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CASE REPORT
Reconstructive

# E-cigarette "Vape" Device Explosion Causing C Spine Fracture

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**Summary:** Electronic cigarette (e-cigarette) use has grown exponentially since its introduction to the US market in 2007.[1] Sales went largely unregulated until 2016, when the Food and Drug Administration expanded tobacco laws to encompass the manufacturing, distribution, and marketing of e-cigarette products.[2,3] Production safety standards are still being established. Rechargeable lithium batteries used have been reported to combust. The US Fire Administration reported 195 cases of e-cigarette explosions and fires from 2009 to 2016. The proximity of the explosions can cause serious burns and facial trauma to the user.[3,4] We present a case report of a 30-year-old woman with oral soft tissue and dental injuries, C1 fracture, and left vertebral artery dissection from an e-cigarette explosion. *(Plast Reconstr Surg Glob Open 2020;8:e2752; doi: 10.1097/GOX.0000000000002745; Published online 14 April 2020.)*

## CASE REPORT

A 30-year-old woman was transferred for facial injuries and burns sustained from the explosion of her e-cigarette device during use. The lithium battery was replaced in her 2-year-old "modified" device. It immediately exploded upon activation as she inhaled while igniting the device. Emergency responders were called to the scene of a large fire which ensued. They reported multiple tiny metallic fragments on the ground around the patient. They could not identify any other remaining recognizable form of the device.

The patient was distraught, but cooperative with Glasgow Coma Scale 15, vitals stable. She localized pain to her mouth and tongue. She arrived in a cervical collar. She denied any loss of consciousness or fall. Her neck was clinically cleared by the trauma surgeon. Physical examination showed a superficial partial thickness burn and a full thickness complex laceration of the lower lip (Fig. 1). The tongue had a deep 4-cm midline laceration with the 2 muscle bellies split into a forked pattern. Two lower incisors and 1 canine were extensively broken. The first and second digit, right hand, had superficial lacerations. A half hour after arrival, the patient began complaining of increasing pain to the left ear and neck. History was complicated by a recent (10 days prior) tonsillar and ear infection requiring oral antibiotics. A computed tomography (CT) scan of the neck showed a comminuted fracture of the left anterior arch of C1, with widening of 4 mm, and nondisplaced fracture through the posterior arch of C1, very close to the vertebral artery foramen, with small hyperdense foreign body fragments and some free air in the prevertebral space (Figs. 2, 3). CT angiogram then showed evidence of left vertebral artery dissection, with nodularity, moderate narrowing, and a subtotal occlusion of the left vertebral artery as it passed through the foramen of C1.

Due to complete right dominance of the vertebral artery and a patent Circle of Willis, the patient remained with no localizing neurologic signs. The fracture was determined to be stable by neurosurgery. It was treated conservatively with a rigid C-collar. The vertebral artery dissection was treated with aspirin and low-molecular-weight heparin. The patient was given narcotics, anxiolytics, and antibiotics. Tetanus status was verified. Soft tissue injuries were reconstructed in the operating room after extensive irrigation. The tongue was reconstructed in the midline, with vicryl and chromic interrupted sutures, to correct the forking deformity. Devitalized tissue was debrided from the lower lip. The C-shaped flap of oral mucosa, orbicularis muscle, and skin was reconstructed in a layered fashion to obtain anatomic alignment and function (Fig. 4).

The patient recovered well without any neurologic deficits and was hemodynamically stable throughout her 3-day stay in intensive care unit. Her lips and tongue healed well with no signs of infection at 2-week follow-up. Repeated CT head and neck angiogram showed return of flow in the left vertebral artery with a persistent dominant right-sided flow 1 month postinjury.

## DISCUSSION

The basic design of an e-cigarette consists of a mouthpiece, liquid reservoir, heating element, and lithium-powered battery. Many designs allow for modification of these separate components for a more personalized use.[5] E-cigarettes and batteries are not subjected to product safety testing, which can lead to poorly designed, defective

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**Fig. 1.** Full thickness lip laceration (forked tongue injury not visible).

products. Consumer modifications with parts bought from secondary vendors can cause the battery to overcharge or overheat.[6] The combination of these and other factors attributes to the malfunctioning of e-cigarette batteries.

The e-cigarette poses a unique hazard to its user because of the close proximity of the explosion to the face. Reports of facial injuries in literature ranged from thermal and chemical burns, inhalation injury, facial fractures, corneal abrasions, and teeth avulsions.[7–10] Lithium batteries in other electronics, such as laptops and cell phones, contain a rigid plastic case that encompasses the battery to prevent it from

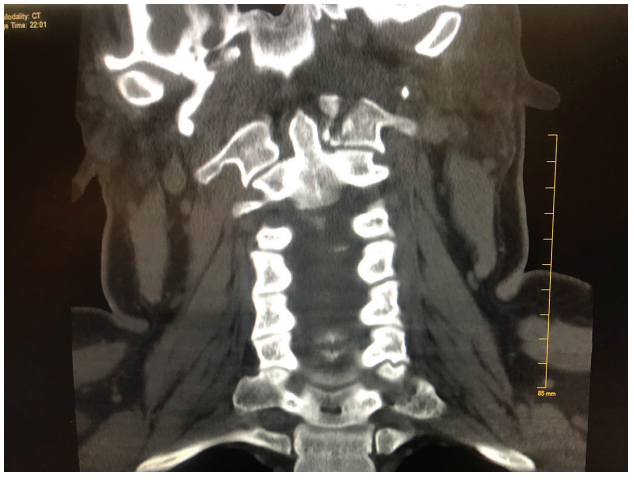

**Fig. 2.** CT scan coronal view C1 fracture.

**Fig. 3.** CT scan axial view C1 fracture.

exploding upon ignition. This safety design is not in place for e-cigarette lithium batteries. This allows the explosion to exude force from the weakest points, as in the two ends of standard smaller e-cigarette,[6] or in the case of our patient, in essence, a pipe bomb. Her modified device was actually a 12-inch long, 1.5-inch diameter aluminum tube, designed to maximize the vapor cloud. On explosion, multiple small shrapnel-like pieces of aluminum were driven through the soft tissue of the lips, tongue, and even the posterior pharynx and finally the C1 vertebra.

There has been one case in literature of an e-cigarette explosion causing a significant vertebral fracture. The

**Fig. 4.** Postoperative reconstruction of soft tissue injury.

mechanism was thought to be the result of the mouthpiece becoming a projectile which fractured both C1 and C2.[11] This occurred immediately after the replacement of the device's lithium battery. There have been 2 deaths reported in the media directly linked to injuries from device explosion. The first was a projectile injury directly to the head.[12] The second was from a cerebrovascular accident from a shrapnel injury to the carotid artery.[13] Our patient was fortunate that she had a right dominant vertebral artery that compensated for her left-sided injury.

Much has been written about the reconstruction of full thickness soft tissue defects of the lower lip.[14,15] Generally, these are classified by proportion of lip lost at <30%, 30%–50%, 50%–80%, and >80% loss, to help guide between various local and rotational flaps, such as the Abbe, "stair-step," Estlander, and Karapandzic flaps, or various combinations of these together depending on the severity of the defect. Another important anatomic and functional consideration is whether the oral commissure is involved. Fortunately, for this young lady, although the injury was full thickness with a curved flap, there was no significant soft tissue loss and the commissure was not involved. No complex flap rotation was required to reconstruct her lip. She unfortunately went back to regular cigarette smoking, developing a small wound dehiscence, but this closed up nicely with conservative therapy only. She had good speech with no drooling or difficulty eating 6 months postinjury.

In conclusion, we feel that it is important to raise the awareness of possible life-threatening severity of associated occult injury with explosions of these devices, in particular, the dangers of "modified" devices. Warning labels of explosive risks should be clearly visible during purchase. Regulations need to be in place to raise safety standards of e-cigarettes sold in the United States.[17,18] Recent analysis of overall e-cigarette–related emergency department visits using the National Electronic Injury Surveillance System from 2008 to 2017 has steadily increased, with a potential projected 835 incidents annually in the United States.[16] Physicians need to be aware of the potential debilitating and life-threatening injuries that can occur from close proximity explosions of this type to the head and neck. Providers need to maintain a higher level of suspicion than previously expected in these accidents, and not hesitate to pursue appropriate diagnostic tests to fully elucidate the extent of the injuries.

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