PATHOMORPHOLOGY OF THE ADRENAL GLANDS IN DAMAGED BY MAGNESIUM CHLORATE EXPOSURE

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ANNOTATION

A single administration of the defoliant leads to structural, hemodynamic disturbances and dystrophic changes in the cells of the cortex and medulla of the organ. The relative weight of the adrenal glands is significantly increased compared to the control. An expansion of the relative width of the adrenal cortex and its zones is noted. The volume of nuclei of cortical and chromaffin cells is significantly increased compared to the control. The vascular reaction is manifested not only in hyperemia, but also in local hemorrhages. Karyopyknosis is determined in cortical cells, vacuolization of their cytoplasm. After a single introduction of the pesticide, there is a decrease in the synthetic processes of the secretory cycle in the cells of the cortical substance zones, and a decrease in the amount of lipids and ascorbic acid indicate an increase in the phase of hormone secretion from cortical cells. With a single exposure to a pesticide at a dose of 1/10 LD50, there is a sharp increase in the morphofunctional activity of the adrenal glands along with the development of reactive-destructive changes in it against the background of disruption of synthetic processes in cells.

Key words: acute poisoning, magnesium chlorate, morphology, adrenal glands.

Relevance. The widespread use of pesticides in agriculture contributes to environmental pollution, the release of toxic substances and their metabolites into the air, soil, water bodies, and through them into the body of humans and animals. the influence of various exogenous factors (Lencher O.S., 2016; Momo C. Et al., 2014) [6,11].

Along with new pesticides, magnesium chlorate is still used in agriculture as a defoliant and desiccant (Blinova S.A. et al., 2021) [2]. The literature does not contain sufficiently complete information on the state of adaptive reactions in the adrenal glands after exposure to pesticides, including magnesium chlorate.

The aim of the study was to identify morphological changes in the adrenal glands after a single exposure to magnesium chlorate.

Materials and research methods. The study was performed on 18 adult mongrel male rats weighing 150-200 g. Magnesium chlorate at a dose of 410 mg/kg of the animal's body weight was administered intragastrically, as a 4.1 % solution, on an empty stomach. The pesticide was dissolved in distilled water. The specified dose corresponds to 1/10 LD50. A regular syringe with a metal probe was placed deep into

the oral cavity of the rats and the preparation was slowly injected. The oral route of magnesium chlorate administration was chosen taking into account the fact that, according to a number of authors, in 85-90% of cases pesticides enter the body with food and water. The dose of magnesium chlorate equal to LD50 (median lethal dose) was chosen taking into account the data obtained by T. Makhmudov (1991) [7]. For rats, it is 4.1 g/kg of body weight. At the same time, the dose of magnesium chlorate equal to 1/100 LD50 (41 mg/kg) for rats corresponds to the threshold, it is this dose that the human and mammalian organism most often encounters in areas of intensive pesticide use, so its use was important in practical terms. The animals of the first series (6 rats) were intact. The animals of the second series (6 rats) served as controls. Under similar conditions to the rats exposed to magnesium chlorate, they received distilled water. The state of the adrenal glands was studied in 6 rats that received distilled water once.

All animals (intact, control and experimental) were kept in identical vivarium conditions. No animal mortality was observed. Before the experiment (for one month) and during the entire period of drug administration, the rats were constantly monitored: their general condition, weight, stool and mobility of the animals were noted. The animals were weighed before and after the experiment. Rats given magnesium chlorate, as well as controls and intact rats, were killed simultaneously by instantaneous decapitation using a specially constructed guillotine. The adrenal glands were removed immediately after slaughter and weighed on a torsion balance.

To assess possible reactive and compensatory changes in the state of the adrenal glands after the introduction of magnesium chlorate, we used histological and histochemical methods of research. After weighing the adrenal glands along the conventional transverse axis of the organ, they were divided in half so that the state of the cortex and medulla could be assessed.

To fix the adrenal glands, we used 12% neutral formalin solution, Carnoy's solution, Baker's solution, 10% silver nitrate solution and Sevki's solution. After the corresponding processing of the material according to the selected methods, it was passed through alcohols of increasing concentration and embedded in paraffin. Sections 5-7 μm thick were prepared from the paraffin blocks.

A quantitative assessment of the obtained results was carried out:

1. The relative weight of the adrenal glands was calculated in mg of absolute weight per 100 g of animal weight (mg %).
2. The relative width of the cortex and its zones was calculated in μm of the width of the cortex and zones per gram of body weight.
3. The volume of nuclei of 100 cells of each zone of the cortex and medulla was measured using the formula of A. Arnold [2].
4. Counting ascorbic acid granules in 50 cells of each cortex zone.

5. The content of RNA, glycogen and lipids was determined on a five-point assessment scale with subsequent determination of the average values for the group (semi-quantitative analysis method). 0 - no substance; 1 - very little; 2 - little; 3 - moderate amount; 4 - a lot; 5 - a lot [2].

6. In order to objectify the results of the scoring, a cytophotometric study was conducted of the content of RNA, glycogen and lipids in histological preparations of the adrenal glands of intact, control and animals with a single administration of magnesium chlorate, and with multiple administration on the 3rd and 90th days.

Results of the study. This series presents data on the study of the morphofunctional activity of the adrenal glands of rats with a single action of magnesium chlorate at a dose of 1/10 LD50 (acute poisoning). The studies were conducted on 6 rats. In rats of this series, an increase in the relative weight of the adrenal glands was noted compared to the control, which was 0.155 ± 0.0022 mg per 100 g of body weight of the animals ($P < 0.001$).

Histological structure of the adrenal cortex and medulla. Histological examination of the adrenal glands reveals thickening of their capsule due to edema. The surface of the organ forms numerous protrusions of varying sizes. Moderate edema is observed in the subcapsular layer (Fig.1).

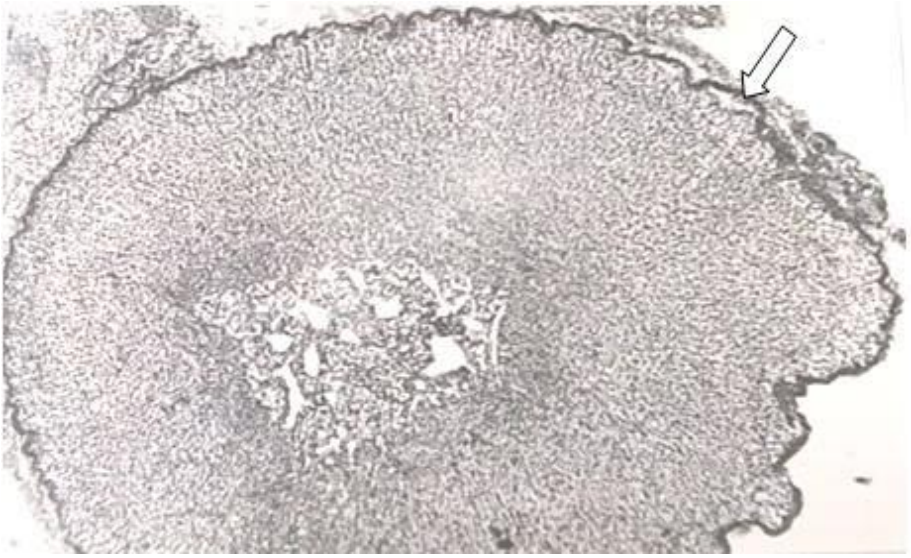

Fig.1. Thickening and swelling of the adrenal capsule and subcapsular layer. (↑) Uneven cortex surface. Rat adrenal gland after a single exposure to magnesium chlorate at a dose of 1/10 LD50. Van Gieson staining. Ob. 8, oc. 15.

The cytoplasm of some cells is lumpy. Argyrophilic fibers are changed in various

ways, fragmented, many of them to the point of lysis, and the rest are thickened. Zonal differentiation of the zones of the cortex is somewhat disrupted. In the glomerular zone, the arrangement of cells is disrupted, as a result of which their glomeruli are poorly distinguishable. Some cells of this zone are subject to hydropic dystrophy. In this case, adrenocorticocytes are flattened with elongated nuclei and oriented parallel to the capsule, with karyopyknosis phenomena. Focal hemorrhages are noted. Fragmentation and focal lysis of argyrophilic fibers are observed.

In the fascicular zone there is a slight edema, in the outer layers its glandular cells are somewhat larger, slightly vacuolated, the columns of cells are tightly adjacent to each other. In the lower layers adrenocorticocytes do not contain vacuoles, are small, the cytoplasm of the cells is moderately granular, with phenomena of karyopyknosis. (Fig.2)

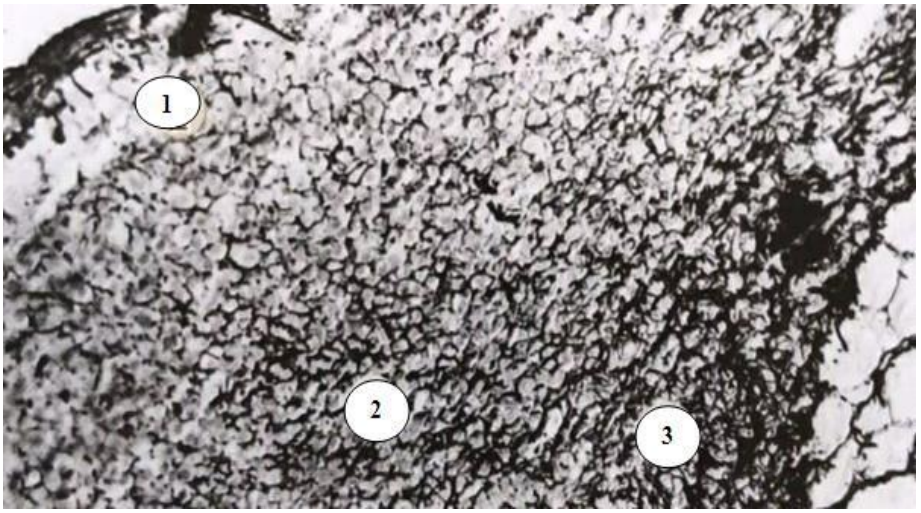

Fig.2. Fragmentation and lysis of argyrophilic fibers in the glomerular (1), their coarsening in the fascicular (2) and reticular (3) zones. Rat adrenal gland after a single exposure to magnesium chlorate at a dose of 1/10 LD50. Impregnation with silver nitrate by the Foote method. Volume 20, approx. 15.

Morphometric indices and histochemical picture of the functional state of the adrenal cortex. Morphometric examination revealed a reliable increase in the relative width of the adrenal cortex compared to the control. The relative width of the glomerular, fascicular and reticular zones was also significantly greater than in control rats (Table 1). The volume of nuclei of the cells of the glomerular, fascicular and reticular zones of the cortex was significantly increased compared to the control (Table 1).

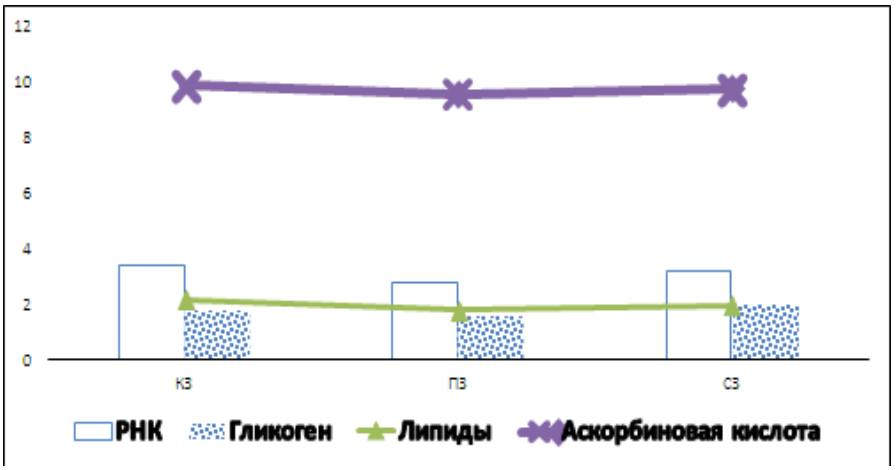

Fig.3. The content of RNA, glycogen, lipids and ascorbic acid in the adrenal cortex of rats given a single dose of magnesium chlorate at a dose of 1/10 LD50.

According to the results of cytophotometry, the content of RNA, glycogen and lipids in all zones of the cortex is significantly lower than in the control (Table 2), which confirms the results of a visual assessment of the amount of histochemically detected substances.

Condition of chromaffin cells of the adrenal glands. In the chromaffin cells of the medulla, the volume of nuclei significantly exceeds the control level ($P < 0.01$) (Table 1). In the medulla of the adrenal glands of rats exposed to a single dose of magnesium chlorate at a dose of 1/10 LD50, an increase in the number of norepinephrine-containing cells is noted compared to the control, and they constitute approximately 50% of the total number of cells.

Table 1

Morphometric indices of adrenal glands in rats given magnesium chlorate once at a dose of 1/10 LD50

Object	Cortex of adrenal glands	Zona glomerulosa	Beam zone	Mesh zone	Medulla
of measurement	512,3±9,34*	42,46± 2,63***	347,23± 4,32*	122,59± 3,4*	-
Relative width of the cortex and its zones (μm)	-	64,63±2,7*	86,69± 3,17*	66,25± 2,93*	101,54± 2,02**

Table 2

The content of histochemical substances according to cytophotometry data the adrenal cortex of rats given magnesium chlorate once at a dose of 1/10 LD50

Histochemical indices	Zona glomerulosa	Beam zone	Mesh zone
RNA	23,8±0,39 *	20,5±0,37 *	21,86±0,35 *
Glycogen	17,49±0,36 *	15,23±0,34 *	18,76±0,35 *
Lipids	16,69±0,36 *	13,2±0,38 *	13,97±0,37 *

Discussion. Thus, the obtained data on the morphofunctional state of the adrenal glands of rats exposed to a single dose of magnesium chlorate at a dose of 1/10 LD50 differ significantly from those in control animals. As shown by the results of the conducted morphological, morphometric and histochemical studies, a single administration of the defoliant leads to structural, hemodynamic disturbances and dystrophic changes in the cells of the cortex and medulla of the organ. Changes in hemodynamics and the structure of the vessels of internal organs under the influence of exogenous factors have been noted by a number of researchers (Gasanov A.G., 2009; Koko et al., 2004) [4,10].

The vascular reaction is manifested not only in hyperemia, but also in local hemorrhages. A secretory cycle in the cells of the cortical substance zones. A decrease in the amount of lipids and ascorbic acid indicates an increase in the phase of hormone release from cortical cells. Disruption of the secretory cycle in glandular cells has been described under various influences (Kostrova O.O. et al., 2016; Odo R.I. et al., 2019) [5,12].

The content of H-cells in the medulla is increased, the secretory activity of most chromaffin cells is expressed moderately. In the adrenal glands, the development of adaptive reactions is observed, which is manifested by the presence of protrusions on the surface of the organ, as well as an increase in the relative weight of the organ, an expansion of the relative width of the cortex and its zones, an increase in the volume of cell nuclei in all layers of the organ. In addition, high pyroninophilia of the subcapsular layer cells is observed. Most authors, when assessing the effect of various damaging factors on the adrenal glands, usually limit themselves to assessing one of the parameters (Volkova N.I. et al., 2018; Gannouni N. et al., 2014) [3,9].

Conclusions. The totality of the indicated changes indicates that with a single action of the pesticide at a dose of 1/10 LD50, there is a sharp increase in the morphofunctional activity of the organ along with the development of reactive-destructive changes in it against the background of disruption of synthetic processes in

the cells. After a single application of the pesticide, the secretory activity of the chromaffin cells of the medulla increases, and the number of norepinephrine-containing cells increases. A sharp increase in the adaptive reactions of the adrenal glands is noted.

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