

TOXIC VISION: FORENSIC INTERPRETATION OF CHEMICAL OCULAR LESIONS IN THE 21ST CENTURY

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Introduction

Chemical eye injuries are one of the most complex and dangerous forms of damage to the visual apparatus. They can lead to serious consequences, including loss of vision, disability and even a threat to life. In forensic medicine, correct diagnostics, assessment of the nature and extent of damage, as well as establishing a cause-and-effect relationship between the impact of a chemical substance and the damage received are of particular importance. This paper examines the features of the clinical picture of chemical eye injuries, methods of their diagnosis, features of forensic medical assessment and issues of examination.

General information about chemical eye injuries. Chemical injuries occur when the eyes come into contact with aggressive substances – acids, alkalis, metal salts and other chemical compounds. The most common injuries are caused by acids (e.g., sulfuric, nitric), alkalis (caustic soda, sodium hydroxide), and metal salts (e.g., chromium). Depending on the type of substance and the conditions of exposure, the injuries can be of varying severity – from superficial burns to deep structural damage.

Classification of chemical eye injuries is based on a number of criteria, including the nature of the chemical agent, the severity of the lesion, the depth and extent of the damage. The main approaches to classification are as follows:

1. By type of chemical:

- **Acid burns** – caused by acids (sulfuric, hydrochloric, nitric, etc.); characterized by protein coagulation, the formation of a dense scab, which partially limits the penetration of the substance deep into the tissue.

- **Alkali burns** – caused by the effects of alkalis (sodium hydroxide, potassium hydroxide, ammonia, etc.); more dangerous because alkalis penetrate deep into tissues, causing liquefaction necrosis.

- **Damage caused by heavy metal salts** – for example, compounds of chromium, silver, mercury; cause toxic and irritating effects, possible formation of sediments in the tissues of the eye.

2. According to the severity of the lesion (clinical classification):

The most widely used classification is the Roper-Hall classification, which distinguishes four degrees:

- **I degree (mild):** corneal epithelial damage without opacity; conjunctival hyperemia.
- **II degree (moderate):** superficial corneal opacity, stromal edema, ischemia of less than 1/3 of the limbus.
- **III degree (severe):** pronounced corneal opacity, ischemia up to 1/2 of the limbus.
- **IV degree (extremely severe):** complete corneal opacity, ischemia of more than 1/2 of the limbus, tissue necrosis is possible.

3. By the nature and depth of the lesion:

- **Superficial** – the conjunctiva and corneal epithelium are affected.
- **Deep** – the corneal stroma, sclera, choroid and internal structures of the eye are involved.

4. By time from the moment of injury:

- **Acute period** – the first 7 days, active inflammatory reaction.
- **Subacute period** – 1–3 weeks, reparation phase.
- **Chronic period** – more than 3 weeks, formation of cicatricial changes and complications.

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The clinical picture depends on the concentration of the chemical, the time of contact and the affected area. In the first minutes after exposure, severe burning, lacrimation and redness of the eyes are observed. In severe cases, ulceration, tissue necrosis, scarring and even loss of eye function are possible.

Clinical characteristics of chemical eye injuries. The clinical picture includes: Corneal burns: manifested by redness, swelling and ulceration of the cornea. Conjunctival damage: hyperemia, swelling, hemorrhage. Keratitis: inflammation of the cornea with possible ulceration. Iris damage: change in color or shape of the iris. Intraocular damage: in severe cases, penetration of the chemical into the eye is possible, causing intraorgan burns. Scarring: leads to deformation of the cornea and deterioration of vision. Exacerbation of complications: development of glaucoma or cataracts. Assessment of the depth of the lesion is of particular importance: superficial burns (I-II degree) usually heal with minimal consequences; deep burns (III-IV degree) require urgent surgical intervention and can lead to complete loss of vision.

Methods of diagnostics and assessment of the severity of damage. Diagnostics include: General examination of the fundus: using a slit lamp to assess the condition of the cornea and conjunctiva. Fluorescein test: detection of defects in the corneal epithelium. Ultrasound examination (US): if examination is impossible due to turbidity of the media. Optical coherence tomography (OCT): to assess the depth of damage. Photo documentation: required for forensic purposes. Biochemical analysis: determination of the composition of the chemical substance, if necessary. Assessment of the severity of damage is carried out according to the classification

of burns by depth (according to Roper-Hall or Dua), which is important for determining the prognosis and treatment tactics.

Forensic assessment of chemical eye injuries. As part of the forensic examination, it is necessary to: Establish the fact of exposure of the chemical to the eye. Determine the nature and extent of the damage. Assess the time frame of the injury. Clarify the circumstances of the incident: whether it was intentional or accidental. Assess the consequences for the health of the victim: loss of vision, disability. The expert must take into account the specifics of the clinical picture, the results of instrumental studies and biochemical data. An important aspect is the differentiation between accidental and intentional actions - for example, when trying to cause harm or as a result of an accident.

Features of forensic examination of chemical injuries. When conducting an examination, it is necessary to: Collect all medical documents: medical histories, examination reports. Examine the victim and record changes. Take photo documentation of injuries. Assign additional studies (for example, laboratory tests). Assess the severity of harm to health in accordance with current legislation. The expert must provide an opinion on the relationship between exposure to a chemical substance and the injuries received, as well as on their severity. Legal aspects and liability for causing harm. If the fact of harm to health as a result of exposure to a chemical substance is established, various legal consequences may occur - criminal liability for intentional harm or civil liability for compensation for damage. The accuracy of the expert opinion plays an important role in determining the nature of the injuries and their connection with the incident.

Prevention and precautions.

To reduce the risk of chemical eye injuries, it is necessary to follow the rules for handling hazardous substances: use personal protective equipment (goggles), properly store substances in special containers, and train personnel in safe working methods. Precautions for chemical eye injuries

Prevention of chemical injuries to the eye is based on timely identification of risk factors, use of personal protective equipment and compliance with the rules for handling hazardous substances. The main precautions are listed below:

1. Use of personal protective equipment (PPE):

- **Safety glasses or shields** when working with acids, alkalis and volatile chemicals.

- In case of increased risk, use tightly fitting glasses or face shields to prevent splashes from getting into the mucous membrane of the eye.

- Use gloves and protective clothing to prevent the transfer of chemicals from your hands to your face.

2. Compliance with safety precautions:

- Storage of aggressive substances in hermetically sealed, labeled containers.
- Maintaining ventilation in areas where work is carried out with volatile substances.
- Conducting briefings and regular training of personnel on the rules for safe work with chemical compounds.

3. Availability of emergency equipment and preparation for emergency assistance:

- Equipping workplaces with emergency eyewash stations.
- Availability of clean running water or special ophthalmic solutions for immediate eye rinsing.
- Availability of first aid kits near work areas, including sterile materials, neutralizing solutions and analgesics.

4. Monitoring working conditions and regular medical examinations:

- Conducting periodic inspections of workers in contact with chemicals.
- **Air quality monitoring** in production and the level of aggressive substances.

5. Learning the algorithm of actions when chemicals get into the eye:

- **Immediate eye flushing** with a stream of water for at least 15–20 minutes.
- **Elimination of mechanical eye friction.**
- **Seeking specialized medical care** even in the apparent absence of serious damage.

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Conclusion. Chemical injuries of the visual organ in living persons require high professional competence of forensic doctors for correct diagnosis, assessment of the severity of damage and establishment of a causal relationship. Modern research methods allow to objectively assess the damage to the health of victims and ensure a fair legal solution in cases of harm to health as a result of exposure to hazardous substances. Chemical damage to the visual analyzer continues to be a relevant and complex problem not only in ophthalmology, but also in forensic practice. In the context of technological progress, widespread use of chemical reagents in industry, everyday life, agriculture and the criminal environment, the frequency of such injuries remains at a consistently high level. Chemical agents can cause rapid and irreversible damage to eye tissue, often leading to partial or complete loss of visual function, which has serious consequences from both a medical and social and legal point of view.

Forensic assessment of chemical eye injuries requires a comprehensive approach, including establishing the nature and mechanism of exposure, determining the severity of damage, predicting the outcome, and assessing the loss of professional or general working capacity. In this case, knowledge of the pathophysiological mechanisms of action of various chemicals, understanding the clinical dynamics of damage, and the use of modern ophthalmological diagnostic methods become critically important.

In the 21st century, the problem of differentiating between accidental, professional and criminal injuries also comes to the fore, including in the context of interpersonal conflicts, domestic violence and terrorist attacks. The increase in the

number of deliberate chemical attacks (including those using acids - the so-called "acid attack") requires the improvement of both forensic medical examination and legislation that ensures the protection of victims and fair criminal prosecution of the perpetrators.

Thus, chemical damage to the visual analyzer is not only a medical problem, but also an important interdisciplinary problem located at the intersection of medicine, law and public safety. Modern challenges require highly qualified forensic doctors, interdisciplinary cooperation and constant updating of knowledge. Only such an approach will ensure an objective assessment of the severity of harm to health, the fairness of court decisions and, ultimately, an increase in the level of protection of life and health of citizens in the conditions of modern society. Chemical damage to the visual analyzer continues to be a relevant and complex problem not only in ophthalmology, but also in forensic practice. In the context of technological progress, the widespread use of chemical reagents in industry, everyday life, agriculture and the criminal environment, the frequency of such injuries remains at a consistently high level. Chemical agents can cause rapid and irreversible damage to eye tissue, often leading to partial or complete loss of visual function, which has serious consequences from both a medical and social and legal point of view.

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