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THE DYNAMICS OF CERTAIN INDICATORS OF NUCLEIN METABOLISM DURING HYPOKINESIA IN RATS OF DIFFERENT AGES UNDER THE INFLUENCE OF SINUSOIDAL MODULATED CURRENTS AND MEASURED PHYSICAL LOAD

Translation of "Dinamika nekotorykh pokazateley nukleinovogo obmena pri gipokinezii u krys raznogo vozrasta pod vliyaniyem sinusoidal'nykh modulirovannykh tokov i dozirovannoy fizicheskoy nagruzki", Voprosy Kurortologii, i Fizioterapii i Lechebnoy Fizicheskoy Kul'tury, No. 5, Sept.-Oct. 1977, pp 67-70

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16. Abstract

This article described a study of the influence of sinusoidal modulated currents (SMC) and measured physical loads on the nucleic acid content and the nucleotide composition of the total RNA in muscles of rats of various age under conditions of hypodynamia.

Methodology utilized is described and four conclusions are presented.

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THE DYNAMICS OF CERTAIN INDICATORS OF NUCLEIN METABOLISM DURING HYPOKINESIA IN RATS OF DIFFERENT AGES UNDER THE INFLUENCE OF SINUSOIDAL MODULATED CURRENTS AND MEASURED PHYSICAL LOAD

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Hypodynamia, as a condition which is widespread under modern conditions of the development of scientific-technical progress, is accompanied by significant disruptions in the functions of various systems in the organism. It aggravates the course of an illness during forced immobilization of a patient undergoing treatment. It has been established that hypodynamia is a factor in premature aging, accelerates in young animals the formation of the aged mechanism for regulating physiological processes, reduces adaptational capabilities of an organism with age (V. V. Frol'kis and I. V. Muravov, M. R. Mogendovich, V. A. Boyer; Kraus and Raab, and others). It may be presumed that biochemical shifts in an organism during a period of hypokinesia, as well as during the effect of physical factors, will have a different character depending on age. In connection with this, we undertook the problem of studying the influence of sinusoidal modulated currents (SMC) and measured physical load on the nucleic acid content and the nucleotide composition of the total RNA in muscles of rats of various age under conditions of hypodynamia.

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Work was conducted with 100 male rats of the Vistar strain, which were divided into two groups by age. In the first group were rats aged 25 - 30 days weighing 50 - 70 g, and in the second -- rats aged 55 - 60 days weighing 140 - 180 g. By the end of the experiment, the rats in the first group were reaching two months of age, and in the second group -- three months.

Hypokinesia was produced for 30 days by placing the rats into individual cages which limited their ability to move. Part of the rats from each group received the influence of SMC during the time of immobilization, and part received measured physical load. The source of the SMC was a "Amplipulse-3" apparatus, the carrier frequency was 5000 Hz, modulation frequency was 100 and 30 Hz, its depth was 100% , and current intensity was 2 - 3 mA, with 2nd type of operation. The electrodes were placed in the area of the right and left thighs of the rat. The procedure was repeated for 20 minutes twice a day for 20 days. Used as physical load was a treadmill run which lasted 2 minutes daily for a period or 20 days. The nucleic acid content was determined by the two-wave spectrophotometric method of R. G. Tsanev and G. G. Markov, and the nucleotide composition of total RNA in the muscles -- by the method of ion-exchange chromatography on columns with the DAUEKS N-50 (Katz and Comb).

The immobilization of the rats in both groups for 30 days led to a sharp reduction in RNA content in the leg muscle, which in rats of the first group comprised 23%, and the second -- 25%, and was statistically accurate ($P < 0.001$). The DNA content, however, did not change (table 1).

The effect of SMC on rats of both groups during hypodynamia hindered the reduction of the amount of RNA in the muscle tissue. Also, its content in the muscles of experimental rats exceeded the level in rats without the influence of SMC by a statistical value, and practically did not differ from normal values. SMC had no effect on DNA content in the skeletal muscles of experimental rats (see table 1).

With measured physical load for rats of both groups found in a state of hypokinesia, the RNA content in the skeletal muscles remained completely reduced, as in the control animals.

The hypokinesia produced in rats of the first group was accompanied at the same time by a change in the nucleotide composition of total RNA in the muscle tissue in the form of a statistically accurate increase in uridine nucleotide (table 2).

Table 1 /68

Content of nucleic acids (in mg % P per dry tissue weight) in skeletal muscles of different age rats in the norm, during hypokinesia and the effect of SMC and measured physical load (M ± m)

Indicator	Norm	Hypokinesia (30 days)	Hypokinesia+ +SMC (100 Hz	Hypokinesia + physical load
		Rats in Group 1		
RNA	63,23±3,13	48,81±1,99	59,50±1,83	50,44±3,04
P		<0,001	<0,001	>0,5
DNA	44,53±1,97	47,05±2,27	46,55±1,89	44,90±1,79
P		>0,5	>0,5	>0,5
		Rats in Group 2		
RNA	61,37±1,98	45,65±1,67	57,74±2,44	46,29±1,53
P		<0,001	<0,01	>0,5
DNA	52,93±2,04	52,33±1,44	53,01±1,30	51,00±1,95
P		>0,5	>0,5	>0,5

In studying the nucleotide content of muscle RNA it was shown that the development of a hypokinetic state in rats of the second group had much in common with that of the first group -- a certain increase in uridine nucleotide was noted.

The application of SMC with frequency modulation of 100 Hz to hypokineticized rats in the 1st group did not noticeably affect the nucleotide composition of the RNA, but with frequency modulation of 30 Hz the nucleotide composition of the total RNA in the skeletal muscles changed noticeably -- there was a statistically certain reduction in the content of cytidin nucleotide and an increase in the proportion of uridine nucleotide. The value of the specificity coefficient of the total RNA decreased reliably.

The same data was obtained also during the study of the effects of SMC of various parameters on the nucleotide composition of muscles of rats in the 2nd group (see table 2).

Under the influence of metered physical load, the relation of nucleotides in the total RNA of the muscle tissue did not change.

The obtained results made it possible to establish a great similarity in the character of changes in the indicators studied in rats of different ages during the time of developing the hypokinetic state as well as under the influence of the applied factors. Thus, hypokinesia produced in rats of both groups led to unidirectional changes in indicators of nuclein metabolism -- a significant reduction in RNA content and a change in the relation of nucleotides in the total RNA of the leg muscles. It is possible that these changes are the basis for the disruption in providing muscle tissue elasticity.

We have noted the expressed influence of SMC on nucleonic metabolism indicators in the muscle tissue of hypokineticized rats of both groups.

Electrical stimulation of muscles using SMC hindered the reduction of RNA content in them. The specifics of SMC influence on the nucleotide composition of total RNA in the muscles depending on current parameters were revealed. Thus, SMC with frequency modulation of 100 Hz had no expressed influence on the nucleotide composition of the total RNA in rats of both groups, while with a frequency modulation of 30 Hz, it reliably reduced their RNA specificity coefficient -- $\frac{Г+Ц}{А+У}$. Such changes may be associated with the fact that under the influence of SMC there is an intensification of the biosynthesis of RNA fractions with the nucleotide compositon, which differs from the nucleotide composition of total RNA and thereby has different functional properties.

Table 2 /69

Nucleotide composition (in mol. %) of total RNA in the skeletal muscles of rats of different ages in the norm, during hypokinesia, and during the influence of SMC and measured physical load (M ± m)

Indicator	Norm	Hypokinesia (30 days)	Hypokinesia + SMC (100Hz)	Hypokinesia + SMC (30Hz)	Hypokinesia + physical load
Rats in Group 1					
Adenine nucleotide (А)	20,8±0,83	20,4±1,66	19,2±2,00	16,6±0,76	19,6±0,70
P		>0,5	>0,5	>0,05	>0,5
Guanine nucleotide (Г)	31,5±1,54	29,7±2,06	30,8±2,74	30,5±1,03	31,3±0,95
P		>0,25	>0,5	>0,5	>0,5
Cytidin nucleotide (Ц)	20,5±1,56	18,6±1,11	21,9±2,59	13,8±0,94	19,9±0,95
P		>0,25	>0,25	<0,01	>0,25
Uridine nucleotide (У)	27,2±1,39	31,1±1,25	26,1±1,61	39,1±1,55	29,2±1,39
P		<0,05	>0,1	<0,001	>0,25
$\frac{Г+Ц}{А+У}$	1,07±0,04	0,96±0,05	1,12±0,11	0,80±0,03	1,07±0,02
P		>0,1	>0,1	<0,02	>0,5
Rats in group 2					
Adenine nucleotide	20,9±1,87	21,6±1,37	20,4±1,53	16,2±1,06	23,2±1,94
P		>0,5	>0,5	<0,01	>0,5
Guanine nucleotide	32,9±2,85	28,3±1,32	31,2±1,55	28,9±0,98	27,4±1,09
P		>0,1	>0,1	>0,5	>0,5
Cytidin nucleotide	21,1±1,31	20,2±1,23	21,8±1,39	15,3±1,16	21,1±2,22
P		>0,25	>0,25	<0,02	>0,5
Uridine nucleotide	25,1±1,15	29,9±1,70	26,6±1,44	39,6±1,61	28,3±2,33
P		<0,05	>0,1	<0,001	>0,5
$\frac{Г+Ц}{А+У}$	1,19±0,09	0,95±0,07	1,14±0,07	0,79±0,02	0,95±0,06
P		>0,05	>0,05	<0,05	>0,5

According to data found in literature, messenger RNA has a low specificity coefficient (O. P. Samarina and co-authors, K. G. Gazaryan and N. G. Shuppye, M. N. Blinov). A comparison of the obtained results with this data allows us to suppose that after the influence of SMC with frequency modulation of 30 Hz, conditions are created in the muscles for an intensified synthesis of messenger RNA. The intensification of synthesis of messenger RNA which occurs in the nucleus may be closely tied with the activation of the genetic apparatus of the muscle cell under the given experimental conditions. This hypothesis is based on the results of our previous studies (Z. A. Sokolova and co-authors), in which it was established that with the influence of SMC in muscles of hypokineticized rats, polypleidization processes were intensified, the content of dry DNA substance for a single nucleus was increased. A comparison of the data obtained in this work with results of our previous studies and with the literature lead us to conclude that under the influence of SMC in hypokineticized animals, the functional capability of the nuclear cell apparatus is increased, and consequently also that of the muscle tissue as a whole.

Conclusions

1. Hypokinesia lasting 30 days produced in rats aged 1 and 2 months led to a reduction in RNA content and to a change in the relation of nucleotides in the total RNA of the muscle tissue.

2. The application of SMC to these rats during the period of immobilization retarded the reduction of RNA level in the muscles. /70

3. With the influence of SMC with frequency modulation of 30 Hz, the specificity coefficient of muscle tissue RNA was reduced, while it remained unchanged at a frequency modulation of 100 Hz.

4. Measured physical load appl[illegible] to the hypokineticized animals had no significant effect on the content of nucleic acids and the nucleotide composition of total RNA in the skeletal muscles.

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