CASE REPORT

Front to back ocular injury from a vaping-related explosion

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SUMMARY

We describe a case of extensive ocular injury secondary to an electronic cigarette (e-cigarette)-related explosion. The explosion was the result of modifications made to a heating element of the e-cigarette device by a non-professional. Extensive ocular injuries that result from an explosion of an e-cigarette device can potentially cause significant and permanent visual impairment.

BACKGROUND

Vaping is a new fad that is trending among the smoking community throughout the world. This case highlights the extensive ocular injury resulting from thermal, chemical and blunt force that occurred following an explosion from a modified e-cigarette device. The authors hope to share knowledge of the potential but avoidable complications when dealing with patient's presenting e-cigarette modification injuries.

CASE PRESENTATION

An 18-year-old man who was attempting to improve his vaping experience presented with a history of explosion injury involving the right side of his face. This involved the right eye and nose. He had been modifying the tank of the mechanical e-cigarette, changing the original coil to a home-made copper coil with the intention of a better experience. However, as soon as he had connected the modified coil to the battery, an explosion occurred, hitting the right side of his face with high pressure and velocity. He immediately complained of pain and blurring of vision in the right eye. He was brought to the emergency department within 1 h of the injury following which irrigation was performed as the pH was noted to be eight using litmus paper, which indicated contact with alkaline fluid. Visual acuity at presentation was counting fingers in the right eye. There was no relative afferent pupillary defect. He sustained right upper eyelid and conjunctival laceration wounds. There were two linear superficial upper eyelid laceration wounds that did not involve the eyelid margin. Each laceration measured about two centimetres. There was one superficial conjunctival laceration wound at the superonasal conjunctiva, about 2 mm away from limbus, measuring 8 mm in length. The underlying Tenons capsule was intact. The patient also had right eye grade one chemical and thermal injury by Roper-Hall (Ballen) classification of chemical injury.¹ In addition, there was traumatic mydriasis, anterior uveitis and cataract with

zonulysis, extensive commotio retinae and Berlin oedema (figure 1). The left eye was normal.

INVESTIGATIONS

Spectral domain optical coherence tomography (sd-OCT) on presentation revealed neurosensory retinal detachment of the macula with a collection of subretinal fluid, also known as Berlin oedema (figure 2).

Skull radiograph was performed on arrival. There was no evidence of a radio-opaque intraorbital foreign body.

Sd-OCT 6 weeks post trauma showed resolution of the Berlin oedema with loss of inner-segment/outer segment junction of photoreceptor layer and scarring (figure 3).

TREATMENT

Toilet and suturing of the eyelid and conjunctival laceration wounds were carried out.

A tapering dosage of topical steroids and topical antibiotics was continued for 3 weeks' duration.

OUTCOME AND FOLLOW-UP

The patient was subjected to regular follow-up at the eye clinic. Serial follow-up revealed improving commotio retinae and Berlin oedema (figure 4), but worsening cataract with anterior subcapsular opacities (figure 5). There was no significant improvement in the visual acuity throughout the follow-up. At last follow-up 6 weeks after injury, his visual acuity was 1/60. There was persistent traumatic mydriasis with pupil diameter of 5 mm

Figure 1 Right fundus photograph showing extensive commotio retinae with Berlin oedema. The media is slightly hazy due to acute anterior chamber reaction.

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Figure 2 Right spectral domain optical coherence tomography (sd-OCT) image showing neurosensory detachment of the macula with collection of sub-retinal fluid, also known as Berlin oedema.

compared to 3 mm in the unaffected left eye. The presence of choroidal rupture at the macula resulting in macular scar (figure 6) is apparently the unfortunate cause of the poor visual outcome.

DISCUSSION

E-cigarettes were first introduced to the market by Chinese entrepreneurs in 2004. The e-cigarette is a battery-powered device that resembles a normal cigarette. It contains a heating element that produces vapours, which are inhaled. The vapours or aerosols can be altered depending on the choice of the user. It is estimated that about 2.6 million adults in Great Britain alone use e-cigarettes.² The e-cigarette is a booming industry, estimated at US\$2.5 billion in the USA in 2014.³ By 2017, it is predicted that the sales of e-cigarettes in the USA will reach US \$10 billion.⁴

There are plenty of e-cigarette designs and manufacturers currently in the market. The design of the device is one of the major factors involved in determining the type and level of aerosol produced. The material used to construct the heating element in e-cigarettes will also determine the various levels and types of aerosols produced.⁵ This can be seen as an opportunity for users to tamper with the heating element for a better vaping experience. However, modifications of the coiling and heating device will expose the user to a higher risk of e-cigarette-related injury. This is illustrated by the case of our patient who modified the heating element leading to an explosion that caused severe ocular injuries.

In general, ocular trauma can be divided into a few categories: thermal, chemical, contusional and penetrating injuries. The

fact that e-cigarettes can cause multiple categories of injury further emphasises the danger of any e-cigarette-related explosion. The material responsible for the chemical injury potentially originates from the alkaline battery of the device. Alkaline ocular exposure can cause significant cornea, conjunctiva and anterior segment injuries, which carry a poor prognosis depending on the grade of the injury.⁶ It was fortunate that this patient only sustained a grade 1 alkaline injury, which carries a good prognosis.¹ This might be partly contributed to by the fast initiation of eye irrigation after the onset of injury and the lower alkalinity of the battery fluid.⁶ Thermal injury to the eye is due to a rapid increase in temperature that accompanies the explosion. The effects of thermal injury in our patient was, fortunately, only confined to the external structures such as the eyelid and eyelashes.

A meta-analysis of ocular blast injuries concluded that most injuries are the result of secondary blast injuries.⁷ In secondary blast injuries, projectile debris and shrapnel are the culprits, causing contusional ocular injuries.⁷ This can happen during an e-cigarette explosion. There is equatorial distension of the globe following anteroposterior compression.⁸ The force is then distributed via shock waves throughout the ocular tissues and damage can happen at all interfaces.

Injuries to the cornea and conjunctiva, such as subconjunctival haemorrhage, conjunctival laceration and epithelial abrasion, usually heal without sequelae.⁸ Iris tissue is susceptible to blunt trauma due to its mobility and lack of support. The most sensitive part of the iris is the pupillary margin and damage can happen to its sphincter muscle causing traumatic mydriasis, as in this patient.⁸ A permanent and significant mydriasis is

Figure 3 Right sd-OCT image 6 weeks post trauma showing resolution of the Berlin oedema with loss of inner-segment/outer segment junction of photoreceptor layers and scarring.

Figure 4 Right fundus photograph 1 week after injury, showing resolved commotio retinae and improving Berlin oedema. There is a visible choroidal rupture seen at the peri-papillary and macula region.

Figure 6 Right fundus photograph at 6 weeks post trauma showing resolved Berlin oedema with macula scarring overlying the choroidal rupture.

uncommon despite being a frequent finding during acute stages of ocular injury, and may lead to long-term issues with loss of near visual acuity due to impaired pupillary miosis.⁸

Contusional cataract can occur and cause significant visual reduction in the long term. Eyes showing progression of cataract may require surgical intervention within 18 months from the onset of injury.⁸ The prognosis in the absence of accompanying ocular injuries for traumatic cataract is generally good.

Blunt ocular injuries to the posterior segment of the eye can affect the vitreous, retina, choroid, sclera and optic nerve. Commotio retinae is a common sign of blunt ocular injury and usually resolves completely without any intervention.⁹ Berlin oedema is commotio retinae affecting the macula secondary to ocular trauma, which tends to subside on its own, without intervention.⁹ As evident in this case, the commotio retinae and Berlin oedema resolved spontaneously within 6 weeks. However, the choroidal rupture that occurred at the subfoveal region resulted in permanent poor vision in this unfortunate patient.

A study by Wood and Richardson¹⁰ found that choroidal rupture occurring at the foveal region will cause visual impairment due to associated photoreceptor damage. This case is particularly interesting due to the linear choroidal rupture that

occurred through the fovea. This reflects the high magnitude and unfortunate trajectory of the explosion force in this patient as a result of the severity of the e-cigarette explosion. Choroidal rupture has a tendency to occur in concentric arcs around the fovea. Even if the fovea is spared, choroidal rupture in the macula region may potentially lead to choroidal neovascularisation thus causing permanent visual impairment. This is the first case, to our knowledge, documenting the severity of front to back eye injury from a vaping explosion.

Learning points

- Modification of electronic devices, in particular e-cigarettes, carries a new potential risk for explosion eye injury.
- E-cigarette explosion-related ocular injury may be very extensive and involve the eye from front to back.
- The high force from ocular blunt injury in a vaping explosion may cause permanent fovea damage and visual loss due to choroidal rupture.

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Competing interests None declared.

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Figure 5 Right anterior segment photograph showing a localised anterior subcapsular cataract.

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