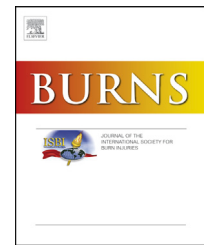


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Burns caused by electronic vaping devices (e-cigarettes): A new classification proposal based on mechanisms

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ABSTRACT

Introduction With more than 10 million of daily users, e-cigarettes encountered a great success. But in the past few years, the number of medical reports of injuries caused by the explosion of e-cigarettes has significantly increased. This article aims at reporting our series and reviewing the literature to propose a new classification based on the mechanisms of injuries related to e-cigarettes that can guide non-specialists and specialists in the management of these patients.

Method We performed a retrospective review of our institutional burn database from June 2016 to July 2017 for injuries caused by or in the context of using an e-cigarette. The patients' demographics (age, gender), burn injury mechanisms, depth, localization, surface and interventions were described.

Results Ten patients suffered from burns related to the use of e-cigarettes. The burns were located at the thigh (80%) and the hand (50%) with a mean surface of 3% of TBSA. Four different mechanisms could be described: Type A: thermal burns with flames due to the phenomenon of "thermal runaway", Type B: blasts lesions secondary to the explosion, Type C: chemical alkali burns caused by spreading of the electrolyte solution and Type D: thermal burns without flames due to overheating. These different mechanisms suggest specific surgical and non-surgical management.

Conclusion Management of injuries sustained from e-cigarettes' explosions should be approached from the standpoint of mechanisms. Different mechanisms could be associated and should be considered in specific management.

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1. Introduction

First created in 2003 in China and then in widespread use in the United-States since 2007 [1], the e-cigarettes encountered a great popular success with more than 2.5 million e-cigarette users in the US [2] and 7.5 million Europeans using personal vaping devices [3]. This is a heterogeneous group of smoking cessation aid devices produced by more than 450 brands on the market, sold either in shops or in the internet. E-cigarettes are designed to resemble traditional cigarettes both in design and operation, but are thought to be healthier due to lack of combustion and carcinogenic additives. E-cigarettes vary widely in terms of product design and are currently largely unregulated. These devices use a battery-powered heating filament to aerosolize volatile compounds, such as propylene glycol or glycerin, nicotine and flavoring compounds. Modifications are constantly being made to make lithium batteries smaller and more powerful. Even in some cases, users can modify their vaping devices to increase the vapor produced. These homemade modified devices are called personal vaporizers or “Mods” and are consequently more dangerous. No guidelines exist for the design, manufacture or safety testing for e-cigarettes [4]. The US Fire Administration reported 25 incidents of explosion and fire related to e-cigarettes (2009-2014) [5]: 88% occurred while the battery was being charged, 8% while in use and 4% during storage and transport.

Since 2016, the number of medical reports of injuries caused by the use of e-cigarettes constantly increased. This article aims at reporting a case series and reviewing the literature to propose a new classification based on the mechanisms of injuries related to e-cigarettes. This new classification will guide non-specialists and specialists in the management of these patients.

2. Material and methods

We performed a retrospective review of our institutional burn database with the key-words: “e-cigarette”, “explosion”, “lithium”, and “battery”. Inclusion criteria consisted in patients referred to Saint Louis Hospital Burn Center in Paris,

France, over a 1-year period, from June 2016 to July 2017 for injuries caused by or in the context of using an e-cigarette. The patients’ demographics (age, gender), burn injury mechanisms, depth, localization, surface and intervention were described.

In order to evaluate this classification for a larger panel of patients, a systematic review was performed in PubMed to retrieve the manuscripts included in the discussion. The applied research strategy included the combination of the same key words. For additional studies; the references of articles found in the bibliography of other articles have also been hand-searched. Non-medical reports such as news articles or institutional reports were excluded to focus on medical articles. Epidemiologic data; clinical presentation; characteristics of the injuries and therapeutic informations were classified to discuss our findings.

3. Results

Over this period of one year, ten patients were treated in our burn center for e-cigarette injuries. Four of them were hospitalized; the remaining six patients were treated in Outpatient Burn Clinic.

All the patients were male, with a mean age of 39 years old [26; 55].

The mean surface of burns was 3% of total body surface area (TBSA) [range, 0.5; 5]. All patients suffered from localized burns of at least one limb. The topography of burns was the thigh (80%) and the hand (50%). Five patients presented isolated burns of the lower limb. Two presented isolated burns of the upper extremity. For the three remaining patients, the burns involved both upper and lower extremity. No one in our series suffered from facial burns, which are the third typical localization of e-cigarette related burns. Burns depth was as follows: five partial thickness, two mixed partial and full thickness burns and three full thickness burns.

In 80% of cases, the e-cigarette exploded while it was in the pocket (Fig. 1). For the remaining 20%, the device fired while in the hand. None of our patients presented lesions due to an explosion while smoking.

Through this article, we propose a classification based on four mechanisms of lesions associated with the use of e-



Fig. 1 – Right thigh on admission after explosion of e-cigarette (A) and typical image of clothing post-explosion (B) demonstrating that burns occurred inside the right pocket.

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