Clinical features of different types of the eye trauma and its outcomes in children

Forlini Matteo [1], Bobrova Nadiia [2], Tronina Svitlana [2], Dembovetska Hanna [2], Romanova Tetiana [2], Dovhan Olga [2]

[1] Department of Ophthalmology, San Marino State Hospital, San Marino (Republic of San Marino)
[2] SI «The Filatov Institute of Eye Diseases and Tissue Therapy of NAMS of Ukraine», Odesa (Ukraine)

Клінічні особливості різних видів травм ока та їх наслідки у дітей

Форліні Маттео [1], Боброва Н. [2], Троніна С. [2], Дембовецька Г. [2], Романова Т. [2], Довгань О. [2]

[1] Державна лікарня Сан-Марино, офтальмологічне відділення, Сан-Марино (Республіка Сан-Марино)
[2] ДУ «Інститут очних хвороб і тканинної терапії ім. В. П. Філатова НАМН України», Одеса (Україна)

Abstract

Purpose: *The study aimed to determine the clinical features of the eye trauma and its outcomes in children in Ukraine.*

Methods: *The features of the clinical picture of different types of eye trauma, methods of treatment and consequences are analyzed.*

Results: *Pediatric eye trauma is characterized by a predominance - 63.4% of OGIs with damage to 3 or more structures of the eye in 88.4% of cases, the highest frequency of injury to the lens (73.1%), in 61.6% of cases with the presence of foreign bodies and in 50% there was a combination of open and closed damage to the eyeball.*

Conclusion*: Clinical features of pediatric eye trauma require differentiated clinical tactics including surgical and conservative methods. Reconstructive surgical rehabilitation including complex procedures with maximum restoration of all injured structures with IOL implantation using advanced technologies combined with conservative treatment allow to restore high visual acuity (0.3 and higher) in 64.3% of cases of the explosive injury in follow up terms.*

Keywords: *ocular injury, treatment, outcomes, children.*

Резюме

Мета: *визначити клінічні особливості травми ока та їх наслідки у дітей в Україні.*

Методи. *Проаналізовано особливості клінічної картини різних видів травм ока, методи лікування та наслідки.*

Результати. *Дитяча травма ока характеризується переважанням – 63,4% відкритих травм з пошкодженням трьох або більше структур ока у 88,4% випадків, найвищою частотою пошкодження кришталика (73,1%), у 61,6% випадків з наявністю сторонніх тіл та у 50% - поєднання відкритого та закритого пошкодження очного яблука.*

Висновки. *Клінічні особливості дитячої травми ока вимагають диференційованої клінічної тактики, що включає хірургічні та консервативні методи. Реконструктивна хірургічна реабілітація, що включає комплексні процедури з максимальним відновленням усіх пошкоджених структур з імплантацією ІОЛ з використанням передових технологій у поєднанні з консервативним лікуванням, дозволяє відновити високу гостроту зору (0,3 і вище) у 64,3% випадків вибухової травми в подальші терміни спостереження.*

Ключові слова: *травма ока, лікування, результати, діти.*

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Corresponding author: Tronina S. SI «The Filatov Institute of Eye Diseases and Tissue Therapy of NAMS of Ukraine» Frantsuzkiy Bulvar 49/51, Odesa, Ukraine, 65015, Ukraine.
E-mail: svetlanatronina@ukr.net

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Introduction

Children and teenagers are among the most vulnerable populations who suffer during armed conflicts. They are most frequently injured by explosions, which may be directly ascribed to hostilities or other reasons. [1] Over the last two decades, public conflicts involving various types of weapons have mainly occurred in cities with a significant population density, including the pediatric population. Children may suffer from intentional injury and may also become accidental victims, being in the center of using any weapon, including explosive devices. The experience of modern conflicts in Iraq, Afghanistan, Syria, and the Gaza Strip supports this. [2, 3, 4, 5]

Analysis of data from military medical facilities located in zones of armed conflict and hostilities, which treat all wounded and victims-including adults and children-shows that the proportion of children who received medical care varied between 3 % and 18 % of all hospitalizations. [6-10] Moreover, children may sustain eye injuries at home when firearms fall into their hands through careless handling or when they are exposed to homemade explosive devices, whose production has become more frequent in recent times.

This study investigated the clinical characteristics of eye trauma and its outcomes among children in Ukraine.

Methods

A total of 36 children (41 eyes) aged 4–17 years (mean age 11 ± 3.2 years) who sustained various explosive and bullet-related eye and ocular adnexa injuries were treated at the Pediatric Ophthalmopathology Department of the State Institution "The Filatov Institute of Eye Diseases and Tissue Therapy of NAMS of Ukraine" and were included in the retrospective study. Among the participants, 35 were boys and 1 was a girl.

This retrospective study followed the principles of the Declaration of Helsinki and received approval from the Institute's ethics committee (protocol № 4, 14.04.2022). Results were collected, organized, and statistically analyzed with SPSS Statistics (trial version).

Nominal data were presented as absolute counts and percentages. Quantitative indices were tested for normality using the Shapiro–Wilk test. For normally distributed data on children's ages, we formed a variational series and calculated the arithmetic mean (M) and its standard error (m).

The classification and identification of mechanical eye injury types within the study group were performed according to the Birmingham Eye Trauma Terminology. [11].

Results

Open globe injuries (OGIs), including penetrating wounds, perforation, and eyeball rupture, were observed in the majority of cases (63%, 22 children, 26 eyes). Closed globe injuries (CGIs) were less common, occurring in 36.6% of cases (14 children, 15 eyes). Binocular trauma was observed in 5 cases (11.1%) within the study group, comprising 4 children (18.2%) with OGIs and one case of contusion. Additionally, 13 eyes (50.0%) with OGIs displayed an extra contusion component, attributable to the characteristics of the damaging agent.

The following circumstances caused eye injury: an explosion of a homemade explosive device in 11 eyes (26.8%), a firecracker explosion or unknown object in 9 eyes (22.0%), a bullet wound, including ricochet, in 20 eyes (48.8%), and an explosion of a combat projectile in 1 eye (2.4%) (Table 1).

Table 1 shows that the most common injury type was OGIs, occurring in two-thirds of the studied cases. These injuries were most often caused by an improvised explosive device (24.4 %) or a bullet wound (26.8 %). Overall, bullet wounds were the most frequently reported injury (48.8 %), accounting for both penetrating wounds and contusions at approximately equal rates (26.8 % and 22.0 %, respectively).

Table 2 presents the clinical manifestations of the eye and ocular adnexa in patients with open explosive injury upon admission to the Pediatric Ophthalmopathology Department.

Table 2 shows that lens damage was the most frequent injury (73.1 %), followed by corneal-scleral injuries, which accounted for 57.7 % of cases in the OGI group. Common symptoms were hyphema (43.3 %), hemophthalmos (38.4 %), and retinal detachment (30.7 % of cases). Terminal damage, defined as rupture of the eyeball with loss of intraocular contents, occurred in two eyes (7.7 %).

While analyzing the clinical features of OGIs in pediatric patients, it should be noted that most cases (88.4%) involved simultaneous injuries to three or more structures of the eye ball. These findings confirm the results of previous studies on the pediatric eye trauma in Ukraine [12,13].

Table 1. Circumstances of eye injury in children

Type of injury	Circumstances of injury								Total	
	Explosion of a home-made device		Explosion of a firecracker		Bullet wound		Explosion of a combat projectile			
	n	%	n	%	n	%	n	%	n	%
Open globe injuries	10	24.4	5	12.2	11	26.8	–		26	63.4
Close globe injuries	1	2.4	4	9.8	9	22.0	1	2.4	15	36.6
Total	11	26.8	9	22.0	20	48.8	1	2.4	41	100

Table 2. Clinical manifestations of the open globe injury in children

Symptom	Number of eyes (26 eyes – 100%)	%
Corneal wounds and scars	11*	43.3
Corneal –scleral wounds and scars	15*	57.7
Hyphema	11*	43.3
Lens damage	19*	73.1
Hemophthalmus	10*	38.4
Tears of the pupil	2*	7.7
Mydriasis	1*	3.8
Eyelids damage	5*	19.2
Retinal detachment	8*	30.7
Rupture of the eyeball	2	7.7
Eyeball subatrophy	4	15.4
Sympathetic irritation of the paired eye	2	7.7

Note. * - in one eye

OGIs were complicated by foreign bodies in 16 cases (61.6%). Intraocular foreign bodies (IOFBs) were most commonly observed, in 12 eyes (75.0%). Among these, 8 eyes (72.7%) had IOFBs in the vitreous cavity, 2 eyes (18.2%) in the lens, and 1 eye (8.3%) in the anterior chamber. In one case, multiple foreign bodies were found within the corneal and conjunctival thickness. Foreign bodies were found in the soft tissues of the eyelids and face in two cases and in the orbit in two cases. Of the 16 foreign bodies, 12 (75.0 %) were metal, 3 (18.8 %) were glass fragments, and 1 was a plastic fragment. In four children, IOFB removal was performed during primary surgical repair (PSR) at the patients' residence, so the magnetic properties were not always known. Of those that were removed in the Pediatric Ophthalmopathology Department during primary corneal wound repair, traumatic cataract removal or vitrectomy, amagnetic foreign bodies were mostly encountered - 6 out of 8 cases. Multiple IOFBs were recorded in 27.3% of eyes. Fragments were localized in the orbit after a wound from an air weapon.

Among patients with IOFBs removed in the Pediatric Ophthalmopathology Department during primary corneal wound repair, traumatic cataract removal, or vitrectomy, amagnetic foreign bodies were found in 6 of 8 cases. Multiple intraocular foreign bodies were observed in 27.3% of the eyes. Fragments were located in the orbit after an air weapon wound.

Among the comorbid injuries the damage to the upper limbs with traumatic amputation of the phalanges of the fingers in two children, injuries to the torso were noted also in cases.

Among the comorbid injuries, two children suffered upper limb damage, traumatic amputation of finger phalanges, and injuries to the torso.

PSR of wounds was carried out at the patient's residence in 15 eyes (36.5%); consequently, this procedure was performed in the Pediatric Ophthalmopathology Department only in 5 eyes (19.2%). The sutures used during PSR at the patient's residence, which were placed at two-thirds of corneal wound thickness, proved insufficient, leading to secondary surgical repair (SSR) in 4 eyes (15.4%) with 100% corneal-thickness sutures [14]. This immediate strengthening of the corneal wound restored the anterior chamber depth on the operating table. SSR also included IOFB removal in one eye.

As it can be seen from the Table 2, since open explosive trauma resulted in damage to the lens in almost 2/3 of the cases, the interventions on the lens appeared to be the most frequent ones and had a reconstructive nature – phacoaspiration with primary IOL implantation with simultaneous separation of anterior and posterior synechias, iridoplasty and anterior vitrectomy (Table 3). It should be noted that it was performed a full volume of reconstructive surgical rehabilitation of this injury type with primary IOL implantation to the partially damaged capsular bag in the cases of three eye structures (cornea, iris and lens) defect, which significantly complicated the very process of IOL implantation [13]. As a result in 90% of primary implanta-

Table 3. Types of surgery in eyes with open globe injury in children

Kind of intervention	Number of eyes (26 eyes – 100 %)	%
Kind of intervention	3*	11.5
PSR of eyelids wounds	5*	19.2
PSR of corneal and scleral wounds	4*	15.4
Secondary surgical repair (SSR)	9*	34.6
Phacoaspiration with primary IOL implantation	13* 10*	50.0 38.5
Lensvitrectomy	2*	7.7
Scar adhesions separation	11*	42.3
Iridoplasty	3*	11.5
Anterior vitrectomy	2*	7.7
Close vitrectomy with vitreous tamponade	6*	23.1
Secondary IOL implantation	1*	3.8
Enucleation with the primary locomotor stump formation	6	23.1
Secondary locomotor stump formation	1	3.8

Note. * - in one eye

tions IOL was placed in the capsular bag and only in 1 case IOL was implanted in the ciliary sulcus.

It should be noted that primary enucleation was not performed even in cases of extensive eyeball injuries. In two cases of eyeball rupture (traumatic spontaneous evisceration) with the loss of almost all eye contents, scleral remnant plasty with removal of residual choroid fragments was performed to create a primary locomotor stump. Severe eyeball subatrophy with the presence of chronic post-traumatic uveitis was the indications for enucleations. A primary locomotor stump was formed in four cases, and sympathetic irritation of the other eye developed during treatment in two cases.

Unlike OGIs, where the anterior eye segment sustained the most damage, CGIs most severely affected the structures of the posterior eyeball segment (Table 4).

In 46.7 % of cases, CGIs resulted from foreign bodies, such as lead balls, that entered the orbit and appeared as an injurious agent during a shot from a pneumatic weapon, like a rifle or a pistol. In one case, the foreign bodies of the orbit were multiple, and in others, they were single. Due to the inert nature of the bullet material, which does not provoke inflammatory or toxic reactions in surrounding tissues, orbital foreign bodies were removed in only two cases: when located superficially in subcutaneous tissue and when a secondary wound-channel infection was present.

In 20.0% of cases, contusion traumatic cataract developed and required phacoaspiration with simultaneous endocapsular IOL implantation. Due to the characteristics of child's organism, particularly the possibility of active resorption of intraocular hemorrhages, surgical treatment of hyphema, hemophthalmos and subretinal hemorrhages was unnecessary; these conditions resolved successfully with conservative management. Post-traumatic inflammation, together with contusive and secondary degenerative changes in the ocular posterior segment structures, also necessitated appropriate pharmacologic treatment.

At admission, visual acuity ranged from 0 to 1.0, the latter is a finding observed only in a single child who had a peripheral corneal scar and a glass fragment in the anterior chamber (Table 5). In most cases, children who sustained explosive injuries exhibited significantly reduced visual function: 19.5 % displayed complete loss of object vision (zero), while 43.9 % had impaired light projection and visual acuity below 0.1.

The results of 33 eyes with OGIs and CGIs were studied after surgery and conservative treatment (out of the original 41 eyes, 2 were spontaneously eviscerated at the injury and 6 were enucleated). VA of 0.3 and higher was obtained in 51.5% of the eyes. During the long-term follow-up, 64.3 % of cases achieved a visual acuity of 0.3 or better, demonstrating the effectiveness of the restorative reconstructive procedures and therapeutic measures even though the injuries were initially severe. In a single contusion case, deterioration of visual function was noted due to progressive optic nerve atrophy.

Table 4. Clinical manifestations of close globe injury in children

Symptom	Number of eyes (15 eyes – 100 %)	%
Subconjunctival hemorrhage	3*	20.0
Hyphema	3*	20.0
Hemophthalmos	6*	40.0
Iridocyclitis	2*	13.3
Traumatic cataract	3*	20.0
Intra – and subretinal hemorrhage	5*	33.3
Berlin's opacification of the retina	2*	13.3
Corneal foreign body	1*	6.7
Choroid rupture	3*	20.0
Mydriasis	1*	6.7
Optic nerve contusion and atrophy	4	26.7
Retinal degeneration	5	33.3
Macular hole	1	6.7
Orbital foreign body	7*	46.7
Orbital walls fracture	1*	6.7
Eyelids and anterior eye surface burn	3*	20.0

Note. * - in one eye

Discussion

Injuries resulting from explosions are classified into four types [15, 16]: 1) primary or level I injuries, where the detonation wave itself can cause primary trauma in a varying degree; 2) secondary or level II injuries, such as damage by fragments that occurred during the destruction of the surroundings objects, for example, glass, dust, and masonry of some buildings; 3) tertiary or level III injuries due to the blast wave, which leads to the movement of the victim body or pressing down; 4) level IV injuries, thermal injuries by a heat wave or high-pressure chemical reaction occurring as a result of an explosion. Injury types differ according to distance from the explosion site, blast severity, and explosion source [17].

Accidental fireworks explosions can also cause serious injuries on a smaller scale, including eye damage in the pediatric population [18-20]. In 2020, the United States alone recorded over 15,000 injuries attributed to fireworks [21], and since 2000, an average of 3,400 explosions has occurred annually [22].

Researchers also note that natural gas explosions and accidental detonations of old ammunition are additional contributors to pediatric injuries from explosions occurring outside armed conflicts [1].

Table 5.Visual acuity of the eyes of children after the injury at the time of hospitalization, after surgical interventions and in the long –term follow –up

Visual acuity	Explosive eye injuries		
	On hospitalization 41 eyes – 100 % n (%)	After surgical intervention and treatment 33 eyes – 100 % n (%)	Long-term follow-up 14 eyes – 100% n (%)
Zero	8 (19.5)	1 (3.0)	1 (7.1)
Wrong light projection	6 (14.6)	4 (12.1)	–
Correct light projection	6 (14.6)	1 (3.0)	1 (7.1)
Hand movement	4 (9.8)	1 (3.0)	1 (7.1)
0.01 –0.09	2 (4.9)	2 (6.1)	1 (7.1)
0.1 –0.2	3 (7.3)	9 (27.3)	2 (14.3)
0.3 and higher	12 (29.3)	17 (51.5)	9 (64.3)

Note. *8 eyes were lost (2 were eviscerated, 4 were enucleated)

Monocular injuries prevailed in our research group (86.1%), whereas binocular injuries were observed only in 13.9% (18.2% of OGIs and a single case of contusion). AlGhadeer et al. [23] and Patel et al. [24] reported similar findings, noting that the binocular nature of injuries unrelated to combat device explosions occurred in 3.33% to 16.32% of cases in the studied group. These characteristics are typical of explosions involving relatively small power devices. However, the same studies reported a prevalence of CGIs compared to OGIs, a finding that contrasts with our data. Studies of modern combat trauma indicated the predominance of OGIs [23, 25-27]. The higher incidence of OGIs observed in our study is likely attributable to the characteristics of the explosive devices used by children; over one third were homemade and produced a large quantity of small fragments upon detonation, resulting in an open wound of the eyeball.

Comparing the clinical characteristics of eye injuries caused by explosions in our cohort with those reported in other studies, it should be noted that the most common symptoms – hyphema and hemophthalmos – were observed by Zhang et al. in 27.88 % and 40.10 % of cases, respectively [28], and met with a similar frequency in the cohort we analyzed, with hyphema in 34.1 % and hemophthalmos in 39.1 % of cases. Furthermore, our findings corroborate those of Zhang et al., who observed a higher frequency of traumatic cataract development (65.25% after OGIs compared to 34.83% after CGIs). Moreover, in our group, lens damage after OGIs was observed more often, in 73.1% of patients, whereas after CGIs it was observed in only 20.0% of patients. The localization of foreign bodies differed from that described in the aforementioned study [28], where superficial foreign bodies were most frequently observed (31.61 %), whereas in our group they were observed only in 16 % of cases. Our study identified IOFBs in 48% of all cases overall, with a rate of 75% in OGIs, compared to 27.54% reported by Zhang et al. In addition, intraorbital foreign bodies were more commoin in our study, 36 % vs. 6.35 % of cases in the aforementioned study.

Conclusion. The analysis of features of eye trauma in children in Ukraine showed that this age group is characterized by a predominance of OGIs (63.4%) with damage to three or more structures of the eye in 88.4% of cases, the highest frequency of lens injury (73.1%), the presence of foreign bodies in 61.6% of cases, and a combination of open and closed damage to the eyeball in 50% of cases. Reconstructive surgical rehabilitation, with complex procedures aiming for maximum restoration of all injured structures and IOL implantation using advanced technologies, together with conservative treatment, achieves high visual acuity (0.3 and higher) in 64.3% of cases with explosive injuries during follow-up.

Author Contributions

Forlini M. – idea; Bobrova N. – conceptualization, methodology, reviewing and editing; Tronina S. – writing – designing; analysis and interpretation of data, reviewing and editing; Dembovetska H. – investigation, analysis and interpretation of data; Romanova T. – investigation, acquisition of data, formal analysis; Dovgan O. – acquisition of data formal analysis. All authors analyzed the results and approved the final version of the manuscript.

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Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

Ethical approval

This retrospective study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration. Written informed consent was obtained from the parents.

The study was the part of the scientific researches of the department which were approved by the local Ethics Committee of the Filatov Institute of Eye Diseases and Tissue (protocol № 4, 14.04.2022).

Data Availability Statement

All data generated or analyzed during this study are included in this published article.

Abbreviations

OGIs – open globe injuries, CGIs – close globe injuries, IOFBs – intraocular foreign bodies, PSR – primary surgical repair.

References

1. Tovar MA, Pilkington RA, Goodwin T, Root JM. Pediatric Blast Trauma: A Systematic Review and Meta –Analysis of Factors Associated with Mortality and Description of Injury Profiles. Prehosp Disaster Med. 2022 Aug;37(4):492-501.. https://doi.org/10.1017/S1049023X22000747
2. Hicks MHR, Dardagan H, Guerrero Serdán G, Bagnall PM, Sloboda JA, Spagat M. The weapons that kill civilians –deaths of children and noncombatants in Iraq, 2003 –2008. N Engl J Med. 2009 Apr 16;360(16):1585-8. https://doi.org/10.1056/NEJMp0807240
3. Bilukha OO, Brennan M. Injuries and deaths caused by unexploded ordnance in Afghanistan: review of surveillance data, 1997–2002. BMJ (Clinical research ed.) 2005; 330(7483):127–128. https://doi.org/10.1136/bmj.38337.361782.82
4. Guha-Sapir D, Rodriguez-Llanes JM, Hicks MH, Donneau AF, Coutts A, et al. Civilian deaths from weapons used in the Syrian conflict. BMJ. 2015 Sep 29:351:h4736. doi: 10.1136/bmj.h4736.
5. Smith K. Devastating Impact: Explosive Weapons and Children. Save the Children. 2011.
6. Heller D. Child patients in a field hospital during the 2003 Gulf conflict. J R Army Med Corps. 2005 Mar;151(1):41-3.
7. Beitler AL, Wortmann GW, Hofmann LJ, Goff JM Jr. Operation Enduring Freedom: the 48th Combat Support Hospital in Afghanistan. Mil Med 2006; 171(3): 189–93 . https://doi.org/10.7205/milmed.171.3.189
8. McGuigan R, Spinella PC, Beekley A, Sebesta J, Perkins J, Grathwohl K, et al. Pediatric trauma: experience of a combat support hospital in Iraq. J Pediatr Surg. 2007 Jan;42(1):207-10. doi: 10.1016/j.jpedsurg.2006.09.020.
9. Creamer KM, Edwards MJ, Shields CH, Thompson MW, Yu CE, Adelman W. Pediatric wartime admissions to US military combat support hospitals in Afghanistan and Iraq: learning from the first 2,000 admissions. J Trauma. 2009 Oct;67(4):762-8. doi: 10.1097/TA.0b013e31818b1e15.
10. Borgman M, Matos RI, Blackbourne LH, Spinella PC Ten years of military pediatric care in Afghanistan and Iraq. J Trauma Acute Care Surg. 2012 Dec;73(6 Suppl 5):S509-13. doi: 10.1097/TA.0b013e318275477c.
11. Kuhn F, Morris R, Witherspoon CD, Mester V. The Birmingham Eye Trauma Terminology system (BETT). J Fr Ophtalmol. 2004 Feb;27(2):206-10. doi: 10.1016/s0181-5512(04)96122-0.
12. Bobrova NF. Eye trauma in children. M, Medicine. 2003.
13. Bobrova NF. Reconstructive surgery of eye in childhood. Odessa: Feniks. 2013. 176 p.
14. Bobrova NF, Shevchik VI. The method of primary surgical treatment of the penetrating cornea injuries. J of Ophthalmol. (Ukraine). 2010. 4:65 –68.
15. Mellor SG. The pathogenesis of blast injury and its management. Br J Hosp Med. 1988; 39:536–539.
16. Wolf SJ, Bebarta VS, Bonnett CJ et al. Blast injuries. Lancet. 2009; 374(9687): 405–415.
17. Kurup SK, Que ET, Kauffmann Jokl DH The world trade center disaster: a brief on-site report from ground zero. Arch Ophthalmol. 2002; 120(3):395–396.
18. Demirbag S, Cetinkursun S, Surer I, Ozturk H. Bronchial tear in a child after a liquid petroleum gas tank explosion. Pediatr Emerg Care. 2005; 21(7):443–444. https://doi.org/10.1097/01.pec.0000169436.44562.26
19. Matheron AS, Hendriks S, Facca S, Liverneaux PA. Hand injuries due to firework devices: a series of 58 cases. Chir Main. 2014 Apr;33(2):124-9. doi: 10.1016/j.main.2013.12.005. Epub 2014 Feb 4.
20. Ratto J, Johnson BK, Condra CS et al. Pediatric blast lung injury from a fireworks –related explosion. Pediatr Emerg Care. 2012; 28(6): 573–576.
21. Marier A, Smith B, Lee S. Fireworks Annual Report: Fireworks –Related Deaths, Emergency Department –Treated Injuries, and Enforcement Activities during 2020. Consumer Product Safety Commission. October 26, 2021.
22. Miller E, LaFree G, Dugan L. Global Terrorism Database. START. 2020.
23. AlGhadeer H, Khandekar R. Profile and Management Outcomes of Fireworks –Related Eye Injuries in Saudi Arabia: A 16 –Year Retrospective Study. Clin Ophthalmol (Auckland, N.Z.). 2021; 15:4163–4168. https://doi.org/10.2147/OPTH.S333121
24. Patel R, Mukherjee B. Crash and burn: ocular injuries due to fireworks. Semin Ophthalmol. 2016; 31(3): 243–248.
25. Alam M, Iqbal M, Khan A, Khan SA. Ocular injuries in blast victims. J Pak Med Assoc. 2012 Feb;62(2):138-42.
26. Verma S, Waikar S, Sharma V, Bhatkoti B , Chauhan R . Ocular trauma in counter insurgency and proxy war environment: epidemiological study, 1992–2004. Med J Armed Forces India. 2021 Oct;77(4):390-396. doi: 10.1016/j.mjafi.2020.02.001.
27. Kalayci M, Er S, Tahtabasi M. Bomb Explosion: Ocular Effects of Primary, Secondary and Tertiary Mechanisms. Clin Ophthalmol. (Auckland, N.Z.). 2020; 14:1145–1151. https://doi.org/10.2147/OPTH.S253438
28. Zhang Y, Kang X, Wu Q et al. Explosive eye injuries: characteristics, traumatic mechanisms, and prognostic factors for poor visual outcomes. Mil Med Res. 2023; 10: 3.