

Morphological Criteria for Assessing Acute Ethylene Glycol Poisoning

A. I. Iskandarov, M. A. Khaydarov

Republican Scientific and Practical Center of Forensic Medical Examination of the Ministry of Health of the Republic of Uzbekistan

Abstract A forensic medical study of acute ethylene glycol poisoning made it possible to determine the main morphological changes in internal organs in these poisonings: severe hemodynamic disturbances in internal organs and systems, local hemodynamics of internal organs, increased venous blood volume, the presence of oxalic calcium crystals in the renal tubules, trophic pathologies in the liver and kidneys.

Keywords Ethylene glycol, Acute poisoning, Oxalic acid, Calcium, Kidney and liver dystrophy

1. Introduction

Toxicological care and its forensic medical assessment may be hindered by such factors as the lack of information from eyewitnesses or the patient himself about the oral intake of a liquid with potentially toxic properties, as well as the possibility of reliably establishing the presence of ethylene glycol in the body only by chemical and toxicological research. Cases of ethylene glycol poisoning, in which treatment does not bring improvement to the patient or at least stability of dynamics, do not automatically make the medical care provided improper (incorrect). In situations of acute oral ethylene glycol poisoning, even proper medical care does not guarantee the prevention of death [5].

From the analysis of literature sources, it follows that alcohol and solvent poisoning is a significant social problem [6,7,8], and the high percentage of mortality and morbidity, especially in methyl alcohol poisoning [9], indicates the importance of taking into account nosological forms of morbidity both in the epidemiological direction of research and in clinical manifestations. Taking into account the above, the purpose of the study is to analyze the frequency of acute poisoning with methyl alcohol and ethylene glycol, the incidence of functional insufficiency of the system and mortality.

Ethylene glycol ($\text{CH}_2\text{OHCH}_2\text{OH}$, glycol, 1,2 ethanediol) is a colorless liquid with shades of blue and without any odor. High solubility in H_2O , $\text{C}_n\text{H}_{2n} + 2\text{O}$. $\text{CH}_2\text{OHCH}_2\text{OH}$ is mainly used as antifreeze, cooling agent, also this substance is a substitute of $\text{C}_3\text{H}_8\text{O}_3$ (glycerin). It is worth noting that intoxication with this substance and products in which it is found develops only by direct ingestion, while intoxication due to its vapors has not been proven.

$\text{CH}_2\text{OHCH}_2\text{OH}$ enters the bloodstream and spreads lonely throughout the body. Apogee level of $\text{CH}_2\text{OHCH}_2\text{OH}$ is registered after 24-48 hours from the moment of ingestion. It is worth noting that the level of $\text{CH}_2\text{OHCH}_2\text{OH}$ in the composition of urine is higher than in the blood. In the pathogenesis of intoxication with 1,2-dihydroxyethane, both its original and transformed forms take part. 1,2-dihydroxyethane, have high values of osmolality, which leads to the release of fluids from the channel and as a consequence of the development of cerebral edema and kidney poisoning, but it is worth emphasizing that the main aspects of the toxic effect of taking 1,2-dihydroxyethane are products of its decay. For the last decades the main emphasis in the theory of poisoning by 1,2-dihydroxyethane has been on the formation of calcium salts with oxalic acid, which has low solubility values. To date, after a number of studies, it has been proven that calcium and oxalic acid salts are only a small part of the transformed 1,2-dihydroxyethane, and this burden is not noted in 100% of cases of intoxication. But do not forget that the formed salts, precipitating, lead to burdens in the activity of the brain, kidneys, and lungs.

To date, the main reason for intoxication with 1,2-dihydroxyethane is the formation of $\text{C}_2\text{H}_4\text{O}_3$ (glycolic acid), as well as products of its metabolism, which has pronounced poisoning properties. The negative effect of these products is the inhibition of oxidation and phosphorylate processes. As a result, metabolites of 1,2-dihydroxyethane lead to the development of strong and multilateral enzymatic aggravations. The above-mentioned aggravations have a large effect due to the presence of high values of toxin osmolality, as well as due to a decrease in pH on the background of copulation of acids and their metabolic products.

Knowledge of the mechanism of action of ethylene glycol on the human body greatly facilitates the expert to understand the morphological disorders of internal organs in these

intoxications and to determine the main informative signs for postmortem diagnosis.

Purpose of the research: Development of expert criterion for evaluation of morphological changes in acute ethylene glycol poisoning.

2. Materials and Methods of Research

This article presents the results of a study of the morphological type of substrate in the development of acute intoxication with 1,2-dihydroxyethane, micro-preparations were also studied during forensic histological studies in 12 bodies of men whose average age was 45.8 ± 10.6 years, whose fatal outcome occurred 24 hours after intoxication. Biological material of heart, lungs, liver and kidneys was removed after more than 24 hours from the moment of lethal outcome, then they were stored in formalin solution, the concentration of which is equal to 10%, then the classical washing of the investigated material in alcohols was carried out. The studied samples were subjected to hematoxylin eosin staining and the results were evaluated. In the course of microscopic study, lenses with magnification of 200 and 400 times were used. Scientific work was carried out through the use of LEICA equipment in the department of forensic histological examination RSPCME.

Purpose of the study. We carried out a study of the retrospective type of the results of the forensic examination of the branch of the Republican Scientific and Practical Center for Forensic Medical Examination of the Ministry of Health. of the Republic of Uzbekistan of the city of Tashkent in the period from 2018 to 2023, in which the death of 12 males occurred due to intoxication with 1,2-dihydroxyethane. During the hospitalization of these persons, the condition was assessed as critically serious. Clinical manifestations consisted of hyperemia of the skin, the presence of marbling and canonicity of the upper and lower extremities, and the presence of hypothermia of the extremities. HR 80 to 120 beats per 60 seconds, firm, rhythmic. Cardiac tones were reduced. During auscultation of the lungs, vesicular respiration of weak type or rigid breathing was noted. There was also an increase in the size of the liver and its protrusion beyond the arches of the ribs by 30-50 mm, with the presence of painful sensations during palpation. Diuresis at urinary catheter insertion varied from 0 to 0.25 L with light yellow color.

Neurologic status: impaired consciousness up to 4th degree coma was observed. Slurred speech was observed in 100% of cases. In the course of ultrasound examination of kidneys and liver, increased echogenicity and size of these organs were registered. In 75% of cases, which is 9 people due to the presence of respiratory disorders were transferred to artificial lung ventilation. Asystole occurred in the course of therapeutic measures, no recovery of vital activity was observed during resuscitation procedures.

During autopsy, a characteristic odor of alcohol was noted in 100% of cases. According to literature sources [4], persons who died as a result of intoxication with

1,2-dihydroxyethane had hemorrhages in the sclera of the eyes, as well as facial cyanosis. In the course of our study only in 16.6% of cases, which is 2 people, these signs were not detected. In the process of macroscopic series of investigations we noted the presence of hyperemia of brain structures, a large number of small focal hemorrhages in internal organs, in the areas under the mucous and serous layers. Data processing of sectional type studies proved that in poisoning by 1,2-dihydroxyethane the most typical manifestation is the development of edema of the brain and its soft layers, which becomes the cause of local hemodynamic disorders and as a consequence the development of small focal diapedesis-type hemorrhages in the brain cortex. In the process of cardiac muscle examination, it had a light red color with the presence of non-homogeneous blood filling with an abundance of white colored interlayers. Morphologic pathologies of the heart consisted in hemodynamic disturbance and development of local nutritional deficiency of the heart muscle.

In the course of myocardial histologic type studies, fragmentation as well as dystrophic changes of cardiac muscle cells were revealed. It should be noted that the most informative sign in cardiac examination was a pronounced edema of cardiac muscle, the degree of which varied from medium to total.

The results of studies of histological type of lung tissue proved that the most typical manifestations of 1,2-dihydroxyethane intoxication are the development of pulmonary edema, as well as the development of alveolar emphysema of acute course. Filling of alveoli with homogeneous masses of pink color with the presence of practically unchanged red blood cells with a small number of white blood cells.

Full bloodedness vessels, emphysema of vesicular type, alveoli adhesion, cubic epithelium is observed in the lumen, with rare presence of red blood cells. Bronchi and bronchioles have reduced lumen values, spasm, blood depletion of local arteries and alveoli. Non-homogeneous blood filling, with pronounced blood stasis in capillaries, sludge of red blood cells.

In the course of gastric examination, the presence of local tissue death of the mucosal layer of the stomach and esophagus with the presence of inflammation of reactive etiology was noted. Local presence of white blood cells in mucous and submucous layer was revealed.

In the course of liver examination we noticed invariability of bar type structure, with all kinds of rare lipid elements. Full blood vessels of the liver are marked. The stroma has a thin-fiber structure (along the course of arteries, veins, and bile ducts).

Dystrophy of centrilobular hydropic type of functional elements of the liver is also detected. Impoverishment of portal arterioles, in the composition of which a large number of white blood cells are found. Congestion of capillaries of sinusoidal type, with the presence of red blood cells sludge, in particular, in the central lobules with rare cases of hepatocyte death and areas of hemorrhage. Renal examination

revealed the presence of blood stasis in the vessels. The diameter of the tubular capsule is open. The epithelial layer of the tubule is edematous, with the presence of light-colored cytoplasm and pronounced cell membranes. There is no staining of the nuclei of single cells, the presence of oxalates in the lumen of renal tubules is also recorded. We also found the presence of edema of the structure of the subcortical layer of the kidneys, the presence of stromal sclerosis of small sizes under the renal capsule, as well as severe parenchymatous dystrophy with local areas of necrosis of the epithelial layer of the tubules, with spasm of the lumen or with the presence of masses of granular type of eosinophilic nature; in the proximal and distal tubules of the kidneys the presence of single crystals and white blood cells is noted. Arteries and arterioles were subject to spasm with plasma effusion. Moderate edema of interstitial space, abundant filling of capillaries and venules of interstitium with blood stasis and sludge of red blood cells and local diapedesis-type hemorrhage were observed. In the course of processing the data of macroscopic and forensic-histological findings, as well as comparing them with the results of our scientific work, we found the common most reliable signs of morphological type, which can be interpreted as specific manifestations of intoxication with 1,2-dihydroxyethane: there can be a violation of hemodynamics and microhemodynamics of internal organs, blood flow, the presence of severe dystrophic areas in the liver and kidneys, as well as the detection of calcium oxalate in the renal tubules; for the respiratory system is typical the presence of edema and with the presence of calcium oxalate in the renal tubules.

3. Conclusions

1. The implemented scientific work proved that in acute ethylene glycol poisoning the main cause of death is acute intoxication with dysfunction of cardiovascular system, as well as respiratory system with dystrophic changes of liver and kidneys.
2. Typical manifestations of poisoning with 1,2-dihydroxyethane include the following signs: severe disturbance of hemodynamics in internal organs and systems, local hemodynamics of internal organs, increased venous blood volume, presence of calcium oxalate crystals in renal tubules, trophic changes in the liver and kidneys.

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