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Case Report

Crazy vaping and crazy-paving, a case of E-Cigarette/Vaping-Associated Lung Injury (EVALI) with chest CT showing crazy-paving pattern ☆

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ABSTRACT

E-cigarettes are devices that generate an aerosol by heating a fluid containing multiple chemicals, such as nicotine, additives, and flavorings. They were developed to aid in smoking cessation and were promoted as socially acceptable, healthier, cheaper than conventional cigarettes. Multiple lung disorders related to e-cigarette use are reported, and they range from mild cases of pneumonitis to life-threatening lung disorders that may require intubation and mechanical ventilation. Most of the complications are due to the generation of various unknown and potentially harmful chemicals within the aerosol generated in the e-cigarette. These disorders are known collectively as e-cigarette/Vaping-associated lung injury (EVALI). E-cigarettes are marketed as safer alternatives to traditional cigarettes, with the highest rates of use are noted in young smokers. Given the significant prevalence of e-cigarettes use and their pulmonary complications, EVALI should be considered a potential etiology in the broad differential diagnosis of patients with pulmonary disease and a history of vaping. Herein, we present a case of cryptogenic organizing pneumonia with a chest C.T. showing a crazy-paving pattern in a patient with a history of vaping.

Abbreviations: CDC, Centers for Disease Control and Prevention; CT, Computed Tomography; E-cigarette, Electronic Cigarette; EVALI, E-cigarettes or Vaping Associated Lung Illness; (COP, formerly BOOP), Cryptogenic organizing pneumonia.

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Introduction

E-cigarettes are commonly used tobacco products, especially among young smokers, and they represent an evolution in the tobacco products industry. E-cigarettes use is highly reported in the 18-24-year age group. There was an increase in the rate of vaping products use amongst high school students by 10-fold during the time period of 2011-2015.[1,2]

In the past two years, many cases of patients who had developed pulmonary disorders associated with vaping were reported throughout the United States. In February 2020, more than 2800 patients required hospitalization due to EVALI, with 68 deaths reported.[3] The mechanism of the disease is not fully understood; however, multiple compounds present in e-liquid could potentially induce injury such as flavorings, vitamin E acetate and heavy metals. This report highlights questions about the spectrum of lung disorders related to E-cigarette use, including cryptogenic organizing pneumonia.

Case presentation

A 31-year-old male with a past medical history of paroxysmal atrial fibrillation, hypertrophic obstructive cardiomyopathy presented with fever, cough, and shortness of breath with chest tightness for 3 days. The patient reported that he used to smoke about 10 cigarettes/day for 18 years. He quit smoking 11 months ago; however, he was using a vaping device to smoke cannabis oils and nicotine products 3-5 times daily. Moreover, he was recently admitted with a similar presentation for vaping-associated lung injury requiring intubation. The patient denied any recent sick contacts, travel history, environmental exposures, such as home renovations or living with pets.

Initial vital signs showed a temperature of 36.8 C, heart rate 77 beats/min, blood pressure 141/97 mm Hg, respiratory rate of 26/min, and hypoxia with SpO2 of 85′s on room air. The patient was subsequently placed on nonrebreather, at which time his saturation increased to 97%. However, he once again began desaturating and was placed on BiPAP with improved oxygenation. Physical exam revealed significant respiratory distress, diminished lung sounds, and poor air entry bilaterally with no rales or rhonchi. Laboratory analysis revealed a leukocytosis of 17,500 with no bandemia and workup for infection, including SARS-COV 2, respiratory viral panel, blood and sputum cultures were negative. A plain chest radiograph demonstrated bilateral generalized infiltrates. Chest computerized tomogram C.T. showed extensive bilateral alveolar infiltrates with peripheral sparing and septal thickening with a crazy-paving pattern. [Fig. 1]

The patient was managed initially with empiric antibiotic therapy for community-acquired pneumonia coverage in addition to steroids due to high suspicion of EVALI. On day 5, given the history of recurrent admissions for pneumonia and long history of smoking and vaping, the decision was made to do right video-assisted thoracoscopic surgery (VATS) with right upper lobe and right middle lobe wedge biopsies. Biopsies pathology result was consistent with cryptogenic organizing pneumonia (COP). [Fig. 2] There was no evidence of community-acquired pneumonia or other infections.

A significant improvement in patient condition with a decrease in oxygen requirements was noted after starting steroid therapy. On day 13 of admission, repeat C.T. revealed marked resolution of previously seen extensive bilateral

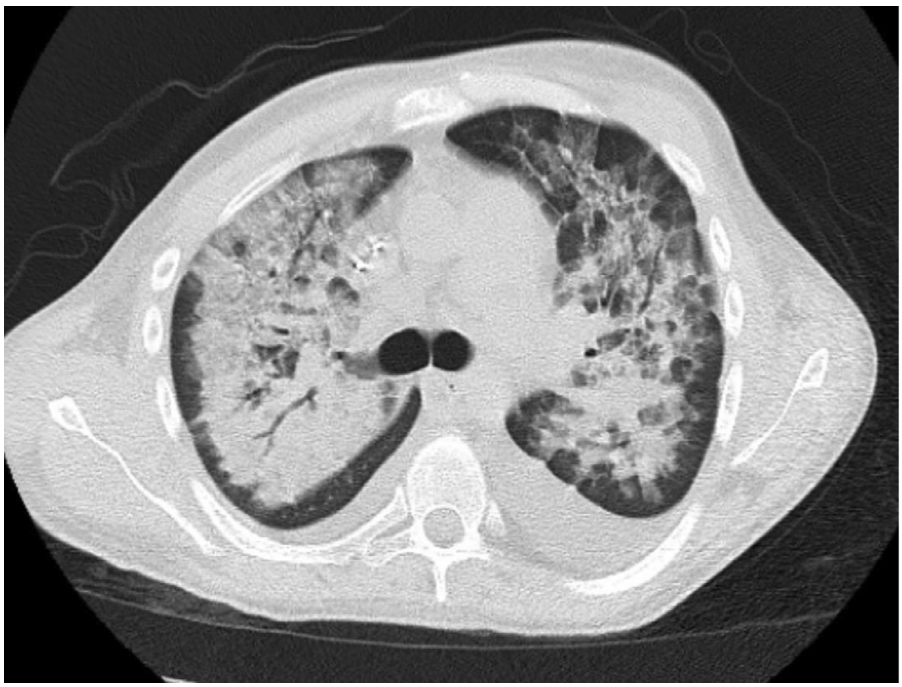

Fig. 1 – Initial Chest C.T. showing extensive bilateral alveolar infiltrates with peripheral sparing and septal thickening with a crazy-paving pattern.

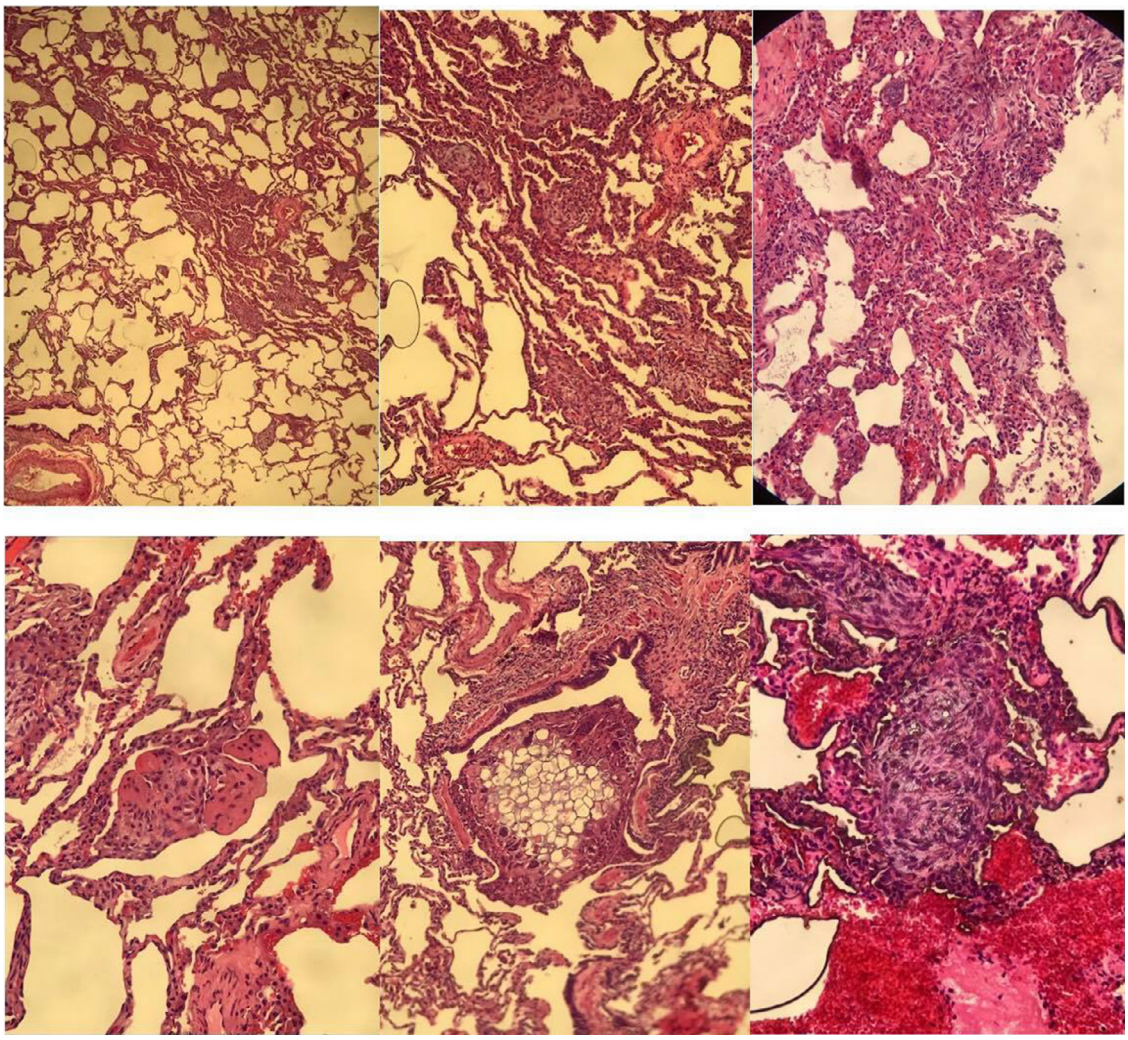

Fig. 2 – Right upper and middle lobes biopsies showing that the lung interstitium is very focally and mildly thickened and there is organizing pneumonia in the form of fibroblastic proliferation mostly seen in multiple foci and only focally present in vague confluence. Foreign body giant cell reaction with refractile material also present.

pulmonary infiltrates with subtle residual infiltrative changes in the right middle and lower lobes. [Fig. 3]

The patient continued to improve, and he was discharged home after spending 16 days in the hospital. He was instructed to follow up in the outpatient clinic and was advised to quit vaping.

Discussion

E-cigarette/Vaping-associated lung injury (EVALI) is a spectrum of lung disorders related to E-cigarette use or vaping. In 2019, multiple cases were published revealing a wide spectrum of lung pathology associated with vaping including acute eosinophilic pneumonia, organizing pneumonia, lipoid pneumonia, acute respiratory distress syndrome, diffuse alveolar hemorrhage, and hypersensitivity pneumonitis.[4]

Although the etiology is poorly understood, multiple agents found in e-liquids are being investigated including propylene glycol, vitamin E acetate, and metals such as arsenic and lead. Inhalation of propylene glycol and glycerol can lead to lipid homeostasis and immune defense impairment[5]. Studies also revealed that vitamin E, which has been recognized in multiple e-liquids and bronchoalveolar lavage (BAL) samples from affected patients, may impair lung surfactant function and cause respiratory disorders. It can accumulate within vacuoles in alveolar macrophages due to the inability of these cells to break this large molecule down, which may lead to an inflammatory response with subsequent acute lung injury[6]. Nicotine itself may cause acute eosinophilic pneumonia and other chemicals such as diacetyl are known to cause bronchiolitis obliterans[7].

The most common symptoms reported in these cases were shortness of breath, cough, and fatigue. Fever, chest pain, nausea, weight loss, and diarrhea were recorded as well. In the same year of 2019, the CDC has established criteria for EVALI diagnosis, including the use of e-cigarettes in the 90 days before the onset of symptoms, developing pulmonary infiltrates on imaging, and the absence of any other likely etiology.[8]

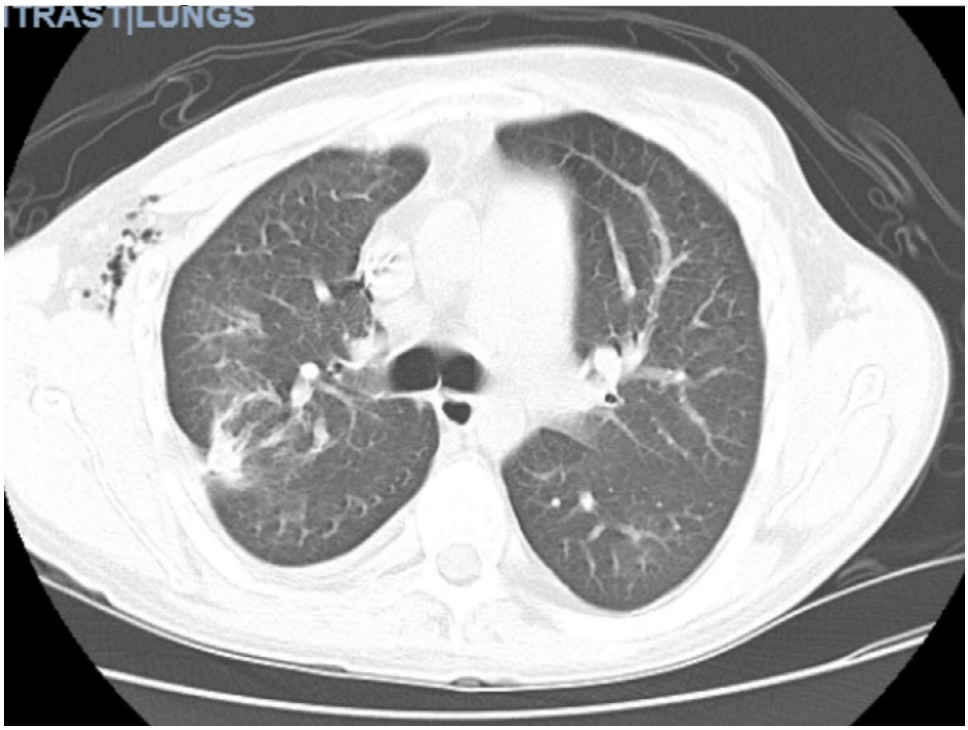

Fig. 3 – Repeat chest C.T. showing marked resolution of previously seen extensive bilateral pulmonary infiltrates with subtle residual infiltrative changes in the right middle and lower lobes.

Supportive care is the mainstay of treatment in EVALI, and the severity of the symptoms always guides whether the patient requires inpatient or outpatient management. Patients with respiratory distress, decreased oxygen saturation and associated multiple comorbidities usually require hospital admission. On the other hand, it is necessary to exclude respiratory infection as a possible etiology. Empiric antimicrobial treatment should also be considered, and it was noticed that patients with severe lung injury usually respond well to corticosteroids.[3]

Our patient fit the pathognomonic criteria of EVALI as recommended by CDC. Furthermore, his lung biopsy findings revealed organizing pneumonia, suggesting a potential relationship between vaping and BOOP development. Butt *et al.* examined lung biopsies from 17 cases with a history of vaping and high clinical suspicion of having EVALI. Histopathological findings revealed various patterns of acute lung injury, including diffuse alveolar damage, acute fibrinous pneumonitis, or organizing pneumonia, as noticed in the case that we are discussing in our report.[9]

Cryptogenic organizing pneumonia (COP, formerly BOOP) was first described in the early 1980s as a subacute or chronic respiratory disease and characterized histopathologically by the presence of intra-alveolar buds of granulation tissue in the bronchiolar lumen, alveolar ducts with interstitial and airspace infiltration by macrophages, and mononuclear cells.[10] A complete history and physical examination is necessary to rule out other pulmonary diseases. Corticosteroid therapy is the cornerstone of treatment and is usually associated with significant and rapid improvement; however, relapses can happen after discontinuing treatment.[11]

Imaging studies also have an essential role in the diagnosis of organizing pneumonia. Chest CT of our case revealed a crazy-paving pattern which refers to the presence of ground-glass opacities with superimposed interlobular septal thickening and intralobular septal thickening. It is a nonspecific finding, and it can be observed in several conditions such as acute respiratory distress syndrome (ARDS), bacterial pneumonia, pulmonary alveolar proteinosis (PAP), drug-induced pneumonitis, chronic eosinophilic pneumonia, Pneumocystis jirovecii pneumonia (PCP), COVID-19, and organizing pneumonia as noted in our case.[12] The diagnosis of COP in our patient was confirmed by the pathology result of lung biopsies.

Conclusion

E-cigarettes are marketed as safer alternatives to traditional cigarettes; however, several studies reported various lung disorders associated with their use. In light of the significant prevalence of e-cigarettes use and EVALI cases, it is important to raise public awareness of the health risks associated with vaping. Additionally, physicians should be familiar with the diagnosis of EVALI and consider COP in their differential diagnosis in patients presenting with respiratory symptoms and history of e-cigarettes use. Further studies are still needed to recognize the process of the disease.

Patient Consent

No patient consent required for images since patient diseased and images have no patient identifiers.

Author Contributions

S.R is responsible for creation, editing and writing of manuscript including submission. C.M and S.G are responsible for image acquisition, editing and writing of manuscript. R.M and A.M are responsible for final editing, proof reading and revision of manuscript.

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