EYE INJURIES OF FORENSIC EXAMINATION: INVESTIGATION, ANALYSIS, EXPERT PERSPECTIVES

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Annotation: The article presents a forensic medical analysis of eye injuries, focusing on mechanisms, classification, and diagnostic methods. It examines trauma caused by blunt, sharp, firearm, and explosive agents, emphasizing the importance of detailed documentation and expert evaluation. Modern imaging and histological tools are discussed as key elements in forensic practice. The article offers practical insights for forensic experts through case studies and current methodologies.

Keywords: Blunt and sharp trauma, crime-related eye injuries, eye injuries, expert analysis, forensic diagnostics, forensic examination, forensic ophthalmology, injury interpretation, injury mechanism, medico-legal evaluation, ocular trauma, visual system damage.

Relevance. Eye injuries are an important medical and forensic problem due to their high incidence, the severity of possible consequences, and the importance of vision as a vital function [1, 3, 4, 8, 11, 13]. A ccording to the World Health Organization, eye injuries are recorded annually in millions of people worldwide, including as a result of criminal activity, road traffic accidents, industrial accidents, and domestic conflicts [2, 5, 7]. Impaired visual function even in one eye can significantly affect the quality of life of the victim, his professional suitability, and social adaptation. Forensic examination of eye injuries is of particular importance in establishing the severity of harm to health, determining the mechanism of injury, and identifying signs of simulation, aggravation, or artificially inflicted damage [6, 9, 10]. Of particular difficulty is distinguishing between different types of injury and establishing a cause-and-effect relationship between the traumatic impact and the identified visual impairment [14, 15, 16]. Considering the wide range of clinical and expert tasks facing forensic medical specialists, it is necessary to systematize modern concepts of eye injuries, generalize diagnostic and expert criteria, and analyze existing regulatory documents governing forensic medical assessment of harm to health in case of ophthalmological injuries [1, 3, 6, 12].

Purpose of the study. To present current data on injuries to the visual organ from the perspective of forensic medicine, to characterize existing classifications, clinical manifestations, expert approaches to assessing the severity of harm to health and to outline current problems and prospects for the development of forensic

ophthalmological examination.

Classification of injuries to the organ of vision. Classification of eye injuries is important not only for clinical practice, but also for forensic medical assessment of the severity of harm to health. Systematization of injuries allows for correct interpretation of the mechanism of injury, determination of its nature, prediction of consequences and determination of qualifying features of the offense.

Classification by mechanism of traumatic impact.

Mechanical injuries. *Dull (contusions)*– caused by the impact of a blunt object without violating the integrity of the membranes of the eyeball. Often accompanied by hemorrhages, retinal detachments, subluxation of the lens. Penetrating – accompanied by a violation of the integrity of the outer membranes of the eye (cornea, sclera) with possible loss of intraocular structures. Non-penetrating – damage to the superficial structures without perforation of the eyeball. Combined – combine several types of damaging effects (for example, mechanical + chemical). Foreign bodies – metal, glass and other particles can get inside the eye or orbit.

Thermal injuries. Occurs when exposed to high or low temperatures. Often combined with burns of the eyelids and face.

Chemical injuries. Caused by alkalis, acids, irritating gases. Alkalis penetrate deeper and cause more severe lesions.

Radiation damage. Exposure to ultraviolet, infrared or ionizing radiation, including laser and microwave radiation. The cornea, lens and retina are most vulnerable.

Classification by localization of the lesion.

Lesions of the eyeball. Cornea, sclera, anterior chamber, iris, lens, vitreous body, retina, optic nerve. Lesions of the accessory apparatus of the eye. Eyelids, lacrimal apparatus, eye muscles, orbit. Lesions of the visual analyzer outside the orbit. Optic nerve (intracranial segment), visual pathways, visual cortex.

WHO Ophthalmological Classification includes levels of visual acuity, degree of visual field impairment, functional limitations. Birmingham Eye Trauma Terminology (BETT) is an international system for standardizing the terminology of eye injuries, dividing them into open and closed injuries with details by the type of damaging agent.

Etiology and mechanism of eye injuries. The study of the etiological factors and mechanisms of eye injuries is of key importance for forensic medical examination, since it allows us to establish the nature of the damaging effect, reconstruct the circumstances of the injury and determine its potential causal relationship with the outcomes.

Household injuries. One of the most common categories. They occur when doing housework, using household chemicals, sharp objects, or playing with children. They

are often characterized by blunt or penetrating injuries to the cornea and sclera, chemical burns, and damage to the accessory apparatus of the eye (eyelids, lacrimal organs). Cases of concealment of the true circumstances of injury or suspicion of self-harm present a forensic medical difficulty.

Industrial injuries. Usually associated with the impact of mechanical, thermal and chemical factors in the workplace - especially in metallurgy, construction, chemical and woodworking industries. Penetrating wounds with foreign bodies, burns, combined injuries are often observed. In judicial practice, the analysis of compliance with safety precautions and assessment of professional risks is of key importance.

Criminal injuries. They occur as a result of intentional physical violence. They are characterized by a wide variety of injuries: from eyelid contusions and hyposphagmas to penetrating wounds and eyeball tears. Of particular importance in forensic examination is the assessment of the mechanism of injury (blunt or sharp object blow, compression), the relationship of injuries with the alleged weapon, as well as the possibility of simulation.

Road traffic accidents. A common cause of severe and combined eye injuries. The mechanism is sudden acceleration/deceleration, contact with foreign bodies (glass, metal), impacts with elements of the car interior. Often combined with craniocerebral trauma. Factors such as speed, body position, and use of seat belts are taken into account.

Sports injuries. Most common in contact and game sports (boxing, football, hockey). Blunt injuries, contusions, retinal detachment are most often observed. The expert assessment takes into account the conditions of the competition, acceptable levels of contact, and the availability of protective equipment.

War and terrorist damage. Occurs when explosives, firearms, and shrapnel are used. Often combined with facial and head injuries, burns, and massive tissue destruction. The examination requires a multidisciplinary approach, including ballistic assessment and analysis of the conditions of injury.

Self-harm, simulation and aggravation. In forensic medicine, there are cases of deliberate self-injury to the eye with the purpose of simulating a disease, evading responsibility, obtaining disability or material gain. Superficial, stereotypical and low-symptom injuries are often observed. A comprehensive assessment of clinical data, anamnesis, psychological status and compliance of symptoms with the objective picture is important.

Clinical manifestations and diagnostics. Clinical manifestations of visual organ injuries depend on the nature of the damaging factor, depth and localization of the lesion. For forensic medical examination, both direct manifestations of the injury and data from objective instrumental examination confirming the degree of visual impairment are important.

General clinical manifestations of eye injuries. Damage may affect both the superficial structures of the eye (eyelid, conjunctiva) and its internal components (cornea, lens, retina, optic nerve). The main symptoms include: eye pain; decreased or complete loss of vision; lacrimation, photophobia; edema, hyperemia, hemorrhage (hyposphagma, hyphema, hemophalmos); deformation of the eyeball; exophthalmos or enophthalmos; eye motility disorders (with injury to the extraocular muscles or orbit).

Methods of clinical diagnostics. To confirm the nature and severity of the eye injury, a set of ophthalmological examinations is used: Ophthalmoscopy (direct and reverse) - assessment of the state of the retina, optic nerve head. Biomicroscopy (with a slit lamp) - visualization of the cornea, anterior chamber, lens. Tonometry - measurement of intraocular pressure, especially relevant if open-angle traumatic glaucoma is suspected. Seidel test - used to detect leakage of aqueous humor if a penetrating injury is suspected.

Visual acuity and visual field testing– objectification of visual function disorders. Radiation and instrumental diagnostics. Modern visualization methods allow us to detect damage to orbital and intracranial structures: Ultrasound of the eye (B-scan) – when direct ophthalmoscopy is not possible (for example, when the media are cloudy). Computed tomography (CT) – is especially effective in the presence of foreign bodies, orbital bone fractures, and evaluation of retrobulbar hematomas. Magnetic resonance imaging (MRI) – is used to assess the condition of the optic nerve, intracerebral structures (if injuries outside the orbit are suspected). OCT (optical coherence tomography) – accurate diagnostics of damage to the retina and optic nerve.

Forensic diagnostics. Forensic medical assessment requires objectification of clinical data and their comparison with the presented circumstances of the injury. The main tasks are: confirmation of the presence of persistent reduction or loss of vision; establishment of the age of the injury (by stages of healing, histological signs); differentiation between organic and functional visual impairment (including suspected simulation); assessment of the reliability of the provided data and medical documentation.

Methods for detecting simulation and aggravation. In forensic medicine, special ophthalmological tests are widely used: Objective perimetry, ERG (electroretinography) - determine the presence of visual reactions in the absence of subjective complaints. Monitoring spontaneous pupil reactions, microsaccades and behavior - can reveal a discrepancy between the declared disorder and the patient's behavior. The cross-stimulation technique (tests with filters, glasses) - allows you to establish the presence of vision with simulated blindness of one eye.

Forensic examination of eye injuries. Forensic medical examination of visual organ damage is an integral part of establishing the severity of harm to health,

determining the mechanism of injury and verifying cause-and-effect relationships. It is carried out based on the analysis of clinical, instrumental, laboratory and legally significant data.

Objectives of the examination. Establishing the presence and nature of damage to the visual organ. Determining the degree of visual impairment (visual acuity, visual field, loss of functions). Qualifying the severity of harm to health. Identifying signs of simulation or aggravation. Assessing the compliance of the presented data (anamnesis, circumstances) with the actual clinical picture. Establishing the age of the injury. Formulating a reasoned expert opinion.

Key Points: Serious Injuriesis established in the case of: complete anatomical loss of the eye; persistent loss of vision in one eye (0 or below 0.04 with correction); loss of vision with significant consequences for professional activity. Moderate damage: long-term health disorder (more than 21 days); temporary loss of ability to work (more than 10%) in the absence of persistent decrease in vision. Mild damage: short-term impairment of functions (up to 21 days); no persistent decrease in vision or temporary disability.

Methodology of expert examination. Study of medical documentation (outpatient cards, extracts, examination results). Examination of the victim: objectification of symptoms, assessment of the data's correspondence to the anamnesis. Analysis of the course of treatment: timeliness of treatment, dynamics of the condition.

Conducting additional examinations if necessary (ultrasound, CT, consultations with specialists). Peculiarities of assessing persistent vision loss. Visual acuity with correction is taken into account. If correction is not possible (for example, with central scotoma), functional tests are taken into account. Visual field impairment may also be grounds for recognizing persistent loss of function (for example, concentric narrowing of less than 10°).

Problem situations in expert practice. Lack of complete medical documentation. Impossibility of objective examination (for example, if the patient refuses). Discrepancy between the stated complaints and objective findings. Borderline conditions (on the border between moderate and severe harm). Need for an interdisciplinary approach (neurologists, psychiatrists, traumatologists).

Causal relationships and legal interpretation. One of the most important tasks of forensic medical examination in case of injuries to the organ of vision is to establish a cause-and-effect relationship between the injury and the consequences that arose. This allows for an accurate classification of the offense, determination of the degree of guilt, and selection of appropriate legal measures of influence. The mechanism of injury, the nature of damage, and its consequences are of decisive importance in the classification of crimes and accidents.

Establishing a cause and effect relationship. The cause-and-effect relationship

between the injury and its consequences must be established based on: The mechanism of injury – it is important to establish how the impact led to damage to the visual organ (blunt force trauma, penetrating injury, chemical burn, etc.). The interval relationship – the moment of injury must be confirmed by time and objective data, such as the documented medical treatment of the victim, the results of examination and instrumental studies. The degree and nature of the injury – the expert must assess the severity of the injury, the degree of loss of functionality of the visual organ and their connection with the actual conditions of the incident. It is important to take into account all associated injuries that could affect the patient's condition.

The role of medical records in establishing communication. Medical documentation is important evidence in forensic medical examination. In case of eye injuries, special attention is paid to: Health dynamics – changes in the victim's condition established during treatment. Timeliness of treatment – failure to immediately contact a medical institution may indicate a questionable nature of the injury. Objectivity and completeness of diagnostics – errors in diagnosis or late diagnostics may cause difficulties in establishing the connection between the injury and its consequences.

Problems and aspects related to establishing causality. False testimony or malingering– one of the difficult aspects of forensic examination is the situation when the victim tries to change the circumstances of the incident in order to receive compensation or avoid criminal liability. In such cases, it is important for the expert not only to diagnose the injuries, but also to assess the objectivity of the data provided. Lack of evidence – if there is no clear evidence confirming the cause of the injury (e.g. video recordings, witness statements), the expert must work only with the available data, which can affect the accuracy of establishing a causal relationship. Complex injury mechanisms – some injuries, such as eye injuries in road accidents or during violence, can be caused by a combination of factors (e.g. a blow with a blunt object followed by chemical exposure), which complicates the process of assessment and causal analysis.

The role of forensic examination in criminal proceedings. Forensic examination of eye injuries plays an important role in resolving issues such as: Classification of the crime: serious or moderate bodily harm; Determination of the guilt and intent of the offender (e.g., intentional or careless actions); Establishing the causes of the injury in the context of the possible intentional or accidental nature of the incident; Predicting the consequences of the injury (e.g., possible disabilities or loss of ability to work).

Modern challenges and prospects for the development of forensic medical examination of eye injuries. With the development of medical science and forensic practice, as well as taking into account technological innovations, forensic examination

of eye injuries continues to develop. However, this field faces a number of challenges that require improvement of diagnostic methods, data interpretation and advanced training of specialists.

Technical and technological limitations: Despite the availability of high-quality diagnostic equipment, methods such as magnetic resonance imaging (MRI) and computed tomography (CT) cannot always be used in cases of eye injuries. Limitations also concern the quality of images when using standard methods and possible errors in data interpretation.

Insufficient training of specialists: despite the high level of professionalism in the forensic field, continuous training of specialists is necessary, since new methods of diagnosis, treatment and forensic examination require deep knowledge and experience.

Lack of standardized protocols: Although international classifications such as BETT and the WHO classification exist, the lack of a single, generally accepted protocol in forensic practice can lead to disagreements in assessing the severity of injuries and classifying crimes.

Uncertainty in legal aspects: Legislators and the judicial system continue to refine approaches to assessing the severity of injuries, which often leads to contradictions in law enforcement. For example, establishing the exact boundary between serious and moderate bodily harm can vary depending on the expert's interpretation.

Prospects for the development of forensic medical examination of eye injuries. Integration of innovative technologies*:*The introduction of new diagnostic methods, such as optical coherence tomography (OCT), artificial intelligence for processing medical images and automation of many aspects of examination, will improve the accuracy of diagnosis and speed up the examination process.

Development of interdisciplinary approaches: integration of ophthalmologists, neuropsychologists, psychiatrists and other specialists for a more comprehensive assessment of eye injuries and their consequences. This is especially important in complex cases where injuries are accompanied by psychological and neurological disorders.

Improving simulation identification techniques: Improving diagnostic tests to detect simulations and aggravations will help minimize the impact of unreliable data on forensic examination. The use of psychophysiological diagnostic methods, such as polygraph and neurophysiological tests, can help to identify falsifications.

Unification of expert opinions: creation of a single database with templates and standards for forensic reports on eye injuries. This will ensure a higher degree of uniformity in expert assessments and improve legal certainty.

International cooperation: the development of international standards and the exchange of experience between forensic experts from different countries will allow

the introduction of best practices and methods, as well as reduce errors in the assessment of injuries, especially in complex cases related to international legal norms.

Conclusions. Eye injuries remain one of the most pressing issues in forensic medical examination, requiring a comprehensive approach and accurate assessment. Not only the success of the trial, but also the possibility of restoring the health of the victim depend on the accuracy of diagnostics, high-quality interpretation of clinical data and correct classification of the injury. The key tasks of forensic medical examination are to establish a causal relationship between the injury and its consequences, as well as an objective assessment of the degree of harm to health, taking into account the characteristics of each specific case. The variety of injury mechanisms and types of damage requires a high level of professionalism and attentiveness of experts, as well as the use of modern diagnostic technologies for an accurate and timely assessment of the condition of the victims. Despite significant advances in the field of medical diagnostics and forensic medical examination, such issues as injury simulation, aggravation of the condition and difficulties in the legal interpretation of the severity of damage remain relevant. Future prospects for the development of forensic medical examination of eye injuries are associated with the introduction of new technologies, improvement of interdisciplinary approaches and improvement of training methods for specialists. Thus, further improvement of forensic examination of eye injuries is necessary to increase its efficiency and accuracy, which directly affects the objectivity and fairness of legal proceedings. It is important to continue working on the unification of methods, the introduction of innovations and the improvement of the qualifications of forensic experts to solve the challenges they face.

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