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Surgery

Recurrent Spontaneous Pneumomediastinum Induced by Electronic Cigarettes

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Abstract **Case Report**

Vaping is the process of inhaling an aerosol produced by heating a liquid or wax containing substances such as nicotine, flavoring, and aditives with a device called electronic cigarette (EC). Consumers who use the EC tend to overinhale and then forcefully exhale to eliminate the vapor, performing an exaggerated Valsalva maneveur, usually produced in much greater quantity than generated by a regular cigarette. This can increase their risk for developing potential spontaneus pneumomediastinum. Pneumomediastinum is the presence of air or gas in the mediastinum, that can be classified as spontaneous or secondary. Here we present a case of recurrent spontaneous pneumomediastinum due to EC use.

Keywords: Pneumomediastinum, Subcutaneous Emphysema, Vaping, Smoking, Nicotine, Lung Injury, E-Cigarette.

INTRODUCTION

The electronic cigarette (EC) is known as the new cigarette of the 21st century. It consists of a battery, an atomizer and a cartridge containing nicotine (there are versions without nicotine) and a component aimed at producing an aerossol such as propylene glycol. In addition, it may contain substances such as fruit extract that modify the flavor, making it more palatable and recreational use more attractive [1, 2]. (Knorst *et al*., 2014; Hage *et al*., 2020).

It was developed by Chinese pharmacist Hon Lik and was patented in 2003 as an alternative to nicotine replacement. However, due to the potential risk to the user's health, the device was banned from commercialization in 2009 by the National Health Surveillance Agency in Brazil. However, EC is well known and accessible to teenagers, even in countries where the product has been banned [1].

Vaping associated pulmonary illness, VAPI is a syndrome presenting with ether mild symptoms as mouth and throat lesions, cough and headache, isolated pulmonary or combined pulmonary, gastrointestinal and constitutional symptoms [3]. (Burgwardt *et al*., 2020). It can be rapidly progressive, leading to respiratory failure [2]. Further serious adverse events were observed such as spontaneous pneumomediastinum (SPM) amount others [4]. (Marasco *et al*., 2018).

Pneumomediastinum is a rare condition in which free air is present within mediastinum. By itself rarely leads to significant complications and is usually self-limiting; in rare cases, it is a marker for a more serious underlying condition[4]. SPM is due to alveolar rupture caused by an increase in intrathoracic pressure, which can be triggered by the inhalation of a large amount of EC aerossol among other causes [5]. (Kumeda *et al*., 2023). This report reviews a case of recurrent SPM induced by EC.

CASE REPORT

All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki Declaration of Helsinki (1964) and its later amendments or comparable ethical standards. Moreover, informed consent was obtained from all individuals included in the study (Approval number: 6.698.072).

An 18-year-old male patient attempted to the emergency room on 11/15/2022 complaining about chest pain, of sudden onset, with no relieving factors, worsening on exercises, associated with pain on inspiration and a non-productive cough. He denied comorbidities or use of regular medication, had no allergies, no previous surgeries, and no previous report of trauma. History of EC use since 2020, denied the use of traditional cigarettes.

The laboratory blood test was unremarkable and the RT PCR result for COVID was negative. The emergency non-contrast computed tomography (CT) of the chest showed scattered gas foci from the left clavicular fossa to the inner mediastinum, extending to the distal esophagus (pneumomediastinum).

The patient had stable vital signs and was admitted to the infirmary bed for clinical and radiological observation. On the third day of hospitalization, a new chest CT scan was performed, which revealed a reduction in scattered gas foci in the left hemithorax. In another CT scan on 11/21/2022, the pneumomediastinum foci on the left were no longer visible, and the patient was discharged from the hospital with instructions.

One year later, on 11/19/2023, the patient returned to the emergency department regarding chest pain that worsened when coughing and deep inspiration, which began 5 hours ago. He reported that the pain was similar to that of 2022 and that the day before the appointment he used intense EC, before the pain started. Associated symptoms included eructation and solution, starting the day before care.

In the emergency room, an electrocardiogram was performed, without any changes, and a chest CT was requested, which showed the presence of diffuse pneumomediastinum extending to the fatty planes of the cervical region (subcutaneous emphysema). Laboratory blood tests were unremarkable. The patient was admitted to the infirmary bed again.

After 3 days, a control CT scan of the chest without contrast was performed, where a reduction in pneumomediastinum was noted, although it still persisted in a diffuse manner and extended to the fatty planes of the lower cervical region (subcutaneous emphysema). The patient was discharged from hospital with instructions on 11/23/2023 for outpatient follow-up.

Imaging

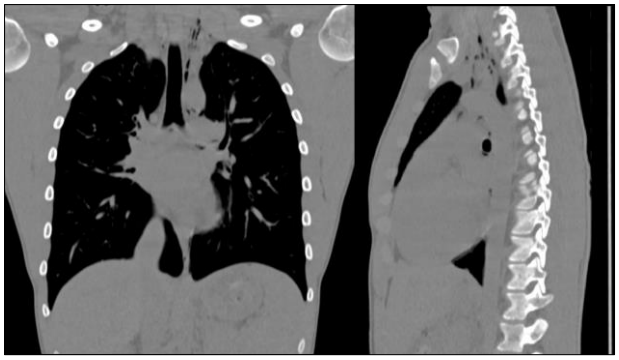

Fig. 1 first episode: Non-contrast computed tomography (CT) of the chest: scattered gas foci from the left clavicular fossa to the inner mediastinum, extending to the distal esophagus (pneumomediastinum)

Fig. 2 second episode: Chest CT: diffuse pneumomediastinum extending to the fatty planes of the cervical region (subcutaneous emphysema)

DISCUSSION

The first cases of EC or vaping products use-associated lung injury (EVALI) were reported to the Centers for Disease Control and Prevention (CDC) in 2019 [6]. (Layden *et al*., 2020). EVALI in earlier days was called vaping-related acute lung injury (VpALI) [7]. (Fuentes *et al*., 2019).

Pneumomediastinum is a rare condition that was first described by Laennec in 1819 after traumatic injury. This disorder was later reported to also occur spontaneously by Hamman in 1939 [4]. It can be classified into two subtypes: spontaneous (primary) or secondary (provoked).

Secondary pneumomediastinum is associated with blunt force trauma, penetrating chest trauma, endobronchial, esophageal or chest wall procedures, lung disease, or mechanical ventilation. The main pathophysiological mechanism involved in the development of SPM is forceful inhalation and exhalation, as observed in individual using EC to inhale aerolized liquid. This mecanism also occur in others predisposing conditions to SPM including Valsalva maneuver, vomiting, coughing, esophageal rupture, aspiration of foreign body, choking, barotrauma, dental extraction, inhalation of helium from balloons, use of illicit inhalation drugs, acute asthma exacerbation, and lower respiratory infections. Acute asthma exacerbation is the main trigger for SPM, 20% to 30% of the cases, followed by lower respiratory infections (10%-20%) [5].

About use of EC role amount the causes, it happens because in order to inhale a large amount of aerosol from the EC, usually produced in much greater quantity than a regular cigarette, the smokers increase their intrathoracic volume. Due to this over inhalation, they tend to forcefully exhale, so as to decompress the lungs. Forceful expiration against the closed glottis increases the intrathoracic pressure, leading to rupture of alveoli and leaking of air, that travels from the lung parenchyma, along vascular sheaths to the hilum, and eventually into the mediastinum, causing the SPM. This mechanism is called Macklin effect [5].

The predominant symptoms of pneumomediastinum include chest pain (55%), shortness of breath (40 %), cough (32%), neck pain (17%), odynophagia (14%), and dysphagia (10%) Subcutaneous emphysema in the neck and precordial area suggest pneumomediastinum [5]. It may appear in the chest x-ray as the “Hamman sign” which are bubbles of gas around the mediastinum, clearly seen above the heart on the left side, often extending into the neck or chest wall. Ultrasound and Computed Tomography (CT) of the chest may also be used to identify pneumomediastinum. There are some possible complications from SPM, which are: tension pneumomediastinum, pneumopericardium, and cardiac tamponade. In these cases, specific treatment in needed, but, in patients with uncomplicated SPM, rest, analgesics, and avoidance of triggers are advised. Treatment of the underlying lung disease and oxygen therapy as needed are recommended. SPM usually resolves in 2-15 days without further consequences. As part of the treatment all patients must be asked to quit smoking EC and have a subsequent imaging exam. SPM is usually self-limiting.

CONCLUSIONS

It is important to obtain a thorough history of the use of EC in young patients with chest pain presentation and have pneumomediastinum as one of the differential diagnoses. It is also crucial to enhance awareness between vaping and serious pulmonary issues, by actively participating in these measures, healthcare professionals contribute significantly to the overall well-being of their patients and the broader community.

Conflict of Interest / Funding

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