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Paintball-related ocular trauma: Paintball or Painball?

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Background: The aim of this study is to describe the type and severity of paintball-related ocular trauma and to determine the necessary precautions to minimize the risk of ocular injury regardless of whether adequate eye protection was used.





Material/Methods: A retrospective chart review identified patients treated for paintball-related ocular trauma at the Ataturk University Medical Hospital from June 2010 through March 2013. A descriptive analysis of data was performed.

Results: Ten patients with paintball-related ocular trauma were identified. At the time of their first examination, 7 of these patients had visual acuity (VA) of 20/200 or worse. One patient had a final VA of no light perception and 4 patients had a final VA of 20/200 or worse. Hyphema was noted in 7 patients, traumatic cataract in 2, iridodialysis in 2, retinal detachment in 3, and secondary glaucoma in 1. Six patients required surgery. Although all victims have used eye protection during the game, all patients were injured after they thought the game was over and had taken off their helmets or eye-protective devices.

Conclusions: Paintball-related accidents result in serious ocular trauma and most of the patients require surgery. These injuries result in severe loss of VA in some patients. Uninterrupted use of proper eye protection whenever a player is in the game field, even after they believe the game has ended, may reduce the incidence of severe ocular trauma in paintball players.

MeSH Keywords: **Eye Protective Devices • Sports Injury • Eye Injuries**

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Background

Paintball is a game played outdoors in an open field between 2 teams. Players try to eliminate the opposing team's players from the game by shooting them with paintballs from compressed CO₂-powered rifles, often in order to capture their flag [1].

Paintballs are 17-mm projectiles containing non-toxic water-soluble dyes within a gelatin shell that ruptures upon impact, releasing the colored liquid to mark the player. Players who have been shot must sit out the remainder of that game. Compressed CO₂-powered rifles project paintballs at a muzzle velocity of 90 m/s (300 ft/s) or greater [2].

Paintball rifles were developed to be used in military training exercises. As war games became popular and as paintball rifles became more readily available for gaming purposes, the incidence of paintball-related ocular injuries increased tremendously [2].

In this study, we aimed to identify the type and severity of ocular injuries suffered during paintball, to determine whether eye-protective devices were used, and to suggest possible solutions to prevent ocular trauma in paintball.

Material and Methods

Ten patients who had been treated and followed in Atatürk University Faculty of Medicine Ophthalmology Clinic with a paintball-related ocular trauma between June 2010 and March 2013 were included in this study. Data from patients' records, collected at initial examination and follow-up appointments, were analyzed retrospectively, including visual acuity, intraocular pressure and examination of the anterior chamber and fundus. How the injury occurred and at what stage of the game were also noted from the patients' initial interview.

The study was planned according to the ethics guidelines of the Helsinki Declaration and study protocol was approved by the Atatürk University Faculty of Medicine local ethics committee.

Patients who opted to be referred to other clinics for follow-up were not included in the follow-up calculation.

Results

All patients were male. Mean age was 22.7 years (range: 16 to 27 years). Mean follow-up period was 12.6±8.3 months. Ocular pathologies due to paintball-related ocular trauma are listed in Table 1.

Table 1. Paintball related ocular pathologies.

	Number of patients
Hyphema	7 (70%)
Iridodialysis	2 (20%)
Cataract	2 (20%)
Lens subluxation	1 (10%)
Seconder glaucoma	1 (10%)
Scleral rupture	1 (10%)
Intravitreal haemorrhage	2 (20%)
Retinal detachment	3 (30%)
Choroidal rupture	1 (10%)

Case 1: A 22-year-old male with a left eye injury had an initial examination showing a VA at the level of hand motion (HM) and an intraocular pressure (IOP) of 36 mmHg. Anterior chamber examination revealed iridodialysis and hyphema. The patient was hospitalized. After hyphema resolved and even with maximum medical treatment, his intraocular pressure could not be controlled. Therefore, trabeculectomy was performed. In the patient's final examination, his VA was 20/20 and intraocular pressure was recorded as 16 mmHg.

Case 2: A 25-year-old male presented with a right eye injury. At the initial examination, his VA was at the level of HM and intraocular pressure was 15 mmHg. Anterior chamber examination revealed traumatic uveitis, iridodialysis in 1 quadrant, traumatic cataract and lens subluxation. Ten days after the trauma, the inflammation had resolved and cataract surgery was performed. After cataract extraction, the intraocular lens (IOL) could not be implanted. Two months after the cataract surgery, a secondary IOL was implanted. Postoperatively, the patient's best corrected VA was recorded as 20/40.

Case 3: A 20-year-old male presented with a left eye injury. His initial examination showed a VA at the level of hand motion (HM) and an IOP of 12 mmHg. Anterior chamber examination revealed cataract and USG suggested retinal detachment. Cataract surgery was performed, after which examination confirmed retinal detachment. Pars plana vitrectomy (PPV) was performed. Postoperatively, the patient's best corrected VA was recorded as 20/400.

Case 4: A 26-year-old male presented with a left eye injury. His initial examination showed a VA at the level of no light perception (NLP). The eye had corneal abrasion, hyphema, subconjunctival hemorrhage involving 360°. Due to ocular hypotony, scleral control was performed. A 1.5-cm rupture in the sclera was discovered and was treated by primary suture repair. After the procedure, ocular USG suggested vitreous hemorrhage. During

follow-up, the patient's VA was still NLP with ocular hypotony. He opted to be referred to another clinic for further treatment.

Case 5: A 16-year-old male with a left eye injury had an initial examination showing a VA at the level of 20/1250 and an IOP of 14 mmHg. Examination of the retina revealed macular edema. He received a posterior subtenon triamcinolone injection. Retinal detachment was detected 15 days after the trauma and PPV. Lens extraction and IOL implantation were performed. In the patient's final examination, the retina was not detached and his best corrected VA was recorded as 20/200.

Case 6: An 18-year-old male with a right eye injury had an initial examination showing VA at the level of hand motion (HM) and an IOP of 17 mmHg. Anterior chamber examination revealed corneal edema and hyphema. The fundus was not clearly observable due to severe vitreous hemorrhage. Ocular USG did not suggest retinal detachment. Vitreous hemorrhage was partially resolved 20 days after trauma and fundus examination revealed retinal detachment in the upper half and submacular choroidal rupture. PPV, lens extraction, and IOL implantation were performed. In the patient's final examination, the retina was not detached and VA was recorded as 20/320.

Four other patients presented to our clinic with blurred vision after suffering a paintball-related ocular trauma. Corneal edema and hyphema were observed. Of the 4, only 1 patient's VA was worse than 20/200 at the initial examination. At their final examinations all patients had VA of 20/20 and did not have any ocular pathology secondary to the trauma.

Of the 10 patients in this study, 7 (70%) had an initial VA of 20/200 or lower. One patient's final VA was at the level of NLP and 4 (40%) had final VAs of 20/200 or less.

Two patients (20%) underwent cataract surgery, 1 patient (10%) underwent trabeculectomy due to secondary glaucoma, and 3 patients (30%) underwent PPV due to retinal detachment. Two of the patients who underwent PPV also had lens extraction + IOL implantation. Scleral rupture in 1 patient (10%) was repaired by primary suturation.

According to patient interviews, each trauma took place on the game field. Although all patients wore eye-protective devices (EPDs) during the game, after completion of the game with the final whistle, they believed the game was over and removed their EPDs.

Discussion

There are many reports of sport-related ocular injuries from various sports, including boxing, basketball, baseball, and

football [3–5]. It is crucial to protect the eyes regardless of the type of the sports.

The war game of paintball was played for the first time in 1981 in New Hampshire. Since then, it has become a very popular game, with millions of players [6,7]. As the popularity of paintball increased, unofficial use of paintball guns also increased, and in some countries, cheaper paintballs made with hard plastic shells entered the market. As a result, the number of injuries suffered by paintball players began to increase dramatically [2].

Paintball-related ocular traumas have similarities with other blunt traumas. Similar ocular injuries result both from paintball projectiles, which travel at 80–130 m/s, and airgun projectiles, which travel at 260 m/s [8]. Globe trauma mechanisms due to paintball injuries consist of coup-contrecoup trauma and equatorial diameter expansion as a result of anterior-posterior pressure to the globe [9,10]. This mechanism explains how choroidal rupture and iridodialysis occur [11]. Large objects that cause diffuse periorbital impact result in less injury to the eye due to absorption of the shock by the orbital margin [12]. In fact, smaller and faster traveling objects usually result in serious ocular injury [13]. Paintball projectiles from compressed CO₂-powered rifles are smaller in size, have relatively higher mass, and most importantly, travel at very high speeds. These factors explain why paintballs are able to cause such serious ocular damage.

The most common anterior segment pathologies following blunt ocular trauma are hyphema, crystalline lens dislocation, traumatic cataract, angle recession, and iridodialysis [14]. The incidence of hyphema in paintball-related ocular trauma cases was 82% and 86% in 2 previous reports [13,14]. This is similar to our findings that 7 of 10 patients had hyphema, the most common anterior chamber pathology we identified. We also observed 2 patients with traumatic cataract (20%), 1 patient with lens subluxation (10%), and 2 patients with iridodialysis (20%).

The most common posterior segment pathologies following blunt ocular trauma include commotio retinae, choroidal rupture, retinal tear and dialysis, traumatic macular hole, and vitreous hemorrhage [14]. In this study we observed 2 patients with intravitreal hemorrhage, 3 with retinal detachment, and 1 with choroidal rupture. These patients had very low VA at the final examination after surgery.

To our knowledge, there are a few reports of scleral rupture following a paintball-related ocular trauma [15,16]. One of our patients had scleral rupture and his VA was NLP in his final examination. Bisplinghoff et al. studied the rupture pressures of 20 human eye bank eyes, finding a mean rupture pressure

of 2175 mm Hg [17]. Gray et al. conducted a study on porcine eyes, identifying of progressive injury mechanisms by paintball observing globe rupture in 6 eyes, with velocities ranging from 80 to 97 m/s. They emphasized that globe rupture occurred when a centerline hit was achieved at the highest impact velocities [18]. In our case, corneal abrasion may refer to a centerline hit and scleral rupture may be related to being shot at close range. Pain, visual loss, hyphema, anterior chamber depth loss, pupil irregularity, and subconjunctival hemorrhage involving 360° around the cornea with blunt ocular trauma are very suspicious for globe rupture [19]. In our cases, ocular hypotony was the most remarkable finding from exploration of the sclera.

Sports-related ocular injuries are 4 times more common in men and younger people also have more frequent ocular trauma [20]. In this series, all patients were young men.

The American Society for Testing and Materials (ASTM) has released field operation procedures, minimum safety requirements, and best practices for the operation of paintball games. These standard specifications and regulations related to paintball include presence of a referee, eye- and head-protective devices, and barrel-blocking devices to prevent accidental firing [2]. Recently, the military started using paintball for training purposes and cases of ocular trauma have also been recorded in military personnel who removed their eye-protective devices during training [13]. Eye-protective device usage became mandatory during war games and military training exercises due to the high risk of ocular injury [2].

In Canada, there have been 26 ocular trauma incidents during war games in 1985, but the number fell to 3 in 1992 [21]. This dramatic decrease is due to lawsuits and player safety briefings that explained proper EPD usage. It has been reported that ocular trauma related to war games most frequently takes place in commercial play areas [22–25]. Managers of commercial paintball arenas, where players pay to play and have fun, may not enforce the rules of the game because of concerns that they will lose business. In addition, ocular trauma occurs in unsupervised war games, where EPD may not be used.

Improper or non-usage of EPDs, lack of compliance to safety briefings, and insufficient audits despite the increasing number of war game arenas are the reasons behind paintball-related ocular traumas. Another possible cause is that war games have become more popular and are readily available. In the literature, these traumas occurred in players who were not

wearing or for some reason removed their EPDs during play [6,7,26]. Zwaan et al. reported 76 cases of ocular trauma; 68 of the patients had not been wearing protective eyewear, 20% of whom removed their EPD due to obscured vision caused by fogging or paint splatter from paintballs [13].

In the literature there are also several instances of ocular trauma occurring when players were wearing EPDs that did not meet current safety standards [21,26]. Mitchell et al. reported that 41% of the patients with paintball-related ocular trauma were in fact wearing EPDs. This indicates that EPD usage alone is not sufficient; players must be properly educated in EPD use and the EPD itself must be manufactured in compliance with ASTM standards [26].

It has been suggested that after proper training, the use of ASTM-compliant EPDs would reduce incidence of ocular trauma incurred during sports and recreational activities by 90% or more [21].

The EPDs provided to the patients who presented at our clinic did not meet ASTM standards; regardless, none of them were wearing their EPDs at the time of injury. In each case, the trauma occurred just as the game had finished with the final whistle, when the patient had removed his EPD but other players continued shooting.

Conclusions

Paintball traumas cause serious ocular pathologies. Paintball is gaining popularity and becoming more widespread; therefore, the issue of how to avoid player injury is receiving more public attention. Stringent rules to protect player safety while in the play arena should be strictly enforced, without financial concern. The most important safety precautions in paintball are that EPDs must meet ASTM standards and, since it is impossible to prevent players from shooting after the game has ended, it is imperative that players never remove their EPDs before completely leaving the playing field.

Statement

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The authors declare that they have no conflict of interest regarding the publication of this article.

References:

- Tardif D, Little J, Mercier M et al: Ocular trauma in war games. *Phys Sports Med*, 1986;14: 91–94
- American Society for Testing and Materials. Standard practice for paintball field operation. In: 1997 Annual Book of ASTM Standards. West Conshohocken, Pa: American Society for Testing and Materials, 1997; 1391–401
- Corrales G, Curreri A: Eye trauma in boxing. *Clin Sports Med*, 2009; 28: 591–607
- Heimmel MR, Murphy MA: Ocular injuries in basketball and baseball: what are the risks and how can we prevent them? *Curr Sports Med Rep*, 2008; 7: 284–88
- Gökçe G, Ceylan OM, Erdurman FC et al: Soccer Ball Related Posterior Segment Closed-Globe Injuries in Outdoor Amateur Players. *Ulus Travma Acil Cerrahi Derg*, 2013; 19(3): 219–22
- Kruger LP, Acton JK: Paintball ocular injuries. *S Afr Med J*, 1999; 89: 265–68
- Kitchens JW, Danis RP: Increasing paintball related eye trauma reported to a state eye injury registry. *Inj Prev*, 1999; 5: 301–2
- Hargrave S, Weakly D, Wilson C: Complications of ocular paintball injuries in children. *J Pediatr Ophthalmol Strabismus*, 2000; 37: 338–43
- Benson WE: The effects of blunt trauma on the posterior segment of the eye. *Trans Pa Acad Ophthalmol Otolaryngol*, 1984; 37: 26–33
- Campbell DG: Traumatic glaucoma. In: Shingleton BJ, Hersh PS, Kenyon KR (eds.), *Eye Trauma*. St Louis, Mo: Mosby-Year Book Inc., 1991; 117–25
- Shehadeh-Masha'our R, Jabaly-Habib H, Garzosi H: Ocular paintball injury with and without eye protection. *Asian J Ophthalmol*, 2004; 6: 13–14
- Eagling EM: Ocular damage after blunt trauma to the eye: its relationship to the nature of the injury. *Br J Ophthalmol*, 1974; 58: 126–40
- Zwaan J, Bybee L, Casey P: Eye injuries during training exercises with paint balls. *Mil Med*, 1996; 161: 720–22
- Easterbrook M, Pashby TJ: Ocular injuries and war games. *Int Ophthalmol Clin*, 1988; 28: 222–24
- Taban M, Taban M, Sears JE: Ocular findings following trauma from paintball sports. *Eye (Lond)*, 2008; 22: 930–34
- Greven CM, Bashinsky AL: Circumstance and outcome of ocular paintball injuries. *Am J Ophthalmol*, 2006; 141: 393
- Bisplinghoff JA, McNally C, Duma SM: High-rate internal pressurization of human eyes to predict globe rupture. *Arch Ophthalmol*, 2009; 127: 520–23
- Gray W, Sponsel WE, Scribbick FW et al: Numerical modeling of paintball impact ocular trauma: identification of progressive injury mechanisms. *Invest Ophthalmol Vis Sci*, 2011; 52: 7506–13
- Pokhrel PK, Loftus SA: Ocular emergencies. *Am Fam Physician*, 2007; 76: 829–36
- Tielsch JM, Parver L, Shankar BS: Time trends in the incidence of hospitalized ocular trauma. *Arch Ophthalmol*, 1989; 107: 519–23
- Pashby TJ: Eye injuries in Canadian sports and recreational activities. *Can J Ophthalmol*, 1992; 27: 226–29
- Easterbrook M, Pashby TJ: Eye injuries associated with war games. *CMAJ*, 1985; 133: 415–19
- Ryan EH Jr, Lissner G: Eye injuries during “war games”. *Arch Ophthalmol*, 1986; 104: 1435–36
- Mamalis N, Monson MC, Farnsworth ST, White GL Jr: Blunt ocular trauma secondary to “war games”. *Ann Ophthalmol*, 1990; 22: 416–18
- Welsh NH, Howes F, Lever J: Eye injuries associated with “war games”. *S Afr Med J*, 1989; 76: 270–71
- Mitchell S, Fineman MS, Fischer DH et al: Changing trends in paintball sport-related ocular injuries. *Arch Ophthalmol*, 2000; 118: 60–64