COMPARATIVE CHARACTERISTICS MORPHOLOGY OF BRAIN IN POISONING BY CARBON MONOXIDE AND COMBINATION WITH ALCOHOLIC INTOXICATION

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ABSTRACT

The article presents the results of brain studies from 99 corpses of persons who died from carbon monoxide poisoning and, depending on the presence of ethyl alcohol in the body, were divided into 2 groups. The study was carried out in 2 stages: 1 - microscopic with a complex of histological techniques, 2 - morphometric with statistical processing of the results. An algorithm has been developed for the state of the brain structures in various types of carbon monoxide poisoning, on a 5-point scale. It was found that morphological changes, more pronounced in combination with carbon monoxide poisoning with acute alcohol intoxication, and are characterized by vascular tissue lesions of various parts of the brain. Also, the main changes appear with an increase in alcohol and lay in the fact that neurons and changes around them play an important role in thanatogenesis.

I. INTRODUCTION

All over the world today, deaths from carbon monoxide (CO) poisoning occupy one of the leading places in the structure of intoxication [1,2,3,4,5,6,7,8]. External factors, the individual state of the body lead not only to a worsening of the course, but also to an increased risk of death. In most cases, CO poisoning occurs against the background of acute alcohol intoxication (AAI) [9,10,11,12,13]. Despite this, to date, there are no clear diagnostic and differential diagnostic criteria for the forensic medical diagnosis of the cause of death, assessment of the thanatogenesis of CO poisoning, as well as when it is combined with OAI. There is no consensus on the course of combined CO poisoning with alcohol intoxication. Some authors point to an aggravation of the course of CO poisoning in the presence of alcohol intoxication, while others note that with a mild degree of alcohol intoxication, CO poisoning decreases the toxicity level of the latter, however, with an increased concentration of ethanol, synergism of these states occurs [14,15,16]. The most sensitive to the action of CO is the central nervous system, in this regard, the purposeful study of changes occurring in the brain (GM) is of great scientific and practical importance for solving problems in the forensic medical examination of corpses, persons who died from CO poisoning [17, 18, 19,20].

Aim of the study: To reveal the features of the morphology of GM in case of CO poisoning and its combination with OAI.

II. MATERIALS AND METHODS

HM of 99 corpses was investigated, persons who died from CO poisoning, depending on the presence of AAS in the body, the study of materials was divided into 2 groups. 1st - CO poisoning (78 cases). Deaths from CO poisoning...
poisoning prevailed in males - 64% of cases. Age was 49% from 17-35 years old. According to the results of forensic chemical analysis, the concentration of carboxyhemoglobin (HbCO) in the blood of the dead was observed from 29.58% -87%, ethyl alcohol and its surrogates were not detected in the blood and urine. Group 2 - CO poisoning against the background of acute alcohol intoxication (21 cases). There are 15 men and 6 women in the structure. Between the ages of 36-60 (71%). The concentration of HbCO in the blood is from 49% –93%. Ethyl alcohol in the blood was found in the range of up to 3 %‰ - 15 cases, over 3 %‰ - in 4 dead. Only in 2 cases the presence of ethyl alcohol was detected only in urine (it was absent in the blood) at concentrations - 0.55 %‰ and 1.05 %‰. The circumstances of CO poisoning in - 90% of cases were homemade or low-quality devices for heating the premises, which affected the frequency of deaths in the winter, as accidents. During the forensic examination of corpses, characteristic signs of CO poisoning were noted in all cases, but with distinctive features in each group.

For a special study, pieces of GM were taken from areas of the cortex with the underlying white matter from the fronto-parietal region and the cerebellum, which were fixed in 10% neutral formalin, passed through an alcohol battery, embedded in paraffin and stained with hematoxylin and eosin, using the methods of Van Gieson, Nissl and according to Mallory. The study was carried out in 2 stages: at the first stage, visual microscopy was used; the second stage included morphometric and statistical processing of the results obtained. A quantitative assessment of the states of neurons, glial cells, states of blood vessels and intravascular contents, pericellular space (PCP) and perivascular space (PVP) was carried out; The severity of the lesion (LT), the volume of the lesion (AP) and the degree of damage (SP) of neurons, based on the method of A.I. Chubinidze, were determined. (1972; 1990), using a computer program developed by S.I. Indiaminov. (2020); When assessing the state of glial cells, the glial index was determined using D.V. Bogomolov (2001); the density of the location of neurons and neuroglia in a standard area; calculation of glio-neuronal, neuron-neuronal, glio-glial relationships in the cortex. Determination of perivascular and pericellular edema was carried out by the point method and the ratio between them; determination of edema of white matter was also studied by the point method in all studied departments of the GM using the point grid Avtandilov G.G. (2002). In this case, small squares were used, each of which consisted of 25 points. In the course of microscopic examination, in addition to the qualitative description of the GM structures, changes in the structural divisions of the GM, they were assessed using a point system. An algorithm was developed for the state of GM structures in case of CO poisoning against the background of concomitant conditions. According to which changes in the structures of GM in different types of CO poisoning were assessed on a 5 point scale from 0 to 4. (0 points - assigned in the absence of microscopic changes; 1 point - with existing changes; 2 points - in the presence of mild changes; 3 points - with pronounced changes; 4 points - with the most pronounced changes).

III. RESULTS

Microscopic examination of the structures of the GM observations of the 1st group revealed that the pia mater (MM) is thin, in some cases thickened due to the proliferation of loose connective tissue. A pronounced edema, destruction of fibrous and cellular elements is revealed. Collagen fibers in MMO are swollen, homogenized, their structure is invisible. There is some thickening of the arachnoendothelium due to moderate cell proliferation. The connective tissue fibers contained single erythrocytes and the usual number of local cells, among which there are many large cells of irregular oval shape with an eccentrically located nucleus, granular cytoplasm of pink color, and rounded shapes of these cells were also observed. Vessels of all types and calibers of the shell are full-blooded, there is blood stasis, separation of blood corpuscles from plasma, but there are few corpuscles in them. In some vessels, sludge phenomena. Due to edema, an enlarged space is revealed between the MMO and the substance of the brain, as well as an enlarged space around the radial artery. Adventitia of arteries and less veins of the sheath with phenomena of moderate collagenization.

In the substance of the brain, a pronounced blood filling of the vessels of the microvasculature was revealed, the erythrocytes in them were separated by small areas of plasma, foci of erythrocyte diapedesis were noted. As a result of precipitated (precipitated) plasma proteins, hemolyzed erythrocytes, a hyaline thrombus is formed in the vessels of the microvasculature. Perivascular edema delimited the vessel walls from the brain tissue, forming cracks. Arteries and veins of uneven blood filling, the endothelium was characterized by somewhere moderately swollen, hyperchromic, weakly pycnomorphic. Venous hyperemia with intravascular stasis and agglutination of erythrocytes, plasma stasis, in places with areas resembling "hyaline thrombi". Small extravasates from rounded contoured erythrocytes. Swelling of collagen fibers.
The structure of neurocytes underwent dystrophic changes, in the form of swelling of cells, shortening of processes, indistinctness of the contours of nuclei and protoplasm, and the presence of chromatolysis were noted. Quite often there were hyperchromic wrinkled neurocytes, where the nucleus was almost not contoured, shadow cells, melting neurocytes, neuronophagy. There was a lively reaction on the part of glial cells with the formation of few drainage forms, satelliteitis, pericellular edema of glia.

In the cerebellum - MMO is full-blooded. The neurons of the ganglionic layer are increased in size, the processes are swollen with severe degenerative changes, shadow cells, "prolapse" of pear-shaped cells. Moderate content of glial cells per unit area of preparations. PVP and PCP are dilated with a small content of tiny, weakly eosinophilic masses in them. Areas of PVP with neuropil cribrosis. Venous hyperemia with intravascular stasis and agglutination of erythrocytes, plasma stasis, abundant extravasates from round, constructed erythrocytes.

### IV. DISCUSSIONS

Summarizing the results of visual microscopic examination, we can say that despite the existing some features of intracerebral circulation disorders, depending on the types of CO poisoning, they do not allow to form a sufficiently clear impression of the dynamics of these reactions and, therefore, to use them as a basis for substantiating signs diagnostics of CO poisoning. Perhaps the reasons are the anatomical and functional features of the blood supply to different parts of the brain and topographic layers of the brain. In this regard, it becomes necessary to use morphometric research.

The conducted microscopic examination of the structures of the GM of the 1st group showed that the main changes were manifested in the form of blood filling of the vessels, diapedesis of erythrocytes, hyaline thrombi were noted. The endothelium is moderately swollen, their nuclei are hyperchromic, weakly pycnomorphic. Neurocytes hyperchromic-shrunken, cells- shadows, melting neurocytes, neuronophagy. Sattelitosis, glial edema. In the cerebellum, vascular congestion, tissue edema, dystrophic changes in Purkinje cells.

The results of a morphometric study of cases of group 1 showed that TP of neurons in case of CO poisoning with a concentration of HbCO in the blood above 60% is more pronounced and amounted to 40.16% in relation to CO poisoning with a concentration of HbCO in the blood of less than 60% - 36.33%. In this group, there was a high percentage of TP -46.15 ± 10, OP - 78.1 ± 25.31 and SP - 73.08 ± 17.73. The average error in the indicators of TP was 0.61%, OP - 1.28% and SP - 0.95%. Consequently, these indicators are higher due to the fact that death from CO poisoning at high HbCO concentrations occurs agonically. According to the results of these neuroglial complexes in acute CO poisoning, the difference between the groups was - distances (Lgl) 1.6 μm, glial density (Prgl) - 0.001, and their ratio Prl / Lgl 1.99. Regarding the difference between the morphometric readings of brain neurons and the pericellular space (PCP) of people who died from CO poisoning, with an area of neurons of 59% and an area of PCP of 41%. The area occupied by the space around the vessel is larger (2.43 ± 0.16) than the area occupied by the vessel (1.5 ± 0.16). The foregoing indicates that the area occupied by neurons in the brain of people who died from CO poisoning is much larger than the area occupied by PCP.

In group 2, microscopic examination of the cortex with the underlying white matter of the GM showed swelling and edema of the MMO, uneven plethora of the MCB vessels. The walls of the arteries of large and medium calibers are thickened, their layers are not clearly defined. In their lumen, an accumulation of fine-grained mass is observed, representing plasma coagulants. However, the veins of the membrane are thin-walled, in which the aggregation of erythrocytes and leukocytes is determined. Perivascular hemorrhages and erythrocyte diapedesis are noted. In the cortex of the cerebral hemispheres of the GM, there are large arteries, the walls of which are also characterized by swelling, thickening. In this case, the layers of the wall are not determined, there is a violation of their structural organization and partial destruction, the lumen in them is narrow or irregular in shape. This characterizes the dystonia of the arteries. Against the background of plethora of blood vessels, stratification of plasma and formed elements of the cell, plasma stasis are noted. Weak to moderate plasmorrhage. There is plethora in the large veins, where there is an alternation of aggregates of blood and plasma corpuscles. In the vessels of medium and small veins, plethora was not uniform. Hypochromic and hyperchromic endothelium nuclei. PVP expanded. Sometimes plasma or discolored erythrocytes are detected in the vessels of the MCR.

In the adjacent white matter, vascular lesions are more pronounced. Along with full-blooded vessels, there are also spasmodic ones. The wall of some arteries is disturbed; in the PVP, diapedesis of erythrocytes can be found.
The layers of the walls of the vessels of the microvasculature are not determined. Stasis of erythrocytes or plasma is noted. CCR is observed around glial cells.

The neurons of the cortex are subject to a more pronounced dystrophic process in the form of cytolysis, karyolysis. Chromolysis is observed. The ARC space is expanded. Satellitosis, neuronophagia, poorly expressed proliferation of neuroglia cells, CCR are observed. Moderate depletion of the cortex by pyramidal cells.

Cerebellum: IMO vessels are full-blooded. In the veins of the cerebellar cortex, stasis, agglutination of erythrocytes. In the ganglionic layer, neurons are subject to severe degenerative changes in the form of acute swelling. Cells-shadows are noted. There is a pronounced PVO and PVO. Glial cells in moderation.

When analyzing the morphometric parameters and the results of the degree of lesion in group 2, the following data on neuronal damage were obtained: the average TP was 26.16% (P<0.001), in this group there was an increased percentage of OP - 90.21% (P<0.05 ), The joint venture was 58.59% (P<0.05). These indicators indicate a shortening of the agonal rate. From the side of neuroglial complexes in the cerebral cortex, as in the previous group, no special changes were revealed. The quantitative assessment of neuroglial complexes in the cerebral cortex is represented by Lgl - 12.3; Rgl-0.009; Rgl / Lgl - 7.67. With an ethyl alcohol content of up to 3 %, the area occupied by the neuron is 54%, and the PCP area is 46%. The area occupied by the blood vessels is 41%, and the space around the vessel is 59%. With CO intoxication with an alcohol content of more than 3 %, the area occupied by the neuron is 53%, and the PCP area is 47%. The area occupied by blood vessels is 40%, and the space around the vessel is 60%. With an alcohol content of more than 3 %, the area occupied by a neuron is much larger, and the proportion of PCP is less. Consequently, the main changes appear as the amount of alcohol increases and lie in the fact that neurons and changes around them play an important role in thanatogenesis.

It was found that morphological changes in the combination of CO poisoning with OAI are manifested by pronounced vascular-tissue lesions of various parts of the GM. The polymorphic nature of the pathology of nerve cells was manifested, from primary irritation to severe changes, up to the death of brain cells.

V. CONCLUSIONS

In acute CO poisoning, the state of intravascular blood with the formation of aggregates, sludge, thrombi and the severity of PVR and CCR, as well as the degree of dystrophic lesions of the nervous tissue, indicated an agonal rate of dying. The intensity of damage to the structures of the GM increases when the content of HbCO in the blood is over 60%. According to the results of a morphometric study, at HbCO concentrations in the blood of more than 60%, TP is expressed. OP indicators within 76.47% - 77.57%. At the same time, JV indicators were within 56.4 - 58.86%, respectively.

In case of CO poisoning against the background of OAI, the characteristic criteria for assessing thanatogenesis are caused by the morpho functional failure of the vascular system of the brain, a violation of the rheological properties of blood. At the same time, the agonal rate is shortened, especially in the presence of ethanol in the blood of more than 3 % and at high concentrations of HbCO in the blood (60% and more). According to the results of a morphometric study of the combined variant of CO poisoning, it was determined that TP in this case was the lowest (26.16% (P<0.05). However, OP had a high percentage in comparison with other groups (90.21% (P<0.05). The SP was determined in the range of 56.4 - 58.86%.

REFERENCES


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