

Effect of prolonged hypokinesia on thiamine phosphoric esters content in rat myocardium

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Summary. Under the effect of prolonged immobilization, the content of thiaminemono-, thiaminedi- and thiaminetriphosphate in rat myocardium decreases.

Prolonged hypokinesia leads to considerable functional as well as morphological changes in different organs and systems: tachycardia¹, reduced synthesis of tissue proteins² etc. Essential changes are evident in myocardium metabolism too, as for example, reduction in enzyme activity of adenosinetriphosphatase³, free amino acids concentration changes⁴, the activity of system adenylate cyclase – cyclic adenosinemonophosphate changes⁵, etc. Thiamine and its phosphates are involved in synaptic transmission⁶ as well as in heart function^{7,8}. To account for the importance of this vitamin and its phosphate esters in the normal course of certain metabolic processes in the organism, we set ourselves the task of investigating the effect of prolonged hypokinesia on their content in rat myocardium.

Materials and methods. Male Wistar albino rats 60 ± 2 days old at the beginning of the experiment were used. They were divided into 2 groups: 10 rats were immobilized and 7 served as controls. The rats of the 1st group were housed in individual cages for physiological immobilization⁹ and the rats of the control group in standard plastic cages. All animals were given food and water ad libitum. After 395 days of immobilization the rats, including the controls, were decapitated under light ether anesthesia. The myocardium was homogenized at 0 °C and the homogenate was treated several times with cold 5% (w/v) NaON and the supernatant was treated with 40% (w/v) NaOH and was then run through a carbon and cellulose column. Thiamine monophosphate (TMP), thiamine diphosphate (TDP) and thiamine triphosphate (TTP) was separated by the method of Rindi and de Giuseppe¹⁰ and the measurements were carried out on a Specol photometer (Zeiss, Jena, GDR) with a fluorimetric (FK) attachment. The data were assessed for statistical significance using Student's t-test.

Results and discussion. The data for the myocardium content of TMP, TDP and TTP for the immobilized and control groups are presented in the table. They show that prolonged hypokinesia causes severe disturbances in the metabolism of these thiamine esters in the myocardium. Their content in the immobilized animals significantly decreases compared with the controls ($p < 0.001$).

The current concepts of the physiological role of TMP in the organism are contradictory. Some authors doubt the biological importance of this compound but others, like Lukashik¹¹, have shown that it participates in the early stages of carbohydrate metabolism. The present results indicate that its level is approximately 3.5 times lower after hypokinesia than that in the controls. Thus it may be suggested that due to prolonged suppression of motor activity in the organism and particularly in the myocardium, distur-

bances occur in carbohydrate metabolism, the carbohydrates being one of the basic energetic sources of muscle contraction. TDP participates as a coenzyme in above 24 enzyme systems in the organism¹² and in this connection its marked decrease in the myocardium after prolonged hypokinesia is of particular interest. It can be assumed that this is an after-effect of immobilization whereby the thiamine pyrophosphokinase (EC 2.7.6.2) activity decreases. This is the enzyme which by participating of adenosine triphosphate and in the presence of Mg^{++} forms TDP. This suggestion is supported by our earlier investigations in which we found out that the activity of different enzymes was decreased both in tissues and organs as a result of immobilization¹³. TTP biological function is not yet completely elucidated¹⁴. It is suggested that this compound is the active neurophysiological form of thiamine¹⁵ and is related to the normal functioning of the heart¹⁶. The present experiments have demonstrated that the TTP content in the myocardium of immobilized animals significantly (with 62%) decreases compared with the controls. The finding could be explained by the data of Prohaska et al.¹⁷ who state that under conditions of limited motor activity the phosphorylation level in the myocardium is lowered due to the lack of coordination between oxidation and phosphorylation processes. The present results support our earlier findings that immobilization strongly decrease thiamine absorption as well as its content in the mucosa of the small intestine¹⁸.

Content of thiamine phosphoric esters (TMP, TDP and TTP) in the myocardium of immobilized and control rats ($\mu\text{g/g}$ fresh tissue)

Animals	No. group	TMP	TDP	TTP
Control	7	0.830 ± 0.03	2.813 ± 0.08	0.248 ± 0.02
Immobilized	10	0.241 ± 0.02*	1.556 ± 0.08*	0.093 ± 0.06*

* $p < 0.001$. The values are expressed as the mean ± SEM.

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