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Case Report / Olgu Sunumu

Hemoptysis following e-cigarette inhalation: A toxicological concern in vaping-related lung injury

E-sigara inhalasyonu sonrası hemoptizi: Vaping ilişkili akciğer hasarında toksikolojik bir endişe

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ABSTRACT

Introduction: Electronic cigarettes were developed in 2003 with the aim of providing a safer alternative for nicotine consumption and reducing the harms associated with conventional cigarette smoking. The diagnostic criteria for E-cigarette or vaping product use-associated lung injury include: onset of symptoms within 90 days of electronic cigarette use, radiological evidence of pulmonary infiltrates, absence of an underlying infectious cause, and exclusion of alternative causes of respiratory failure.

Case report: A 35-year-old male patient presented to the emergency department with a complaint of massive hemoptysis following heavy electronic cigarettes use. Flexible bronchoscopy was performed, and the bleeding was successfully controlled. However, the patient was readmitted after discharge due to recurrent massive hemoptysis. This time, bronchial artery embolization was performed, resulting in effective control of the symptoms.

Discussion: In terms of treatment, aside from corticosteroid therapy, management is generally supportive and includes oxygen supplementation. The purpose of presenting this case is to highlight a rare clinical manifestation of E-cigarette or Vaping product use-Associated Lung Injury, distinct from the commonly reported presentations. Specifically, we report a patient who presented with two separate episodes of massive hemoptysis, a presentation that has been rarely documented in the literature. In the first episode, the bleeding was controlled with flexible bronchoscopy, while in the second episode, bronchial artery embolization was required. To the best of our knowledge, no other case with recurrent massive hemoptysis associated with E-cigarette or vaping product use-associated lung injury has been reported in the literature to date.

Keywords: EVALI, hemoptysis, bronchoscopy, embolization

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ÖZ

Giriş: Elektronik sigaralar (ES) 2003 yılında, nikotin tüketimi için daha güvenli bir alternatif sunmak ve geleneksel sigara kullanımına bağlı zararları azaltmak amacıyla geliştirilmiştir. Bu batarya ile çalışan cihazlar, başlıca nikotin olmak üzere çeşitli maddeler içeren sıvıları buharlaştırır ve kullanıcı bu buharı inhale eder. Bu sıvıların kimyasal bileşenlerinin pulmoner immün sistemi bozduğu ve DNA hasarına yol açtığı gösterilmiştir. EVALI (E-sigara veya Vaping ürün kullanımına bağlı akciğer hasarı) tanı kriterleri şunları içerir: elektronik sigara kullanımını takiben 90 gün içinde semptomların başlaması, radyolojik olarak akciğer infiltratlarının varlığı, altta yatan enfeksiyöz bir nedenin bulunmaması ve solunum yetmezliğinin diğer nedenlerinin dışlanması.

Olgu Sunumu: 35 yaşında erkek hasta, yoğun ES kullanımı sonrasında masif hemoptizi şikâyeti ile acil servise başvurdu. Hemoptiziyi açıklayacak başka bir patoloji saptanmadı ve hasta EVALI tanı kriterlerini karşıladı. Fleksibl bronkoskopi uygulandı ve kanama başarıyla kontrol altına alındı. Ancak hasta, taburculuk sonrası tekrarlayan masif hemoptizi nedeniyle yeniden hastaneye başvurdu. Bu kez bronşiyal arter embolizasyonu (BAE) yapıldı ve semptomlar etkin bir şekilde kontrol altına alındı.

Tartışma: Tedavi açısından kortikosteroid tedavisine ek olarak yönetim genel olarak destekleyici nitelikte olup oksijen desteğini içerir. Doğal olarak, en kritik ve ilk adım ES kullanımının bırakılmasıdır ve hastalar uzun dönem yakın takip edilmelidir. Bu olgunun sunulmasındaki amaç, EVALI'nin nadir bir klinik bulgusuna dikkat çekmektir. Özellikle, literatürde nadiren rapor edilen, iki ayrı masif hemoptizi atağı ile başvuran bir hasta bildirilmiştir. İlk atakta kanama fleksibl bronkoskopi ile kontrol altına alınırken, ikinci atakta BAE gerekmiştir. Bildiğimiz kadarıyla, EVALI ile ilişkili tekrarlayan masif hemoptizi olgusu literatürde bugüne kadar rapor edilmemiştir.

Anahtar Kelimeler: elektronik sigara, EVALI, hemoptizi, bronkoskopi

Introduction

Electronic cigarettes (ECs) were developed in 2003 by a Chinese pharmacist with the aim of providing a safer method for nicotine consumption and reducing the harms associated with conventional cigarette smoking. Their use has increased globally since the early 2000s. These devices vaporize liquids containing various substances, primarily nicotine, which are then inhaled by the user. In addition to nicotine, these liquids often contain flavoring agents, formaldehyde, acetaldehyde, acrolein, reactive oxygen species, and toxic metals such as nickel, chromium, and lead.[1] In 2019, it was reported that over 10 million adults in the United States were using ECs. A more concerning issue, however, is the frequent use of ECs among middle and high school students. According to a study, 22,5% of high school students and 9.4% of middle school students reported using electronic cigarettes.[2] Following the flavor ban implemented in 2020, the production of disposable flavored ECs products increased; however, this regulation does not encompass all devices and liquids. These flavoring agents have been associated with various pulmonary complications. Some of them are chemically similar to substances known to trigger asthma through hypersensitivity reactions and may pose significant health risks.[3]

ECs have detrimental effects on human health and negatively impact multiple physiological systems. The chemicals contained within these devices impair the immune response in the lungs and contribute to DNA damage. In addition, they may lead to complications such as pneumothorax and pneumonia.[4] In addition, ECs use has been associated with oral infections, adverse cardiovascular effects, increased susceptibility to infections such as influenza, and a heightened risk of developing lung cancer. Beyond these effects, ECs use has been linked to secondary respiratory failure, a condition referred to as E-cigarette or vaping product use-associated lung

injury (EVALI). In a study involving 53 patients, the diagnostic criteria for EVALI were defined as: onset of symptoms within 90 days of ECs use, presence of pulmonary infiltrates on radiological imaging, absence of any underlying infection, and exclusion of alternative causes of respiratory failure.[5] It is important to note that many of these symptoms may also present nonspecifically in ECs users without meeting the full diagnostic criteria for EVALI.

There are no specific laboratory parameters for the diagnosis of EVALI. However, leukocytosis, elevated C-reactive protein (CRP), and increased erythrocyte sedimentation rate (ESR) are commonly observed. In bronchoalveolar lavage (BAL) samples, a neutrophil-predominant cellular profile is typically seen.[5] In addition, a detailed medical history should be obtained, with particular attention to ECs use, the type of flavoring, and whether the product contains tetrahydrocannabinol (THC). Imaging modalities such as chest radiography and thoracic computed tomography (CT) may be utilized. To exclude infectious causes, appropriate cultures and laboratory analyses should be performed.[6] Radiological findings in EVALI may resemble those seen in acute eosinophilic pneumonia, diffuse alveolar damage, and lipoid pneumonia. In addition, pleural effusion, pneumothorax, and pneumomediastinum may also be observed.[7]

The purpose of presenting this case is to highlight a rare clinical manifestation of EVALI that differs from its commonly observed presentations. We report a patient who experienced two distinct episodes of massive hemoptysis, an extremely rare occurrence. In the first episode, the bleeding was controlled via flexible bronchoscopy, whereas the second episode required bronchial artery embolization. To the best of our knowledge, no other case with recurrent episodes of hemoptysis associated with EVALI has been reported in the literature.

Case Report

A 35-year-old male patient with no known comorbidities other than migraine, and no history of cigarette smoking, illicit drug use, or exposure to pneumotoxic substances, presented to the emergency department with complaints of coughing up, by his own statement, approximately 1000 cc of bright red blood following a 5–6 hour car journey during which he reported intensive ECs use (Figure 1). Initial blood tests in the emergency department revealed white blood cell (WBC): 12.3 $\times 10^9$/L, HGB: 16.2 g/dL, PLT: 354 $\times 10^9$/L, C- reactive protein (CRP): 3.67 mg/L, and INR: 0.87, with no significant abnormalities detected. CT angiography was performed with a preliminary diagnosis of pulmonary embolism. The CT scan showed bilateral ground-glass opacities and areas of consolidation (Figure 2). As no parenchymal or bronchial lesions were identified that could account for embolism or bleeding, the patient was admitted for further investigation and treatment. An urgent flexible bronchoscopy was performed under operating room conditions. During bronchoscopy, active bleeding was observed in the basal segment of the right lower lobe (Figure 3). The bleeding was aspirated, and repeated lavages were performed using 500 cc of cold 0.9% NaCl solution containing one ampoule of adrenaline and one ampoule of tranexamic acid to achieve hemostasis. BAL fluid samples were collected for both bacterial culture and tuberculosis testing during the procedure. Subsequent culture results showed no microbial growth. A post-procedural chest radiograph revealed a consolidated area in the right lung. Follow-up laboratory tests showed WBC: 14.1 $\times 10^9$/L, HGB: 13.0 g/dL, PLT: 331 $\times 10^9$/L, INR: 1.0, and CRP: 4 mg/L. Arterial blood gas analysis revealed a pH of 7.27 and a pCO_2 of 53 mmHg, leading to endotracheal intubation and admission to the intensive care unit. The patient was monitored under mechanical ventilation for 24 hours and was transferred to the ward following successful extubation. During follow-

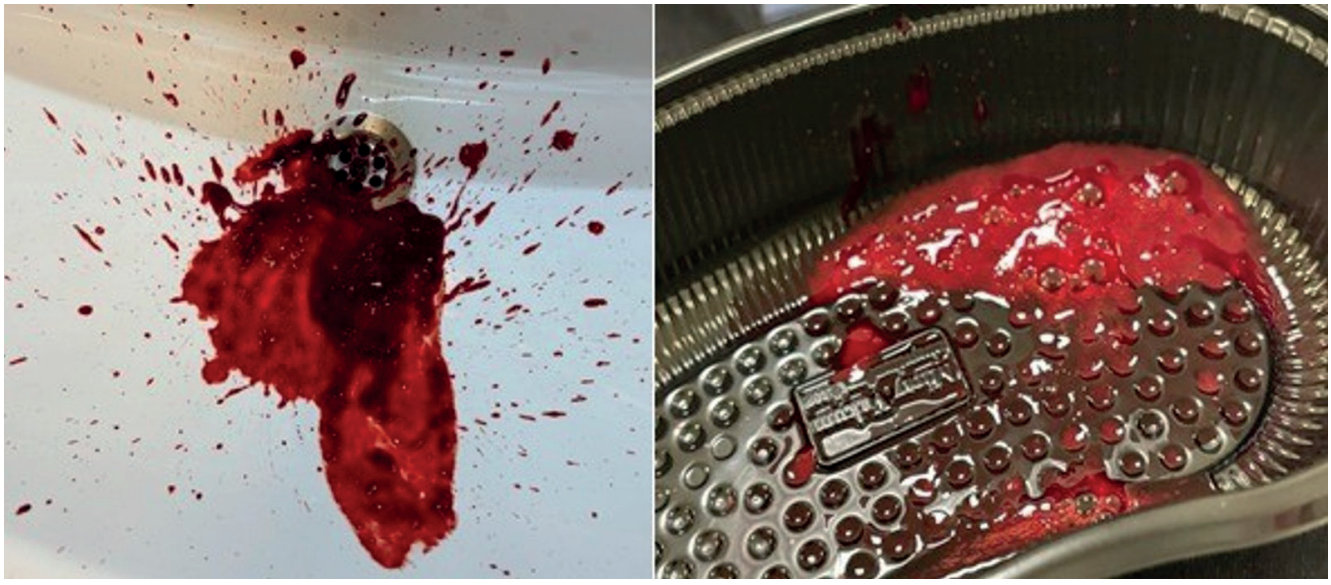

Figure 1. Photograph of the bright red, frothy blood expectorated by the patient following hemoptysis

up in the ward, a drop of approximately 4 g/dL in hemoglobin levels was observed compared to the patient's initial emergency department values. The hemoglobin decline stabilized by postoperative day 3. The absence of elevated CRP levels and the lack of clinical signs suggestive of infection led us to rule out infectious etiologies. On postoperative day 5, the patient was discharged in stable condition with no active complaints. However, on post-discharge day 3, the patient presented to the emergency department again with recurrent hemoptysis. He was referred to interventional radiology for bronchial artery embolization (BAE). The patient, who underwent BAE, was transferred to our ward on the same day due to improvement in his symptoms. Post-procedural evaluation, including chest radiography and hemoglobin levels, revealed no pathological findings. The patient was discharged in good condition on post-procedure day 2. He continues to be followed up in outpatient clinic visits and has had no further complaints of hemoptysis.

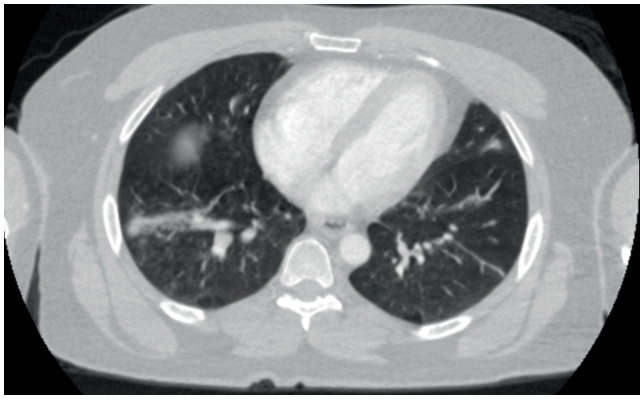

Figure 2. Pulmonary CT angiography revealed bilateral ground-glass opacities and areas of consolidation

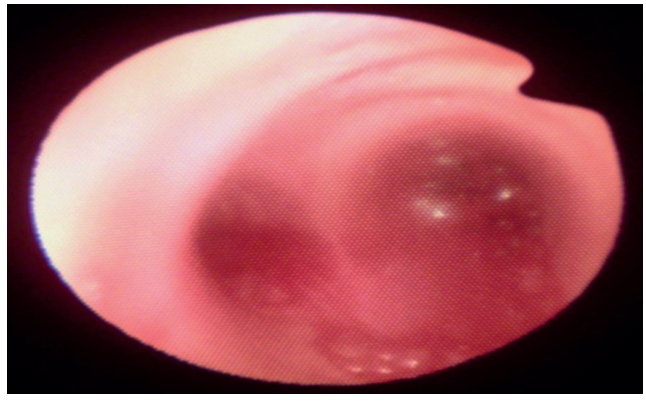

Figure 3. During bronchoscopy, the right main bronchus was observed to be obstructed by active bleeding starting from its entrance

Consent for publication of this case was obtained and provided to the journal in accordance with Turkish Journal of Tobacco Control policy.

Discussion

Since 2019, more than 1,000 cases of EVALI have been reported in the United States, 18 of which resulted in death. In one study, 12 patients diagnosed with EVALI were evaluated, and no underlying infections were identified. The mean age of the patients was 27 years, and 58% were male. Interestingly, 92% of them reported using ECs products containing THC. The most commonly observed symptoms included dyspnea, fever, vomiting, and cough; however, none of the patients experienced hemoptysis. Most showed clinical improvement within 1–2 weeks following cessation of ECs use and initiation of corticosteroid therapy.[8] Unlike the majority of reported cases, our patient presented with hemoptysis and had no history of cannabinoid use or ECs products containing THC at any point in his life. Moreover, invasive interventions were required for the management of his condition. In another study, it was reported that 80% of EVALI patients had used THC-containing products. Additionally, a separate study noted that 67% of EVALI patients were male, with a mean age of 24 years.[9] Although our patient was male, his age was 35, which is notably higher than the average reported in the literature.

Among patients diagnosed with EVALI, risk and prognosis vary depending on factors such as the type of device used, the presence of flavoring agents and other chemical constituents, as well as the patient's overall health status. The clinical spectrum ranges from mild dyspnea to acute respiratory distress. Common clinical features include dyspnea, chest pain, cough, hemoptysis, and fatigue. On physical examination, findings may include tachycardia, tachypnea, fever, and hypoxemia. The degree of respiratory compromise is variable, and some patients may require endotracheal intubation and mechanical ventilation.[5] Our patient, however, presented with massive hemoptysis—a clinical feature that deviates from the commonly observed manifestations of EVALI. According to the patient's report, the hemoptysis volume was approximately 1000 cc, leading to significant respiratory failure. The recurrence of this condition further distinguishes the case from those previously reported in the literature. In the study by Layden et al., the most frequently observed radiological findings were ground-glass opacities, in addition to tree-in-bud patterns and nodular infiltrates.[5] İn our case, thoracic CT imaging similarly revealed bilateral ground-glass opacities and areas of consolidation, which were also partially visible on the chest radiograph. From a pathological standpoint, the role of histopathological examination in EVALI has not yet been fully elucidated. In the study by Layden et al., biopsies demonstrated nonspecific findings consistent with acute lung injury, including inflammation, alveolar damage, and macrophage infiltration.[5] From a pathophysiological perspective, analysis of 29 BAL samples associated with EVALI revealed the presence of vitamin E acetate in all cases, suggesting a strong correlation between this compound and the development of the condition.[9] While there is substantial evidence indicating that products containing THC, particularly those with vitamin E acetate, play a central role in the pathogenesis of EVALI, there also exists a small but consistent group of patients who report no history of THC use. Therefore, further research is still needed to better understand the pathophysiology of EVALI.[6] As observed in some studies, vitamin E acetate has been detected in BAL analyses; however, in the BAL analysis performed in our case, no such substance was identified.

Overall, in cases where there is a history of ECs use within the past 90 days, the presence of characteristic radiological findings, and the absence of alternative diagnoses such as infection,

the diagnosis of EVALI is highly probable. There is no definitive guideline regarding the necessity of bronchoscopy, BAL, or lung biopsy; however, these procedures may be performed when clinically indicated.[9] In terms of treatment, aside from corticosteroid therapy, management is generally supportive and includes oxygen supplementation. Naturally, the first and most essential step is the cessation of ECs use. Patients should be monitored long-term, and it is crucial that their symptoms are effectively controlled.[10] Our patient met all diagnostic criteria for EVALI, and we only required a consultation with the pulmonology department, as the possibility of infection had been excluded. Additionally, flexible bronchoscopy was necessary both for the control of massive hemoptysis and for diagnostic purposes, during which BAL analysis was performed. Throughout hospitalization, the patient did not receive corticosteroid therapy; instead, management included oxygen supplementation, pain control, antitussive treatment, and tranexamic acid administration.

Conclusion

In conclusion, the use of ECs is on the rise, particularly among younger populations, where their popularity is rapidly increasing. A more concerning issue is the widespread perception of ECs as a smoking cessation aid and the belief that they are less harmful than conventional cigarettes. Such assumptions contribute to the perception of these devices as harmless. We believe that large-scale, prospective, multicenter studies are needed to better understand the harms associated with ECs use and EVALI. Furthermore, public health campaigns should be utilized to raise awareness about their potential risks. The aim of presenting this case was to highlight that, although rare, patients diagnosed with EVALI may present with recurrent episodes of hemoptysis. Additionally, we aimed to demonstrate that invasive procedures may be required for the management of massive hemoptysis secondary to EVALI.

Ethical approval

Written informed consent was obtained from the participants.

Author contribution

Study conception and design: SEA; data collection: MSO; analysis and interpretation of results: HEY; draft manuscript preparation: HEY, MSO. The authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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