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EFFECT OF RESTRICTED MOBILITY ON RNA CONTENT AND NUCLEOTIDE COMPOSITION AND ON PROTEIN CONTENT IN MOTONEURONS OF SPINAL CORD ANTERIOR HORNS

A. V. Gorbunova.

Translation of "Vliyaniye ogranicheniya podvizhnosti na soderzhaniye i nukleotidnyy sostav RNK i n soderzhaniye belka v motoneuronakh perednykh rogov spinnogo mozga", Doklady Akademii Nauk SSSR, Vol. 199, No. 4, 1971, pp 976-979

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16. Abstract

This article describes an investigation into the effect of hypokinesia on the RNA content, the nucleotide composition and dynamics of protein content in the motoneuron of the rat spinal cord anterior horns. Methodology and findings are presented. The study results showed that the nucleotide composition of the total cellular RNA at all the studied periods of hypokinesia remained unchanged (table 2) and is characteristic for the cytoplasmic, high polymer ribosomal RNA. This means that with a change in the functional state of the neuron the newly formed RNA of the nerve cell has the same composition of bases as the original RNA that belongs to the ribosomal type.

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EFFECT OF RESTRICTED MOBILITY ON RNA CONTENT AND NUCLEOTIDE COMPOSITION AND ON PROTEIN CONTENT IN MOTONEURONS OF SPINAL CORD ANTERIOR HORNS

By
A. V. Gorbunova*

Reduced motor activity always leads to a change in the functioning of many /976** physiological systems in the organism of man and animals [1-3]. The proprioceptive and interoceptive impulses coming from these systems to the central nervous system are an indispensable condition for the normal functioning of the nerve tissue, and consequently, the normal occurrence of its metabolism.

A large amount of data has been accumulated that indicates that the prolonged stay of the human organism in a state of hypokinesia results in a number of functional disorders in the nervous system [4,5]. There is information on a disruption in the cellular metabolism of the nervous system during restricted mobility [2,6]. Since the link between the functional activity of the cell and the metabolism of of RNA and protein in it [7,8] has been noted repeatedly in the literature it was important to investigate the effect of hypokinesia on the RNA content and nucleotide composition, as well as on the dynamics of protein content in the motoneuron of the rat spinal cord anterior horns.

The experiments were conducted on 35 mongrel albino male rats weighing 260-300 g. The animals were placed in individual, special small-sized cages. Such

*Institute of Medical and Biological Problems, USSR Ministry of Public Health

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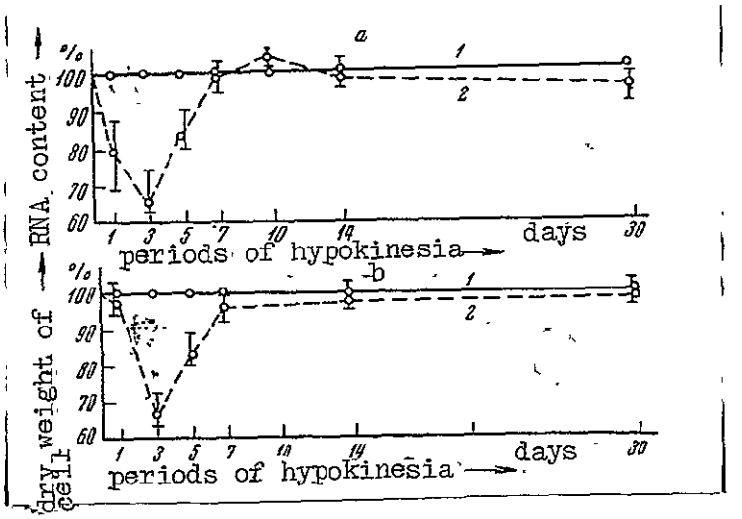

Figure 1. Change in RNA Content (a) and Protein Content (b) in Motoneurons of Spinal Cord Anterior Horns of Rat at Different Periods of Hypokinesia
1--control; 2--experiment

cages sharply restricted the movements of the animal, however, without complete immobilization. Conditions were created under which even the prolonged stay of the animals in the cages did not lead to the development of chafings, bedsores and disorder in the integrity of the integument. Thirty-five rats kept under vivarium conditions served as the control. The spinal cord at the level of the intumescentia lumbalis was taken for study from the experimental and control animals at the same time on the 1st, 3rd, 5th, 7th, 10th, 14th and 30th day of the experiment. Fragments of the spinal cord 2-3 mm in size were fixed in Carnua's solution for 1 hour and poured into paraffin. The motoneurons of the spinal cord anterior horns were isolated from sections 60 μ thick with the help of a Fonbryun micromanipulator under control of a MBI-3 microscope. The RNA content and nucleotide composition in the isolated cells were determined according to the Edstrom method [9]. The RNA content in an individual cells was computed by the Slagel and Edstrom method [10]. Every average amount of RNA content in the cell was determined from the results of analyzing 50-60 cells taken from 4-5 animals. Groups of 4-5 neurons were used for electrophoretic separation of nucleotides. /977

The dry cellular weight was determined by the method of interferometry [8] on sections 7 μ thick. Since under conditions of a fixed preparation the content of dense substances is protein for more than 80% of the dry weight, the method

TABLE 1.* CHANGE IN PROTEIN CONTENT IN MOTONEURONS OF RAT SPINAL CORD ANTERIOR HORNS WITH RESTRICTED MOBILITY, μμg

	Experiment		Control
1st day	1706±69		1721±71
3rd day	1171±41		1733±58
D		0.01	
5th day	1800±68		2133±85
D		0.05	
7th day	1960±78		2008±71
14th day	1966±95		1971±84
30th day	1982±126		1996±138

*Data for three animals and 90 measurements

of interferometry has become popular as a means of determining the total cellular protein.

All the numerical material was processed by the method of variational statistics according to Student-Fisher.

Changes in the RNA content were noted already on the first day after the beginning of the experiment, which lasted up to the 5th day inclusively. At later periods, all the way up to the 30th day of restricted mobility, no changes were observed in the RNA content in the motoneurons (fig. 1,a).

Analysis of the changes in the protein content in the motoneuron cytoplasm indicated that hypokinesia was accompanied by a considerable reduction in the protein content in the nerve cell cytoplasm on the 3rd and 5th day of the experiment; no reliable changes were noted in the protein content in the remaining periods (fig. 1,b, table 1).

Analysis of the behavior of the animals during the experiment demonstrated that in the experiments with hypokinesia two phases were noted in the motor activity. The first phase lasts 1-5 days and is characterized by a striving by the animal to free itself of the unaccustomed conditions, which in our experimental conditions was accompanied by an increase in the motor activity. Further the animals seemingly become accustomed to the new conditions of existence. The high motor activity of the animals in the period of the first to fifth days of the experiment, apparently, can be appraised as the cause of the reduction in the RNA content in the motoneurons of the spinal cord, and can be qualified as the

"cytochemical equivalent of high functional stress and even overexcitation of these structures" [1]. This is the more likely since there is published information on the link between the function activity of the cell and the RNA content in it [7,8,11]. Further, by the seventh day of the experiment, the animals adapt /978 to the conditions of hypokinesia, i.e., a state occurs in which catabolism and anabolism of RNA are well balanced with each other on a new level corresponding to hypokinesia; as a consequence of this no changes are observed in the RNA content.

TABLE 2. NUCLEOTIDE COMPOSITION OF RNA IN MOTONEURONS OF RAT SPINAL CORD AT DIFFERENT PERIODS OF HYPOKINESIA

	No. of animals	No. of analyses	Relative content of purine and pyrmidine bases, molar ratios in %			
			A	G	C	U
Control						
1st day	3	30	21,9±0,96	37,4±0,966	22,8±1,01	17,9±0,94
30th day	3	30	21,53±1,07	36,9±0,96	22,8±0,73	18,7±0,75
Experiment						
1st day	3	30	21,6±0,92	37,4±1,09	22,7±1,03	18,32±1,15
3rd day	3	30	21,35±0,99	37,1±1,1	22,8±0,95	18,7±0,84
5th day	3	30	21,26±1,03	37,2±1,131	23,2±1,11	18,4±0,911
10th day	3	30	22,06±1,03	36,2±0,92	23,2±0,88	18,6±0,887
14th day	3	30	21,9±0,79	36,6±0,83	23,02±0,94	18,9±0,79
30th day	3	30	21,3±0,94	37,1±0,87	23,2±0,85	18,2±0,78

Protein metabolism in the nerve cell is characterized by the same features as RNA metabolism, and namely its functional lability. Here both the biochemical and the cytochemical studies show that with excitation of the nerve cells intensified protein synthesis occurs in them; with the onset of overexcitation and exhaustion of the nervous system a breakdown of protein molecules begins to dominate, as a result of which the protein content is reduced [11, 12]. The reduction in the total cytoplasmic protein in the motoneurons of the spinal cord anterior horns obtained under conditions of hypokinesia on the 3.5 day of the experiment, apparently, can be explained by the occurring fatigue of the neurons induced by the high motor activity in this period.

Changes in the RNA content under conditions of our experiments were accompanied by analogous changes in the protein content that were somewhat lagging in time, which confirms the link between RNA and protein synthesis in the cell.

Since the detected shifts in the RNA content during hypokinesia are apparently a reflection of the qualitative changes in the RNA molecules, we undertook a

study of the qualitative nucleotide composition of the total cellular RNA at all the studied periods of hypokinesia. The study results showed that the nucleotide composition of the total cellular RNA at all the studied periods of hypokinesia remained unchanged (table 2) and is characteristic for the cytoplasmic, high-polymer ribosomal RNA. This means that with a change in the functional state of the neuron the newly formed RNA of the nerve cell has the same composition of bases as the original RNA that belongs to the ribosomal type.

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