visceral pleura from a reaction to the accumulated chemicals from e-cigarette liquids. We cannot completely exclude another underlying etiology other than vaping-induced lung injury, but this appears unlikely. Additional reports may secure a firmer causal basis for spontaneous pneumothorax from vaping using concentrated cannabis.

This is the first reported case of VASP in a previously healthy pediatric patient who exclusively vaped cannabis concentrate. In this case, despite the initially normal lung examination, a thorough, confidential history and CXR were key to establishing the correct diagnosis and treatment plan. Given the prevalence of e-cigarette and cannabis use and the availability of highly concentrated THC, as well as the many ways teens are using cannabis, pediatricians must be vigilant to identify this newly described and potentially serious condition. This case highlights the importance of conducting a detailed and nonjudgmental confidential history in all adolescents, including those presenting with chest pain. Among hospitalized pediatric patients, only 5% are interviewed confidentially and only 32% are queried about drug use.[29]

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### ABBREVIATIONS

CXR: chest radiograph
ED: emergency department
EVALI: e-cigarette or vaping use-associated lung injury
THC: tetrahydrocannabinol
VASP: vaping-associated spontaneous pneumothorax

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