Descemet’s membrane injury due to bullet shockwave trauma

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ABSTRACT

Purpose: To report a case of corneal edema associated with Descemet membrane (DM) damage likely due to shockwave trauma from a bullet passing by the eye.

Observations: A 27-year-old man presented to the emergency department with pain, redness, and severely decreased vision in the left eye immediately following a gun assault. Examination of the eye revealed a temporal conjunctival laceration, corneal edema, hyphema, and vitreous hemorrhage. Bullets were found in the patient’s left chest and axilla, and a laceration was present on the bridge of his nose, but no foreign bodies were found in or around the eyes. The intraocular hemorrhage and corneal edema gradually resolved, and it became apparent that there were DM irregularities that possibly represented micro-ruptures. After 7 months, uncorrected visual acuity improved to 20/25, and the cornea was free of edema but had persistent small focal areas of DM thickening and scarring.

Conclusions and Importance: This case illustrates that DM and possibly endothelial cell damage can occur due to shockwave injury from high-speed projectiles. In our case of presumed small central DM micro-ruptures, the corneal edema resolved, and the vision significantly improved with topical therapy and observation, suggesting an overall good prognosis from such injuries.

1. Introduction

Blast injury is due to an explosion, defined as a sudden release of energy resulting in pressure or shockwaves that emanate from the explosive source, and can occur due to explosive devices or bullets fired from a gun.1 Blast injury is further categorized based on its mechanism of injury: primary (shockwave or pressure of blast itself), secondary (debris or shrapnel accelerated through the body), tertiary (inertial or blunt trauma due to displacement of the body from the blast), and quaternary (other blast-related injuries, including burns, chemicals, smoke, etc.).1 Blast injuries to the eyes are most commonly secondary blast injuries.1 Only a few cases of pure primary ocular blast injury from explosive devices have been reported previously, and presentations typically include conjunctival injection, traumatic mydriasis, iridodialysis, recurrent hyphema, and angle recession.2–4 As for primary blast injury from passing bullets, cases of retinal and choroidal tears and hemorrhage have been attributed to the shockwaves generated from projectiles passing near the eye, and this type of injury is referred to as chorioretinitis scleropetaria.5

Only one case of damage to the cornea due to primary blast injury has been reported previously, specifically folds in Descemet membrane (DM) due to a blast from explosive powder.6 Blunt ocular trauma without foreign bodies is also a rare cause of DM injury or rupture, which has been shown to present with corneal edema.6–8 In this report, we present a case of corneal edema and micro-ruptures of the central DM, as well as hyphema and vitreous hemorrhage, associated with a firearm bullet passing close to the cornea. The mechanism of injury in our case is likely primary blast injury related to a shockwave generated by a gunshot that potentially grazed the temporal conjunctiva and the bridge of the patient’s nose, passing in front of the cornea without making contact with it.

2. Case report

A 27-year-old man presented to the emergency department with two bullet wounds to the left chest/axilla and a nasal bridge laceration
following a close-range gun assault. The patient reported pain, redness, and decreased vision in his left eye immediately following the assault. Upon initial examination, his uncorrected visual acuity (UCVA) was 20/20 in the right eye and eccentric count fingers at face in the left eye. The average of two sets of intraocular pressures (IOP) was 16 mmHg in both eyes by Tono-Pen (Reichert Inc., Buffalo, NY, USA). Extraocular movements were normal in both eyes. Confrontation visual fields were full in the right eye and deficient in all four quadrants in the left eye. The slit lamp examination was remarkable for diffuse scleral injection and a triangular conjunctival laceration (~1 cm) temporally, but no foreign bodies or scleral laceration were noted. The cornea had diffuse edema and DM folds, but no corneal lacerations or epithelial defects other than a pinpoint area of temporal fluorescein staining were observed. The anterior chamber was deep, with the presence of a layered inferior hyphaema (2 mm). The undilated pupil was round, and the iris was partially obscured by blood. Upon instillation of 2.5% phenylephrine and 1% tropicamide, a temporal section of the left iris failed to dilate. There was no iridodialysis. Vitreous hemorrhage was observed, and retinal details were not observable via slit lamp examination. A computed tomography (CT) scan showed no foreign bodies and unremarkable globes and orbits (Fig. 1). A B-scan showed vitreous hemorrhage with layering of blood on the hyaloid face in the left eye. The patient was started on cyclopentolate 1% and tobramycin/dexamethasone ointment twice daily.

Over the following week, UCVA improved to 20/400 with pinhole. The conjunctival laceration healed without complication. The peripheral corneal edema had cleared, but the central cornea had persistent microcystic edema. Also, 3+ red blood cells or pigment were noted in the anterior chamber. A repeat B-scan confirmed a flat retina with no detachment. Prednisolone acetate 1% was started four times daily.

One-month post-injury, UCVA had improved to 20/200, but was still limited by vitreous hemorrhage as well as central corneal edema. The IOP was elevated at 32 mmHg in the left eye via applanation tonometry. On slit lamp exam, the cornea had a central 3 mm × 3 mm area of focal edema with an underlying area of irregularly thickened and mildly opacified DM or endothelium. The vitreous hemorrhage had improved. The optic disc was pink and sharp. Ultrasound pachymetry showed thickening of the left cornea (585 μm) compared to right (483 μm). To lower IOP in the left eye, treatment with brimonidine and dorzolamide-timolol was initiated, and loteprednol 0.5% was substituted for prednisolone acetate 1%, in case the elevated IOP was due to a steroid response. The patient’s left eye IOP improved to 8 mmHg over the next month.

Two months post-injury, the patient’s UCVA had significantly improved to 20/30, IOP was 8 mmHg. Corneal edema had resolved on slit lamp exam, but a “wrinkled” central corneal opacity remained (Fig. 2). Anterior segment optical coherence tomography (OCT) showed posterior stromal hyper-reflectivity with focal areas of DM thickening, as well as an area that resembled a DM detachment superior to the bulk of the lesion (Fig. 3). The anterior chamber still had 3+ pigmented cells but was without layered hyphaema. The vitreous hemorrhage was largely resolved, and the retina did not show any hemorrhage or signs of chorioretinitis scleropatia. Treatment with loteprednol was tapered over 3 weeks and stopped with dorzolamide-timolol. Cyclopentolate was continued.

At 7 months post-injury, the patient’s UCVA had improved to 20/25 without surgical intervention. His cornea was free of edema, but small focal areas of DM irregularity and scarring remained. His vitreous hemorrhage was resolved, save for a small amount of residual inferior de-hemoglobinized blood.

3. Discussion

This case of corneal edema from possible focal DM micro-ruptures, or other effects on the endothelium and DM, illustrates an additional finding that may present after shockwave trauma from a bullet passing tangentially to the eye. Our case had some similar findings consistent with primary blast injury including hyphaema, iris sphincter tear, and vitreous hemorrhage. It appeared that the bullet passing across the patient’s face that grazed the bridge of his nose may have just passed by the anterior temporal aspect of the eye to cause the conjunctival laceration and corneal endothelial/DM trauma. With symptomatic medical treatment and careful follow-up, our patient recovered vision in his left eye to 20/25 after resolution of the vitreous hemorrhage, hyphaema, and corneal edema. Therefore, we decided against any surgical intervention. Because the focal areas of mild thickening and opacification of DM could have represented a scarring reaction, it was not clear how the DM would have behaved were an attempt made to strip the irregular areas from the visual axis.

Only a few cases of pure primary blast injury due to explosives have been reported previously.2-4 In all of these cases, the diagnosis of primary blast injury was made by lack of evidence of foreign bodies on slit-lamp examination and/or CT (i.e. secondary blast injury). In one case, a young man was mildly injured in an explosive powder blast from 90-m away.5 The cornea was clear, and no particular DM irregularities were described, except for DM folds. The AC was formed with a 3 mm hyphaema, and bleeding at the iris root was described. The patient recovered with bed rest and topical corticosteroids. Another case of primary blast injury was reported in a 43-yr-old soldier who was exposed to a pipe-bomb blast in Afghanistan from 4 m away in an armored vehicle.6 The patient suffered from a ruptured tympanic membrane, orbital floor fracture, maxillary antral hematoma, facial lacerations, and contusions to both upper and lower extremities. His right eye suffered from traumatic mydriasis, vitreous hemorrhage, and breaks in Bruch’s membrane in the macular region, without globe rupture or penetrating injury. Although this second case found no corneal findings, both of these cases had some similarities with ours, including traumatic mydriasis, vitreous hemorrhage, and hyphaema. Lastly, in a review of 13 cases of primary blast injury in war veterans, no corneal pathologies were reported; however, damage to the iris, choroid, retina, lens, and vitreous were observed.7 Similar to these reports, we concluded that our case was likely primary blast injury (i.e., the shockwave generated by the bullet) due to the lack of evidence of secondary blast injury on CT and slit-lamp examination. The only described corneal pathology in the aforementioned previous reports of primary blast injury was DM folds in one of the cases. In our case of

Fig. 1. Computed tomography (CT) scan showed unremarkable globes and orbits with no evidence of foreign bodies.
presumed primary blast injury, we additionally found focal micro-ruptures of the DM, which has not been previously described.

Primary blast injury to the eye due to bullet shockwaves has been described more commonly than those due to explosions, but the previously reported findings have been restricted to the posterior segment. Non-penetrating globe injury characterized as choroidal and retinal rupture secondary to a high velocity projectile passing adjacent to the globe has been termed chorioretinitis sclopetaria. Similar to the presumed mechanism of injury in our case, the mechanism of injury in chorioretinitis sclopetaria is thought to be due to the force of the shockwave created by the projectile as it passes adjacent to the eye. Chorioretinitis sclopetaria could be considered a form of primary blast injury, in that the retinal and choroidal damage is caused by the pressure wave generated by the bullet without penetrating injury. Many cases have been described in the literature of chorioretinitis sclopetaria due to bullets, BB gun pellets, paintballs, etc., with observed foreign bodies, from secondary penetrating or blunt trauma.

In contrast to our case, chorioretinitis sclopetaria generally presents with a foreign body lodged in the orbit that is visualized on CT without globe rupture. Additionally, it has been estimated that only ~8.5% of cases present with associated corneal abrasion, edema, or laceration. In a review of 6 cases, 2 had corneal findings: 1) one presented after a rifle injury to the left eye with a conjunctival laceration, corneal epithelial defect, hyphema, and vitreous hemorrhage, and 2) another presented after a BB gun injury, and showed only a central corneal opacity. While the mechanisms of injury are likely similar, our patient did not have chorioretinitis sclopetaria, most likely because the bullet passed closest to the anterior segment, rather than the posterior segment and did not enter the orbital space adjacent to the retina and choroid.

Corneal injury appears much more common in secondary blast injury with observed foreign bodies, from secondary penetrating or blunt trauma. One observational cross-sectional study examined 17 eyes with combat blast-related injuries of which 15 had corneal lacerations and 6 had DM ruptures. In another study of corneal injury due to non-penetrating secondary blast injury, traumatic corneal rings have been observed surrounding lodged foreign bodies. While our case did not have evidence of secondary blast injury on slit-lamp examination or CT, we cannot rule out that he did not suffer from blunt trauma from the passing bullet. It is possible that the passing bullet may have grazed the patient’s left eye and caused the conjunctival laceration observed temporally, and that this may have led to the shearing of the endothelium and DM, representing a type of blunt force trauma. Only a few cases of DM rupture secondary to blunt trauma without foreign bodies have been reported previously. One case of DM rupture was reported due to blunt trauma from a high-pressure water jet injury directly to the eye. The patient presented with a large 7 mm corneal epithelial defect, stromal edema, and DM rupture. Other findings included hyphema and a fixed, dilated pupil, which were similar to our case. Another case reported a 39-yr-old veteran thrown from a car by a blast which bruised the left side of his face and was presumed to be a contusion injury. The patient presented with a large DM rupture and corneal edema and no retinal findings; however, the type of blast injury could be considered as primary (due to proximity to the blast), or possibly tertiary (due to displacement of the body by the blast). In contrast to this second case, our case did not have a large DM rupture but instead had small areas of DM thickening and opacification once the edema resolved (Fig. 2). Although it is possible that in our case the bullet did actually contact the patient’s eye, micro-ruptures in DM of the type we observed have not been previously reported in blunt trauma cases either. Furthermore, given that there was no underlying scleral burn or scleral laceration noted, we suspect that the bullet would not have caused a significant direct blunt force to the eye as much as a shockwave force, or else would have likely caused globe rupture.

4. Conclusions

In summary, we have described a rare case of corneal edema associated with small central DM irregularities that may have resulted from micro-ruptures after likely shockwave trauma from a passing bullet (i.e., primary blast injury) without contact to the cornea. We believe that this case represents a form of sclopetaria affecting mainly the anterior segment due to the trajectory of the bullet. This case has illustrated that anterior shockwave trauma can be associated with a good prognosis, whereas posterior shockwave trauma leading to chorioretinitis sclopetaria is generally associated with a poor prognosis. Finally, the small...
focal areas of DM thickening and opacification that we identified in this case can be considered a new type of injury that can occur from a primary blast injury to the eye.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Declaration of competing interest

None of the authors have any financial disclosures to declare.

Patient consent

Written consent to publish this case report was not obtained. This report does not contain any personal identifying information.

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