Case Report

Ocular Injuries: Another Example of the Heavy Prize of Terrorism

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Abstract

Injuries to the face and ocular structures could occur at the war front not only to the enemies, but also to unsuspecting friends of the security agents. We report here a case of ocular injury involving an air force personnel (lance corporal) who was mistakenly hit on the face by the back blast of a rocket-propelled grenade shot by a colleague without prior warning resulting in varying degrees of ocular injuries.

Key words: Blast, ocular injury, rocket-propelled grenade, terrorism

Introduction

Terrorism is now a global challenge. Over this past decade, activities of insurgents have steadily gained momentum in Nigeria. This has led to the engagement of more young people into various security agencies in Nigeria. A coalition of the army, air force, navy, and mobile police force termed the Joint Task Force has been formed to counter the menace of terrorism. The pressure of war and sometimes inadequate training or mastery of newly acquired weapons could lead to inadvertent injury to self or fellow security agents. Rocket-propelled grenade (RPG) – Figure 1a is a commonly used weapon at the warfront.[1]

The eyes are particularly susceptible to injuries because of their strategic position on the facial skeleton. The orbit encloses vital anatomical organs (eyeball, muscle, fat, vessels, and nerve tissues) containing a unique interface (air–fluid–soft tissue medium). Impact of a blast on the face results in spread of shock wave to the surrounding medium related to the eyeball and orbital anatomical tissues. Ocular damage occurs from coup-contrecoup or anterior–posterior expansion of the globe [Figure 1b-d]. This could result in varying ocular injuries such as abrasions, lacerations, or globe rupture. Other air-fluid filled organs that could be affected include the tympanic membrane, lungs, and hollow viscera.[2,3]

The explosive materials released by RPG as primary blast causes ocular injuries. A back blast covers a radius of 25 meters from the RPG. Another cause of eye injury is metal spall. These are small fragments from the melted metal in the external armor plate. This results in a shower spray of small, irregularly-shaped, very hot, metallic fragments. Small metallic spalling projectiles of 2–3 mm size could penetrate or rupture the eyeball and, when in concert with blast overpressure, shower the exposed face. The velocity of fragments or blast wave is faster than the blink reflex ability to protect the eye. A missile of 0.82 mm in size has a velocity of 60 m/s whereas a blink reflex takes approximately 0.1 s. Colleagues, if not adequately alerted, are usually close to the explosive, and are therefore, exposed to high thermal burns.[1,4]

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Case Report

A 25-year-old air force personnel (lance corporal) presented to our accident and emergency unit, with a 5-day history of pain and poor vision in both eyes following back blast from a RPG. The incidence took place during a counter-attack on the insurgents in the North Eastern region of Nigeria. The patient was standing behind a colleague in an open Hilux van. The

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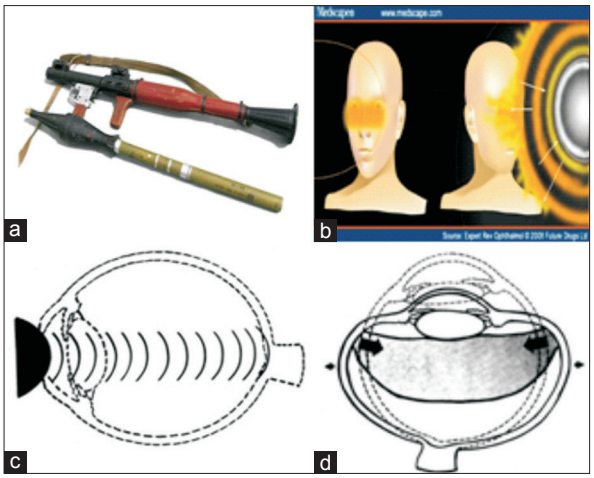

Figure 1: Rocket-propelled grenade and impact of blast on face/eye culled from Medscape and Duane's ophthalmology. (a) Rocket-propelled grenade. (b) Blast impact on the face. (c) Antero–posterior compression of the globe. (d) Equatorial expansion.

Figure 2: Rocket-propelled grenade and impact of blast on the face/eyes. (a) Face swelling following back blast. (b) Hyphema in the right eye and mid-dilated left pupil. (c) Facial picture at follow-up visit. (d) Helmet with visor.

colleague shot a RPG without prior warning. This resulted in a jet of air hitting him on the face. There was immediate pain in both eyes, reduced vision, swelling of the face, tearing, and photophobia. He was not sure if he lost consciousness, but was confused. He had an episode of epistaxis lasting 24 h which stopped spontaneously. He had pain in the right ear, tinnitus, and headache. There was no bleeding from the ears. He was not wearing protective eye device at the time of the incidence. There was no injury to other parts of the body.

There was no prior history of eye disorders, spectacle wear, or use of traditional eye medications.

He was first seen at the Nigerian Air Force Hospital where he was commenced on diclofenac tablet 50 mg b.d. and diclofenac (0.1%) eye drop t.d.s. to both eyes.

Examination revealed a young man with a bruised and swollen face [Figure 2a]. His blood pressure was 120/100 mmHg, pulse rate was 64 bpm, and Glasgow Coma Scale was 14/15. The right eye had a vision of light perception with good light projection in all the four quadrants. The eye lids were edematous; he had excessive tearing, but no crepitation. He had chemosis with black particles embedded in the injected conjunctiva. He had punctuate corneal opacities which did not stain with fluorescein, and over two-third of the anterior chamber was filled with both fresh blood and blood clot obstructing further view of the pupil, lens, and fundus. The intraocular pressure (IOP) was 16 mmHg. On the left eye, his vision was counting fingers at 1 m. There was excessive tearing with swelling of the eyelids without crepitus. The nasal conjunctiva was injected with black particles embedded in the conjunctiva. He had mucous strands on the cornea that stained with fluorescein. The anterior chamber was active with cells and flare. The pupil was mid-dilated and unreactive to light stimulus. The lens was transparent with iris pigment on the anterior lens capsule. Fundoscopy revealed a pink disc with well-outlined margin, cup-to-disc ratio (CDR) of 0.4, and normal vessels, but the whole retina and macula were edematous. The IOP was 8 mmHg. There was no restriction of movement in both eyes in all directions of gaze. Ocular findings are as shown in Figure 2b and Table 1.

A review by an otorhinolaryngologist revealed that the right ear had mild tragal tenderness; the tympanic membrane was hyperemic, but intact. The left ear and nose were normal.

A diagnosis of bilateral blunt ocular trauma (with the right eye hyphema, left filamentary keratitis, acute left anterior uveitis, and left traumatic maculopathy) was made.

He was admitted and placed on Occ. Maxitrol® (neomycin 3500 I.U/ml, polymyxin B 6000 I.U/ml, and dexamethasone 0.1%) RE q.d.s., gutt. diclofenac (0.1%) LE t.d.s., tablet acetazolamide 250 mg b.d., gutt. timolol (0.5%) RE b.d., gutt. ciprofloxacin (0.3%) BE b.d., tablet paracetamol 1g t.d.s., and tablet trypsin/chymotrypsin (100,000 units) ii t.d.s. He was nursed in Fowlers' position, the right eye was padded, and he was advised to be strictly on bed with bathroom privileges.

Ocular ultrasound scan revealed bilateral vitreous hemorrhage with no features of retinal detachment.

On day 4 of admission, the patient complained of pain in the right eye associated with right-sided headache. On examination of the right eye, the visual acuity (VA) had improved to hand movement. Hyphema had reduced to Grade 2 and a dark reflex was seen on fundoscopy. The IOP was 32 mmHg. Examination of the left eye revealed VA-6/60, other findings were unchanged, and IOP was 8 mmHg. He was placed on tablet acetazolamide 500 mg stat, then 250 mg b.d. for 3 days while his previous medications were unchanged.

He was reviewed by the neurosurgeons, and an assessment of posttraumatic headache with possibly high intracranial

pressure was made. A computed tomography (CT) scan did not reveal fracture of the bony architecture or intracranial collections. He was placed on tablet dihydrocodeine 30 mg t.d.s. and tablet phenobarbitone 30 mg b.d., both for 5 days.

He was discharged 17 days after admission following remarkable improvement. At discharge, the VA in the right eye was 6/36 which improved to 6/24 with pinhole. The only abnormal finding in the anterior segment was a pupil that was mid-dilated, irregular, and plastered to the lens with 360° synechiae. The posterior segment showed a normal disc with CDR of 0.3, normal vessels, and flat retina with good foveal reflex. The IOP was 8 mmHg. In the left eye, vision was 6/60, with no improvement with pin hole. The pupil was still mid-dilated, unreactive to direct and consensual light reflex. The lens was transparent with iris pigments on the anterior lens capsule. The disc was pink, CDR 0.4, still had retinal and macula edema and scattered preretinal hemorrhages [ocular findings in Table 2]. A resolving vitreous hemorrhage in the right eye was noted.

His discharge medications included Gutt. timolol (0.5%) b.d. right eye, gutt. cyclopentolate (1%) t.d.s. right eye, and gutt. voltaren ophtha (0.1%) t.d.s., on both eyes. He was counseled on the need for adequate bed rest at home.

At the 5th weekly follow-up visit [Figure 2c], examination revealed the following - Right eye: VA-6/18, punctate corneal opacities, 360° posterior synechiae, the vitreous hemorrhage in the right eye had cleared, but had synchisis scintillans, retinal findings did not change, and IOP was 12 mmHg. Left eye: VA was unchanged - 6/60, there was synchisis scintillans in the vitreous while the macula was still edematous with peripapillary epiretinal membrane, and IOP was 14 mmHg. On account of the nonresolving macula edema and epiretinal membrane, he was referred to the vitreoretinal surgeon. Refraction did not improve his vision.

Discussion

At the war front, not only the enemies are at a risk of injuries, but also security personnel are at a risk of various facial and ocular injuries.[4,5]

The blast from explosions expands in spherical nature as a primary wave. When a blast front reaches a victim, it causes an instantaneous rise in ambient pressure. The air-fluid-filled organs are damaged by dynamic pressure changes at the tissue borders due to the interaction of a high-frequency stress wave and a lower frequency shear wave. One or the other of these waves predominates, depending on the characteristics and location of the blast. Orbital region containing liquid and other tissue media bounded by thin bone plate walls of air-containing sinuses are also vulnerable. Blast injuries to the face have the potential to cause permanent eye damage. Blast could also lead to perforation of the eardrums, lungs, and hollow visceral organs.[3,6]

When a primary wave impacts the orbit, it results in anterior–posterior compression of the globe, raising IOP to

Table 1: Findings on Ocular Examination at Presentation in JUTH after Parting the Eyelids

	Right eye (RE)	Left eye (LE)
Visual acuity (VA)	Perception of light (PL)	Counting fingers @1M
Lids/lashes	Oedematous, tearing, healed bruises, no crepitus	Oedematous, tearing, healed bruises, discharge, no crepitus
Conjunctiva	Injected, black particles embedded in the conjunctiva	Injected, black particles embedded in the conjunctiva
Cornea	Punctate corneal opacities not staining with fluorescein	Filamentary keratitis stained with fluorescein
Anterior chamber (AC)	Grade 3 hyphaema (fresh blood and blood clot)	Cells and flare
Pupil	No view	Round mid-dilated, unreactive to direct light stimulus
Lens	No view	Transparent with iris pigment on anterior lens capsule
Fundus	No view	Pink disc, with well outlined margin, cup disc ratio 0.4, normal vessels, commotio retinae
Intra ocular pressure (IOP)	16 mmHg	8mmHg
Extra ocular muscle motility (EOMM)	No restriction in all direction of gaze	No restriction in all direction of gaze

Table 2: Ocular Findings on Discharge

	Right eye (RE)	Left eye (LE)
VA	6/36 PH-6/24	6/60
Lids/Lashes	Normal	Normal
Conjunctiva	Mild injection nasally	White
Cornea	Punctate corneal opacities not staining with fluorescein	Transparent
AC	Normal depth and calm	Normal depth and calm
Pupil	Mid-dilated, irregular, 360° Posterior synaechiae	Mid-dilated, unreactive to direct and consensual light reflex
Lens	Lens opacity, Iris pigments on anterior lens capsule	Iris pigments on anterior lens capsule
Fundus	Inferior vitreous hemorrhage, pink disc, CDR 0.3, normal vessels, flat retina, good foveal reflex	Pink disc, CDR 0.4, retinal and macula oedema, pre-retinal haemorrhage
IOP	8 mmHg	9 mmHg

a point that globe rupture may occur. A rupture may also occur when the integrity of the outer membranes of the eye is disrupted by a blast overpressure wave and penetrating shell fragments which weaken the eye coats.[3]

The distance between the victim and the recoil blast (whether the blast occurred in a closed or open space) and any surrounding environmental barriers or hazards may be the contributing factors to the degree of injury. Forces of the blast waves decrease exponentially with distance from source, so is the damage that could result. Explosion in confined quarters results in higher morbidity and mortality compared to open-air explosion. In open-air explosions, the quick dissipation and velocity decline of the shock front result in predominantly noncritical injuries.[3,4,7]

Our patient suffered a primary blast injury with superficial bruises to the face and blunt ocular trauma from back blast particles because the patient was exposed to the outdoor blast effect. This resulted in a bilateral periorbital edema, hyphema, vitreous hemorrhage, and nasal bleeding, but there was no orbital wall fracture clinically which was confirmed by the CT scan. Conservative management of the hyphema was adopted with a relatively good visual outcome. The subsequent rise in IOP could be attributed to clogging of the trabecular meshwork by red cells, inflammatory cells, and ghost cells.[2,8]

The commotio retinae (retinal contusion) seen in the left eye resulted from impact of the globe on the nonexpansile bony orbit housing it (contrecoup injury). The retinal edema that developed is the result of intracellular edema, fragmentation of the photoreceptor outer segments, and intracellular edema of the underlying pigment epithelium.[3]

Military ocular injuries cause great ocular damage, with an initial VA of <6/60 as seen in our patient at presentation. His vision steadily improved that at the last visit, his VA was 6/18 in the right eye and 6/60 in the left eye. Our patient had mild visual impairment. This has socioeconomic impact which cannot be estimated. Beyond the medical implications of eye injuries in this otherwise fit and healthy soldier, he may become unfit for further combat service which he has been trained for.[9]

Explosions have the potential to cause life-threatening multi-systemic injuries; in this patient, the eyes, ears, and head were involved, hence the multidisciplinary approach in the management of our patient. Just as the eyes were affected by the blast pressure, so also the ears of our patient, fortunately, it was shear stress on the tympanic membrane without an ear drum rupture. Pressure difference as little as 5 psi can cause injury to the ear drum. The common belief that ear drum injury is a predictor of lung injury was not seen in this patient.[6]

The posttraumatic headache he had could have resulted from an impact from the blast displacing the victim's body against a stationary object in the van.[5]

Other patterns of blast injuries which could be seen alone or in combination include:

- Secondary blast injuries: Projectiles such as shrapnels, steel balls, glass, sand particles, nails, spoons, screws, and nuts packed around the explosive cause secondary blast injuries, and the wounds reflect their velocity and shape. The impact of these particles on the outer fibrous coat of the eye (cornea and sclera) creates stress on mechanical contact. This results in partial or complete cornea or sclera contusion and laceration, with diminished ocular wall resistance. Damage by such pellets results in increased mortality and devastating injuries
- Tertiary blast injury: This results when the blast wind thrusts the victim against stationary objects. In some patients, the dynamic pressure from the blast wind may result in limb amputation
- Quaternary blast injury: This is related to the thermal effects of the blast and from ignited flammable materials on the scene
- Quinary blast injury: This results from toxic substances absorbed by the casualties through their injuries or via inhalation. Asphyxia could result from inhalation of fumes from toxic and burnt materials. This bizarre hyperinflammatory state results from absorption of explosive such as pentaerythritol tetranitrate, which possesses vasodilatory properties.[4,6,10,11]

Wearing a helmet with a visor [Figure 2d] designed to break the stress of the wave pressure will provide protection against blast-induced injuries, especially the upper-middle-third of the facial skeleton. This protects the ocular–orbital region as well as prevents traumatic brain injury through cribriform plates of the ethmoid bone. The helmet will also safeguard against the peppers of fragments of secondary blast effects while attenuating the primary blast stress force. The visor could save many eyes from blast injuries. We strongly suggest that not only our men in uniforms, but also civilians in unstable regions should make use of proper protective eye glasses.[4,12]

Conclusion

The clinical consequences of blast injuries and strategies outlined for the immediate management of eye blast trauma and specific effects resulting from explosion are of prime medical importance. Our men at the war front need to be adequately trained to ensure safety precautions and the use of protective helmets with visor to avoid injuries to friends instead of foes.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/ their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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