ORIGINAL ARTICLE

Investigation of forensic cases with ocular trauma

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ABSTRACT

BACKGROUND: Medico-legal reports prepared for cases involving ocular trauma play an important role in the legal process. After obtaining a detailed medical history, these cases must be examined comprehensively. This study aimed to analyze medico-legal reports prepared for ocular trauma cases referred to the forensic medicine outpatient clinic and to determine the sociodemographic characteristics of the patients, the types of trauma sustained, and the nature of the injuries.

METHODS: In this study, the forensic medical records of 424 patients with ocular trauma resulting from forensic incidents were retrospectively analyzed. The cases were reviewed based on variables such as gender, age, age group, cause of injury (type of incident), nature of the incident (intentional or accidental), medical diagnosis, site of the eye injury, whether inpatient treatment was required in the ophthalmology clinic, and whether the injury resulted in visual sequelae.

RESULTS: Of the 424 cases, 310 (73.1%) were male and 114 (26.9%) were female. The most common age group was 20-29 years, accounting for 118 cases (27.8%). The most frequent cause of injury was assault, reported in 330 cases (77.8%). Women were found to be more frequently exposed to domestic violence ($p<0.001$, Cramer's $V=0.487$). The most common finding was periorbital edema/ecchymosis, observed in 288 cases (67.9%), followed by subconjunctival hemorrhage in 71 cases (16.7%). Patients with open-globe injuries were more frequently hospitalized ($p<0.001$, Cramer's $V=0.788$) and underwent surgical treatment ($p<0.001$, Cramer's $V=0.879$) compared to those with closed-globe injuries.

CONCLUSION: It was observed that most forensic cases examined in our study involved mild injuries, limited to adnexal structures and the anterior segment, with generally minor symptoms. Physicians are advised to carefully examine and assess female patients with ocular trauma for potential signs of domestic violence.

Keywords: Forensic medicine; medico-legal report; ocular injury; trauma.

INTRODUCTION

Although the eye accounts for only 0.27% of the total body surface area and 4% of the facial area, it is the third most frequently affected organ by trauma, following the hands and feet.[1] After ocular trauma, individuals most commonly seek initial treatment in emergency departments.[2] In addition to medical complaints, eye injuries can lead to loss of workforce, increased treatment and care costs, and psychological or cosmetic concerns.[3] Ocular trauma is one of the leading causes of unilateral vision loss.[4]

Medico-legal cases play a crucial role in routine clinical ophthalmology practice.[5] The most common examples of foren-

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sic traumatic incidents include assault, injuries from sharp or penetrating objects, traffic accidents, and industrial accidents.[6] In cases involving eye injuries, a detailed medical history should be obtained, and a comprehensive examination must be conducted to assess the severity of the injury and the potential for permanent sequelae.[3,5] Medico-legal reports serve as essential documentary evidence in legal proceedings; therefore, they must be meticulously prepared, complete, accurate, and impartial.[5]

This study aimed to analyze medico-legal reports prepared for cases of ocular trauma by the forensic medicine outpatient clinic and to determine the sociodemographic characteristics of these cases, the types of trauma sustained, and the nature of the injuries.

MATERIALS AND METHODS

Sampling, Setting, and Procedure of the Study

In this study, the forensic medical records of 424 patients with ocular trauma resulting from a forensic incident, occurring during the five-year period from January 1, 2017 to December 31, 2021, were retrospectively analyzed.

The cases were reviewed based on variables such as gender, age at the time of the incident, age group, cause of injury (type of incident), origin of the incident (intentional or accidental), medical diagnosis, injured eye site (right, left, or both), presence of facial bone fractures, type of fractured bone (if any), whether inpatient treatment was received in the ophthalmology clinic, length of hospital stay (if any), type of treatment (conservative or surgical), presence of sequelae affecting visual function, severity of the injury, and Injury Severity Score (ISS).

Ages were grouped by decade. After evaluating the medical anamnesis, forensic investigation documents, and medical records, the cause and origin of each incident were determined. The origin of the incident was classified as either accidental or intentional. Assaults, sharp object injuries, and firearm injuries were categorized as intentional injuries, while traffic accidents, occupational accidents, and falls were classified as accidental injuries. Traffic accidents were further analyzed as in-vehicle, motorcycle/bicycle, or out-of-vehicle accidents. An in-vehicle traffic accident (IVTA) includes the driver and all passengers inside a vehicle, whereas an out-of-vehicle traffic accident (OVTA) refers to incidents involving pedestrians. The cases were also categorized as adnexal (extraocular, involving the orbit and eyelids) or globe injuries. Globe injuries were classified as either closed or open. A full-thickness wound of the sclera or cornea was defined as an open globe injury (OGI). A closed globe injury (CGI) was defined as an injury without a full-thickness wound of the sclera or cornea.

Trauma Severity Assessment Instrument

In trauma cases, the severity of injury and mortality risk are assessed using scoring systems. These systems evaluate physiological data, the anatomical location of the injury, or a combination of both. The Abbreviated Injury Scale (AIS) and the Injury Severity Score are anatomical scoring systems. The AIS assigns a score from 1 (minor) to 6 (fatal) based on the severity of the injury. For ISS calculation, the body is divided into six regions: head and neck, face, thorax, abdominal and pelvic organs, extremities/pelvic bones, and soft tissue/skin. The ISS is calculated by summing the squares of the AIS scores from the three most severely injured regions. The total score ranges from 1 to 75, with an ISS of 16 or higher indicating major trauma.[7,8] In this study, the AIS and ISS scoring systems were used to assess injury severity, with cases grouped according to the anatomical region affected. AIS scores were assigned as follows: 1 point for eye injuries and facial fractures, and 2 points for orbital bone and maxillary fractures.

Statistical Analyses

Categorical variables were presented as frequencies and percentages, while descriptive statistics and continuous variables were expressed as mean±standard deviation. Categorical variables were grouped, percentages were calculated, and Pearson's chi-square test or Fisher's exact test was used to compare frequencies, as appropriate. To determine differences among multiple groups, post hoc analysis methods for the chi-square test and Bonferroni correction were applied. Cramer's V was calculated for categorical comparisons as a measure of effect size, and the strength of association was reported accordingly. Cohen et al.[9] provided the following guidelines for interpreting Cramer's V: for df=1, a small effect is >0.1, a medium (moderate) effect is >0.3, and a large effect is >0.5. The Kolmogorov-Smirnov test was used to assess the normality of continuous variables ($p>0.05$), and kurtosis-skewness values were also evaluated. To compare mean values between two groups, the independent samples t-test was used for normally distributed data, while the Mann-Whitney U test was applied for data not showing a normal distribution. All statistical analyses and table generation were performed using SPSS version 22 (IBM Corp., Armonk, NY). A p value of <0.05 was considered statistically significant. The statistical relationships between variables were also examined.

Ethical Statement

The privacy rights of human subjects were respected throughout the study. Informed consent was not required, as it is assumed that all individuals who applied to the outpatient clinic did so with awareness of the scientific use of their data. Ethical approval for the study was obtained from the local Ethics Committee (decision dated 18/01/2022, protocol number 2022/01-20). This study was conducted in accordance with the ethical standards outlined in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

RESULTS

In this study, 424 cases (5.5%) involving ocular trauma resulting from forensic incidents were identified among a total of 7,730 cases admitted to the Forensic Medicine Outpatient Clinic of a Training and Research Hospital over a five-year period.

Of the 424 cases, 310 (73.1%) were male and 114 (26.9%) were female. The age range of the cases was 2-91 years, with a mean age of 32.8±16.1 years. The mean age was 33.2±16.1 years for male patients and 31.7±16.1 years for female patients, showing no statistically significant difference (p=0.293). In terms of age distribution by decade, the most common age groups were 20-29 years (118 cases, 27.8%) and 30-39 years (106 cases, 25.0%). The lowest prevalence was observed in the extreme age groups: 0-9 years (5.4%) and 70 years and older (3.3%).

Assault was the most common cause of injury, accounting for 330 cases (77.8%) (Table 1). Among the 64 cases (15.1%) involving traffic accidents, 29 were IVTA, 21 were motorcycle accidents, 10 were OVTA, and four were bicycle accidents. A total of 337 cases (79.5%) were the result of intentional acts, while 84 cases (19.8%) involved accidental trauma. The origin of the incident could not be determined in three cases. Intentional injuries were found to be more common among women (χ2=4.519, standard deviation [SD]=1, p=0.034, Cramer's V=0.104) (Table 1). It was determined that 52 cases (12.3%) involved domestic violence, of which 51 resulted from physical assault and one from a sharp object injury. Among the perpetrators of domestic violence, 33 (63.5%) were the victims' spouses. Women were found to be more frequently exposed to domestic violence (χ2=100.479, SD=1, p<0.001, Cramer's V=0.487) (Table 2).

When the distribution of examination findings was analyzed, the most common finding was periorbital edema/ecchymosis, observed in 288 cases (67.9%), followed by subconjunctival hemorrhage in 71 cases (16.7%) (Table 3). Only adnexal injuries were identified in 325 cases (76.7%), CGIs in 87 cases

Table 1. Distribution of cause and origin of incident by gender

Cause/Origin of Incident	Male[α]	Female[α]	Total[α]
Assault	232 (74.8%)	98 (86.0%)	330 (77.8%)
SOI	2 (0.6%)	1 (0.9%)	3 (0.7%)
FI	2 (0.6%)	-	2 (0.5%)
Assault + SOI	2 (0.6%)	-	2 (0.5%)
Intentional injuries	**238 (76.8%)**	**99 (86.8%)**	**337 (79.5%)**
IVTA	20 (6.5%)	9 (7.9%)	29 (6.8%)
MA	21 (6.8%)	-	21 (5.0%)
FFH	9 (2.9%)	3 (2.6%)	12 (2.8%)
OVTA	7 (2.3%)	3 (2.6%)	10 (2.4%)
OA	8 (2.6%)	-	8 (1.9%)
BA	4 (1.3%)	-	4 (0.9%)
Accidental injuries	**69 (22.3%)**	**15 (13.2%)**	**84 (19.8%)**
Uncertain origin	**3 (1.0%)**	**-**	**3 (0.7%)**
Total	**310 (73.1%)**	**114 (26.9%)**	**424 (100.0%)**

[α]Percentages were calculated by column. SOI: Sharp object injuries; FI: Firearm injuries; IVTA: In-vehicle traffic accident; MA: Motorcycle accident; FFH: Falling from height; OVTA: Out-of-vehicle traffic accident; OA: Occupational accident; BA: Bicycle accident.

Table 2. Distribution of domestic violence victims by gender

Domestic Violence	Male[α]	Female[α]	Total[α]
Present	8 (2.6%)	44 (38.6%)	52 (12.3%)
Absent	302 (97.4%)	70 (61.4%)	372 (87.7%)
Total[β]	310 (73.1%)	114 (26.9%)	424 (100.0%)

[α]Percentages were calculated by column. [β]Percentages were calculated by row.

Table 3. Distribution of medical diagnoses

Medical Diagnosis	n	%
Periorbital edema/ecchymosis	288	67.9
Subconjunctival hemorrhage	71	16,7
Orbital fracture	60	14.2
Eyelid injury	31	7.3
Hyphema	6	1.4
Traumatic retinal detachment	6	1.4
Ocular perforation	5	1.2
Corneal abrasion	4	0.9
Traumatic mydriasis	3	0.7
Scleral injury	2	0.5
Optic neuropathy	2	0.5
Canalicular injury	2	0.5
Others*	3	0.7

*Other diagnoses included iris injury, corneal perforation, and intraocular hemorrhage. Some patients had more than one type of injury.

(20.5%), and OGIs in 12 cases (2.8%).

Traumatic findings were observed in the left eye only in 214 cases (50.5%), the right eye only in 166 cases (39.2%), and in both eyes and/or their surrounding areas in 44 cases (10.4%). The distribution of injury localization by incident origin was similar (p=0.891). Orbital fractures were observed in 60 cases (14.2%). Among the fractured facial bones, the most commonly affected was the nasal bone (65 cases), followed by the maxilla (51 cases), frontal bone (21 cases), zygoma (18 cases), and ethmoid bone (12 cases).

It was observed that 32 cases (7.5%) were hospitalized in the ophthalmology clinic for follow-up and treatment, and 20 of these cases (4.7%) underwent surgical procedures during their hospital stay. Patients with open-globe injuries were hospitalized and underwent surgery more often than those with closed-globe injuries (p<0.001, Cramer's V=0.788 for hospitalization; p<0.001, Cramer's V=0.879 for surgery). The length of hospital stay ranged from 1 to 21 days, with a mean duration of 6.8±5.8 days. A total of 11 cases (2.6%) experienced vision loss following trauma, of which seven had open-globe injuries and four had closed-globe injuries.

The Injury Severity Score of the cases ranged from 1 to 75, with a mean score of 4.2±10.3. The mean ISS was lower in female cases (2.7±7.0) compared to male cases (4.7±11.3) (d=0.21, t(321.3)=2.1, p=0.033). Additionally, 18 cases (4.2%) experienced major trauma in conjunction with ocular trauma.

DISCUSSION

Eye injuries can result in serious socioeconomic consequences, including emotional distress, reduced economic productivity, and financial loss.[1] There is a lack of sufficient research on ocular trauma in developing countries such as Türkiye and India.[10,11] This study highlights the sociodemographic, forensic, and clinical characteristics of ocular trauma cases admitted to the forensic medicine outpatient clinic of a tertiary care hospital in southeastern Türkiye.

The finding that 73.1% of the cases were male is consistent with previous studies conducted in Türkiye, which reported male rates ranging from 70.0% to 76.5% among patients presenting to emergency departments and forensic medicine outpatient clinics with ocular trauma.[2,10,12] Similar trends were observed in studies conducted in India and Italy on patients admitted to ophthalmology and emergency departments for ocular trauma, where a higher proportion of males (84.6%-88.3%) was reported.[11,13-15] In studies from Ethiopia and Pakistan, the proportion of male patients (71.0%-75.0%) was similar to that in our study.[1,16] A common finding across these international studies is that the majority of individuals exposed to ocular trauma were male. This has been attributed to men's greater participation in the workforce, more active social lifestyles, and increased exposure to traffic-related risks.

The mean age of patients (32.8 years) and the predominant age group (20-39 years) align with findings from other studies conducted in Türkiye and globally on ocular trauma.[5,11,13-16] In studies conducted in Ethiopia and Türkiye examining cases of ocular trauma resulting from both forensic and non-forensic incidents, the majority of cases were found to be in the pediatric age group, with mean ages lower than those reported in our study.[1,12] This difference may be related to the varying scopes of the studies. Additionally, the economic and sociocultural characteristics of different societies likely influence the age distribution of ocular trauma cases.

When examining the causes of incidents, the most common reasons for admission in our study were assault and traffic accidents, respectively, which is consistent with findings from similar studies.[10,13] In a study conducted in western Türkiye, 79.3% of patients presented with ocular trauma due to intentional injury, and 14.4% due to traffic accidents, closely aligning with our results.[10] Notably, a higher rate of intentional injury was observed among women in our study. This was largely attributed to the 52 cases identified as victims of domestic violence, the majority of whom were women. A study from Pakistan reported that the aggressive behavior often exhibited by young males makes them more likely to be involved in assaults, while women, who are more often engaged in domestic life, are at higher risk of experiencing domestic violence.[5] Physicians are advised to carefully examine and evaluate female patients with ocular trauma for possible signs of domestic abuse. In contrast to our findings, a study conducted in India[11] reported that 79.5% of ocular trauma cases were related to traffic accidents. This high rate was attributed to the proximity of the healthcare facility to a highway with a high risk of accidents, resulting in a greater

number of victims presenting for treatment. Overall, the incidence of traffic accidents as a cause of eye injuries in India, reported to range from 14.7% to 23.6%, was comparable to our study.[11]

In 79.5% of cases, the trauma was caused by intentional acts, which is consistent with the findings of Hosukler et al. and Gupta et al.[10,13] Fists, stones, and sticks, being easily accessible, are commonly used in assaults. These blunt objects lack sharp edges and cause non-penetrating injuries.[5] In forensic traumatology, it has been reported that most injuries result from intentional acts, often targeting the head and neck regions.[17] The data from our study on forensic ocular trauma cases are in line with these findings in the literature.

The prevalence of adnexal injuries among individuals with trauma to the eyes and surrounding areas has been reported to range between 71.2% and 77.1%.[10,14] The rate of adnexal-only injuries in our study (76.7%) is consistent with this range. However, studies evaluating cases admitted to ophthalmology clinics have reported lower rates (46%) compared to our study.[13,18] This discrepancy may be attributed to emergency physicians managing mild ocular injuries independently, without consulting ophthalmologists, and handling both diagnosis and treatment within the emergency department. The frequent observation of periorbital edema/ecchymosis and subconjunctival hemorrhage in our study also aligns with findings from similar forensic studies.[10,13,19] Most injuries were limited to the adnexal structures and the anterior segment, indicating relatively mild injury severity.

While some studies[11,15,20] in the literature report that the right eye is most commonly injured, others[1,14,16] indicate that the left eye is more frequently affected. Additionally, some studies have found that injuries often involve both eyes simultaneously.[19] In our study, injuries to the left eye were the most common. The rate of orbital fractures observed in our study (14.2%) was similar to that reported by Jha et al. (13.8%) but higher than the rate reported by Wadwekar et al. (8.8%).[11,21] Burm et al. found that nasal bone fractures were the most common facial fractures associated with orbital fractures.[22] Consistently, nasal bone fractures were the most frequently observed facial fractures in our study.

In studies examining forensic cases with ocular trauma, open globe injury rates have ranged from 1.2% to 7.5%, which is comparable to the findings in our study.[5,10,19] However, studies focusing on ocular trauma cases presenting to ophthalmology clinics have reported higher rates of open globe injuries (47.1%–57.0%) compared to those observed in our study.[1,15,16] A study by Cillino et al. in Italy reported that patients with open globe injuries required longer hospital stays compared to those with closed globe injuries.[15] It is well established that open globe injuries carry a higher risk of vision loss compared to closed globe injuries. Moreover, severe injuries involving the posterior segment may not be salvageable, even with advanced microsurgical techniques.[15,21] Similarly, in our study, patients with open globe injuries were more frequently hospitalized, underwent surgical treatment more often, and experienced post-treatment vision loss more frequently than those with closed globe injuries.

Limitations

This study has certain limitations. As the data were collected retrospectively, certain details, such as the specific cause of the forensic event, the type of instrument used during the assault, the use of protective eye equipment, and the presence of pre-existing eye conditions or previous trauma, were not available.

Recommendations for Ophthalmologists

It is a misconception to assume that all trauma-related visits to eye clinics are unrelated to forensic incidents. It is essential to assess whether such cases may involve a forensic context and, if so, report them to the appropriate authorities. Forensic cases involving ocular trauma require meticulous eye examinations and precise, thorough documentation. Simulated complaints or pre-existing ocular conditions unrelated to the incident should be carefully ruled out, and vision-related symptoms must be clearly linked to the recent trauma. Finally, we emphasize the clinical importance of conducting repeated eye examinations during the follow-up period in patients with ocular trauma.

CONCLUSION

In our study of forensic cases involving ocular trauma, the majority of patients were male and aged between 20 and 39 years. The incidents were primarily intentional, assault-related injuries. The most frequently observed clinical findings were periorbital edema/ecchymosis and subconjunctival hemorrhage. It is notable that intentional injuries were more common among women, likely due to the higher prevalence of domestic violence. Physicians are strongly encouraged to carefully assess female patients with ocular trauma for potential signs of domestic abuse.

It was observed that most forensic cases in our study involved mild injuries, limited to the adnexal structures and the anterior segment, with generally minor symptoms. Among cases involving globe injuries, patients with open globe injuries were more frequently hospitalized, underwent surgical treatment more often, and experienced greater post-treatment vision loss compared to those with closed globe injuries.

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H.K., B.Ö.; Design: K.S., M.A.Ö., Ş.N.G., H.K., B.Ö.; Supervision: K.S., H.K., B.O.; Materials: K.S., H.K., B.O.; Data collection and/or processing: K.S., M.A.Ö., Ş.N.G.; Analysis and/or interpretation: K.S., M.A.O.; Literature review: K.S., Ş.N.G.; Writing: K.S.; Critical review: K.S., H.K., B.Ö.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Göz travması bulunan adli olguların incelenmesi

AMAÇ: Göz yaralanması bulunan olgular için düzenlenen adli raporların yasal süreçte önemli bir yeri bulunmaktadır. Olgulardan ayrıntılı öykü alınmasının ardından, olguların kapsamlı muayene edilmesi gerekmektedir. Bu çalışmada adli tıp polikliniği tarafından göz travması bulunan olgulara yönelik düzenlenen adli raporlar incelenerek, bu olguların sosyodemografik verileri, maruz kalınan travma çeşidi, yaralanma özelliklerinin belirlenmesi amaçlandı.

GEREÇ VE YÖNTEM: Çalışmada adli olay sonucunda göz travması bulunan 424 olgu retrospektif olarak incelendi. Olgular cinsiyet, yaş, yaş grubu, olay nedeni, olay orijini (kasıtlı-kaza sonucu), medikal tanı, göz kliniğinde yatarak tedavi olup/olmadığı ve travma sonrası görme fonksiyonu verileri açısından incelendi.

BULGULAR: Olguların 310'u (%73.1) erkek, 114'ü (%26.9) kadındı. Olgular en sık %27.8 (n=118) oran ile 20-29 yaş grubundaydı. Olay nedenlerine bakıldığında; darp eylemi 330 olgu (%77,8) ile en sıktı. Kadınların daha yüksek oranda aile içi şiddet mağduru olduğu gözlendi (p <0,001, Cramer's V: 0.487). Muayene bulgusu olarak en sık 288 olguda (%67.9) periorbital ödem/ekimoz, ardından 71 olguda (%16.7) subkonjunktival kanama izlendi. Açık glob yaralanması geçirenlerin, kapalı glob yaralanması geçirenlere göre daha yüksek oranda göz kliniğinde yatış yapıldığı (p<0,001, Cramer's V: 0.788) ve cerrahi tedavi gördüğü (p<0,001, Cramer's V: 0.879) gözlendi.

SONUÇ: Çalışmada olguların büyük çoğunlukla adneksal ve ön segment ile sınırlı yaralanma geçirdikleri ve yaralanma ciddiyetinin de hafif olduğu gözlendi. Göz travması bulunan kadın olgularda, hekimlerin hastaları aile içi şiddet açısından dikkatli muayene etmesi ve değerlendirmesi önerilmektedir.

Anahtar sözcükler: Adli tıp; adli rapor; göz yaralanması; travma.

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