Electronic cigarette explosion associated with extensive intraoral injuries

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Electronic cigarettes (ECIGs) first emerged into the marketplace in 2007 as an aid for smoking cessation (1). By 2014, there was an estimated 2.4 million ECIG smokers in the United States, with projected sales totaling 10 billion dollars by 2017 (2, 3). There are increasing numbers of ECIG users who also currently smoke tobacco as well as those individuals who have not been tobacco smokers (4, 5). The level of usage of ECIGs in high school students has surpassed that of smoking tobacco products (6). An assortment of electronic nicotine delivery systems are in use, including prefilled disposable, rechargeable, pen-style rechargeable with refillable cartridges, tank style with oversized refillable cartridges, ‘direct drip’ atomizer, and electronic hookah (7, 8). The liquid products sold for ECIG vaporization (e-liquids) are available with a variety of flavoring agents and a wide range of nicotine concentrations or without nicotine. In addition, alcohol, cannabis extracts, and other psychoactive agents can be mixed with the e-liquid for recreational activity (9).

There are public perceptions that the use of ECIGs is a healthier alternative to combustible tobacco and they lower the risks of morbidity and mortality, chiefly cancer (lung, oral) and cardiovascular disease (10). However, the efficacy of ECIGs has been questioned with the discovery of elevated levels of carcinogens, such as formaldehyde, acetaldehyde, and various heavy metals in the generated vapor (11, 12).

Another compelling concern is the potential for explosions and fires that have been attributed to the ECIG self-contained lithium-ion batteries, resulting in property damage and personal injuries. The vast majority of these events has been reported in the news media and on internet websites (13, 14). Only a limited number of reports of head and neck trauma from electronic cigarette explosions have appeared in the peer-reviewed medical literature (15–18), and even fewer articles have been published in dental journals (19, 20). To increase the knowledge of ECIG-related oral and maxillofacial injuries, the following case report is presented.

Case report
An 18-year-old male presented to the author’s (J.W.K.) private practice for consultation and evaluation of extensive injuries to the dentition and intraoral soft tissues from an explosion while smoking an ECIG (Fig. 1). The patient reported that he had not lost consciousness but was ‘covered in blood’. He also reported a transient episode of tinnitus. Initially, he was...
transported by ambulance to a hospital emergency room and he was released later that same day, with discharge prescriptions for an opioid, antibiotic, and an antimicrobial oral rinse. The patient was seen by the author the next day for further dental examination.

At the time of the incident, the patient reported using an ECIG comprised of an electrically heated coil that required the periodic dispensing of flavored e-liquid containing nicotine onto a wick (‘drip’ atomizer) for vapor production. He indicated that he had been smoking for about an hour after an overnight recharge of its lithium-ion battery. The patient recalled that immediately after he had replenished the ECIG with the e-liquid, an explosion had occurred and propelled the mouthpiece into his mouth. The opposite end of the device, referred to as the ‘button’, projected outwardly with such force to ricochet against the nearby wall, ceiling and floor, leaving burn residue (Fig. 2a). Blood spatter was also found on the adjacent wall. The recovered lithium-ion battery showed evidence of rupture and severe heat damage (Fig. 2b). The cause of the explosion is currently under investigation. The adverse event was reported to the US Food and Drug Administration (FDA) through the Safety Reporting Portal.

The patient’s medical history was significant only for asthma, which was induced by seasonal allergies and managed with albuterol. The patient admitted smoking cigarettes for about 1 year and then he switched solely to ECIGs for the last year and a half, expressing that the use of the ECIG ‘made him feel better about himself’ and smoking tobacco ‘could cause oral cancer’ and ‘made his teeth feel dirty’.

Clinical assessment was significant for the apparent absence of teeth #12, 11, and 21. Multiple teeth had varying degrees of coronal damage, and notably, teeth #14, 13, and 42 demonstrated severe vertical crown:root fractures and were deemed non-salvageable by his restorative dentist. Furthermore, tooth #13 displayed grade 1 mobility and was tender to percussion; the tooth was displaced labially and its surrounding palatal gingiva exhibited marginal laceration. The upper right ventral tongue and upper right labial mucosa were also lacerated. A conspicuous labial expansion was evident in the site of tooth #21. The palatal soft tissue contiguous to teeth #12 to 24, including the incisal papilla, had become detached and rotated distally. The left side of his facial skin also had superficial abrasions. Imaging with a maxillofacial computed tomogram without contrast revealed a comminuted fracture of the anterior nasal spine that extended inferiorly to the apical regions of the central incisors, fracture of the premaxilla with minimal displacement, complete avulsion of tooth #12, and avulsion of the coronal portion of tooth #11 and its retained root fragment (Fig. 3a). Tooth #21 had extruded through the labial alveolus and accounted for the presence of the soft tissue labial bulge (Fig. 3b). A summary of the sustained injuries can be found in Table 1.

It was decided that the limited extent of the maxillary dentoalveolar fracture did not warrant reduction or immobilization. The immediate goal of treatment was wound management and extraction of tooth #21. Written consent was obtained and local anesthesia was achieved with 2% xylocaine with 1:100,000 epinephrine. A full thickness flap was elevated through the wound for visualization of tooth #21 and it was then luxated and extracted with forceps. Following pressure hemostasis, 4-0 plain gut sutures (Ethicon, Inc, Somerville, NJ, USA) were placed for flap closure and

![Fig. 1. Facial view at hospital arrival.](image1)

![Fig. 2. Physical evidence of the electronic cigarette explosion.](image2)
reapproximation of the incisive papilla. Post-operatively, the patient was given instructions for wound care and prescribed ibuprofen 600 mg every 4 hours for 1 week as needed and advised to rinse twice daily with 0.12% chlorhexidine gluconate. One week later, the intraoral tissues were healing uneventfully (Fig. 4a,b). Subsequently, the patient was seen by an oral and maxillofacial surgeon who extracted teeth #14, 13, and 42, and the retained root fragment #11.

Discussion
Multiple reports of ECIG-related explosions resulting in head and neck injuries have been publicized over the past several years, with the preponderance of cases having been reported in the news media and on Internet websites (13, 14). Although the accuracy of most of these cases has not been vetted in peer review journals, several observations of ECIG usage and injuries can be summarized. Interestingly, over 90% of the reported individuals were male, which is in contrast to the slight gender difference with ECIG users overall (male—14.2% versus female—11.2%) (4). The majority of the injuries were classified as ‘severe’, including one patient who lapsed into a coma and two who had a fractured neck. More than 50% of the patients encountered injuries to their dentition (fractures, avulsions, luxation), eight patients suffered ocular injuries (one of whom lost an eye), and four patients experienced fractures to the maxilla (including the current case). Other injuries involved thermal burns and lacerations to the lips, palate, pharynx, tongue, gingiva, and facial skin.

The magnitude of force of an ECIG explosion is somewhat analogous to the detonation of a firecracker in one’s mouth (21). To date, only one fatality has

**Table 1. Patient’s injuries sustained from an electronic cigarette explosion**

<table>
<thead>
<tr>
<th>Teeth</th>
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<tbody>
<tr>
<td>Coronal fractures #14, 13, 22, 23, 31, 41, 42</td>
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<tr>
<td>Root fracture with avulsion of the coronal fragment #11</td>
</tr>
<tr>
<td>Avulsion #12</td>
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<tr>
<td>Luxation #13, 21</td>
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<th>Bone</th>
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<tr>
<td>Greenstick fracture of the premaxilla</td>
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<tr>
<td>Comminuted fracture of the anterior nasal spine</td>
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<tr>
<th>Soft tissues</th>
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<tr>
<td>Intraoral</td>
</tr>
<tr>
<td>Lacerations to the upper labial mucosa, tongue, gingivae, hard palate</td>
</tr>
<tr>
<td>Face</td>
</tr>
<tr>
<td>Lacerations to the upper lip, cheek</td>
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Fig. 3. Computed tomograph. (a) Fractures of the premaxilla (small arrows) and anterior nasal spine, and labial emergence of the apex of tooth #21 (large arrow). (b) Tooth #21 seen partially embedded within the labial soft tissue.

Fig. 4. One week postoperatively. (a) Intraoral demonstration of adequate wound healing with close approximation of the incisive papilla. (b) Extensive damage to multiple teeth (refer to Table 1).
been attributed to an ECIG-related explosion; although the specific injuries were not disclosed, the deceased apparently had been in close proximity to his oxygen tank (14). Several other patients have experienced burns subsequent to smoking an ECIG while receiving oxygen therapy (22). The blast injuries of the patient in the current report were extensive and resulted in a maxillary dentoalveolar fracture, comminuted fracture of the anterior nasal spine, tooth avulsions, multiple fractured anterior teeth, tooth luxation, and lacerations to the upper lip, labial mucosa, and gingivae, tongue, hard palate, and facial skin.

The physical examination of an individual who has had an ECIG-related explosion to the head and neck should include an inventory of injuries to the hard and soft oral tissues, eyes, ears, and facial skin. The patient should also be assessed for evidence of oropharyngeal, nasal, and pulmonary thermal inhalation. It is imperative that the patient receive a neurologic evaluation for possible concussion, and airway competency must be maintained. A computed tomogram without contrast can assist trauma assessment and localization of any partially avulsed teeth, as seen with the current patient.

The development of the lithium-ion battery has yielded substantial improvements in cellular telephones, transportation vehicles, and a myriad of medical devices and other electronics, owing to their enhanced power source, longevity, and miniaturization. Over-heating or overcharging these batteries can promote electrolytic destabilization, creating a ‘thermal runaway’ reaction that leads to rapid exothermicity and gas formation, potentially culminating in a violent explosion (23). Various factors can contribute to excessive temperatures, especially modification of the heating coil element, incomplete battery seal, and incompatible interchange of components and battery chargers (24, 25). Greater strides should be undertaken to increase public awareness of the dangers of ECIGs and institute educational programs to deter their practice, particularly targeting the at-risk younger generation.

Disclosure
None of the authors reported any disclosures.

Conflict of interest
The authors confirm that they have no conflict of interest.

References