



# Ocular injury from plastic airsoft bullet through protective steel mesh mask

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## ABSTRACT

The importance of protective eyewear during activities which involve high velocity projectiles is often emphasized to patients, however the material and design of such eyewear is also important. We present the case of a boy who sustained ocular injury from a plastic airsoft bullet while wearing a protective mask issued by the manufacturer. The patient was found to have decreased vision, a corneal abrasion and hyphema. The patient fully recovered with topical prednisolone, cyclopentolate, and moxifloxacin. It is important to advocate for using polycarbonate protective eye wear for our patients who are engaging in activities which involve high velocity projectiles.

## 1. Introduction

The need for protective eyewear during activities involving high velocity projectiles is well-accepted, but the choice of eyewear is more nuanced. Airsoft is a sport involving low-powered guns that shoot small plastic bullets, requiring eye protection. We report the first documented case of ocular injury from an airsoft bullet despite protective eyewear used as intended. It is our aim to highlight the importance of using appropriate polycarbonate eye protection during airsoft sporting.

## 2. Case report

A 12-year-old male presented to the UF Health Shands Hospital emergency department for decreased vision and left eye pain 2 hours after sustaining an ocular injury to the left eye (Fig. 1a). He was shot by a sibling from an airsoft gun through a protective mask. His protective mask had 1.5 mm diameter perforated steel mesh eye shields with a dent but no breaks (Fig. 1b). He had no past medical history or family history. His best corrected visual acuity was 20/20 in the right eye and 20/800 in the left eye. Intraocular pressure was 18 mmHg OD and 13 mmHg OS. Pupils were equal, round, and briskly reactive to light. Extraocular movements were full. Slit-lamp examination of the left eye revealed 1+ conjunctival injection, a 3.1 mmH x 2.8 mmV corneal abrasion superiorly (Fig. 1c) with underlying endothelial haze, and a 2.4mm layering hyphema with cells and flare in the anterior chamber. The lens and vitreous were normal. CT of the head and orbits (Fig. 1d), ultrasound of the left eye and limited fundus exam of the left eye were unremarkable.

He was prescribed topical cyclopentolate and moxifloxacin drops and instructed to follow up in clinic.

Upon examination on day 2 after the injury, the left iris was mid-dilated on cyclopentolate. Commotio retinae was observed peripherally on dilated fundoscopic exam. The hyphema had improved to 1 mm in height and his corneal abrasion had healed. The corneal endothelial haze was present but improving. He was treated with prednisolone acetate drops four times daily and cyclopentolate drops twice daily. The moxifloxacin drops were discontinued. His hyphema and corneal haze resolved completely by day 17 after his injury and his vision returned to 20/20. Regular follow-up was scheduled to monitor for long-term sequelae of the injury.

## 3. Discussion

Airsoft guns fire relatively low velocity small spherical plastic bullets (BBs), but they are still capable of inflicting significant ocular trauma. To our knowledge, this is the first documented case of an airsoft BB fragment causing ocular trauma through eyewear marketed for and intended for airsoft eye protection. A comprehensive review of ocular airsoft injuries between 2002 and 2012 found 71 cases where eyewear status was reported, from which 70 patients wore no eyewear while only one patient wore sunglasses.<sup>1</sup> A retrospective study published in 2018 found 92 patients in India with ocular airsoft injuries, none of whom wore eye protection.<sup>2</sup> Another study published in 2019 on toy guns found 12 ocular airsoft injuries in patients not wearing eye protection, although four patients were wearing eye protection that was removed before the

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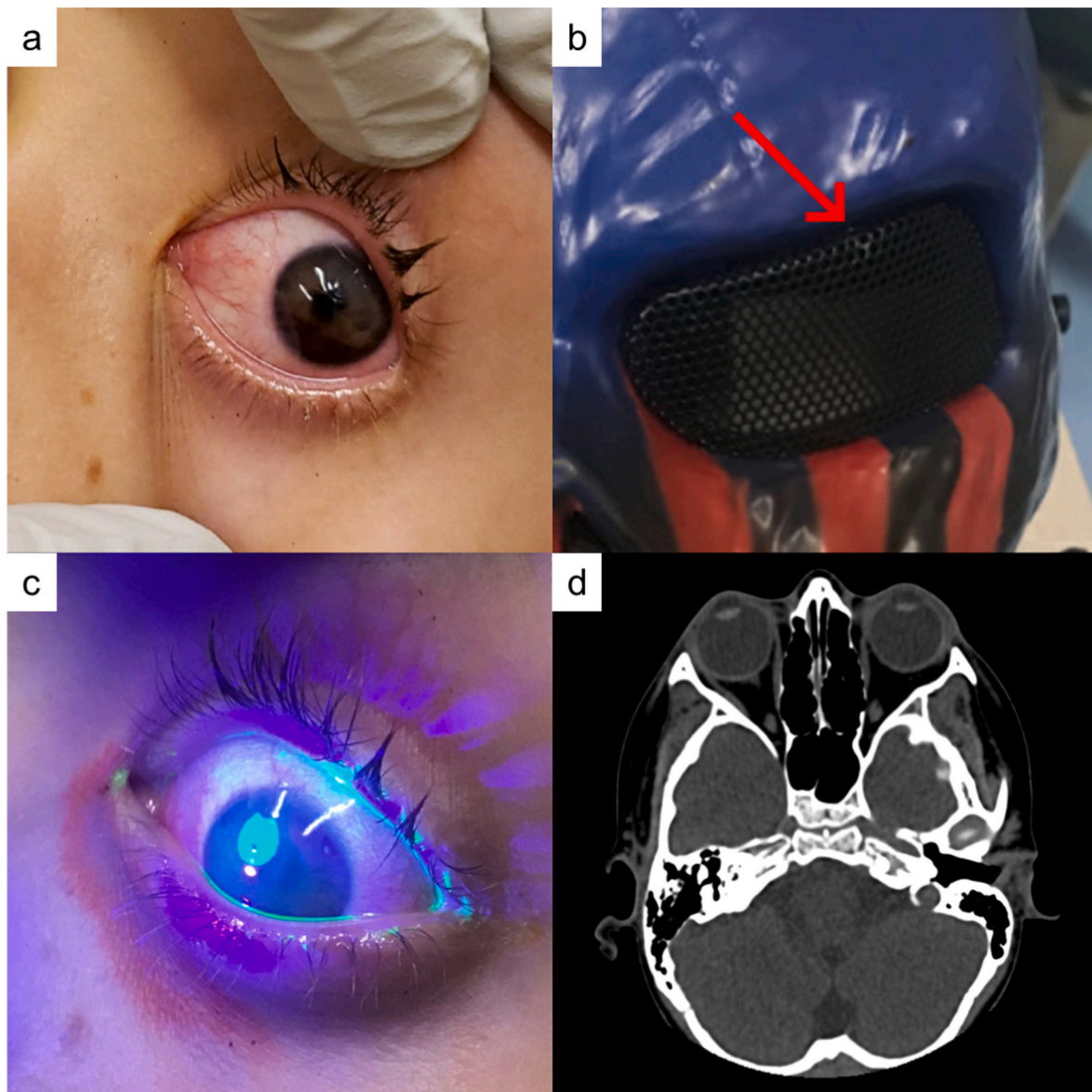
injury.<sup>3</sup>

Airsoft guns have a well-documented history of causing ocular trauma. A review of case series documenting injury type in 109 total patients documented anterior and posterior chamber injuries such as corneal abrasion, hyphema, mydriasis, iridodialysis, cataract, vitreous hemorrhage, and retinal edema.<sup>4,5</sup> Long-term follow-up studies found that some injuries may persist with subjective pain or vision impairment and that delayed cataracts may develop after acute trauma resolution.<sup>3,6</sup> Our patient had two of the most documented injuries, corneal abrasion and hyphema, and was scheduled for follow-up to monitor for formation of a traumatic cataract. Of note, his corneal abrasion also presented as a “donut” on fluorescein examination, characteristic of abrasions caused by airsoft guns.<sup>5</sup>

The projectile injuring our patient was a 0.20 g, 6 mm plastic bullet from a gun with a muzzle velocity of 375 feet per second (fps). Although the bulk of the bullet did not penetrate this patient’s mask, a plastic bullet fragment up to 1.5 mm wide (the diameter of the eye holes in the

mask) passed through the mesh to impact his eye. This mechanism of injury reduces the total energy of impact, but experiments found that a projectile’s normalized energy (energy per unit area) best predicts injury of the eye.<sup>7</sup> Even when a projectile’s mass is low, it can impact with a high normalized energy and cause serious ocular trauma. Results from this experimental analysis estimates that a 50% injury risk for corneal abrasion occurs at 775–2,214 kg/s<sup>2</sup>, while a 50% injury risk for globe ruptures require 20,194–30,714 kg/s<sup>2</sup>. Assuming the BB fragment striking this patient’s eye was spherical and broke off inelastically from the BB, it had a normalized energy of up to 11,560 kg/s<sup>2</sup>, well within the estimated normalized energy to cause significant ocular trauma.

Perforated eyewear such as the one worn by this patient is sometimes used because it does not fog or refract light. Its product information and promotional material states that it can resist an impact from a 0.2 g airsoft BB at up to 600 fps, far more energetic than the airsoft gun used to injure our patient. It also warns users to wear goggles for paintball guns but lacks such a disclaimer for airsoft BBs. Evidently, BB fragments may



**Fig. 1.** Images of the patient injury and paraphernalia obtained in the acute setting. (a) Patient’s left eye on initial presentation with 1+ conjunctival injection and grossly visible hyphema. (b) Left eye shield of protective mask, marketed to withstand standard 0.2 g airsoft BBs at 600 fps. There is a dent on the upper border where the culprit BB impacted marked with a red arrow. (c) Classic “donut” corneal abrasion under UV light with fluorescein stain. (d) Computed Tomography of head and orbits without contrast. No evidence of globe rupture, retained radiodense foreign body, or orbital hematoma. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

pass through small openings and cause ocular trauma regardless of the impact rating. The American Society for Testing and Materials (ASTM) sets standards for airsoft protective eyewear, which stipulates that airsoft protective eyewear may not have orbital openings greater than 4.5 mm in width.<sup>8,9</sup> The American Academy of Ophthalmology and American Academy of Pediatrics further recommends that all safety eyewear follow ASTM standards and be made from polycarbonate, a shatter-resistant plastic.<sup>10</sup> As of the writing of this case, this mask's manufacturer has recalled their perforated metal eye shields, but many other manufacturers still use wire mesh and perforated metal sheets with potential for similar injury.

#### 4. Conclusion

Airsoft guns fire relatively low velocity small spherical plastic bullets but have a well-documented history of causing ocular trauma. Perforated eyewear still exists on the market, and this case demonstrates that ocular injury from airsoft bullet fragments can occur even when using such eye protection as intended by the manufacturer. It is important to educate patients on the importance of using polycarbonate protective eyewear, as recommended by the American Academy of Ophthalmology and American Academy of Pediatrics.

#### Patient consent

The patient's legal guardian consented to publication of the case orally and in writing.

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#### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship. Yujia Zhou: conceptualization, methodology, images, calculations, and writing original draft. Esther Osuji: Patient care, images, writing, reviewing, and editing. Casey Beal: Supervision, patient care, reviewing, editing, and funding.

#### Intellectual property

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with

respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

#### Research ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

IRB approval was obtained (required for studies and series of 3 or more cases).

Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

#### Declaration of competing interest

There are no financial conflicts of interest to disclose.

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