Dynamics of changes in the content of proteoglycans in the tissues of the cerebellum of rats under the influence of hypokinesia

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Abstract. The article reflects the dynamics of changes in the content of proteoglycans in preparations that were taken from the cerebellum of experimental animals after modeling hypokinesia. Laboratory animals were removed from the experiment at different time intervals (3, 7, 14, 21 and 30 days of simulated hypokinesia) to identify the dynamics of changes in proteoglycan content using histochemical studies. The experiment was carried out on laboratory rats of the *Vistar* breed. The animals were divided into two groups: control and experimental. All laboratory rats were kept under standard vivarium conditions. The experiment is based on the model of hypokinesia proposed by E. A. Kovalenko. Complex studies showed the dynamics of changes in the content of proteoglycans, which were not homogeneous at different stages of the experiment. However, despite the different trends in the dynamics of the content of various fractional components of proteoglycans, one can note a general trend towards a decrease in proteoglycans. This indicates a negative effect of hypokinesia on the productive function of cerebellar tissue in experimental animals.

1 Introduction

The historical development of civilization leads to the fact that modern man inevitably has to monitor the optimal level of physical activity [1-3]. Since this very activity is no longer enough for a person to maintain health at an optimal level in everyday life. And with the development of digital technologies, this problem has become even more acute [4-6].

A decrease in physical activity for reasons of various etiologies, and even more so its absence, leads to the appearance of such conditions in a living organism (human or animal) as physical inactivity and hypokinesia. These conditions have a damaging effect on entire organs and systems, and in some cases can lead to the death of the individual [7-9].

Proteoglycans are high molecular weight compounds that consist of protein (about 5%) and glycosaminoglycans (about 95%).

Proteoglycans are the main component of the intercellular matrix and play a leading role in the normal functioning of the central nervous system (in trophism, differentiation, migration and adhesion, as well as in the implementation of specific and other functions of

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neurons and glial cells) and the formation of an adaptive mechanism to the effect of a negative factor [10-11].

Based on this, the main goal of the work is to determine the effect of hypokinesia on the content of proteoglycans in the cerebellar tissues of rats at various time stages of the experiment.

To achieve this goal, we identified two main tasks: First, determining the dynamics of changes in the content of proteoglycans (sulfated and non-sulfated fractions). Second, a comparative analysis of the results obtained with the data of the control group.

2 Materials and methods

Laboratory rats were divided into 2 groups. The first group, the control group, was kept under normal vivarium conditions. The second group is experimental. Hypokinesia was modeled in this group under the same conditions as in the first group.

To determine the level of proteoglycan content (both total content and its individual fractions) at various time stages of the experiment (on days 3, 7, 14, 21 and 30), we carried out a histochemical analysis of materials from the cerebellum of laboratory rats.

The determination of various classes of proteoglycans was carried out based on the method proposed by H. Lupp [11]. For this purpose, standard cryostat sections 7 microns thick were prepared and stained with Alcian blue. This dye was prepared at different pH (1.0 and 2.5) and molarities ($MgCl_2$ content in solution 0.2 -1.0 mol), which makes it possible to separate proteoglycans into groups - sulfated and non-sulfated.

In our work, we analyzed the following fractions: sulfated (represented by chondroitin sulfates and heparan sulfates) and non-sulfated (represented by hyaluronic acid).

3 Results and Discussion

The proteoglycan content in materials taken from the control group was 71.98 ± 4.15%. At the same time, fractional analysis of proteoglycans showed that non-sulfated glycosaminoglycans were at the level of 30.8 ± 1.3%, and sulfated glycosaminoglycans at the level of 42.06 ± 1.8%. These indicators are necessary for comparison with the experimental group.

In the material of the cerebellum of the experimental group, after the first 7 days of hypokinesia, there is a tendency towards a decrease in the content of proteoglycans (Figure 1).

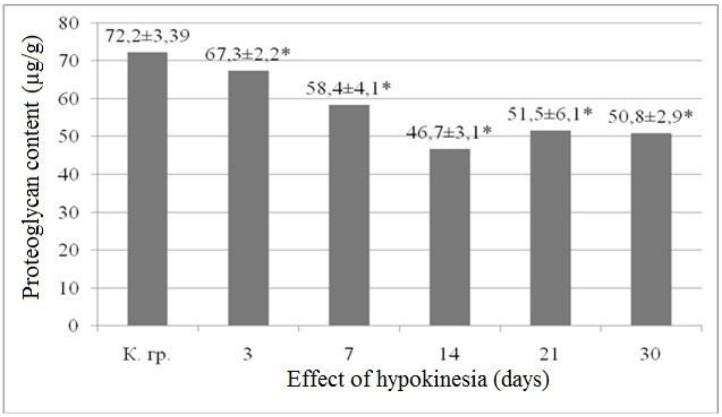

Fig. 1. Dynamics of changes in the content of proteoglycans in the cerebellar tissues of rats in the experimental group (%) (Note: * - differences are significant compared to the control group ($p < 0.05$).

The graph shows that a decrease in the level of proteoglycans in the cerebellar material of experimental animals is observed on the 7th day of the experiment and is about 30.6% of the control group.

Further, on days 14-21 of the experiment, an increase in the content of proteoglycans was detected, which is about 15.4% of the increase from the value on day 7. An increase in the content of proteoglycans on days 14-21 of the experiment indicates that compensatory-adaptive processes occur in the tissues of the cerebellum of rats.

On the 30th day of the experiment, a decrease in the total level of glycosaminoglycans was observed, which may indicate degradation of cerebellar tissue due to hypokinesia.

The content of hyaluronic acid (one of the fractions of proteoglycans) in materials taken from the experimental group at different time periods of the experiment is shown in Figure 2.

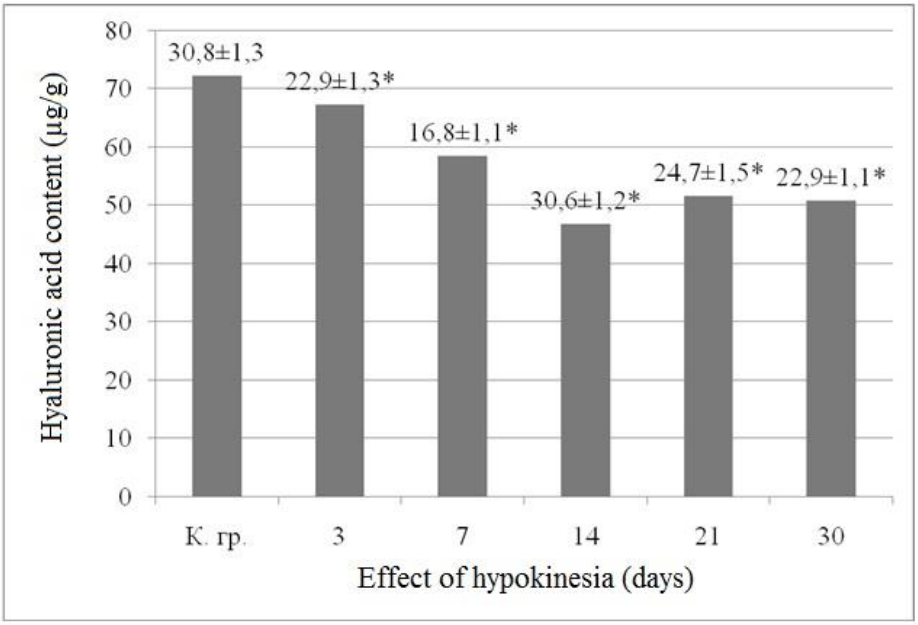

Fig. 2. Dynamics of changes in the content of hyaluronic acid in the cerebellar tissues of rats in the experimental group. (Note: * - differences are significant compared to the control group ($p < 0.05$).

From the data indicated in graph 2, we see that on the 7th day of the experiment the content of hyaluronic acid was minimal. Its value during this time period was 16.8±1.1%. This is 45.5% lower compared to the control group.

Then, on day 14, an increase in the content of non-sulfated glycosaminoglycans was detected. This also indicates that compensatory-adaptive mechanisms were activated in the cerebellar tissues of experimental animals. This is followed by a decrease in the concentration of hyaluronic acid by the 30th day of the experiment.

Changes in the content of sulfated glycosaminoglycans identified during the experiment are shown in Figure 3.

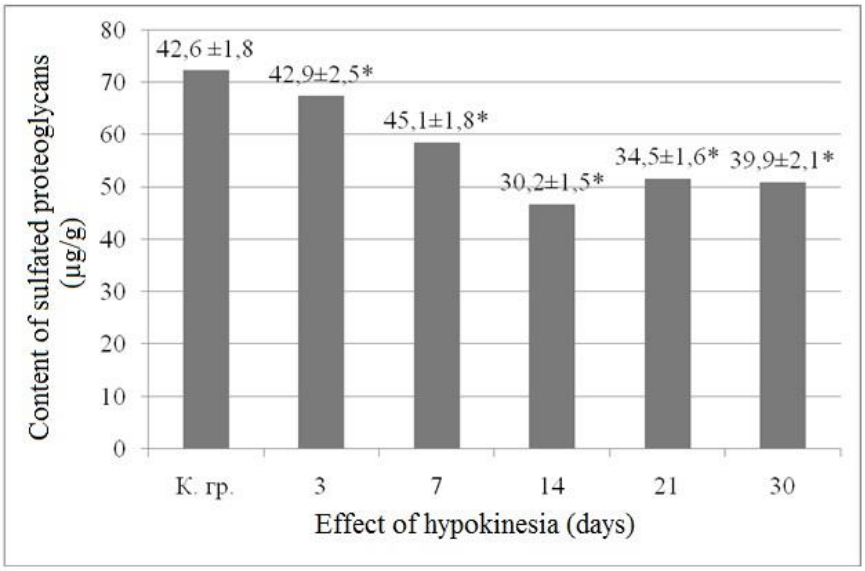

Fig. 3. Dynamics of changes in the content of sulfated proteoglycans in the cerebellar tissues of rats in the experimental group. (Note: * - differences are significant compared to the control group ($p < 0.05$).

Referring to the data given above, you can easily trace the dynamics of their changes. We see that on the 7th day of the study, the maximum value of sulfated glycosaminoglycans is observed. This is 5.8% higher compared to the beginning of hypokinesia modeling. Here we see that the minimum is determined on the 14th day of the experimental study (this is approximately 33% lower than on the 7th day).

This indicates the heterogeneity of the processes occurring under the influence of hypokinesia and those compensatory-adaptive processes that are launched in the body under its influence.

Based on the data obtained, presented in the graphs, it can be concluded that the negative effect of hypokinesia can be traced in the heterogeneity of the productive function of cerebellar cells. This is indicated by changes in the content of glycosaminoglycans at different time periods of the experiment. Simulated hypokinesia makes it possible to trace significant differences in the content of sulfated and non-sulfated glycosaminoglycans. More pronounced changes are observed among non-sulfated glycosaminoglycans.

4 Conclusion

Histochemical studies we performed when modeling 30-day hypokinesia indicated the following: First, the negative effect of hypokinesia can be traced in the heterogeneity of the productive function of cerebellar cells during the experiment (determined by changes in the content of proteoglycans).

Secondly, turning to the data obtained, we see that on the 7th day of experimental work there is a decrease in one fraction of proteoglycans (non-sulfated) and an increase in the other (sulfated). An increase or decrease in the level of content of a particular fraction of proteoglycans, relative to the level of the control group, indicates the reactions of cells to various external influences and allows us to track these changes over time. We consider these changes as the inclusion in the work of cells of compensatory - adaptive mechanisms to the action of a destructive factor in the form of simulated hypokinesia.

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