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ORIGINAL ARTICLE

Trends in forensic ophthalmology consultations

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Abstract

Purpose: Ocular trauma is a leading cause of monocular blindness worldwide, requiring forensic and medical evaluation. This study retrospectively examines forensic ophthalmology consultations, trauma types, and medicolegal implications.

Methods: A retrospective analysis was conducted on ophthalmology consultation reports from the Forensic Medicine Clinic at Ordu University Training and Research Hospital (2017–2024). All statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). The normality of the data was tested using the Shapiro–Wilk test. If the data were normally distributed, descriptive statistics were reported as mean±standard deviation. If the data were not normally distributed, the Mann–Whitney U test was used, and descriptive statistics were presented as Median (Min-Max). Categorical variables were expressed as frequency (n) and percentage (%). For group comparisons of categorical variables, the Fisher-Freeman-Halton exact test, Chi-square test, and Fisher's exact test were used. Statistical significance was set at $\alpha=0.05$. .

Results: A total of 123 eyes from 108 patients were included in the study. Among 108 cases, the mean age was 41.84±17.61 years, and 74.1% were male. Blunt trauma was most common (88.8%), while injuries caused by a sharp object were significantly more frequent in males ($p<0.05$). The mean duration from trauma to forensic evaluation was 3 (0–654) days, with longer delays in trauma from a sharp object cases ($p<0.05$). The presence of an intraocular foreign body was a key finding in a subset of open-globe injuries, which also showed a higher frequency of fundus pathologies ($p<0.05$). Post-traumatic severe visual impairment was recorded in 11.7% of right-eye cases and 4.16% of left-eye cases.

Conclusion: Forensic ocular trauma cases are predominantly associated with blunt injuries, with males being more frequently affected. In forensic medical reporting, assessing functional impairment and the forensic evaluation process with a multidisciplinary approach is of great importance.

Keywords: Blunt trauma; forensic ophthalmology; medicolegal assessment; ocular trauma; trauma with a sharp object; vision loss.

Ocular trauma is one of the leading causes of vision loss worldwide, significantly reducing the quality of life on an individual level while also imposing substantial socioeconomic burdens on society.[1,2] According to the World Health Organization, approximately 55 million people suffer from ocular trauma each year, with nearly 1.6 million cases resulting in permanent blindness.[3,4] In particular, traumatic corneal opacities are among the most common causes of corneal blindness in low- and middle-income countries.[5]

Although the eye constitutes only a small portion of the total body surface area, it is highly exposed to external forces and is particularly vulnerable to physical trauma.

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[6,7] Consequently, vision impairment due to ocular injuries can lead to significant psychological distress, reduced occupational efficiency, and long-term economic losses.[8]

In the forensic medicine context, ocular trauma is not merely a clinical concern but also serves as a critical forensic indicator, providing key insights into the mechanism, severity, and timing of trauma.[3] Findings such as intraocular hemorrhages, periorbital hematomas, and retinal lesions are of paramount importance in distinguishing cases of physical assault, particularly in child and domestic abuse investigations. Forensically significant ocular injuries necessitate meticulous evaluation not only for criminal legal proceedings but also for medico-legal assessments related to functional impairment and compensation claims.[9] A study conducted by Ligget et al. [10] reported that ocular trauma accounted for 1.3% of emergency department admissions. Similarly, in a study by Üstündağ et al. [11], 180 ocular trauma cases were reported over 20 months in the emergency department of Ordu University Hospital. Doğan et al. [12] identified that 3.1% of trauma cases presenting to forensic medicine units involved ocular trauma. These findings emphasize the necessity of both ophthalmological and forensic evaluations in cases of ocular trauma.

Given that the eye is an anatomically and functionally independent sensory organ, it is crucial to assess each eye separately. Evaluations of visual acuity (VA), visual field integrity, retinal damage, and optic nerve involvement are essential not only for determining the medical impact of trauma but also for forensic classifications of "functional loss" and "permanent visual impairment." Accordingly, forensic ocular consultations should not be limited to diagnostic assessments but must also consider their legal implications.[13]

This study aims to retrospectively analyze forensic ocular consultations requested by the Forensic Medicine Department of Ordu University Training and Research Hospital between 2017 and 2024. The study seeks to examine the distribution of trauma types, their effects on visual function, and the critical multidisciplinary considerations required for forensic reporting. In this regard, the study provides a literature-supported, interdisciplinary perspective on the intersection between ophthalmology and forensic medicine.

Materials and Methods

This study is based on the retrospective evaluation of forensic ophthalmology consultation reports requested by the Forensic Medicine Clinic and prepared by the Ophthalmology Clinic of Ordu University Training and Research Hospital between 2017 and 2024. The research was conducted in accordance with the ethical principles outlined in the 2008 Declaration of Helsinki and was approved by the relevant local ethics committee (Ethics Committee Approval: Decision No. 2025/76 dated July 04, 2025).

All ocular injuries included in this study were classified according to the standardized Birmingham Eye Trauma Terminology (BETT). This system provides an unambiguous, globally accepted framework for defining mechanical eye injuries, categorizing them into closed-globe and open-globe injuries based on the integrity of the corneoscleral wall.[14] To ensure standardized assessment of outcomes, key clinical terms were operationally defined based on VA. "Severe visual impairment" was used to describe cases with a VA of counting fingers, hand motion, or light perception (LP). The term "Complete vision loss" was reserved specifically for cases with no LP, representing a total loss of visual function. Furthermore, the medicolegal terms "functional impairment" and "functional loss" were defined according to the national forensic medicine guideline for the Turkish Penal Code.[15] "Functional impairment" was categorized as a permanent but partial decline in the organ's function (e.g., a measurable decrease in VA that does not render the eye blind). In contrast, "functional loss" was defined as the complete or near-complete cessation of the organ's primary function, rendering it legally non-functional.

All cases included in the study were patients who were referred to the ophthalmology department under official forensic investigation due to suspected ocular trauma. The dataset comprised the following variables: Age, gender, type of trauma (blunt or trauma with a sharp object), affected eye (right, left, or bilateral), the interval between trauma and consultation, type of ocular lesion detected (contusion, laceration, rupture, etc.), level of VA, functional impairment status, and necessity for medical intervention.

All statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics for continuous variables were presented as mean±standard deviation, minimum, and maximum values. Categorical variables were expressed as frequency (n) and percentage (%).

For group comparisons of categorical variables, the Fisher-Freeman-Halton exact test, Chi-square test, and Fisher's exact test were used. Statistical significance was set at $\alpha = 0.05$.

Results

A total of 108 cases referred to the Ophthalmology Clinic for forensic consultation between 2017 and 2024 were retrospectively analyzed. The age range of the patients varied between 5 and 83 years, with a mean age of 41.84±17.61 years. In terms of gender distribution, 80 (74.1%) of the patients were male, while 28 (25.9%) were female. The time interval between trauma occurrence and forensic medical evaluation exhibited considerable variability. The shortest interval was on the same day, whereas the longest was 654 days. The mean consultation delay was 3 (0–654) days.

Regarding the type of trauma, 96 (88.8%) of cases involved blunt trauma, while 12 (11.2%) involved trauma with a sharp object. Gender-based analysis revealed that trauma with a sharp object injury was significantly more frequent in male patients ($p<0.05$). In addition, when the interval between trauma occurrence and forensic consultation was compared by trauma type, it was observed that trauma with sharp object injuries was associated with a significantly longer delay in presentation ($p<0.05$). Demographic variables stratified by trauma type are detailed in Table 1.

The annual distribution of forensic consultations indicated that the number of cases increased over time, with 7 cases (6.5%) in 2017 and 19 cases (17.6%) in 2024 (Fig. 1).

Regarding seasonal and monthly variations, the highest number of cases occurred in August (*n*=14, 13.0%) and May (*n*=13, 12.0%), while the lowest number of cases was observed in February (*n*=5, 4.6%). Seasonal analysis revealed that trauma cases were most frequent in the summer (*n*=27, 25.0%) and least common in the winter (*n*=21, 19.4%).

Table 1. Sociodemographic characteristics by type of ocular trauma

Age	Type of trauma				*p*
	Blunt trauma		Sharp trauma		
	n=96	%	*n*=12	%	
≤25 years	22	22.9	1	8.3	0.471
26–35 years	16	16.7	3	25	
36–45 years	15	15.6	3	25	
46–55 years	22	22.9	4	33.3	
≥56 years	21	21.9	1	8.3	
Sex					0.034
Female	28	29.2	0	0	
Male	68	70.8	12	100	
Time to ophthalmic evaluation (days)	Blunt trauma (*n*=94)		Sharp trauma (*n*=14)		0.225
	3 (0–654)		5 (1–180)		

Among the 123 eyes analyzed, 109 cases (88.6%) were classified as closed-globe injuries, whereas 14 cases (11.3%) involved open-globe injuries. Laterality assessment revealed that the left eye was affected in 57 cases (52.8%), the right eye in 36 cases (33.3%), and bilateral involvement was present in 15 cases (13.9%).

In terms of specific lesions, contusion was the most common finding, primarily seen in closed-globe injuries and observed in 104 eyes (84.5%). The 14 open-globe injuries consisted of 12 full-thickness lacerations from sharp trauma (9.7%) and 2 ruptures from blunt trauma (1.6%). An intraocular foreign body (IOFB) was detected in 8 eyes (6.5%), all of which were, by definition, classified as open-globe injuries.

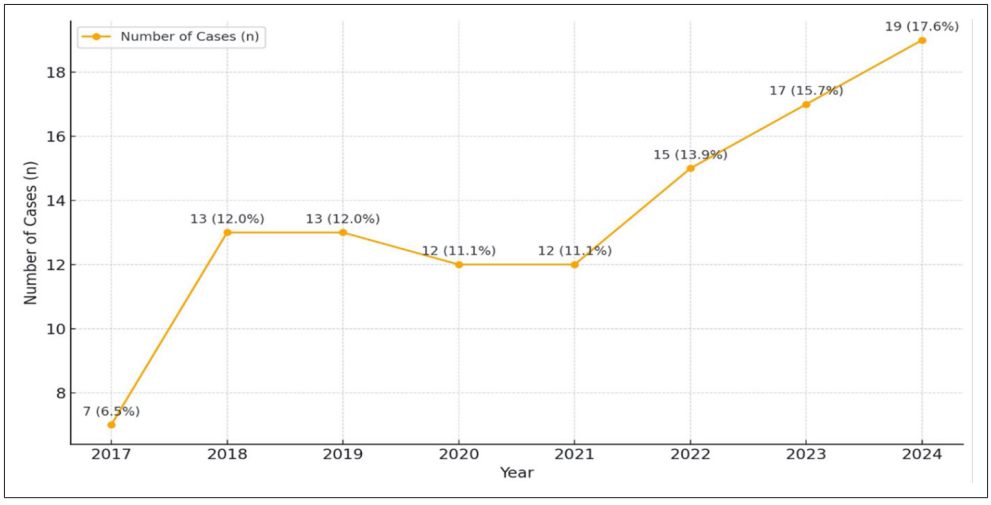

Fig. 1. Annual distribution of cases between 2017 and 2024.

Similarly, corneal, anterior segment, and fundus findings were significantly more frequent in open-globe injuries compared to closed-globe injuries ($p<0.05$). In addition, 70.6% of closed-globe injuries were classified as treatable with basic medical intervention, whereas all open-globe injuries required advanced medical or surgical interventions (Table 2).

Table 2. Distribution of ocular findings and injury characteristics by trauma type

Structural ınjury	**Consultation evaluation parameter**				***p***
	Closed globe injury		**Open globe injury**		
	***n*=109**	**%**	***n*=14**	**%**	
Contusion	104	95.4	0	0	<0.001
Lamellar laceration	5	4.6	0	0	
Laceration	0	0	12	85.7	
Rupture	0	0	2	14.3	
Affected eye	*n*=94	%	*n*=14	%	0.295
Right eye	30	31.9	6	42.9	
Left eye	49	52.1	8	57.1	
Bilateral	15	16	0	0	
Presence of intraocular foreign body	*n*=109	%	*n*=14	**%**	<0.001
Present	0	0	8	57.1	
Absent	109	100	6	42.9	
Periorbital finding	*n*=109	%	*n*=14	%	
Present	84	77.1	9	64.3	0.326
Absent	25	22.9	5	35.7	
Conjunctival finding	*n*=109	%	*n*=14	%	
Present	61	56	10	71.4	0.270
Absent	48	44	4	28.6	
Corneal finding	*n*=109	%	*n*=14	%	
Present	7	6.4	8	57.1	<0.001
Absent	102	93.6	6	42.9	
Fundus finding	*n*=109	%	*n*=14	%	
Present	12	11	6	42.9	0.006
Absent	97	89	8	57.1	
Anterior segment finding	*n*=109	%	*n*=14	%	
Present	9	8.3	7	50	<0.001
Absent	100	91.7	7	50	
Orbital bone fracture	*n*=109	%	*n*=14	%	
Present	16	14.7	2	14.3	1.000
Absent	93	85.3	12	85.7	
Accompanying systemic trauma find	*n*=94	%	*n*=14	%	0.882
Present	49	52.1	7	50	
Absent	45	47.9	7	50	
Basic medical ınterventıon status	*n*=109	%	*n*=14	%	<0.001
Treatable with basic medical intervention	77	70.6	0	0	
Not treatable with basic medical intervention	32	29.4	14	100	

Based on the results of the visual function assessment, no visual loss was observed in 37 of the 51 right eyes (72.5%) with closed-globe injuries, while 8 eyes (15.7%) exhibited functional impairment. In contrast, among the right eyes with open-globe injuries, functional loss was recorded in 6 eyes (11.8%). Regarding the left eye, 58 of the 72 eyes (80.6%) with closed-globe injuries maintained normal visual function, and functional impairment was identified in 6 eyes (8.3%). Among the left eyes affected by open-globe injuries, functional impairment was observed in 5 eyes (6.9%), and functional loss was present in 3 eyes (4.2%). These findings underscore the fact that open-globe injuries are more frequently associated with functional loss compared to closed-globe injuries and tend to result in a poorer visual prognosis (Table 3).

Based on the clinical findings and visual functional assessments, a classification scheme was developed to assist forensic evaluation. This classification integrates visual outcomes with treatment needs and is intended to guide standardized medico-legal reporting. The details of this framework are presented in Table 4.

Discussion

The classification of ocular trauma in this study was based on the BETT, which categorizes injuries into two primary types: open-globe and closed-globe.[14] This distinction is critical, as open-globe injuries, defined by a full-thickness defect of the corneoscleral wall, carry a significantly different prognostic and therapeutic profile compared to closed-globe injuries, where the globe remains intact.

Table 3. Functional status of the right and left eye following trauma

Right eye, (*n*=51)	**Ocular function-consultation evaluation result**				***p***
	Closed globe injury		**Open globe injury**		
	***n*=45**	**%**	***n*=6**	**%**	
No visual loss	37	82.2	0	0	<0.001
Functional ımpairment	8	17.8	0	0	
Functional loss	0	0	6	100	
Left eye, (*n*=72)	*n*=64	%	*n*=8	%	<0.001
No visual loss	58	90.6	0	0	
Functional ımpairment	6	9.4	5	62.5	
Functional loss	0	0	3	37.5	

In our study, this classification was used alongside a multidisciplinary approach, considering the forensic medical assessment criteria outlined in the "Evaluation of Injury Offenses in Forensic Medicine under the Turkish Penal Code (2019)" guideline (Table 4).[15]

In our study, 88.6% of eyes involved closed-globe injuries, whereas 11.4% presented with open-globe injuries. Hösükler et al. [16] reported a 94.6% prevalence of closed-globe injuries and a 5.4% prevalence of open-globe injuries in their study. The literature consistently highlights that closed-globe injuries are more common, often resulting from blunt trauma mechanisms.[17,18] While both injury types carry the risk of permanent ocular sequelae, open-globe injuries pose a significantly higher risk for severe complications, primarily due to disruptions in corneal and scleral integrity.[19] In our cohort, blunt trauma was the predominant mechanism, a finding consistent with existing literature. These injuries most commonly manifested as closed-globe injuries, with clinical findings such as contusion, subconjunctival hemorrhage, and periorbital ecchymosis being frequently observed, which underscores the typical presentation of this trauma type.

Among the key prognostic factors in open-globe injuries, the presence of an IOFB is of particular concern, as it can significantly impact visual outcomes. Studies indicate that IOFBs may induce retinal toxicity over time and increase the risk of proliferative vitreoretinopathy, leading to further complications in long-term visual prognosis.[17-20] Consistent with these findings, our study also found that the presence of foreign bodies, as well as corneal and fundus abnormalities, was significantly higher in open-globe injuries ($p<0.05$).

In our study, 41.5% of cases involved right-eye trauma, while 12.2% exhibited bilateral ocular involvement. Üstündağ et al. [11] reported that both eyes were affected at an equal rate in their study. However, literature findings regarding laterality in ocular trauma remain controversial. Some studies suggest that right-eye injuries are more prevalent, which has been hypothesized to be associated with the dominance of right-hand usage in the majority of individuals, leading to asymmetrical reflex movements and exposure patterns.[21] Nonetheless, this remains a topic of ongoing debate, as some researchers report a higher prevalence of left-eye injuries, whereas others support the predominance of right-eye involvement.[22,23]

Traumatic ocular injuries are more frequently observed in males, a finding well-established in epidemiological studies.[3,6] In our study, 74.1% of cases were male, while

Table 4. Forensic medicine criteria to be considered during ophthalmology consultation report preparation

Pathology	Forensic assessment
Ecchymosis/hematoma or superficial lacerations on eyelids/periorbital area	Treatable with basic medical ıntervention
Subconjunctival hemorrhage without visual impairment or cosmetic-functional defect	Treatable with basic medical ıntervention
Corneal abrasion or contusion without perforation	Treatable with basic medical ıntervention
Iris, uvea, vitreous injuries (e.g., intraocular hemorrhage)	Not treatable with basic medical ıntervention
Traumatic lens lesions (subluxation, luxation, cataract, hyphema)	Not treatable with basic medical ıntervention
Enucleation or evisceration	Not treatable with basic medical ıntervention
Lacrimal canal injuries	Not treatable with basic medical ıntervention
Choroidal rupture	Not treatable with basic medical ıntervention
Retinal trauma (edema, laceration, detachment, hemorrhage)	Not treatable with basic medical ıntervention
Scleral and/or conjunctival perforation	Not treatable with basic medical ıntervention
Globe perforation	Not treatable with basic medical ıntervention
Persistent traumatic epiphora	Not treatable with basic medical ıntervention
Traumatic ptosis	Not treatable with basic medical ıntervention
Trichiasis, entropion, ectropion (post-traumatic)	Not treatable with basic medical ıntervention
Traumatic strabismus (non-intracranial origin)	Not treatable with basic medical ıntervention
Optic nerve injury (non-intracranial origin)	Not treatable with basic medical ıntervention
Fracture of a single orbital bone	2 points
Fracture of multiple orbital bones or open/comminuted fracture	3 points
Light perception only, hand motion, finger counting, visual acuity 1/10–3/10	Loss of function
Visual acuity 4/10–7/10	Permanent functional ımpairment
Traumatic strabismus	Permanent functional ımpairment
Hemianopia	Permanent functional ımpairment
Persistent traumatic epiphora	Permanent functional ımpairment
Total traumatic ptosis	Permanent functional ımpairment
Diplopia	Permanent functional ımpairment

25.9% were female, further reinforcing this trend. This male predominance has been linked to greater engagement in outdoor activities, physical labor, and high-risk occupations, which contribute to a higher susceptibility to ocular trauma.[24]

In Turkey, studies conducted in emergency departments have reported mean ages for ocular trauma cases ranging between 18.6 and 27.8 years.[11,22,25] However, international studies indicate that this average extends up to 30 years.[26] In forensic medicine studies, the mean age has been reported as 35 years.[12,16] Consistent with these findings, the mean age in our study was 41.84±17.61 years, aligning more closely with forensic medicine reports.

This age discrepancy may be attributable to the broader age distribution typically observed in forensic cases. In addition, older individuals may undergo more frequent forensic evaluations due to an increased risk of post-traumatic complications. Another contributing factor to the higher mean age in our study may be the higher life expectancy in the region where the research was conducted.[27]

The Forensic Medicine Clinic at our hospital was established in 2017, and as the clinic developed and the number of personnel increased, a progressive rise in ophthalmology consultation requests was observed in our study. Analyzing the seasonal distribution of traumatic ocular injuries, we identified that the highest number of cases occurred in August and May. The existing literature supports this trend, suggesting that ocular trauma is more frequent during the summer months, largely due to increased participation in outdoor activities, recreational sports, and a rise in occupational accidents.[16,28,29] The findings of our study are consistent with these reports.

Our study also revealed that a significant proportion of open-globe injuries required advanced medical intervention, as

they were not manageable with basic medical treatment ($p<0.01$). In a study by Üstündağ et al.[11], only four cases of open-globe injuries resulted in total blindness. Similarly, Doğan et al.[12] reported that 7.6% of cases exhibited permanent functional impairment. However, in our study, this proportion was found to be 8.3%, suggesting a higher incidence of severe ocular sequelae compared to previous reports.

A thorough and timely ophthalmological evaluation is of paramount importance in the forensic assessment of patients presenting with ocular trauma. This is particularly critical in forensic reporting, where the collaboration between ophthalmologists and forensic medicine specialists is essential. In forensic ophthalmology consultations, repeated assessments may be required due to changes in clinical findings or the need for additional examinations. Our study demonstrated that the time interval between trauma and consultation was significantly longer for trauma with a sharp object injury, suggesting that these cases undergo extended follow-up evaluations, potentially due to the need for a more detailed assessment of functional loss or the prolonged recovery period following trauma with a sharp object.

Study Limitations

As a retrospective study, our research has inherent limitations. The study only included data from forensic ophthalmology consultation reports, which means that sociodemographic characteristics and other medico-legal factors, such as the assessment of permanent facial scars in cases involving ptosis, could not be extensively analyzed. Furthermore, considerations related to compensation law were not addressed in detail, as they fall outside the scope of this study.

Ethics Committee Approval: This study was approved by The Ethics Committee of Ordu university

(Decision No. 2025/76 dated July 04, 2025).

Informed Consent: Written informed consents were obtained from patient and his family.

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