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CASE REPORT

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Pepper-Ball-Related Ocular Injury

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Abstract

The pepper-ball is a less-than-lethal projectile that releases a plume of PAVA (capsaicin II) pepper upon impact to incapacitate the target. To our knowledge, there are no reports of direct or indirect ocular injuries from this weapon in the medical literature despite several reports from the mainstream media. We report a middle-age male who presented with a pepper-ball injury to the right eye, resulting in a 10-millimeter scleral rupture with uveal prolapse and no light perception (NLP) vision at presentation, total retinal detachment, full-thickness eyelid lacerations and tissue damage, medial orbital wall fracture, and severe retro-bulbar hemorrhage due to direct trauma and capsaicin-induced chemical injury. Globe exploration and repair were performed, and the vision remained NLP. The patient declined early vitreo-retinal surgery to attempt repair of the retinal detachment due to his guarded prognosis.

Keywords: ocular trauma, pepper ball injury, globe trauma, ballistic ocular trauma, less than lethal

Introduction

Combat-related ocular trauma is well-known to cause high rates of multi-system organ injury, damage to periorbital structures, open globe injury with posterior segment involvement, and very poor visual outcomes. (1) With law enforcement and military use of kinetic impact projectiles (KIPs) in crowd-control settings around the world, these types of severe ocular injuries, primarily seen in military conflicts and terrorist attacks, appear to be on the rise and increasingly well-publicized in the civilian sector as well. One of the newest KIPs being employed in these settings is the pepper-ball – a less-than-lethal projectile that carries an irritant payload of a powder called PAVA (capsaicin II) pepper. It is designed to incapacitate the target through both blunt trauma from the projectile and chemical irritation of exposed skin, mucous membranes, and the respiratory tract from the plume of PAVA pepper dispersed upon impact.(2) This weapon has entered the public eye in recent times due to its use in various theaters of civil unrest and public protesting around the world, and as a result, serious injuries to civilians from its use have come to light.(3) For law enforcement officers and military personnel, the primary advantage of the pepper-ball over traditional less-than-lethal projectiles is that it does not require a direct hit to incapacitate the target, but due to the inherent inaccuracy, potential for misuse, and risk of severe injury, disability, and death with the use of KIPs of all types, some authors have advocated against their use in crowd-control settings.(4)

To our knowledge, there are no reports of direct or indirect pepper-ball-related ocular injuries in the medical literature despite several reports from the mainstream

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media. We herein present a case of severe blunt injury to the globe, total retinal detachment, full-thickness eyelid lacerations and tissue damage, medial orbital wall fracture, and severe retro-bulbar hemorrhage due to direct trauma and capsaicin-induced chemical injury from a pepper-ball.

Case Report

A middle-aged man sustained direct trauma to the right eye from a pepper-ball fired from approximately 1.8 meters away and was immediately brought to the emergency department. Upon initial examination, the right eye had no light perception (NLP) vision. The left eye was within normal limits. The right globe was proptotic leading to severe corneal exposure keratopathy. The scleral rupture was four clock hours from 2 to 6 o'clock with significant uveal prolapse and total hyphema (Figure 1). A right relative afferent pupillary defect (RAPD) by reverse was present. Computed tomography was performed of the orbits, which revealed the presence of a minimally-displaced medial orbital wall fracture, severe retro-bulbar hemorrhage, and air within the proptotic, distorted right globe (Figure 2).

Figure 1: Patient as seen on presentation after being hit in the right eye by a pepper-ball with scleral rupture and significant uveal prolapse (arrow).

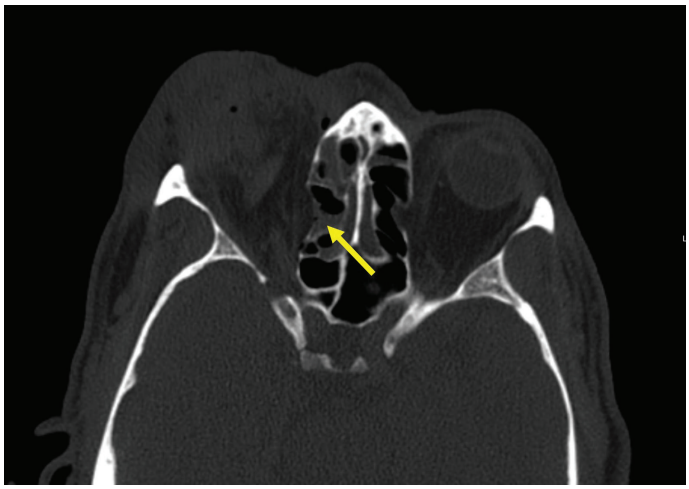

Figure 2: Computed tomography scan of the face/orbit done upon presentation with axial view demonstrating severe retro-bulbar hemorrhage, air within the proptotic, distorted right globe, and the presence of a mildly-displaced right medial orbital wall fracture (arrow).

The patient was taken to the operating room for repair of the open globe. Globe exploration revealed a scleral rupture adjacent to the limbus from 2 to 6 o'clock. The rupture extended 5 millimeters posterior from 2 o'clock limbus and extended 5 millimeters posterior from 6 o'clock limbus. The prolapsed uvea (iris and retina) was repositioned with a 0.12 forceps, and uvea that could not be repositioned was resected with Westcott scissors. The scleral rupture was re-approximated with interrupted 9-0 nylon sutures. A 2-centimeter right upper eyelid laceration and 4-centimeter right brow laceration were identified and re-approximated using 6-0 plain gut suture. It is important to note that the eyelid structures, including the skin, orbicularis muscle, and levator aponeurosis, were severely altered by the chemical payload making it difficult to identify natural tissue planes. The patient was placed on oral levofloxacin 750 mg daily for 10 days for endophthalmitis prophylaxis and oral prednisone 60 mg daily for 10 days to reduce periorbital swelling. The eye was coated with copious erythromycin ointment and covered with a large Tegaderm transparent dressing (3M, St. Paul, MN, U.S.A.) to manage the severe proptosis and exposure keratopathy.

On post-operative day 1, the vision remained NLP, and B-scan ultrasonography demonstrated severely disorganized intraocular tissues with total retinal detachment. He had reduced periorbital edema and proptosis and was without pain by post-operative week two. He was offered early vitreoretinal surgery to attempt repair of the retinal detachment but he declined additional intervention due to his poor visual prognosis. At his one-month post-operative visit, he remained without pain

but developed early findings of phthisis bulbi. The minimal risk of sympathetic ophthalmia was discussed with the patient at length, and he elected globe sparing measures. He was successfully fitted for a scleral cover shell prosthesis by a local ocularist and subsequently was lost to follow up.

Discussion

Various commercially-available pepper-ball launchers are marketed as non-lethal self-defense weapons that are most often deployed by law enforcement personnel for large-crowd control. Due to the rise of civil unrest and public protesting around the world in recent years, non-lethal weapons such as the pepper-ball launcher have entered the public eye and there is increased interest in characterizing their ocular morbidity. Pepper-ball launchers have a range up to 18.3 meters, and upon impact with the target, the pharmaceutical grade PAVA (capsaicin II) pepper powder is capable of dispersing up to 3.66 meters.(2) For law enforcement and military personnel, the primary advantage of the pepper-ball over traditional less-than-lethal projectiles is that it does not require a direct hit to incapacitate the target. The dust cloud of pepper powder irritant is intended to cause chemical irritation of exposed skin, mucous membranes, and the respiratory tract lasting up to 15 minutes.(2)
The pepper-ball consists of a 17.3 mm plastic shell weighing approximately 3 grams in total with its internal capsaicin II payload. When fired, the pepper-ball travels at 85-107 m/s.(5) According to Ifantides et al, these ballistic and kinetic properties are essentially identical to that of paintballs, which are well-known to be capable of severe blunt trauma to the eye and leading to permanent vision loss.(5,6)

Although the mechanical trauma appears to be the main etiology for our patient's vision loss, we suspect that the chemical payload of the pepper-ball may also contribute significantly to ocular morbidity. The profile of ocular injuries caused by standard pepper spray has been discussed in the literature and suggests that most pepper spray injuries are relatively innocuous and short-lived. Although most patients experience resolution of symptoms by 1 hour after exposure, Epstein et al reported a patient who developed a persistent corneal epithelial defect with smoldering stromal inflammation that ultimately resulted in irregular astigmatism and corneal opacity.(7) One article by Hay et al discusses the use of pepper-balls by the Israeli Defense Force causing severe skin injuries as a result of the capsaicin payload, its inert carrier, and its dispersive agent.(3) We noted that upon exploration of our patient's upper eyelid laceration, the natural tissue planes of the eyelid structures were severely disrupted by the chemical payload. Upon exploration of the eyelid laceration, the surgeons encountered orange coagulum and necrotic orbicularis muscle in the wound that were carefully debrided with a #15 blade prior to re-approximation of the tissue. It is unclear if this unusual tissue reaction is related to the PAVA powder, a carrier substance, or a dispersive agent, and at this time, we are not able to characterize the possible tissue reaction that could occur should the offending chemical reach significant concentrations in the cornea, conjunctiva, and sclera.

We present the first case of ocular trauma secondary to pepper-ball injury reported in the literature despite few reports from the mainstream media of pepper-ball-related ocular injuries. We are aware that some authors have suggested that NLP eyes with intact optic nerves and potentially treatable intraocular pathology such as retinal detachment should be considered for additional surgery and that the chance of recovering ambulatory vision has been reported as 5%.(8) However, after extensive discussion with our patient regarding his poor visual prognosis, he declined additional surgical intervention for the total retinal detachment and elected to be fitted for a scleral cover shell prosthesis. Due to loss of follow up, we were unable to obtain further information regarding the model of the pepper-ball launcher implicated in this injury.

Although the pepper-ball carries the advantage of being able to incapacitate an assailant without need for a direct hit, it is clear that a hit to susceptible tissues is capable of inflicting devastating ocular injury nearly identical to those reported with other non-lethal self-defense weapons such as rubber bullets, plastic bullets, and paintballs. Multiple authors have advocated against the use of these weapons in crowd-control settings, pointing to their inherent inaccuracy, potential for misuse and associated health consequences of severe injury, disability and death.(4) In this case, the pepper-ball caused direct trauma to our patient's eye resulting in an immediate and permanent decrease in visual acuity to NLP. Therefore, it is important to characterize the potential risk of permanent vision loss when a pepper-ball inadvertently encounters the eye. Emergency physicians and trauma surgeons should have a low threshold for obtaining emergent ophthalmology consultation to rule

out occult globe rupture when faced with a pepper-ball related ocular injury. In addition, it can be difficult to ascertain the extent of ocular injury from KIPs by clinical examination alone. Therefore, imaging should be obtained when KIPs such as pepper-balls encounter the eye to avoid missing inconspicuous, yet significant injuries requiring urgent intervention to preserve anatomy and ultimately the patient's vision.(9) Ophthalmologists should be aware of the ocular morbidity related to these newer less-lethal-lethal weapons and advocate for their judicious use by law enforcement and military personnel. Furthermore, law enforcement and military personnel that employ this weapon should be encouraged to wear eye protection to decrease the risk of friendly fire injury.

Acknowledgements

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