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Ophthalmological injuries caused by gunshot wounds and shell fragments

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HIGHLIGHTS

This study recommends a comprehensive approach to addressing gunshot eye injuries, including peace strategies, targeted education, improved medical care and enhanced prevention measures.

ABSTRACT

This retrospective study analyses 57 gunshot eye injury cases at Trauma University Hospital in Tirana, Albania, from 1995–2006 using SPSS software. Gunshot eye injuries made up 33% of all explosion and firearm-related eye injuries, with peaks in 1997 and 1999 due to the escalation of conflict. Males constituted 93% of cases, with 38.5% aged 11–20. Severe injuries were 84%, with 90% causing serious eye damage and 10% resulting in death or bilateral blindness. Concomitant injuries occurred in 88% of cases, and all had foreign bodies complicating treatment. This study provides data to improve prevention, diagnosis, treatment, and rehabilitation of gunshot eye injuries.

Key words: foreign bodies, visual acuity, blindness, military conflicts, eyeball trauma

INTRODUCTION

Ophthalmic injuries are a major cause of visual impairment and blindness globally, posing a serious challenge to healthcare systems. These injuries significantly impact victims' quality of life and entail substantial treatment and rehabilitation efforts, with notable social and economic repercussions. Among these, eye injuries caused by firearms – whether from bullets or shell fragments – are particularly concerning. While often associated with military conflicts, such injuries also occur in peacetime due to accidents or civilian firearm use.

Gunshot wounds to the eyes often result in severe, irreversible outcomes, such as vision loss, necessitating complex and prolonged treatment and rehabilitation. The study by Menezes et al., based on data from the Nationwide Inpatient Sample, found that among 101,300 firearms injuries, 15.9% involved the head and neck [1]. Injuries to this area were characterised by higher mortality rates, length of hospital stay and costs than injuries to other parts of the body. The results highlight the high medical and financial burden associated with head and neck injuries caused by bullets. Another study by Rana et al. from 2023 covered 131 cases of ophthalmic injuries in military personnel involved in counter-terrorism operations [2]. The main causes of injuries were related to explosions (45.8%), shooting (11.42%) and stone-throwing (12.21%). These findings highlight the severity of the impacts faced by soldiers in active combat zones and the importance of providing protective equipment, such as safety glasses, to reduce the risk of such injuries. Outside of combat, these types of injuries are very rare. A study by Mayer et al. found only 7 cases of orbital gunshot wounds recorded in a university hospital over 11 years (2007–2018) [3]. The main cause of injuries was suicide (71.4%). The level of vision after the injury varied, but none of the patients died as a direct result of the injury.

Watanachai et al. note that the characteristic features of gunshot eye injuries are combined injuries to the eyeball and orbit, often complicated by the presence of intraocular foreign bodies and concomitant injuries to other organs and systems [4]. The problem of gunshot eye injuries is caused by several factors, including direct bullet or projectile impact and secondary damage from shrapnel and the shock wave of explosions. The high kinetic energy of the striking elements causes extensive tissue destruction due to the shock wave and the effect of secondary wounding by bone fragments, which significantly complicates the diagnosis and treatment of such injuries. The complexity of treating gunshot injuries to the eyes is exacerbated by the high risk of developing post-traumatic complications, including infections, haemorrhages, swelling and the development of secondary glaucoma and cataracts. The importance of developing and implementing new methods of diagnostics, treatment and rehabilitation of eye injuries is undeniable.

A retrospective analysis by Elegbede et al. of the medical records of the trauma centre showed that of 47 patients admitted with such wounds, 70% survived and were discharged from the hospital [5]. The patients were divided into 3 groups depending on the affected structures: open wounds of the eyeball, fractures of the orbit with preservation of the eyeball and optic nerve, as well as damage to the optic nerve with preservation of the eyeball. The study, thus, determined that open wounds to the eyeball were associated with higher mortality and significant visual loss. Furthermore, according to Dentel et al., AlGhadeer and Khandekar, these injuries are most often associated with children due to the use of unsafe toys [6, 7]. This requires the joint efforts of specialists in ophthalmology, surgery, traumatology and rehabilitation, as well as engineers developing medical equipment and protective ammunition. Current advances in military medicine and traumatology are already making significant progress in the treatment and restoration of eye function after gunshot wounds, but many aspects, such as early diagnosis, medical evacuation of victims and rehabilitation measures, require further study and improvement [8]. This is necessary to minimise the long-term negative health effects and improve the quality of life of those affected.

The study aims to thoroughly examine cases of gunshot eye injuries caused by bullets and various projectiles. It explore the mechanisms, clinical features, and long-term effects of such injuries on vision. A key focus is the development and implementation of effective medical and technical interventions to mitigate the impact on the eye and reduce the risk of irreversible vision loss. Additionally, the study seeks to formulate practical recommendations for preventing gunshot eye injuries, including enhancements to ammunition and personal eye protection, as well as improved behavioural tactics in hazardous conditions.

MATERIALS AND METHODS

The study of gunshot eye injuries caused by bullets and projectiles, conducted at the Trauma University Hospital in Tirana, Albania, from 1995 to 2006, represents a significant retrospective analysis of clinical data. This analysis involved a comprehensive review of medical histories, treatment protocols, and outcomes for patients with gunshot wounds to the eyes. A notable aspect of the study was the use of the Statistical Package for the Social Sciences (SPSS), a highly reliable tool for processing and analysing data in social sciences.

SPSS software was utilized for complex statistical analyses, including correlation and regression, to provide a detailed examination of the data. This approach revealed both direct relationships between injury types and outcomes, as well as hidden trends and patterns not apparent in initial reviews. Notably, the analysis highlighted significant risk factors influencing injury severity and treatment efficacy. The study meticulously reviewed the medical records and

photographs of 57 patients with gunshot eye injuries. Each case was analysed with attention to several key parameters: the timing and circumstances of the injury, patient demographics (age, gender), occupation (to identify occupational risks), the weapon type, and the nature and extent of the eye damage. Additionally, the presence of concomitant injuries and foreign bodies in the orbit was evaluated to assess case complexity and develop more effective treatment strategies. For a thorough assessment of gunshot eye injuries, a study conducted at the Trauma University Hospital in Tirana utilized digital photographs captured with specialized medical equipment. These images were crucial for documenting the injuries' condition before and after treatment, including surgical interventions. They provided detailed insights into the nature and depth of the injuries, essential for treatment planning and effectiveness evaluation. Additionally, the photographs were used to assess the cosmetic and functional outcomes of surgery, which is vital for restoring patients' quality of life.

The use of SPSS statistical software in the study of gunshot eye injuries was crucial for both qualitative and quantitative data analysis. SPSS offered powerful tools for processing and interpreting data, enabling in-depth analyses and identification of key patterns and factors. Descriptive statistics were employed to outline general trends and characteristics across cases, including age, gender, and the type and circumstances of injury. This approach helped create a comprehensive profile of typical cases and identify the most vulnerable patient groups. The analysis informed recommendations for enhancing treatment methods and preventing future issues. Thus, SPSS not only facilitated a detailed examination of the data but also provided evidence-based recommendations for improving medical practice in treating and preventing gunshot eye injuries.

RESULTS

The analysis of data from table 1, which presents information on eye injuries caused by explosions and gunshot wounds from 1995 to 2006, was used to reach several conclusions on trends and changes in the prevalence of these injuries. Between 1995 and 2006, the total number of cases was 172, of which 57 were related to gunshot wounds, accounting for 33% of the total number of cases. The most notable peak in cases occurred in 1997 and 1999 when 43 and 37 cases were registered respectively. These years also saw a high percentage of gunshot injuries – 9.8%. This may indicate an increase in conflict or a change in the security environment at the time. In subsequent years, the number of cases decreased, which may indicate improved security measures or a change in hostilities. In 2000, 2004 and 2006, the lowest rates were recorded, which may be the result of effective work by law enforcement agencies or the introduction of new protection technologies. This was especially noticeable in 2006, when there was only one case, and it did not involve gunshot wounds.

TABLE 1

Dynamics of gunshot injuries to the eye.

Year	Total number of cases of explosive and gunshot eye injuries	Number of cases of gunshot eye injuries caused by bullets and shells	%
1995	1	1	0.5
1996	6	5	2.9
1997	43	17	9.8
1998	14	4	2.3
1999	37	17	9.8
2000	19	1	0.5
2001	15	4	2.3
2002	15	2	1.1
2003	6	2	1.1
2004	8	1	0.5
2005	7	3	1.7
2006	1	0	0
Sum	172	57	33

Source: compiled by the author.

The percentage of gunshot wounds to total cases, which fluctuates from year to year, also highlights the variability of conditions that may have influenced the nature of injuries. The low percentage in some years may reflect changes in the types of weapons or tactics of their use. Thus, the evidence suggests that the number and nature of eye injuries from explosions and gunshot wounds reflect broader social and political processes, including the level of military conflict, the effectiveness of law enforcement and the development of security technologies. These factors should be considered when developing strategies to prevent similar injuries in the future (tab. 1).

Out of the total number of eye injuries caused by explosions and gunshot wounds (172 cases), 57 cases (33%) were specifically related to gunshot wounds from bullets and shells (tab. 2). Of note is the fact that 60% of these gunshot injuries occurred in just 2 years – 1997 and 1999. This represents about 20% of all reported cases, indicating peaks in violence or changes in the security environment in these years.

TABLE 2

Share of gunshot wounds in the total number of blunt and gunshot injuries to the eye.

Total number of cases of explosive and gunshot eye injuries	Number of cases of gunshot eye injuries caused by bullets and shells	%
172	57	33

Source: compiled by the author.

Gender analysis of injuries shows a significant disparity between men and women: 93% of cases are among men and

only 7% are among women. This highlights those men are significantly more likely to be victims of gunshot eye injuries, which may be due to their greater involvement in potentially hazardous activities, including risky jobs or participation in military operations. This may include improving gun control measures, raising public awareness of the risks and consequences of gunshot injuries, and improving public safety (tab. 3).

TABLE 3

Gunshot injuries to the eyes from bullets and shells, depending on gender.

Gender	Number of cases	%
Male	53	93
Female	4	7
Total number	57	100

Source: compiled by the author.

Age analysis revealed that the highest percentage of injuries occurred among young people in the 11–20 age group (38.5%), followed by the 21–30 age group (24.5%). These data indicate a high level of vulnerability of young people to gun violence, which requires special attention when developing measures to prevent such injuries. Thus, the results of the analysis highlight the need for enhanced prevention and education measures, especially among young men, to reduce the incidence of gunshot eye injuries. The main vulnerability to gunshot eye injuries is among young people: the 11–20 age group accounts for 38.5% of cases, highlighting their high-risk exposure. The next largest category is people aged 21–30 with 24.5%, which also indicates the significant vulnerability of young adults. This may be due to their active participation in social and risky activities. In terms of occupation, civilians, who account for 74% of those affected, are at significant risk, reflecting the widespread nature of civil conflict or the impact of hostilities on the population. The inclusion of children and students (26% of civilian casualties) in these statistics highlights the critical need to strengthen security measures in educational facilities and places where children are gathered (tab. 4).

TABLE 4

Gunshot eye injuries from bullets and projectiles, by age group.

Age group	Number of cases	%
0–10 years	4	7
11–20 years	22	38.5
21–30 years	14	24.5
>30 years	17	30
Sum	57	100

Source: compiled by the author.

When considering the causes of injuries, shell and bullet explosions are the most common cause (70%), reflecting the dangers associated with military operations or the active use of firearms in conflict zones. Explosions, although less frequent (7% of cases), still pose a serious security threat, especially in situations of conflict or terrorist attacks. The detonation of various explosives and explosive devices can cause serious eye damage. It is also worth paying attention to cases involving grenades, mines and bombs, which account for 23% of the total number of cases. These data underscore the importance of measures to prevent terrorist acts and armed conflicts, as well as the need to comply with international humanitarian law (tab. 5). As for the nature of the injuries, they are mostly unilateral (68%), but bilateral injuries are also common (32%). This highlights that many injuries can have serious consequences, including loss of vision in one or both eyes. It is therefore important to focus on educating the public about injury prevention and timely medical care. In addition, most cases (84%) are severe eye injuries. This points to the significant threat posed by gunshot eye injuries and the need to develop and implement effective strategies to prevent them. Such measures may include stricter legislation on the safe handling of firearms, first aid training and information campaigns on the risks of such injuries.

TABLE 5

Gunshot eye injuries from bullets and shells, depending on the type of shot and explosion.

Causes of damage depending on the type of shot (firearm)	Number of cases	Sum	%
Bullets and casings		40	70
Bullets	20		
Fragments	10		
Buckshot	10		
Explosion		4	7
Dynamite	3		
Detonating projectile	1		
Grenades, mines, bombs		13	23
Grenades	6		
Mines	7		
Total number	57	57	100

Source: compiled by the author.

A study of the severity and consequences of gunshot injuries to the eyes caused by bullets and shells suggests that these injuries are very serious. Analysis of the data shows that 84% of all reported cases (48 out of 57) are classified as severe injuries (grade III). This indicates a high risk of irreversible damage to visual function in gunshot wounds to the eyes. In terms of outcomes, of the 48 serious injuries, 43 cases (90%) resulted in serious damage to one eye, while 5 cases (10%) resulted in death or bilateral blindness. Among the main types of injuries recorded in this category, the most frequent was a complete loss of the eyeball (anophthalmos) in 23 cases (48% of all se-

vere injuries), atrophy or subatrophy of the eyeball in 4 cases (8%), and complete loss of visual acuity in 16 cases (33%). Of particular concern is the high percentage of cases with foreign bodies in the ocular or orbital region, recorded in 100% of gunshot eye injuries. This significantly complicates the treatment process and increases the risk of developing additional complications, such as infections or further deterioration of vision. When analysing concomitant injuries to other organs or systems, which were recorded in 88% of cases (50 out of 57), it becomes evident that gunshot eye injuries are often not isolated incidents but are accompanied by other serious injuries, which underlines the need for a comprehensive approach to the treatment and rehabilitation of victims. These findings confirm the critical need to develop and implement effective strategies to prevent gunshot injuries, improve diagnostic and treatment methods, and educate the public about the risks associated with firearms use.

The analysis of the data obtained during the study also provides detailed information on the prevalence and nature of additional injuries in gunshot eye injuries caused by bullets and projectiles. Out of 57 cases of gunshot injuries to the eyes, 50 cases (88%) were accompanied by injuries to other organs. This high percentage indicates the seriousness of the situation when gunshot injuries to the eyes often entail additional injuries, which compounds the treatment and worsens the prognosis for the victims. It was also confirmed that all 57 cases of gunshot eye injuries were accompanied by the presence of foreign bodies inside the eye or orbital region, which is 100%. The presence of foreign bodies not only complicates medical intervention but also significantly increases the risk of developing infectious and inflammatory processes, further impairing vision and general health.

Based on the analysis, it is possible to state that monitoring and analysis of gunshot eye injuries provide important information for the development of effective strategies to reduce the number of injuries. The results of such research can be used to develop prevention programmes aimed at improving safety measures, as well as to create more effective methods of treatment and rehabilitation for victims. The importance of such measures is particularly relevant in the context of ongoing or potential conflicts, where the likelihood of such trauma remains high. A detailed analysis of the nature and extent of the injuries sustained during the study period revealed a predominance of unilateral eye injuries, which accounted for 68% of the total number of cases, while bilateral injuries were recorded in 32% of cases. This statistic indicates that in most situations, the traumatic impact affected only one eye. This trend may be due to both the specifics of the impact of firearms and the defensive reaction of the victims at the time of injury when instinctive actions could have contributed to partial protection of one of the eyes.

Analysis of the extent of the damage revealed even more alarming data: serious, severe eye injuries were recorded in 84% of cases. Within this group, the largest proportion were cases of severe injuries to one eye (90%), which highlights the high frequency of critical injuries caused by gunshot wounds. In addition, 10% of serious injuries resulted in extremely serious consequences, including death or complete loss of vision in both eyes, which indicates the extremely high risk of firearms to human health and life. Thus, these studies highlight the need to develop and implement improved protection measures aimed at reducing the risk of injury and increasing safety for both civilians and military personnel. An important aspect of prevention is not only improving protective equipment but also raising public awareness of the dangers associated with the use of firearms in conflict zones. Gunshot injuries to the eyes were often accompanied by multiple injuries, which were detected in 88% of cases. This underlines that such incidents are not limited to localised injuries but entail complex trauma affecting various organs and body systems. Such polytrauma significantly complicates the process of medical intervention, requiring a multidisciplinary approach to treatment. It is necessary to coordinate the efforts of specialists from various fields, including traumatologists, ophthalmologists, surgeons and rehabilitation specialists, to optimise the recovery process and minimise the long-term effects of injuries.

In addition, in all the cases analysed, foreign bodies were found in the eyes or orbits of the victims, such as glass or metal fragments. These foreign bodies make treatment much more difficult, as they can lead to additional complications, including infections, chronic inflammation and the need for complex surgical procedures to remove them. Detecting and managing such complications requires high diagnostic accuracy and individualised treatment planning, which increases the requirements for the qualifications of medical staff and the technologies used. Thus, the high incidence of multiple traumas and the presence of foreign bodies in the organs of vision underscore the need to develop improved diagnostic and treatment protocols, as well as to provide medical facilities with appropriate equipment and specialised staff training to work effectively in conditions of high trauma and complexity of medical cases.

A study conducted at the Trauma University Hospital of Tirana revealed not only the high level of danger posed by firearms to the eyes but also several difficulties encountered in treating such injuries. The main problems were the frequent combination of eye injuries with other severe injuries and the presence of foreign bodies, which complicates the treatment process and worsens the prognosis for the victims. These data provide valuable information for the development of more effective treatments and preventive measures. Improved diagnostic and surgical techniques aimed at the early detection and removal of foreign bodies can significantly improve treatment outcomes. At the same time, a focus on preventative measures, including educational cam-

paigns to raise awareness of the risks of firearms use and the importance of wearing protective equipment can help reduce the number and severity of injuries.

DISCUSSION

This study presents a detailed analysis of gunshot injuries to the eyes caused by bullets and shells for the period 1995 to 2006. The results highlight the seriousness of the problem and the need to develop effective strategies to prevent and treat such injuries. For instance, the high proportion (33%) of gunshot injuries among all reported cases of eye injuries indicates the significant threat that the use of firearms poses to the health of the eyes. For comparison, the study by He et al., analysing data from the US National Trauma Database for 2008–2014, showed that ophthalmic injuries accounted for 5.93% of hospitalised trauma patients, in men, with the main mechanisms of injury including falls, car accidents and blows [9]. These findings indicate a decrease in the incidence of severe gunshot eye injuries in peacetime, in contrast to the higher proportion of such injuries during the period of the present study, highlighting the changing circumstances and possible nature of conflict.

Truong et al. also characterised gunshot injuries to the eye, identifying groups at increased risk [10]. According to the data for the same period (2008–2014), gunshot injuries to the eye occurred in 3.7% of hospitalised patients with gunshot injuries. The most common injuries included orbital fractures and open eye injuries, most of which occurred at home or on the street. These data also confirm that in peacetime the incidence of this type of injury is significantly lower than during combat operations, which confirms the findings of the current study. It is necessary to note that the analysis of the data by year of this study revealed peaks in injuries in 1997 and 1999, which may be due to the escalation of conflicts or deterioration of security conditions during these periods. A gradual decline in the number of cases in subsequent years may indicate improved security measures or a change in hostilities. These findings can be used to compare current data with the results of previous years and emphasise the importance of research in the dynamics.

A gender analysis of this study revealed a significant disparity between men (93%) and women (7%), highlighting the higher vulnerability of men to gunshot eye injuries. This may be due to their active involvement in potentially dangerous activities or military operations. Similar findings are present in the study Ashby et al., which analysed the epidemiology and clinical characteristics of eye and ocular trauma in children in Olmsted County, Minnesota, from 2000 to 2009 [11]. During the 10 years, 740 cases of injury were reported, corresponding to an incidence of 203 per 100 000 children (95% CI: 189–218). The median age at diagnosis was 10 years old, and 62.4% of the victims were boys. Most injuries (69.6%) were reported in emergency departments, with 31.6% of cases occurring outdoors in the summer months (29.7%). The main causes of injuries were blows (21.5%), foreign bodies (13.8%) and sports activities (13%). Injuries to the anterior segment of the eye were observed in 63.5% of cases. At the initial examination, 13.8% of patients had 20/40 or worse vision, and at the last examination, 7.7% had 20/40 or worse vision. Surgical intervention was required in 3.9% of cases. Important risk factors for vision loss and/or long-term complications were male gender, age over 12 years, outdoor injuries, injuries during sports and use of firearms/ammo, and hyphae or posterior segment injuries ($p < 0.05$).

Of particular concern is the high proportion (38.5%) of injuries among young people aged 11–20, followed by the 21–30 group (24.5%). This determines the need to strengthen safety measures and educational programmes for the younger generation, who are most at risk of gunshot eye injuries. The risk of long-term complications and visual impairment associated with male gender, age ≥12 years, outdoor injuries, sports injuries and haematoma or damage to the posterior segment of the eye ($p < 0.05$) underscores the importance of targeted prevention in this demographic. This was reflected in Chopra et al. study, the average age was 28 years (range 13–57 years), male (83%) [12]. The average ISS (Injury Severity Score) injury severity on admission was 14.15 (±9.69), and the Glasgow Coma Scale was 12.85 (±4.16). The average length of hospital stay was 9.27 days (±12.31). Gunshot wounds to the eyes were sustained by 11% of patients, to the orbit – 28%, and to other parts of the head – 61%. It is known that 46% of the patients were wounded with handguns, 31% with airguns, and 23% with shotguns. Causes of injuries: violence (64%), accidents (29%), self-harm (7%). 28% of patients suffered bilateral eye injuries, and 72% had damage to one eye. Additional injuries, including facial fractures, facial nerve damage, and head and limb injuries, were reported in 56% of patients.

The analysis of the present study showed that gunshot injuries to the eyes are often accompanied by additional injuries to other organs (88% of cases) and the presence of foreign bodies in the ocular or orbital region (100% of cases). These factors significantly complicate the treatment process and increase the risk of complications, such as infections or further deterioration of vision [13, 14]. These findings correlate with the results of the study by Shah et al., conducted in Kashmir, India [15]. This study followed 664 eyes in 643 patients for 6 months. The study determined that penetrating trauma was the most common, and the site of entry wound was of prognostic significance. Successful recovery was achieved in 66.3% of the eyes, requiring an average of 2.8 surgeries per eye, which emphasises the importance of accurate determination of the location and type of injury in predicting treatment outcomes. Additional data was obtained in the

study by Lee et al., which showed that in 40% of cases, eye injuries were accompanied by brain damage [16]. Most acute eye injuries (64–84%) were caused by explosions, with improvised explosive devices (IEDs) responsible for 51–69% of these cases. Surgical intervention was required in 41–45% of cases, with enucleation performed in 12–17% of them. These results highlight the seriousness and complexity of treating gunshot and blast eye injuries, which is consistent with the findings of the study. Based on these comparisons, it is possible to conclude that an integrated approach to the diagnosis and treatment of eye injuries is important, given their multifaceted impact on patient health.

Most gunshot wounds to the eyes (84%) were classified as severe injuries, of which 90% resulted in serious damage to one eye and 10% in death or bilateral blindness. These findings highlight the high risk of permanent damage to visual function and the critical need to develop improved treatment and rehabilitation methods. Wu and Nguyen, Harvey et al. emphasise the critical need to develop improved treatment and rehabilitation methods, given the high risk of permanent damage to visual function due to the severity of gunshot eye injuries [17, 18]. This problem was also studied by Shakarchy-Kaminsky et al., based on the analysis of 2312 military wounded from 2013 to 2019, which revealed that 8.9% (113 people) of them had combat eye injuries [19]. Ocular injuries were observed in men (98.2%) with an average age of 22.7 (±4.6) years. Eye injuries were more commonly penetrating (59.3%) and blunt (22.1%). About half of the cases (51.3%) were isolated eye injuries and more than 40% of them were moderate injuries, while the rest had associated injuries such as head (32.7%), upper limb (17.7%), lower limb (15.9%), torso (8%), neck (6.2%) and other (5.9%) injuries. It is important to note that the incidence of eye injuries was similar among those injured who were wearing protective goggles (11.2%) and those who were not (13%) at the time of injury (p = 0.596). However, the proportion of open-eye injuries was 9.1% among those wearing protective goggles and 39.5% (p = 0.002) among those not wearing them. These data also demonstrate the high proportion of severe eye injuries among all eye injuries sustained in combat.

A study by Breeze et al. among the US military shows that 8% of the total number of survivors or deaths from wounds had eye injuries, mostly open-eye wounds without foreign bodies inside [20]. In addition, injuries to periorbital structures were recorded. The likelihood of undergoing eye surgery for an open eye wound was highest among local citizens, but no significant differences were found between US and UK servicemen. The presence of an ophthalmic surgeon had a significant effect on the likelihood of eye removal surgery. It also shows a high proportion of severe damage to the visual apparatus, which confirms the results of the present study. Another study by Elbeyli and Kurtul showed that the majority of patients were men (n = 194, 91.5%) [21]. The average age was 29.50 (±10.76) years (range from 1 to 74 years). Of these, only 30 (14.15%) were under the age of 18. Among the eye injuries, the vast majority (n = 177, 79%) were ruptured eyeballs, and the remaining 21% (n = 47) were closed-eye injuries. Intraocular foreign bodies were found in 106 (47.32%) eyes. Primary repair was performed in 74.1% of cases (n = 166), while evisceration was performed in only 4.46% of cases (n = 10), indicating that severe eye injuries account for a large proportion of all patients.

Overall, the results of the study highlight the need for a comprehensive approach to addressing the problem of gunshot eye injuries. This includes strengthening gun control measures, raising public awareness of the risks and consequences of gunshot wounds, improving public safety conditions, and improving methods of diagnosis, treatment and rehabilitation.

CONCLUSIONS

The study's findings underscore several critical conclusions regarding gunshot eye injuries and necessary countermeasures. The significant proportion of these injuries among all eye injuries from explosions and firearms highlights the severe threat firearms pose to visual health. This calls for decisive actions to control arms trafficking and ensure safe firearm use. Additionally, observed peaks in injuries during specific years suggest a close link between gunshot eye injuries and the overall security situation and regional conflict levels. Thus, efforts to prevent such injuries should be incorporated into broader strategies for achieving peace and stability.

The heightened vulnerability of specific groups, such as young people and men, necessitates targeted awareness and education programs about the risks and consequences of gunshot eye injuries. Developing specialized educational campaigns for these groups is essential. The frequent occurrence of gunshot eye injuries alongside additional trauma and foreign bodies complicates treatment and rehabilitation, highlights the need for improved diagnostic, surgical, and rehabilitation methods, as well as enhanced medical equipment and staff training. The high incidence of severe eye injuries, which can lead to significant and permanent visual impairment, underscores the importance of preventive measures. Efforts should focus on not only advancing treatment methods but also preventing injuries through stricter arms control, increased public awareness, and the promotion of safer living conditions.

The study's results emphasize the need for a comprehensive, multi-level approach to addressing gunshot eye injuries. This includes implementing safety measures, public education, enhanced medical care and rehabilitation, and stricter control over arms trafficking. Coordinated efforts across these areas are essential to effectively reduce the incidence and impact of gunshot eye injuries.

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