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BB Gun–Related Open Globe Injuries

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Purpose: To describe the characteristics and outcomes of patients treated for BB and pellet gun–related open globe injuries.

Design: Retrospective case series.

Participants: Patients presenting to a tertiary care trauma center with open globes secondary to BB or pellet gun injury from January 2002 to November 2017.

Methods: A retrospective chart review was conducted of all patients presenting with open globe injuries from January 2002 to November 2017. Charts were reviewed to isolate the mechanism of injury related to BB or pellet guns. Demographic data, injury type, presenting clinical examination findings, visual acuity (VA), secondary ocular complications, necessary surgical procedures and long-term outcome data were recorded. Additionally, the ocular trauma score (OTS) was calculated for all patients who had documented VA on presentation.

Main Outcome Measure: Final VA.

Results: During the study period, 681 open globe injuries were identified, 16 of which met inclusion criteria. Fourteen cases were due to injury from a BB gun and 2 were due to a pellet gun. Fourteen of the 16 patients (88%) were males. The average age of patients at time of presentation was 14±6.4 years (range, 4–28 years). Common presenting complications included hyphema, traumatic cataract, and retinal detachment. Twelve of the 16 patients required at least one additional surgery after open globe repair. Fifteen (94%) patients had hand motion–only or worse vision at time of final presentation. Eight patients had no light perception vision in the injured eye at final follow-up.

Conclusions: Open globe injuries related to BB or pellet guns result in devastating visual outcomes. They are often associated with multiple complications and the need for additional surgeries. Modern surgical techniques can increase the rate of globe salvage although final vision remains poor. The study findings highlight the risks associated with widely available BB and pellet guns and underscore the importance of eye protection in this setting. *Ophthalmology Retina 2018;■:1–6 © 2018 by the American Academy of Ophthalmology*

Open globe injuries can result in devastating trauma to the eye.[1–4] They are often associated with a need for multiple surgical procedures including enucleation and generally portend an overall poor visual prognosis. A nonpowder gun is a gun that does not need gun powder to fire and instead uses compressed air, springs, or electricity to fire. This includes BB guns, paintball guns, Airsoft guns (Airsoft Station, St. Paul, MN), and pellet guns. BB guns fire ball bearings, small 4.5mm round balls made of lead or steel, and can reach maximum velocities of 380 m/s if powered by a spring.[5] Similarly, pellet guns fire 4.5mm metal, nonspherical pellets.

Although often marketed as toys, BB guns and other nonpowder guns have been shown to injure as many as 21 840 Americans each year.[6] Children and teenagers account for about 80% of all injuries due to nonpowder guns and the majority of these injuries result from unintentional shootings. In the United States, up to 12% of these injuries involve the eye.[6] In 2012, 3161 children 2 to 18 years of age were treated in U.S. emergency departments for eye injuries secondary to nonpowder gun use.[5] Injuries have shown to be more common among young males.[7–9] Nonpowder guns represent a rising public health concern given their ease of acquisition and unsuspecting ability to cause serious harm.

Open globe injuries caused by BB guns are particularly severe and associated with poor visual prognosis.[10,11] The largest case series to date covering BB gun–related open globe injuries in the United States evaluated patient data from the 1970s; in this series a significant number of patients subsequently required enucleation.[1] More recent studies analyzing the risks associated with nonpowder guns have been performed abroad.[12,13] In this study, we describe the injury type, management, and outcomes of eyes with BB gun–related open globe injuries in patients presenting to a tertiary care trauma center from 2002 to 2017. To our knowledge, this series represents the largest compilation of recently reported BB gun–related open globe injuries in the United States and their outcomes in the setting of modern ophthalmic surgical technique.

Methods

A retrospective chart review was performed of all patients with open globe injuries secondary to BB and pellet guns who presented to the Vanderbilt University Medical Center adult and pediatric emergency departments between January 2002 and November 2017. All open globe cases were identified using Current Procedural Terminology codes 65280 and 65285 (repair of laceration

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Table 1. Demographics

Patient	No. (%)
Male	14/16 (88%)
Average age (yrs)	14±6.2
Right eye	7/16 (44%)
Race	
Caucasian	9/16 (56%)
African American	5/16 (31%)
Unknown race	2/16 (13%)
Laceration location	
Cornea	5/16 (31%)
Sclera	8/16 (50%)
Cornea and sclera	3/16 (19%)
BB location	
Orbit	9/16 (56%)
Globe	5/16 (31%)
Sphenoid sinus	1/16 (6%)
Temporal lobe	1/16 (6%)
Initial vision	
20/200	1/16 (6%)
HM	2/16 (13%)
LP	6/16 (38%)
NLP	5/16 (31%)
Unable to assess	2/16 (13%)
Final vision	
20/100	1/16 (6%)
HM	3/16 (19%)
LP	4/16 (25%)
NLP	8/16 (50%)

HM = Hand motion; LP = light perception; NLP = no light perception.

procedures on the eyeball). These charts were reviewed and open globe injuries due to BB guns or pellet guns were selected. Open globe injury was defined as any full-thickness laceration of the sclera, cornea, or both. The retrospective chart review was approved by the Vanderbilt University institutional review board (IRB 171711).

We characterized these injuries by age, sex, race, presenting visual acuity (VA), laceration site, laceration size, and location of BB or pellet. All operative reports were reviewed. Exclusion criteria included nonpenetrating injuries, open globe injuries not related to BB or pellet guns, or those due to unidentified trauma. Patients were followed up for the need for enucleation, number of subsequent surgical procedures, and length of follow-up. Only patients with at least 3 months of follow-up were included. Final VA was recorded as vision at the last follow-up visit. We also assessed for the presence of complications, including hyphema, cataract, vitreous hemorrhage, retinal detachment (RD), and intraocular foreign body. Any evidence of endophthalmitis was recorded.

The ocular trauma score (OTS)[14] was calculated for all patients. The following OTS parameters were analyzed: initial VA, globe rupture, endophthalmitis, perforation of the globe (presence of both an entrance and an exit wound), RD, and the presence of relative afferent pupillary defect (RAPD). Patients were excluded if no initial VA was available. Patients were not excluded if the presence of RD or RAPD was not documented at time of initial evaluation.

Results

Sixteen eyes from 16 patients with open globe injuries from BB or pellet guns were identified between January 2002 and November 2017. The average patient age at time of presentation was 14±6.2 years (range, 4–28 years), with the majority (81%) younger than 20 years of age. Fourteen cases (88%) were due to BB gun injury and 2 cases (12%) were due to pellet gun injury. All were monocular injuries. Five patients (31%) were African Americans, 9 (56%) were Caucasians, and 2 (13%) had no race or ethnicity recorded during their hospital or clinic visits (Table 1).

Presenting VA ranged from 20/200 to no light perception (NLP). Only one patient presented with 20/200 vision. Two (13%) patients presented with hand motions vision. Six (38%) patients presented with light perception–only vision and 5 of 16 (31%) patients had NLP vision at time of presentation. The presenting VA results for 2 patients were unable to be recorded due to poor cooperation. Most patients (94%) had documented vitreous hemorrhage, hyphema, or both.

Eight eyes (50%) had scleral laceration, 5 eyes (31%) had corneal laceration, and 3 eyes (19%) had combined corneoscleral laceration. The laceration size for those eyes for which this was recorded ranged from 2mm to 7mm.

All patients underwent computed tomographic scanning of the orbits to evaluate for retained foreign bodies. For 9 patients (56%) the projectile landed in the orbit. For one patient, the projectile landed in the temporal lobe of the brain, and for another (6%) patient it landed in the sphenoid sinus. Five patients (31%) had confirmed intraocular foreign bodies.

RD developed in all patients, either at the time of diagnosis or at subsequent follow-up. A traumatic cataract developed in 11 (69%) eyes. Our series had no cases of endophthalmitis. A total of 22 subsequent ocular surgeries were performed in this cohort of 16 patients. Twelve patients (75%) required at least one additional ocular surgery after their initial open globe repair. One patient eventually underwent an enucleation, and another patient underwent an evisceration due to blind painful eyes (Table 2).

At the time of final follow-up (before any globe removal surgery), 15 (94%) patients had hand motions vision or worse. Eight of these patients subsequently had NLP vision. One patient in this cohort had final vision better than hand motions (20/100). The length of follow-up ranged from 5 to 68 months.

The ocular trauma score (OTS) was calculated for all patients for whom adequate data points were available. Two patients were excluded because their presenting VA was not recorded. Of the 14 patients for whom the OTS was calculated, 12 patients had an OTS of 1 and 2 patients had an OTS of 2. The 2 patients with an OTS of 2 both had NLP vision at the time of final visual assessment. It is important to note that only patients who had a documented RD at time of presentation received points in this category when calculating the OTS. Although a RD eventually developed in all patients in our study, only 3 patients had a documented RD at time of diagnosis (Table 3).

Discussion

Our cases series of BB and pellet gun–related ocular injuries reaffirms the devastating visual consequences of trauma in this context. The majority of patients in our study had final best-corrected visual acuity of hand motions or worse vision (94%), and exactly half of our patients had final vision of NLP at final assessment. Two patients eventually required globe removal surgery due to NLP