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## **Influence of mineral water of well No. 3 of Semyanivka village of Poltava district of Poltava region (Ukraine) on the structural and functional state of the kidneys with experimental nephritis**

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**Summary.** In an experiment on white rats with toxic nephritis, pathological changes in the structural and functional state of the kidneys were determined. An increase in the daily diuresis ( $p < 0.001$ ) was found, due to an increase in the glomerular filtration rate by ( $p < 0.001$ ) and a significant decrease in the percentage of fluid back-suction ( $p < 0.001$ ). The excretion of creatinine and urea increased by ( $p < 0.01$ ), and the excretion of chloride ions, on the contrary, decreased ( $p < 0.01$ ). Application on the background of the development of low-mineralized silicon chloride-hydrocarbonate sodium water leads to partial

normalization of kidney function - the volume of diuresis is moderately restored by increasing the tubular reabsorption against the background of a significant increase in the glomerular filtration rate and a significant increase in the amount of silica. The manifestations of inflammation in the kidneys disappear, but the destructive changes of the nephrons remain. The partial restoration of the activity of redox enzymes has been established.

**Key words:** mineral water, structural and functional state kidneys, experimental nephritis.

**Introduction.** Kidney disease is widespread in the world and significantly reduces the life expectancy and quality of life of patients [1, 2, 3], which necessitates the effective need for effective therapies. According to experts, the effectiveness of modern drugs for the treatment of kidney disease is limited and does not meet the expected results, which is obviously due to the complex structure of the kidneys, as well as the difficulty in establishing appropriate endpoints for clinical trials and the definition of appropriate therapeutic targets [4].

In this aspect, it is necessary to pay attention to mineral waters (MW), which have a multifaceted nonspecific effect and rightfully occupy one of the leading places in the rehabilitation and rehabilitation of the population [5, 6]. The positive effect of the use of MW is associated with the peculiarities of their physicochemical composition: the presence of biological agents - macro- and

trace elements and biologically active components and compounds (sodium, potassium, magnesium, silicon, boron, iron, hydrogen sulfide, organic substances, etc.), and their ratio [6].

In addition, in the composition of MW ions and biologically active components and compounds are in the most active for absorption form, which determines their significant biological effect (unlike pharmaceutical drugs) [7, 8].

A special place among MBs is occupied by a group of low-mineralized waters with high content of biologically active components and compounds to which silicon, organic matter and others belong. MWs of low mineralization in some cases operate more effectively (hormesis effect) than high mineralization waters. Under the influence of such MW the metabolism in the tissues is stimulated, the components of the MB are included in the composition of hormones, enzymes, vitamins, metabolites [8, 9].

Modern work on the biological role of silicon, indicates that this trace element is involved in the synthesis of glycosaminoglycans, elastin and collagen, which form the backbone of connective tissue and give it strength and elasticity, strengthens the walls of the vessels necessary for the formation of the main substance in the formation of the main substance participation in the process of bone mineralization [10]. In epithelial tissues silicon is in the form of low molecular weight compounds of cell membranes, the presence of which causes their elasticity and impermeability [11]. The latter circumstance is especially important for the normal functioning of the kidneys, as the excretion of toxic metabolites in the presence of silicon is not accompanied by damage to the epithelium of the tubules [12]. It can be assumed that silicon compounds are capable of preventing membrane damage and reducing their permeability.

Studies on the effects of MW of this type in experimental kidney damage in the available literature are small and unsystematic [13, 14]. In view of the

above, the purpose of the work is to evaluate the effectiveness of the use of low-mineralized silicon chloride-bicarbonate sodium water in the correction of toxic changes in the structural and functional state of the rat kidney with toxic nephritis.

**Materials and methods of research.** The experimental studies were performed on 35 white Wistar rats of a Wistar auto-breeding line with a body weight of 180.0 - 200.0 g. Animal studies were conducted according to legal documents [15]. Animals were ranked in three groups. And the group consists of 15 intact animals. Group II - 10 animals with jade; Group III - 10 animals receiving a course of CF on the background of nephritis. The model of nephritis (toxic kidney damage) was reproduced by a single subcutaneous injection of 0.5 mg of uranyl acetate dissolved in 0.5 ml of 50% hydrogen glycerol per 100 g of rat body weight [16]. Starting from the 2nd day to the 8th day of the experiment, rats on the background of the development of the pathological process were received in the mode of internal dosed watering of MV SVR. № 3 p. Semyanivka. CFs were injected into the esophagus of rats with a soft olive probe once a day at a dose of 1% by weight of the animal in the evening (approximately 16.00), taking into account the daily rhythm of the rats. The complex of researches was carried out:

1. Studies of the functional state of the kidneys were evaluated by the influence on the function of the urinary tract (glomerular filtration rate, tubular reabsorption, diuresis), excretory function (by the excretion of creatinine, urea and chlorides). Determined the acid-alkaline reaction of daily urine in terms of the concentration of hydrogen ions.

At the conclusion of the experiment, biological material was selected in the interval from 16 hours to 18 hours after the last application of CF. Animals from the experiment were removed by the method of decapitation under ether anesthesia.

2. When performing morphological studies, 2 pieces of 1 cm<sup>3</sup> kidney were removed from rats. The first slice was passed through alcohols of increasing concentration and poured into the celloidin. Made histological sections stained with hematoxylin-eosin. Microscopic studies of the structural changes of the kidneys were performed on the obtained sections. The second slice was frozen with dry carbon dioxide (- 70 ° C), histochemical reactions were performed on the prepared cryostat sections to determine the activity of succinate dehydrogenase (SDG) and lactate dehydrogenase (LDG) according to Lloyd's prescription. Statistical processing of the data obtained in the series of experiments was performed with the involvement of programs for biomedical research Statistica and Excel. Methods used are given in the manual and approved by the Ministry of Health of Ukraine, experimental studies were carried out in accordance with legal documents [17]. With all means of processing statistical material, those within the range of the Student's tables were considered to be significant shifts of less than  $(p < 0.05)$ .

In the study, MW was applied. № 3 p. Semianivka of Poltava district of Poltava region, quality criteria of which were evaluated in accordance with the requirements of GSTU 42.10.02-96 "Mineral healing waters. Specifications"[18].

Groundwater svr. No. 3 with a faint smell of hydrogen sulfide, fresh in taste, transparent, colorless, alkaline (pH 8.95 pH). By temperature it belongs to low-thermal ones (21.5 ° C). The gas composition contains carbon dioxide (6.6 mg/l) and hydrogen sulfide (0.36 mg/l). The main elements in the chemical composition of groundwater are hydrocarbonate ions (275.5 mg/l), chloride ions (131.8 mg/l), among the cations are Na<sup>+</sup> and K<sup>+</sup> ions (221.1 mg/l). Other cations and anions - SO<sub>4</sub><sup>2-</sup> (58.6mg/l), Ca<sup>2+</sup> (3.0 mg / l) and Mg<sup>2+</sup> (1.0 mg/l) have low concentrations and do not reach 20 eq. %. The content of methacrylic acid is from 0.045g/l to 0.051g/l. According to their physico-chemical indicators

groundwater svr. № 3 p. Semyanivka, Poltava district, Poltava region characterized as low-mineralized silicon chloride-hydrocarbonate sodium, alkaline, slightly thermal. The content of components and compounds in the groundwater of the well does not exceed the maximum permissible limits.

**Results and Discussion.** Data on the functional state of the nephritis rat kidney and its correction with silicon MW are shown in Table 1. The daily diuresis was increased by 266% due to the increase of the glomerular filtration rate by 54% and a significant decrease in the percentage of liquid back-up by 9.94% compared to control values ( $p < 0.001$ ). The excretion of creatinine and urea increased by 54% and 145%, respectively, and the excretion of chloride ions, by contrast, decreased by 25%. Course internal application of MV sv. № 3 in jade rats results in a slight recovery in diuretic volume due to a marked recovery in the percentage of tubular reabsorption (Table 1). GFF increases even more and exceeds control data by 200%. The daily excretion of creatinine, urea and chloride ions increased significantly and significantly exceeded the control group data by 325%, 422% and 86% ( $p < 0.001$ ), respectively.

Thus, the course application of CFSv. No. 3 against the development of nephritis has a positive effect on the course of partial processes in the kidneys, which contributes to the decrease in the amount of diuresis in comparison with the corresponding indicator of rats with nephritis only due to the significant but incomplete recovery of tubular reabsorption. The established changes from the excretory function of the kidneys indicate that CF does not delay the development of the pathological process.

Table 1. Functional state of nephritis and neonatal rat kidneys in the background of development of nephritis were internally administered CFS. № 3, %

Indicators	Group I	Group II	Group III
	%	%	%
Daily diuresis, ml/dm <sup>2</sup> of body surface	100	366*	281**
Speed glomerular filtration, ml/(dm <sup>2</sup> × min)	100	154*	300**
Tubular reabsorption, percentage to filter, %	100	90,06*	98,65**
Creatinine excretion, mmol	100	154*	425**
Urea excretion, mmol	100	245*	522**
Daily excretion of chloride ions, mmol	100	75*	186**
pH of daily urine, unit	100	95	91

Note: the control group of animals was 100% accepted;

\* - significant changes ( $p < 0.05$ ) calculated between control group and group of rats with pathology;

\*\* - significant changes ( $p < 0.05$ ) were calculated between the control group and the rats group with pathology and CF course.

Morphological studies of the kidneys in rats with experimental nephritis revealed that macroscopically the kidneys are somewhat enlarged, crumbling to the touch, the surface is smooth, the surface staining is gray-brown, heterogeneous. Histologically, there are small, few, even-numbered taurus in the kidney cortex. Some of them have lymphocyte accumulation. Endothelial cells with cytoplasmic vacuolation and lymphocyte infiltration. Bowman's space is slender. Part of the renal little bodies shriveled, reduced in size, the internal structure is not readable. Intercranial layers also with infiltration by lymphocytes.

Bowman's space is slender. Part of the renal little bodies shriveled, reduced in size, the internal structure is not readable. Intercranial layers also with lymphocyte infiltration. The coiled tubules are partially filled with eosinophilic homogeneous mass, the epithelium is represented by disordered nuclei. In the tubules, the epithelium is clearly represented, the cytoplasm swollen, until the lumen is closed; nuclei of epitheliocytes enlarged, rounded, pale in color. The vessels of the renal parenchyma are stably full-blooded.

The activity of SDH in the epitheliocytes of the destroyed tubules is ( $3.00 \pm 0.11$  at  $p < 0.001$ ) dm. units wholesale dense, which is less than in the group of intact animals ( $7.00 \pm 0.19$ ). LDH activity in epitheliocytes of destroyed tubules is ( $3.00 \pm 0.09$  at  $p < 0.001$ ) dm. units wholesale dense, which is lower compared to the group of intact animals ( $6.00 \pm 0.12$ ) dm. units wholesale dense. That is, the activity of enzymes is significantly reduced.

Morphological studies of the rat kidney with a model of nephritis receiving a course of loading MV established the following. By microscopy of the kidneys, it is determined that the capillary glomeruli of the renal little bodies are swollen with vacuoles. In the tubules, the disordered arrangement of epitheliocytes with small dark nuclei. In the part of the tubules, the structure is not readable, they appear to be heavier than epitheliocytes and structureless eosinophilic masses. Interstitial layers are distributed due to the structureless eosinophilic masses. Lymphoid infiltration is undetectable.

The activity of SDH in epitheliocytes of the preserved tubules is ( $7.00 \pm 0.16$ ) dm. units wholesale dense, in the weights of the residual tubules - ( $3,00 \pm 0,07$ ) dm. units wholesale dense; LDH activity in all tubules is ( $6,00 \pm 0,17$ ) dm. units wholesale dense.

### **Conclusions**

Thus, the use of MW No. 3 rat eliminates the manifestation of inflammation in the kidneys, but does not affect the course of destructive



processes in the nephrons. The partial restoration of the activity of redox enzymes has been established. It should be noted that the reproduced experimental model of nephritis is quite severe, and the positive changes established indicate that the MW applied exhibits significant adjustments in ability.

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